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ON DEVELOPING ROUTE-SPECIFIC INTRALATA TOLL COSTS

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EXECUTIVE SUMMARY

This project was initiated for the purpose of exploring ways in which route-specific intraLATA toll cost studies could be performed. This involves two primary tasks:

1. Providing a generic guide for performing route-specific cost studies.

2. Presenting an illustrative example of some descriptive analyses useful in exploring alternative regulatory policies regarding rate design and competitive entry, once the route-specific costs are known.

A generic guide should be more useful than a cost manual utilizing one specific set of procedures, because of the perceived need to tailor cost study procedures to individual state characteristics. The guide includes basic "building blocks" of information regarding network design and intraLATA toll cost elements. It discusses alternative procedures; reviews the relationship of intraLATA toll routes, access charges, and separations; and examines some practical problems in implementing route-specific cost studies.

The illustrative example utilizes a set of one company's route-specific embedded costs for transmission facilities and circuit equipment. The descriptive analyses are used to investigate (1) the impact of deaveraging, (2) the likelihood of broadscale price competition developing, and (3) the factors which cause differentials in costs among routes.

Background

The issue of route-specific cost studies has gained interest recently because of the potential for competitive entry in the intraLATA toll markets. One contention is that if competitive entry is allowed, competitors will be most interested in the high density routes and will presumably price those routes at their costs. The regulated local exchange carrier that is currently pricing intraLATA toll routes on the basis of averaged costs may then be at a competitive disadvantage (assuming the averaged costs are higher than the route-specific costs of high density routes). This scenario poses difficulties for the state regulatory commission. If open entry is allowed, cost-based prices (which means deaveraged toll rates) are desirable for promoting a true test of the competitive nature of the market and for removing a competitive disadvantage faced by the regulated local exchange company. On the other hand, there is concern about the impact of deaveraged rates on universal service.

In more rural or sparsely populated exchanges, emergency calls and calls for other vital services may be toll calls. If these routes are high-cost routes, then their rates would rise with deaveraged rates. Regardless of the conventional wisdom regarding the relative costs of high density versus low density routes, route-specific cost studies will be needed in order to correctly identify which rates would rise and the magnitude of the changes that would occur with deaveraged rates.

IntraLATA Toll Network Design and Costs

The major components of the intraLATA toll network are the switches and transmission facilities used to interconnect communities within the LATA. These are essentially the same switches and facilities that constitute access facilities for intrastate interLATA toll transmission and for interstate toll, and in some cases, for local services. Within any one LATA, it is not unusual for several local operating companies to be operating in close proximity. While each local company has an exclusive franchised service territory, the exchanges making up these service territories may not all be contiguous. As a result, there has been historically some joint planning and cooperation in network design among the local companies. Generally, only the Bell Operating Companies and the larger non-Bell companies will operate their own toll switches and toll centers. Small companies will use toll switches of another company, with appropriate compensation agreements. In most cases a toll call must be routed to a toll center before being routed to the point of termination. This is necessary for recording and billing purposes. This means that the total distance of a toll route may be greater than the distance between the points of origination and termination.

The costs of intraLATA toll include all of the investment and expense items associated with the provision of intraLATA toll services. An intraLATA toll cost study should identify the total cost of intraLATA toll as well as the cost for each route. With respect to total costs of intraLATA toll, some part of nearly all telephone company investment and expense accounts are used in providing intraLATA toll. Some of these costs can be directly assigned, others cannot. Determining the total amount of intraLATA toll costs is important in order to see that cross subsidies between intraLATA toll and local services do not occur. Preventing or at least minimizing the potential for cross subsidies is necessary when services are opened to competition and even more so if the service is deregulated.

Some of the cost elements of intraLATA toll can be expected to vary route by route, while others are unlikely to do so. Among the investment costs, the costs of transmission facilities, circuit equipment, and switches can be expected to vary significantly among routes. Continuing property records and other central office records will, in most cases, provide good detailed information on these investment items, and they can usually be directly assigned to a route. Other investment costs such as land and buildings, and subscriber loop costs will also vary among routes. However, identifying these costs on a route-specific basis will require more detailed study efforts.

Similarly, some expense items can be expected to vary significantly among routes, while others will not. Maintenance costs, advertising, and marketing expenditures are types of expenses that might be expected to vary among routes, and thus might justify special studies. Expenses such as general overhead, however, would not be expected to exhibit much variation per unit of service among routes.

<u>Implementing a Route-Specific Cost Study</u>

In collecting data on the costs of transmission facilities it is important to collect information on the composition of the cable links between communities. These point-to-point cable links are typically made up of several segments with differing channel capacities and differing costs of installation due to the fact that some segments may be aerial cable, others underground, and still others buried. This variation in cable capacity and type of installation represents two characteristics of network design. First, the type of installation used will generally be the least-cost method for the terrain and climate conditions involved. Terrain can exhibit much variation between two exchanges so that portions of the cable link may be buried cable and other portions may have soil conditions or other characteristics that require aerial or underground cable. Second, traffic exiting a central office will go to several locations, and traffic entering a central office will represent aggregations of traffic from several locations, thus causing variations in channel capacity along the link. Since the cost of the toll route should represent only the costs for the number of through channels, the cost data must be adjusted for the variation in channel capacity.

In implementing a route-specific cost study, a major decision point is the choice between the use of marginal costs and fully-distributed embedded costs. In support of fully-distributed cost studies is the fact that the resulting rates will recover the revenue requirement. Also, fully distributed cost studies will ensure that all services bear some portion of the common costs and are particularly helpful in keeping costs of competitive services separate from those of non-competitive services in order to prevent cross subsidies. The arguments in favor of marginal cost studies are that competitors are likely to price on the basis of marginal costs and that marginal cost pricing leads to economic efficiency. Whichever type of cost study is chosen, the results should provide useful insights into the relative costs of different routes. It is possible that a commission may elect to use both types of cost studies. For example, a fully distributed cost study might be used to delineate the total costs of intraLATA toll in preparation for either reduced regulation or deregulation. Either marginal costs or both fully distributed and marginal cost procedures could be used for costing individual routes, and the results can be used either for setting rates, or for setting limits on rates if banded rates are used.

Another decision point in implementing route-specific cost studies is, of course, selection of the routes to be costed. The study could involve all routes within a LATA. As an alternative, however, if the number of possible routes is very large, a sample of routes can be analyzed. If a sample is used, cost equations can be developed from these data, and the equations used to estimate the costs of routes not in the sample.

Summary Results of a Partial Analysis of IntraLATA Toll Route Costs

A local exchange company made available to the NRRI data on the costs for circuit equipment and transmission facilities plus an allocated amount for test equipment, power equipment, and common equipment for many of its intraLATA toll routes. While these do not represent all of the company's intraLATA toll costs, they do represent a significant amount of the costs. These data were analyzed to see what could be learned about the cost structure of intraLATA toll. The data were examined at three levels of aggregation: the individual cable segments, the point-to-point links between communities, and the routes composed of one or more point-to-point links.

A model of causal relationships for intraLATA toll costs was developed[1] to illustrate the assumptions being tested in the analysis. Within that model, it was assumed that the major factors influencing these costs were technology, distance, and number of channels.

The analysis of the cable segments indicates that underground cable costs are typically higher than the costs of buried or aerial cable. The difference in costs is statistically significant. The analyses of cable segments shows a strong positive relationship between total cost of cable outside plant (cable, poles, and conduit) and distance.

The analysis of the point-to-point links was based on the embedded cost of the circuit equipment and transmission facilities of microwave and T-carrier cable links. Both microwave and T-carrier links had a high degree of excess capacity, which means that rates could be reduced if usage were increased and these links operated closer to full capacity. For the microwave links, the difference in cost per channel in use between the lowest cost link and the highest cost link was approximately $3,200, suggesting that rate deaveraging on these links might have a noticeable effect. The full impact of rate deaveraging cannot be known until the usage on each link is found.

The 71 T-carrier links used in the analysis are typically composed of several segments representing different types of installation. As was the case with microwave links, there is a large amount of excess capacity on most T-carrier point-to-point links. T-carrier links have an average cost per channel for channels in use of $235.54 as compared to slightly over $1,000 for the microwave links.

The 25 percent of the links with the highest cost per channel in use have an average cost per channel nearly six times that of the average cost per channel in use of the 25 percent with the lowest costs. It is interesting to note that the highest cost links are, on average, much longer, have a smaller channel capacity and operate at less than 50% of capacity, as compared to the low-cost links.

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[1] See chapter 5, p. 76, figure 5-1.

Surveying all 71 T-carrier links with respect to cost per channel in use, the difference in cost between the most expensive and the least expensive is slightly over $1,000. However, the lower 60 percent are within $200 of each other in cost per channel in use, and the lower 83 percent are within $300 of each other. This suggests that if these same results hold when all costs are computed (i.e., switching, operating expenses, etc.) then deaveraging rates on those links may have only a limited impact on most of them.

The point-to-point links were combined to create 62 intraLATA toll routes. A route was defined as the set of links connecting the community of origination through a toll center with the community of termination for a call. In some cases a route consisted of one link; in others, as many as seven links.

As with the point-to-point links, there is a substantial amount of excess capacity on these routes with the average percent of capacity in use being less than 50 percent. This raises questions about the ability of competitors to compete on prices, since the marginal costs of these routes with excess capacity will be quite low.

The cost per channel in use on these routes varies significantly with the average cost of the upper 25% of the routes being $1,453.08 as compared to $380.78 for the lowest 25 percent, as ranked in order of cost per channel in use. The high-cost routes are nearly 2 1/2 times as long as the low-cost routes. In addition, the coefficient of correlation between total cost and length for all routes is .604. Thus, it seems that for this set of data, distance is a major factor in determining route costs.

While the low-cost routes have a higher average fill factor, the difference between the high and low-cost routes for this variable is not great (46.97% vs. 42.86%). Further research is needed to pin down the effect of factors other than distance on the costs of intraLATA toll routes.

Some interesting observations stem from looking at the identity and channel characteristics of the individual low or high-cost routes as measured by cost per routes. The high-cost routes cannot be identified as being all rural routes connecting small communities. In fact, in both groups, high-cost and low-cost routes, only approximately one-third of the routes connected small communities. Another one-third of the routes in each group were between small and medium-sized communities. The final one-third of the routes in each group were between a large city and a small community with the small community often being in close proximity to the largest city. It is important to note, however, that these results may change when all route costs are included in the analyses. Similarly, they may change when the costs are converted to rates based on the utilization of each route. For example, if the high-cost routes have many more messages per channel than do the low-cost routes, then the results may be quite different. What these results do show is the need for state-specific analysis of the route costs and usage so as to correctly identify the high-cost and low-cost routes in each state.

For this data set it would be inaccurate to characterize low-cost routes as urban routes and high-cost routes as rural routes. However, there may be some relationship between location and high-cost routes. Nearly half of the high-cost routes in this data base were served by the same toll center. No such pattern existed for the low-cost routes. Much more work is needed in order to correctly classify routes as high or low-cost. In particular, the full costs of the routes need to be computed and then a statistical econometric technique such as regression analyses could be used to determine the factors most responsible for causing the differentials in route costs.

Since these analyses represent data from only one company, the results should not be generalized. Analyses of companies with significantly different structural characteristics might yield different results. For example, companies with different network design standards or different geographic parameters, such as companies operating in single LATA states, or in LATAs with mountainous terrain or extreme weather conditions, or in LATAs with fewer exchanges and greater distances between exchanges, may well exhibit different cost relationships. Further testing of the results presented in this report would be needed before they could be universally applied with a high degree of confidence.

Policy and Pricing Implications of Route-Specific Costing

Examination of the data shows that, on average, there is a large amount of excess capacity on many of the intraLATA point-to-point links. There is reason to believe that this may be typical for many LATAs. The LATA definition under the Modified Final Judgment requires that only one Standard Metropolitan Statistical Area be included in each LATA. Thus, a LATA might typically include numerous small and medium-sized communities. Wire pairs laid originally in groups of 25, 50, or 100 pairs or multiples of these may be converted to an increased number of channels at a ratio of 24:1 with T-carrier facilities. Thus, the potential channel capacity of existing wire facilities may outstrip the needs of small communities.

Excess capacity on a link or route means that the marginal cost of additional channels is relatively small (and the average cost of existing in-use channels may be high). This raises a question as to whether broad scale competition will occur on such routes.

One possible scenario, if an open entry policy is adopted for intraLATA toll, is that the market will--at least initially--fragment into submarkets. That is, certain markets and customers may be subject to considerable competitive market forces while others will see little competitive activity. In such a situation route-specific cost studies will be important so as to prevent cross subsidies and undue price discrimination while still allowing the local exchange company to price its services in relation to costs and perhaps to employ some flexibility in pricing.

Even without a decision to allow open entry, route-specific cost studies are important tools for state regulatory commissions. They provide good information on cost structures that is relevant to rate designs. Such cost studies are important for implementing various intercompany settlement plans such as the Originating Responsibility Plan and will provide information on whether any type of intraLATA universal service plan is needed. Finally, such analyses--especially when combined with elasticity estimates--will yield good data on whether a LATA has cost and demand conditions such that it is capable of developing a competitive market that can ultimately be deregulated or whether it is more likely to have only limited competition on selected routes or for selected customers.

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FOREWORD

Some states allow intraLATA competition and the issue of whether or not to do so is before many of the others. Opening LATAs to competition implies changes in pricing and these changes imply some knowledge of costs. This report was initiated for the purpose of exploring ways in which route-specific intraLATA toll costs might be ascertained. In the course of the study some real data from a real carrier were employed by way of illustration.

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CHAPTER 1
INTRODUCTION

Currently some states allow intraLATA competition and other states face strong pressures to do so. Opening LATAs to competition may bring pressures for deaveraging the intraLATA toll rates of the local exchange companies. Exchange companies will seek permission to deaverage rates on the grounds that only selected routes will attract competitors, and that these particular routes should be priced at cost in order to allow the local exchange company to compete effectively.

The regulator is faced with a dilemma. On one hand, the goal of fostering a workably competitive market calls for movement toward cost-based pricing, and implies a move toward toll rate deaveraging. Rate deaveraging would remove a major competitive disadvantage for the regulated carriers. On the other hand, deaveraged rates could cause substantial rate increases on high-cost routes. This result raises concerns about universal service, especially for those areas where toll service is needed for emergency services. The issue of toll rate deaveraging and the impact of intraLATA competition is difficult because little is known about the costs of intraLATA toll and the extent to which some routes may be subsidizing others.

In general, concerns about competitive entrants and deaveraged rates for intraLATA toll are rooted in historical perceptions regarding route costs. Little documented evidence is publicly available regarding the range of costs among the individual routes or the factors driving the costs. This is because little work has been done on this subject by regulatory analysts, and internal studies done by telephone companies have typically not been made publicly available. This report is a first step towards developing a better understanding of intraLATA toll costs.

Purpose

There are two primary objectives to this report: (1) to provide a generic guide for performing route-specific cost studies and (2) to present some route-specific cost data to illustrate some types of analyses that can be done in order to understand the factors affecting these costs and to develop information needed to formulate appropriate policies. The development of route-specific costs involves many decisions regarding what costs are relevant to intraLATA toll and what procedures to use in associating the individual costs with particular routes. These decisions need to reflect the regulatory, technological, demographic, and market conditions existing for each company in each state. This report is designed to serve as a reference and to suggest possible procedures for those commission staff who will be performing route-specific cost studies, or critiquing those performed by others.

With respect to the first objective, several activities were undertaken. One was to identify, present, and discuss basic "building blocks" of information related to toll network design. The individual cost elements of intraLATA toll were analyzed and alternate methods for associating these cost elements to individual routes were reviewed. Specific practical problems in implementing route-specific cost studies were identified and discussed.

To meet the second objective, a model for viewing the causal relationships of intraLATA toll costs is presented and analyses of certain embedded route costs are undertaken within the framework of this model. The analyses presented are directed toward answering three major questions: 1) What factors determine the level of intraLATA route costs? 2) What is the likely impact of deaveraging rates for these routes? 3) Is successful competition likely to develop? The conclusions reached regarding these data cannot, in most cases, be generalized to other companies. However, the intent is to illustrate type of useful analyses and to begin to raise questions about the impact of deaveraging and competitive entry.

In this report, a route is defined to be the path that a call travels from its point of origination to its point of termination, including the subscriber loop. Recognizing that there are those who contend that subscriber loop costs should all be assigned to local service, the material is organized so as to be useful whether an analyst includes or excludes loop costs in a route-specific cost study. It should also be noted that this definition of the route may typically involve greater route distance than the airline distance between the points of origination and termination, due to the network routing parameters.

A secondary objective of this report is to examine some policy questions related to intraLATA toll. Thus, the relationships of route-specific costing to such issues as intraLATA competition, access charges, and pricing policies are discussed.

Background

Throughout much of the history of telephony, rates for long distance message toll service (MTS) were set on the basis of averaged costs. The rates for interstate services were set by the FCC on the basis of averaged nationwide costs--including both the costs of the toll carrier and the costs of access to the local telephone company networks. The interstate share of local company costs was determined by the separations process, and revenue was returned to local companies via the Settlements/Division of Revenue procedures. A similar process occurred for intrastate toll. That is, the state public utility commissions set intrastate toll rates on the basis of the average of all relevant costs, with costs being defined differently by different states. The result of this traditional system for toll service was that toll rates varied with distance but were the same for all routes of the same distance. Since the rates were averaged, the rates for any given route may be above or below the true costs for that route. Interstate telephone services were typically provided by AT&T Long Lines, while the Bell Operating Company (BOC) in each state provided the bulk of intrastate toll services.

The AT&T Divestiture[1] resulted in a reorganization of the Bell System with the divestment of the Bell Operating Companies (BOCs). The agreement also called for the drawing of new, larger exchange areas called Local

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[1] United States v. American Telephone and Telegraph Company et al., No. 74-1698 (District of Columbia, August 24, 1982).

Access and Transport Areas (LATAs) and confined the BOCs to providing services only within these LATAs. As a result, intrastate interLATA toll services (as well as interstate toll services) were assigned to AT&T, and the BOCs retained intraLATA toll services.

Another change pertained to the method of payment for the use of local exchange company facilities for the origination and termination of toll calls. Previously, payments were made by AT&T to the local Bell companies through the Division of Revenues process and to the Independent (Non-Bell) companies via the settlements process. The Division of Revenue/Settlements procedures were a system of contracts detailing the terms and conditions for payment for the use of local exchange facilities in originating and terminating interstate traffic. A similar set of contracts existed for payments for the use of local exchange facilities in originating and terminating intrastate toll traffic.

An end to all contracts between AT&T and the BOCs including the Division of Revenues contracts was ordered in the Divestiture Agreement. Further, the Divestiture called for the BOCs to implement a system of access charges for the use of local exchange facilities in the origination and termination of interLATA toll calls. The Federal Communications Commission (FCC) in its MTS/WATS Market Structure Inquiry, Third Report and Order,[2] defined the access charge system for use by all local companies with respect to interstate toll calls. This change to a system of access charges was motivated by the presence of competitive entrants in the interstate market. The access charge system was thought to be a way of removing some artificial barriers to entry.

These events in the interstate jurisdiction led to similar developments in the intrastate toll jurisdiction, with those toll services now being segmented into two categories--intrastate interLATA services and intrastate intraLATA services. The individual state regulatory commissions determine whether competitive carriers are allowed, and what system of access charges will be used with intrastate interLATA toll services and intrastate intraLATA toll services. Generally, competitive toll carriers have been

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

allowed entry into intrastate interLATA markets and a system of access charges has been put in place for these markets. However, fewer states have allowed facilities-based competition for intraLATA toll. Whether competitive entry should be allowed in the intraLATA toll markets is a difficult public policy issue, because of its uncertain impact on local service rates and on intraLATA toll rates for remote and sparsely populated areas. A resolution of these regulatory concerns will require an understanding of toll route costs.

The BOCs lost a significant revenue source when they were precluded from providing interLATA toll. The advent of competition in the intraLATA toll markets risks diluting another source of revenue, depending on the elasticities of demand and the magnitude of growth in these markets. To the extent that rates for these services were providing a contribution to local exchange services, there is an uncertain and potentially adverse impact on local exchange rates. Thus, the potential impact of intraLATA toll competition on local rates is one major concern of state regulators.

A second area of concern is the impact of intraLATA toll competition on the intraLATA toll rates of the exchange companies. In sparsely populated and rural areas, toll service is often considered to be a significant component of universal service, since toll calls may be needed for emergency services and for contacts with government entities and with entities providing needed goods and services. Thus, affordable intraLATA toll rates are needed if affordable universal service is to be maintained for these areas.

Organization

A discussion of the toll network design parameters is contained in chapter 2 along with a description of the various technologies in use today. Chapter 3 analyzes the cost elements involved in intraLATA toll services. The various investment and expense accounts are identified and examined for their relevance to intraLATA toll. The relationships of these accounts to separations accounts and to interstate access charges are explained. Many practical problems are encountered in implementing a route-specific cost study. A discussion of these issues is found in chapter 4. A framework for examining key causal factors affecting intraLATA toll costs and descriptive analyses of certain embedded route costs of a local exchange company comprise chapter 5. The last chapter is a discussion of policy issues. It brings together several issues related to intraLATA competition and rate deaveraging.

The material in this report is presented for the purpose of providing information that will assist state commissions regarding some of the many decisions they will make with respect to intraLATA toll. Since market conditions and regulatory structure vary among the states, the stance taken throughout this report is to present issues and information as well as the implications of alternative choices, rather than to select any one policy position as being preferable.

CHAPTER 2

BASICS OF THE INTRALATA TOLL NETWORK

The material in this chapter provides an introduction to the intraLATA toll network design and a description of the basic technologies used. An understanding of these features is useful in designing cost studies that are relevant to the area under study.

A brief description of pre- and post-divestiture networks is included in the introductory section. The next section contains an overview of how the intraLATA toll network is designed. This is presented for the purpose of aiding cost analysts in conceptualizing the problem and designing a framework for analysis. It also illustrates some specific problems that will need resolution, such as the fact that often intraLATA toll calls are routed through the facilities of more than one local company. This section is meant to be a generic discussion and thus there may be company-specific variations.

The last section reviews the dominant technologies in place today for switching and transmission facilities and briefly reviews the types of circuit equipment used with different technological combinations of switch and transmission facilities. Understanding the differences among types of technology is important for developing an appropriate cost study design. For example, for fully distributed cost studies, differences in switch technologies suggest that the allocation factors used for components of a digital switch may not be appropriate for allocating components of electromechanical switches. As another example, if statistical estimation techniques are used, technological differences in transmission, switching, or both may suggest the need to stratify the analyses.[1]

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[1] The reader already familiar with the basic features of the intraLATA toll network may choose to skip the remainder of this chapter.

Introduction

In the pre-divestiture days there was a well-established, nationwide toll network managed essentially by AT&T, with the Bell Operating Companies and independent companies participating through joint planning and through the Division of Revenues/Settlements processes. There was a five-level hierarchy for switches ranging from the class 5 local switches to the class 1 regional switches. The nation was divided into ten regions, each with a class one regional toll switch. Regions were subdivided into sectional centers, each with a class 2 sectional switch; sections were subdivided into primary centers, each with a class 3 primary switch; and primary centers were subdivided into toll centers each with a class 4 toll switch. The class 5 switches served the local area end-office customers. Toll calls would be routed from a class 5 switch to a class 4 toll switch. From there they would go to the class 4 switch serving the terminating location. If the trunk group serving two class 4 switches was busy, the call could be routed up the toll hierarchy to a class 3, 2, or 1 switch to alternate routing facilities. Figure 2-1 illustrates this pre-divestiture hierarchy.

The class 1, 2, and 3 switches were owned by AT&T. The class 4 switches were owned either by AT&T or the local operating company and their use was shared by AT&T and the BOCs, with AT&T using them for interstate toll and the BOCs using them for intrastate toll.

The post-divestiture toll network is different in many respects. The joint planning between AT&T and the local exchange companies (LECs) for switching and trunking needs is reduced. The Division of Revenues/Settlements processes have been replaced by access charges in the interstate jurisdiction and by a variety of mechanisms in the intrastate-interLATA and intrastate-intraLATA jurisdictions.[2] And, the design of the network has been changed in many ways. AT&T, for example, is employing new technologies and gradually introducing dynamic, non-hierarchical routing of calls.

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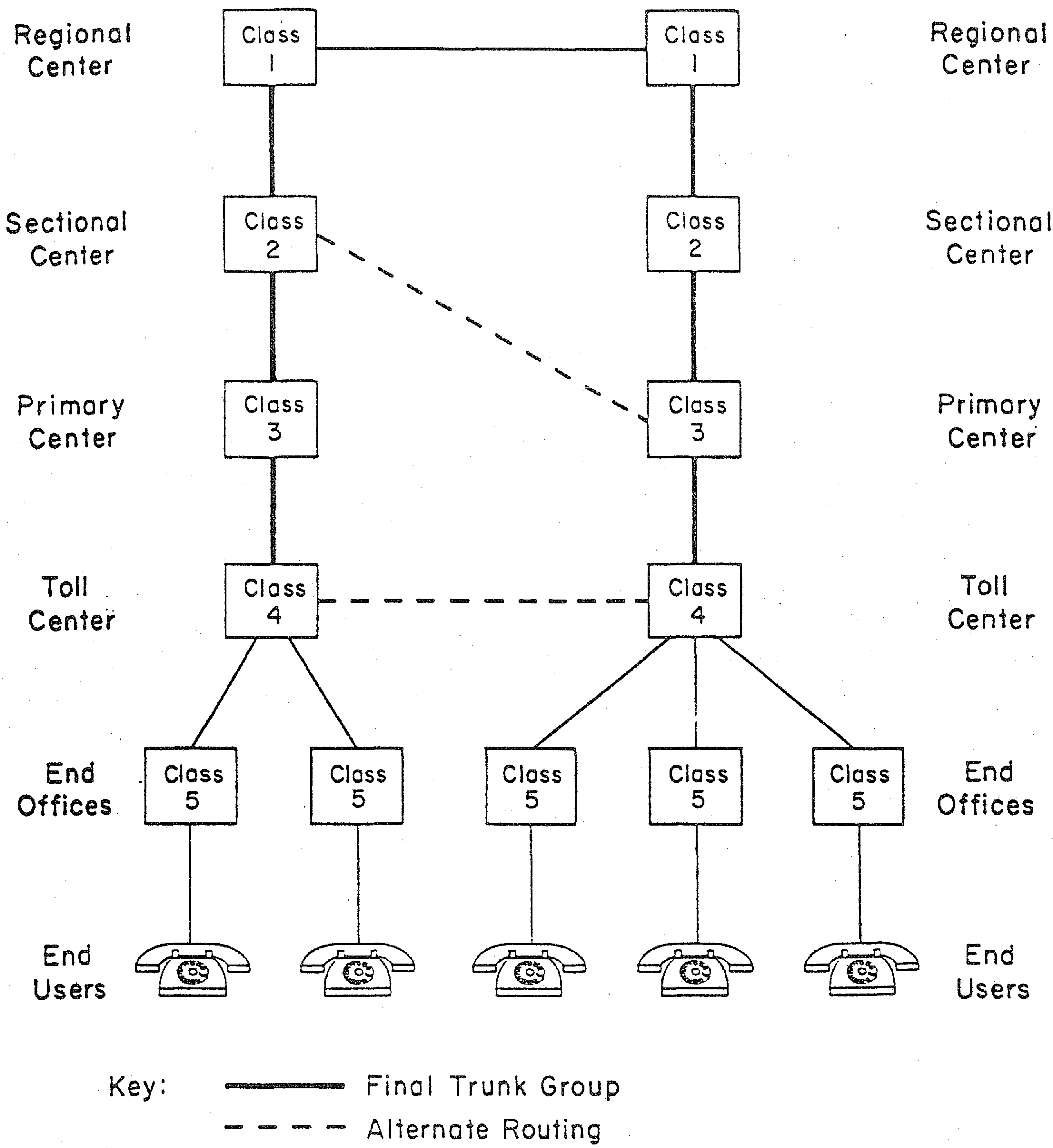
[2] For a review of these mechanisms, see Jane L. Racster, A Status Report on Intrastate Pooling Arrangements and Alternative Toll Revenue Distribution Mechanisms (Columbus, Ohio: The National Regulatory Research Institute, 1986).



Source: Authors' construct

Fig. 2-1. Pre-divestiture toll network

The divestiture divided the Bell intrastate service area into LATAs and restricted the BOCs to providing services only within LATAs. AT&T provides services between LATAs (both intrastate and interstate) and can provide intraLATA services if the state regulatory commission allows competitive carriers to operate within the LATA. Ownership of the individual class 4 switches went either to the BOCs or AT&T depending on which party had made predominant use of the switch. During an interim time period one party could lease part of the toll switch from the other. At the end of the interim time period each party was to have established its own toll switch facilities.

The interstate toll network now consists of several networks, with each interexchange carrier (IXC) providing its own facilities (switching and trunking) and in some instances leasing toll facilities from others. Each IXC establishes at least one point of presence (POP) in each LATA through which its traffic that terminates or originates in the LATA is aggregated for transmission into or out of the LATA. The POP can be either a switch or a transmission facilities node.[3]

The BOCs are required to provide, over time, equal access to all IXCs, at all medium-to-large BOC central offices. Equal access requires new switches or, at minimum, new software if the existing switch is a modern one. The requirements for equal access and the prohibition on the BOCs against serving interLATA traffic required reconfigurations of BOC intraLATA networks.[4] This, in turn, caused some non-Bell companies to also reconfigure parts of their networks.

More than one local exchange company may be operating within a LATA. Thus, the intraLATA toll network is composed of the toll switches and transmission facilities of all local companies. In many cases facilities are shared since the call may originate in the service territory of one company and either pass through or terminate in the service territory of another. Each toll call must go from the end office to a toll switch or

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[3] Notes on the BOC Intra-LATA Networks (Network Planning Central Services Organization, A&T, 1983), Section 2.

[4] General Telephone Company is also subject to LATA restrictions and equal access requirements under terms of a separate agreement relating to its purchase of Sprint.

toll center for recording purposes and/or switching to its termination point. For very small companies with few end offices, the cost of a toll switch or a tandem switch performing both toll and local functions may not be economically justifiable. In these cases arrangements are made for the small company's toll calls to "home" on or be routed to the toll switch of another company. Larger companies may also occasionally "home" on the toll switch of another company. Service territories frequently are not composed of all contiguous exchanges. If a company has an exchange located at some distance from its nearest toll switch, it may prove more economical for that exchange to home on the nearby toll switch of another company (with appropriate compensation arrangements).

The IntraLATA Toll Network Design

A key feature of the intraLATA network is that this network is used to provide both intraLATA toll calling and access services for interLATA traffic. These two types of traffic may be carried over the same trunk groups. In some cases, however, separate trunk groups may be used for each service to facilitate administrative goals. In fact, four types of traffic may be carried over the transmission paths: local,[5] intraLATA toll, access for intrastate interLATA toll, and access for interstate interLATA toll. Since each of these types of traffic is tariffed under different regulations, a method is needed for measuring the amounts of each type of traffic. This may be done in central office measuring facilities, or by the use of separate trunk groups to facilitate cost allocation procedures.

The network design has many possible configurations. The specific configuration used may vary among different companies depending, for example, on the technical standards of the individual company. The configurations may also vary among and within companies depending on such factors as calling patterns, population density, the presence or absence of

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[5] Local traffic may also include extended area service.

Extended Area Service (EAS),[6] the type of switch technology in place, and the terrain of the area.

Toll trunk groups between switches can generally be classified into four types: High Usage Trunk Groups, Alternate Routes, Final Trunk Groups, and Only Route Trunk Groups. A <u>high usage trunk group</u> is installed between two switches with a heavy volume of traffic between them, as the name implies. When there is excess traffic on a High Usage Trunk Group, the excess is routed on an <u>alternate route</u>, which is a second choice path between the two points. A <u>final trunk group</u> is the last choice route for overflow traffic. While it can also carry "first route" traffic, there is no alternate route for the Final Trunk Group. <u>Only route trunk groups</u> provide the sole route for traffic, with no alternate route. No overflow traffic is routed on an Only Route Trunk Group, only "first route" traffic is carried.

A call is first switched to a High Usage Trunk Group and then to an Alternate Route and then to a Final Trunk Group.

An Only Route Trunk Group may be used, for example, between an end office and a POP when no tandem office has been designated. Only Route Trunk Groups are also used for end offices that do not have common control or stored program control systems to route traffic to specified destinations.

The intraLATA toll call may be routed from the end office to a toll switch or to an intermediate toll point where toll traffic is collected from several locations for switching on to a toll switch. These switches may be tandem switches serving both toll and local services or access tandems providing both intraLATA toll and interLATA access services. Toll traffic from an intermediate toll office is switched to a toll center or toll point for switching either to another intraLATA office (to complete an intraLATA toll call) or to an interexchange carrier's POP for termination as an interLATA toll call.

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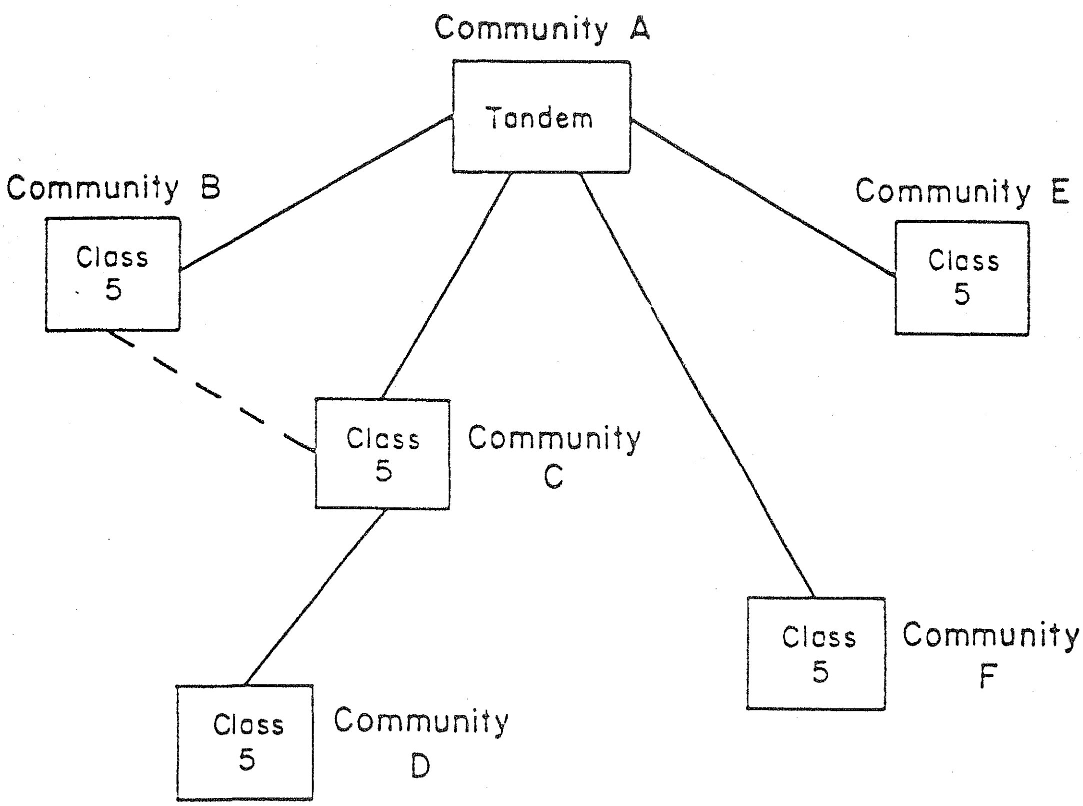
[6] Extended Area Service is a service whereby end users in one local calling area can call into another local calling area without paying toll rates. The end users pay a higher rate for local service than would be assessed without EAS.

In discussing the intraLATA network configuration it is useful to distinguish between heavily populated metropolitan areas and less populated, more rural or nonmetropolitan areas.

In nonmetropolitan areas the end offices in each of a cluster of small towns may be connected to a tandem office in a nearby larger town for transmission of toll calls between the towns. If the end offices in any two smaller towns are equipped with stored program control (SPC) systems, high use trunk groups can be used for toll calls between the two towns, assuming the toll traffic is sufficient to justify their installation. Figure 2-2 illustrates this, with the dotted line representing a high use trunk group between communities B and C.



Source: Authors' construct

Fig. 2-2. Illustration of an intraLATA network for a nonmetropolitan area

The tandem in figure 2-2 can route toll calls between communities B, C, D, E, and F, and can also route them 1) to another toll switch for termination elsewhere in the LATA, or 2) to an access tandem or an interexchange carrier's POP for termination outside the LATA. The tandem would also be used to distribute terminating calls from a POP or from elsewhere in the LATA.

An alternative arrangement for rural areas is the use of a host/remote switching facility. Host/remote systems are a relatively recent technological advance in stored program control switching. A small switching system is installed in more remote, thinly populated areas that, in effect, is an extension of a large switch located in another more densely populated area. The two switches are connected by a data link. All toll switching, testing, and other switch commands originate at the host switch and are transmitted to a microprocessor at the remote unit, which interprets and carries out the command. Most local switching within the wire center area of the remote unit is done by the remote unit.

Several remote units can be served by one host switch. Use of these host-remote systems means that services requiring state-of-the-art technology (generally requiring stored program control) can be made available to rural areas at significantly lower costs than if "stand alone," new technology switches were used. A toll route for calls originating in a remote unit is shown in figure 2-3. Usually the call is routed to the host unit and then on to the toll switch for switching to the terminating end office. However, where the technology of the unit permits and the volume of traffic is large enough, direct trunking from a remote unit to another end office might be used for toll calls to that end office (e.g., between communities A and C in figure 2-3). However, while this can be done, it often is not cost justified, and is not the usual design.[7]

The portion of the intraLATA toll network in large cities is more complex than that in small towns and rural areas. Because of the numerous end offices in a large town, tandem offices are used to connect the end offices in order to gain trunking efficiency. These tandems can be used for

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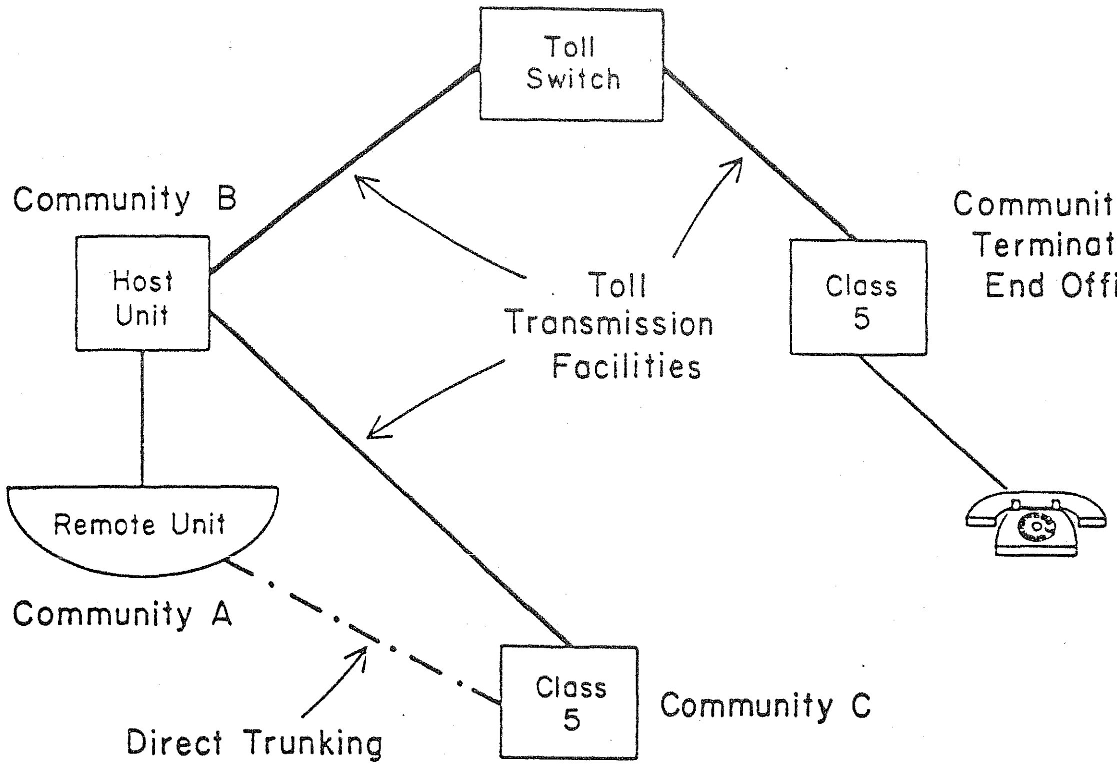
[7] Notes on the BOC Intra-LATA Networks, Section 4.



Source: Authors' construct

Fig. 2-3. IntraLATA toll routing from a remote unit

both local and toll switching. In very large areas, the city may be divided into sectors, each with its own tandem, with the tandems connected to each other. One tandem may be an access tandem that provides equal access facilities to the POPs of all interexchange carriers. This access tandem can also be used to provide intraLATA toll switching. One or more access tandems may be located in a LATA, depending on traffic needs and the network design policies of the individual local exchange companies.[8]

Additional complexity in intraLATA toll routes is caused by the fact that several local exchange companies may operate within a LATA and within close proximity of each other, with toll routes often including switches and facilities of more than one company. Figure 2-4 illustrates this. Here, a

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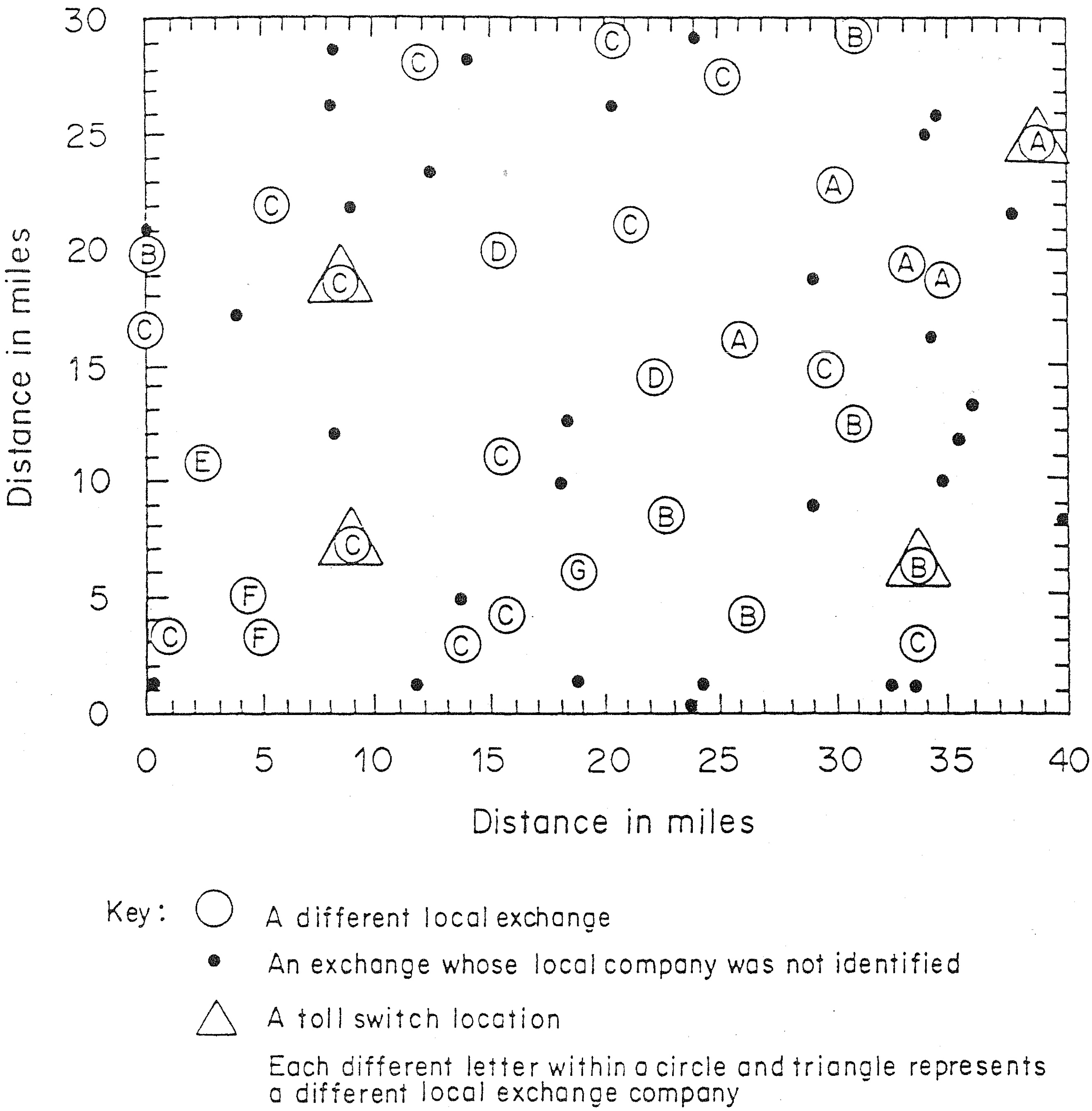
[8] The access tandem can be located outside the LATA under certain circumstances. Where this occurs, the access traffic must be routed back to POPs within the LATA.



Source: <u>Telephony's Directory and Buyers Guide</u>

Fig. 2-4. Illustration of the proximity of exchanges and local companies within a LATA section of an actual existing LATA is shown, with the various local exchange companies serving that area indicated. In this small area (120 square miles), there are four toll switches, owned by three different companies. In addition there are fifty-seven other communities served by at least seven different local companies, even though distances between company locations are quite short. Thisproximity of exchanges of differing companies illustrates why joint planning and the shared use of facilities can result in lower total costs for toll services.

Network Technologies

Transmission Facilities

There are four major types of technologies available for toll transmission facilities in addition to the twisted pair cable, which is now rarely used. These are carrier facilities, microwave, optical fiber, and satellite/earth stations. The choice of technology installed on any one route is presumably made on the basis of cost effectiveness. There are several factors that influence the installed cost of a transmission facility, either for additional channels on an existing route or for facilities for a new route. These include the current and projected traffic volumes, the physical terrain, the existing network configurations, and the technologies of the switches and transmission facilities already in place.

The current and projected volumes of traffic determine the number of new channels needed. Given the number of channels needed, the lowest cost technology for that level of capacity can be determined. Microwave, for example, is more cost effective for large numbers of channels than small numbers. The type of terrain involved can have a significant effect on installation costs. As would be expected, mountainous areas typically generate high installation costs for laying cable.

A given type of transmission facility requires different interface arrangements for different types of switches, and these various interface arrangements have different costs. Thus, the type of switch in place will influence the choice of transmission facility. Another example of the influence of the existing technology occurs where the existing transmission facility is paired cable and the growth rate in the traffic volume is low.

In this situation, conversion to carrier facilities may be the most economical way to add channel capacity. Existing network design will also be considered in adding capacity, since the location of additional capacity is influenced not only by the growth of traffic on a given route but also by such factors as the need for alternate routing for other facilities. The following subsections contain brief descriptions of the capabilities and characteristics of the individual transmission technologies.[9]

Carrier Facilities

Carrier systems were first introduced in the early 1960s and are used to increase the number of channels on a paired cable. Two pair of copper wires normally provide only two voice channels. To install a carrier system circuit equipment is attached to the pairs so that each pair can then carry several channels. The additional channels are derived either through the use of frequency division multiplexing (for analog) or time division multiplexing (for digital). Analog carrier systems use frequency division multiplexing to combine several voice channels into a group signal for transmission. The multiplexer (also called channel bank) on the transmitting end compresses each voice signal into a different modulation level (in effect coding each voice signal). The terminal on the receiving end translates (or decodes) the modulation levels to their original form for distribution to the receiving party.

Time division multiplexing is used to provide digital carrier systems. In time division multiplexing each channel is assigned 1 byte (8 bits) per time slot. Each time slot is sampled at a rate of 8,000 bits per second for coding the conversations. In effect, each conversation is coded in terms of a time slot and several conversations can then be carried on one wire pair. In addition, one bit per time slot or frame is used for synchronization.

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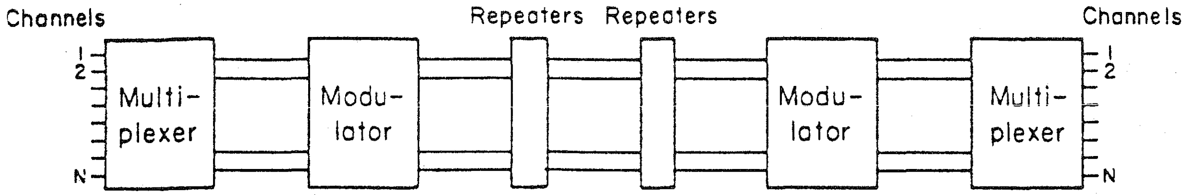
[9] For a more detailed dicussion of these technologies, see The Bypass Issue: An Emerging Form of Competition in the Telephone Industry, Jane L. Racster, Michael Wong, and Jean-Michel Guldmann, (Columbus, Ohio: The National Regulatory Research Institute, 1984), chapter 2 and appendix A. See also, Leonard Lewin, ed., Telecommunications: An Interdisciplinary Text, (Dedham, Massachusetts: Artech House, 1984), chapters 7, 8, 10-12.

The T-1 digital carrier systems transmit at a rate of 1.544 megabits per second. The digital carrier systems are used for both voice and data transmission.

Carrier systems require channel banks at each end, plus repeater equipment for longer distances to boost signal strength. Figure 2-5 denotes the basic components of carrier systems. Twenty-four voice grade circuits are put on each wire pair.



Note: The modulators shown will be frequency modulators for analog systems and pulse code modulators for digital systems.

Source: Authors' construct

Fig. 2-5. Components of a carrier system

Fiber Optics

Fiber optics (also referred to as optical fiber) is the newest of the transmission mediums. It uses light waves to send communications through glass fibers. Fiber has many advantages over traditional technologies, with its greatest disadvantage being its high cost and difficulty in splicing the fiber. It has a broad bandwidth, which means that with the proper circuit equipment a single cable can transmit voice, data, and video communications and still have excess capacity. It is not affected by electro-magnetic interference or by radio frequency interference; it is durable in harsh physical conditions and is not affected by noisy environments. Consequently, fiber can be installed nearly everywhere: underground, under water, and under streets or above railroads. Fiber optics, however, must be protected from water seepage. Fiber is small in size (diameter) and light in weight as compared to copper cables. These attributes mean that installation costs may be low compared to those of copper or coaxial cable, and particularly so on a per channel basis, given its large capacity. While initially the cost of fiber optics was quite high, its cost has been steadily decreasing and distances between repeaters has been increasing, thus further decreasing its cost. Local and long distance carriers often offer T-3 or 45 mbps service on a fiber optic line. This is equivalent to 28 T-1 lines, so its current total capacity is 672 voice grade circuits.

Microwave

Microwave transmission systems are radio transmissions and are used most cost effectively where geographic conditions would create high installation costs for cable. This is typically true for intra-urban areas where digging up the city streets is costly or for mountainous or other difficult terrain that adds excessive costs to the installation. Use of microwave facilities requires FCC licensing for use of the frequency and a shortage of available frequencies tends to reduce its use in urban areas. Microwave requires line-of-sight transmission, so the presence of large buildings may also inhibit its use.

Microwave systems consist of the transmission equipment, receiving equipment, towers at each end of the route, the interface with the trunking into the microwave site, and repeaters as necessary. Generally, for distances greater than 10 miles, repeaters are needed. Repeaters can be active or passive. Passive repeaters are used, for example, to go around an obstacle in the transmission path if the obstruction is near one end of the route. An active repeater has two antennas with electronic circuitry between them to amplify the signals. A passive repeater has two antennas connected with coaxial or fiber optic cable, or it may be a flat "plate" used to reflect the signal. Active repeaters allow longer microwave routes, but are more expensive than passive repeaters, and require a power source for the electronic equipment. Taller towers can mean that fewer repeaters are needed, but the trade-off is greater tower costs.

Satellite/Earth Station

Satellite/earth station facilities are used primarily for very long distance transmissions and are particularly effective when either the originating or terminating point or both are located in remote, sparsely populated areas in difficult terrain. A prime example is the network of earth stations connecting remote villages in Alaska to each other and to the urban centers of the state.

The satellite acts as a switch, completing calls from one earth station to another. The earth stations transmit signals to and receive signals from, the satellite.

Satellite transmission paths can be a good choice for data transmissions and are often used in private networks with large amounts of data traffic traversing very long distances. They are a less desirable alternative for voice communications. The signal travels 24,000 miles from the transmitting earth station to the satellite and then 24,000 miles back to the receiving earth station. These distances mean there is a .5 second delay between origination and termination of signal and thus, voice or other interactive communications are more difficult over satellite facilities than over cable or microwave.

Switches

The choice in switching technology is between analog and digital switches. The digital switch is the newer technology and is typically the technology of choice installed today as existing offices need replacement. Analog switches are either electronic or electromechanical, with electromechanical being the older of the two.

The advantages of the digital switches are 1) their greater speed and flexibility due to the power of the processors, 2) the ease of expansion since a modular form of expansion can be used, 3) the ease of enhancement since updates usually require only a change in the software, not in the switch hardware, 4) the fact that digital offices allow T-carrier and fiber optics to be used more efficiently, and 5) the variety of new services that can be offered.[10]

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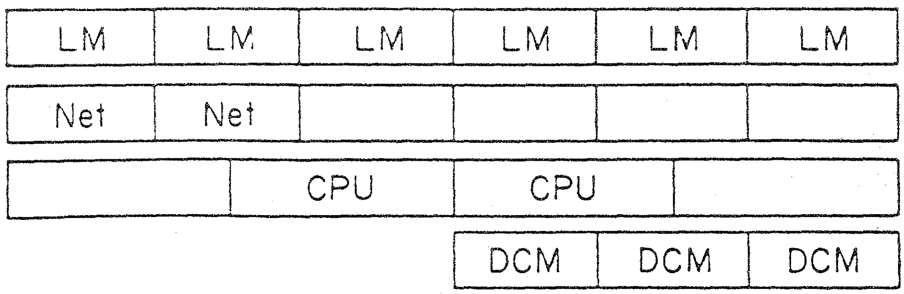
[10] It should be noted that some new services can be provided by analog switches with the use of specialized adjunct peripheral equipment. See Ramesh Joshi, "Impact of Technology on Depreciation and Service Lives," Final Report of the NARUC Capital Recovery Task Force, Current Issues in Capital Recovery by Telecommunications Utilities (NARUC, 1988), p. 55.

The following brief descriptions of the various types of switches are presented to illustrate the need for different allocation factors because of the different ways the switch components are used in completing calls.

Digital Switches

The components of a digital switch can handle several calls at once through the use of time division multiplexing. Time division multiplexing involves separating the signals of various calls by discrete time intervals, and sampling each call at the rate of 8,000 times a second. The digital switch can be illustrated as drawn in figure 2-6 below.



Net = Network
LM = Line Modules
CPU = Central Processing Unit
DCM = Digital Carrier Modules

Source: Authors' construct

Fig 2-6. Generic illustration of a digital switch

A digital switch may have its capacity increased in increments as traffic increases. The number of CPUs (central processing units) in place is a function of the number of calls. One CPU can address many networks. The NETS are essentially equivalent to the local switch, and the number of networks is determined by the number of CCS (hundred call seconds). Thus, the cost of both the CPU and the network is influenced by the volume of traffic. Line modules are a function of the number of lines and represent line equipment equivalent to line termination in an analog switch. Line modules have line drawers that line cards are plugged into, and have some intelligence that talks to the CPU. The DCM are the "ports" or trunk connections and have some intelligence for distributing traffic. In addition to these components, the digital switch has a variety of software available to enable it to perform various functions.

Analog Switches

Analog switches switch calls by varying the amplitude and frequency of the signals rather than by converting the signal to a digital format. The parts of the switch involved in switching a call are generally in use throughout the duration of the call.

There are three basic types of analog switches in use today: step-by-step, cross-bar and electronic. Step-by-step offices (the oldest type) handle calls beginning with a line finder that connects the calling line to an intraoffice circuit called a selector. The selector provides a dial tone which is cut off as digits are dialed. The selector then moves the call along the appropriate switch path as each digit is received. With the final digits the connector makes an outgoing trunk or line connection to complete the call. The line finder, selector switch, and connector switch constitute the major elements of a step-by-step office. All of these elements stay in use throughout the call.

The crossbar offices are electromechanical switches using common control switching systems. That is, the control portion of the switch is used in common by all switch processing functions, but stays in use only during the procedures for a particular function. After the call is established, these components (markers, registers, sender) are available for other calls. For the duration of the call, only the line link, trunk link, and trunk circuit in use remain dedicated to the particular call.

The electronic switch operates with stored program control (central processor) rather than the hard-wired control of the crossbar office. The stored program control directs all call-related functions. The equipment for stored program control includes a central processor, peripheral equipment (scanners and distributors), and memory. The central processor can handle many calls at once using time-sharing techniques.

Interfaces Between the Switch and Transmission Facilities

The cost of a particular route is also influenced by the combination of technologies of the switch and transmission facility. Table 2-1 contains a generic description of the types of equipment used for differing combinations of switch and transmission technologies.

The table shows, for example, that connecting any type of analog transmission facility to a digital switch requires different interface equipment than would be needed to connect analog transmission facilities to an analog switch. Analog/digital combinations will be a common feature on the intraLATA network until a company's modernization program is completed. Even then it is likely there will be analog/digital combinations since the modernization (i.e., conversion to digital) may not be cost-justified in all cases.

The content of this table can be helpful in identifying route-specific circuit equipment from central office records in order to derive the appropriate costs for each route.

Additionally, the table illustrates the likelihood that investment costs (specifically circuit equipment costs) will vary among routes as a result of the particular combination of technologies employed. This suggests that if estimation techniques are used for cost studies, a variable representing different combinations of technology should be considered.

TABLE 2-1
INTERFACE EQUIPMENT NEEDED BY DIFFERENT COMBINATIONS OF SWITCHING AND TRANSMISSION TECHNOLOGIES

Transmission Technology	Switch Technology: Analog Switch	Switch Technology: Digital Switch
Twisted Pair	Circuit Equipment Trunk Equipment Switch Matrix	Reverse Channel Bank Digital Signal Port Switch Matrix
Analog Carrier	Frequency Division Multiplexing Equipment Trunk Equipment Switch Matrix	Frequency Division Multiplexing Equipment Reverse Channel Bank Digital Signal Port Switch Matrix
Digital Carrier	Time Division Multiplexing Equipment Trunk Equipment Switch Matrix	Spare Termination Equipment Digital Signal Port Switch Matrix
Analog Microwave	Radio Frequency Equipment Intermediate Frequency Equipment Frequency Division Multiplexing Equipment Trunk Equipment Switch Matrix	Radio Frequency Equipment Intermediate Frequency Equipment Frequency Division Multiplexing Equipment Reverse Channel Bank Digital Signal Port Switch Matrix
Digital Microwave	Radio Frequency Equipment Intermediate Frequency Equipment Baseband Equipment Time Division Multiplexing Equipment Trunk Equipment Switch Matrix	Radio Frequency Equipment Intermediate Frequency Equipment Baseband Equipment Time Division Multiplexing Equipment Digital Signal Port Switch Matrix
Fiber Optics	Lightwave Modulator Time Division Multiplexing Equipment Trunk Equipment Switch Matrix	Lightwave Modulator Time Division Multiplexing Equipment Digital Signal Level 1 Port Switch Matrix

Source: Authors' construct

CHAPTER 3
AN OVERVIEW OF INTRALATA TOLL COSTS AND PROCEDURES

Introduction

This chapter is intended to provide basic information on the cost elements of intraLATA toll and is divided into two sections. The first section describes the relationship between the intraLATA toll network and interstate access charges. An understanding of this relationship is important because interstate access charge data may be useful to the analysts performing route-specific cost studies. For example, traffic and other data collected for access charges may include data that can be used to devise allocators for fully-distributed cost studies. Similarly, special studies conducted for interstate access charge purposes may be helpful.[1] Additionally, costs derived for interstate access charges can be used to derive rough estimates of the differentials in route costs. For example, an analysis of the range of costs for the local transport element can be used as a proxy for estimating the range of transmission costs for intraLATA toll routes. However, these results would be valid for ratemaking purposes only if the definition and procedures used for calculating interstate access charges were considered to be equally appropriate for intraLATA toll costing.

The final section of this chapter reviews the individual accounts--both investment and expense--for telephone companies. This section can be viewed as a generic cost manual. It explains each account and suggests procedures for identifying the appropriate amounts of each to associate with both the

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[1] For a description of costing procedures used for interstate access charges, see The National Exchange Carrier Association, Inc.: Structure and Operation, Jane L. Racster, (Columbus, Ohio: The National Regulatory Research Institute, 1985).

total costs of intraLATA toll and the costs of individual routes. The stance of this section is to provide suggestions that will be of use regardless of whether fully distributed or marginal cost methods are used.

The derivation of route-specific costs is, in reality, a two-stage process since the total cost of intraLATA toll as well as the costs of individual routes must be determined. Deriving the total cost is necessary to guard against cross-subsidies between local and toll services. Individual route costs are needed for deaveraging rates or for implementing banded rates or flexible pricing plans.

Deriving Total IntraLATA Toll Costs

The total cost of intraLATA toll can be determined either by working with total company costs and separating out the intraLATA toll costs, or by calculating the costs of each route and totaling these costs. A third alternative is to pursue both techniques, compare the results, and make any needed adjustments.

Historically, procedures for developing an intrastate toll revenue requirement have varied among states and, in some cases, among companies within a state. Some states have applied the principles of the separations process to the state jurisdictional costs, others have developed their own cost study procedures, and still others have used some form of value-of-service pricing. In a competitive world, however, the use of value-of-service pricing principles for competitive services may put the regulated company at a market disadvantage and any resulting stranded plant would either create upward rate pressures for customers of noncompetitive services or create financial difficulties for the company.

There are sound arguments that can be used to support either the use of separations procedures or the development of a state's own cost study procedures. In support of the use of the separations procedures is the fact that "toll is toll." That is, the facilities (transmission, switching, circuit equipment, etc.) needed to provided intraLATA toll are essentially the same type of facilities needed to provide access for intrastate interLATA toll and for interstate interLATA toll. It is the degree of use by each service that is the most significant variable. Thus, it could be argued that the cost for each type of toll service should be determined on the same basis. In addition, the separations procedures are well understood by both commission staff and telephone company personnel, so that their implementation for intraLATA toll is relatively easy.

However, several arguments can be made in support of states developing their own cost procedures rather than using separations procedures. The separations process is a type of fully-distributed cost methodology. If a state has adopted a policy of marginal cost pricing, the use of separations runs counter to this. A second argument in favor of state-derived cost methods is that there may be legitimate differences of opinion as to appropriate procedures. In this case, a state commission would choose to implement the procedure that it felt was most "economically correct" in identifying cost causation. The "correct" assignment of cost causation can be influenced by many factors such as the elasticities of demand for various services, the degree of competition for each service, the technological mix, the rates of growth for different services, the presence of services that have been deregulated, and other highly individualized factors. Thus, a state-specific cost study is likely to be more attuned to actual cost and market conditions within an individual state. Finally, a state-specific cost study allows for more consistency in costing principles among all intrastate services.

Deriving Route-Specific Costs

There are three possible procedures for attributing each cost element to individual routes. These are direct assignment, use of an allocator, or use of special studies and statistical techniques. Which costs can be directly assigned is largely dependent on the type of records kept by the telephone company. Generally, the intraLATA toll share of the costs of transmission facilities, switches, and circuit equipment can be directly assigned on a route-specific basis, through the use of continuing property records and other central office records. Other costs such as land and buildings can be directly assigned but may require special studies to do so.

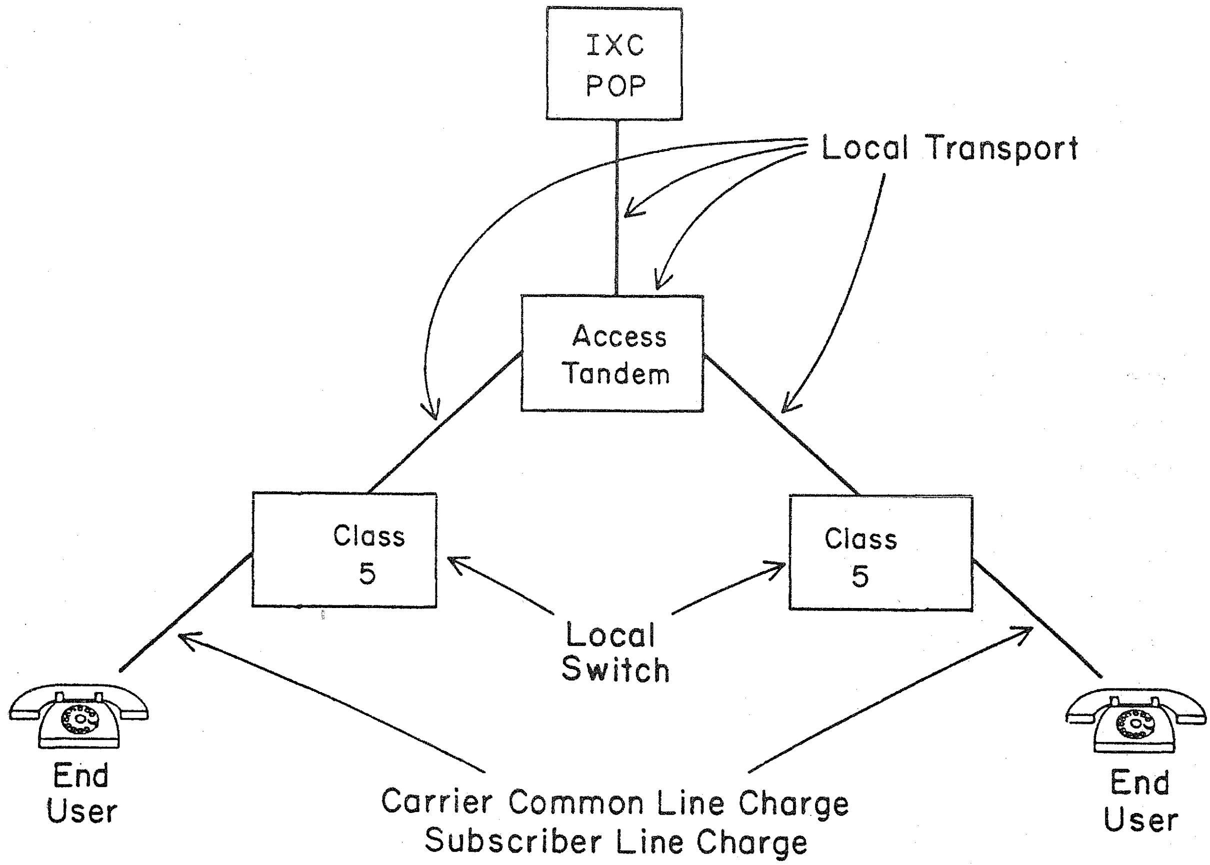
Costs such as general administration, maintenance, and similar expenses used in common by all routes would be very difficult to assign directly to individual routes. Allocators can be used to assign these costs or statistical techniques can be used to estimate the extent to which they vary among routes. Additionally, in some cases, special studies can be undertaken if the amount of money involved is sufficient to justify the effort. For example, if maintenance expenses are thought to vary significantly among routes, then sampling the time records of maintenance personnel would generate data that could be used to devise appropriate cost assignments among routes.

The use of uniform study procedures for total intraLATA toll costs that are consistently followed by all local companies within a state is particularly important, since local companies may compete with each other on some routes within a LATA. For the same reason, uniform procedures for determining individual route costs within a state are needed. The remainder of this chapter analyzes the individual cost elements and reviews the relationships between intraLATA toll costs, interstate access charges, and the separations process.[2]

The Relationship of IntraLATA Toll Costs and Interstate Access Charges

The interstate access charges are developed from the interstate revenue requirement developed as a result of the separations process. The access charges are imposed for the purpose of charging the interexchange carriers (IXCs) for the use of the local exchange company facilities in the origination and termination of interstate toll traffic. In general, these are the same facilities used for providing intraLATA toll services. The interstate access charges consist of several parts. These are the carrier common line charge (CCLC), the subscriber line charge (SLC), the local transport element, the local switch element, the intercept element, the information element, the billing and collection charge, and the special access charge. Special access is the charge for private line services. Intercept and information are charges for operator services, and the billing and collection charge is for measuring, recording and collecting toll

[2] The reader already familiar with access charges and telephone company costs may wish to proceed to chapter 4.



Source: Authors' construct

Fig. 3-1. Diagrammatic representation of interstate access charges

revenues. The remaining access charge elements correspond to the intraLATA toll network as illustrated in figure 3-1.

The subscriber line charge and the carrier common line charge recover the interstate share of the subscriber loop costs. The local switch charge is for the interstate toll share of the cost of local switching facilities. The local transport element recovers the cost of interoffice trunking, the toll tandem or other toll switch and the trunking to the IXC point of presence.

If competitive entry is allowed within the LATA, a similar set of access charges is needed that will be assessed against both the competitive entrants and the regulated local exchange carrier. In most cases, the costs recovered by the access charges are the same costs that represent the local exchange companies' intraLATA toll costs.

Overview of Cost Components

The major components of intraLATA toll costs are surveyed in this section. The subsections on each type of cost contain a description of the cost, its location in the Uniform System of Accounts (USOA), and a brief explanation of how the cost is treated for separations purposes. Some thoughts on the appropriate treatment of each cost for developing the total cost of intraLATA toll are given. Finally, where appropriate, reference is made to possible procedures for determining the route-specific costs for each cost component.

Investment Costs

The major investment components for intraLATA toll are subscriber lines, transmission facilities, and central office equipment. In addition, there are various support-type investments such as land, buildings, vehicles, etc., that are an integral part of providing intraLATA toll service, but typically represent smaller dollar amounts than do the other plant investments. Each of these categories is reviewed in the following subsections. These discussions refer to the Uniform System of Accounts (USOA) numbers that have historically been in use for Class A telephone companies.[3] A revised USOA became effective January 1, 1988, with a new numbering and classification system. Table 3-1 contains a chart that shows the relationship of the old investment account numbers to the revised investment accounts. The intent of the revision is to create a more functionalized accounting system and this should be of help in performing

[3] Class A telephone companies are companies with over $100 million in investment. Class B telephone companies have less than $100 million investment.

TABLE 3-1

RELATIONSHIP OF REVISED USOA INVESTMENT ACCOUNTS
(EFFECTIVE 1/1/88) TO PRE-1988 ACCOUNT NUMBERS

Revised Account Numbers and Titles			Pre-1988 Accounts
2100	Land and Support Assets		
	2111	Land	211
	2112	Motor Vehicles	
	2113	Aircraft	
	2114	Special Purpose Vehicles	
	2115	Garage Work Equipment	
	2116	Other Work Equipment	
	2121	Buildings	212
	2122	Furniture	
	2123	Office Equipment	
	2124	General Purpose Computers	
2210	Central Office-Switching		
	2211	Analog Electronic Switching	221
	2212	Digital Electronic Switching	221
	2215	Electro-Mechanical Switching	221
2220	Operator Systems		
2230	Central Office-Transmission		
	2231	Radio Systems	
	2232	Circuit Equipment	
2310	Information Origination/Termination Assets		
	2311	Station Apparatus	231
	2321	Customer Premises Wiring	232
	2341	Large Private Branch Exchanges	234
	2351	Public Telephone Terminal Equipment	235
	2362	Other Terminal Equipment	
2410	Cable and Wire Facilities Assets		(including subscriber loop plant previously recorded in 232)
	2411	Poles	241
	2421	Aerial Cable	242.1
	2422	Underground Cable	242.2
	2423	Buried Cable	242.3
	2424	Submarine Cable	242,4
	2425	Deep Sea Cable	
	2426	Intrabuilding Network Cable	
	2431	Aerial Wire	243
	2441	Conduit Systems	244

Source: Part 32, Title 47, CFR, - Uniform System of Accounts for Telecommunications Companies cost analyses. However, the discontinuity in accounts before and after January 1, 1988 will complicate some time series analyses.

Subscriber Line

The subscriber line (also called subscriber loop) refers to the connections from the customer's premises to the end office serving that customer. It consists of the drop wire, found in account 232, and the remaining outside plant (OSP) needed to connect the customer to the central office, found in account 242. The division of these costs between state and interstate jurisdictions and the format of their subsequent assignment to interstate access elements is the subject of a well-known, long-standing debate. Currently, 25 percent of these costs are allocated to the interstate jurisdiction and this 25 percent is then allocated between end-user charges and carrier common line charges.[4]

Within the state jurisdiction the remaining 75 percent of subscriber line costs can be divided among many services including intrastate interLATA access, intraLATA access, intraLATA toll, and local exchange services. The subscriber line is a common cost, used by many services. There is no one theoretically correct method of assigning common costs to the services using that plant. This lack of a single "correct" method for assigning common costs has led to the public debate over who should pay the interstate share of subscriber line charges. In essence, the argument regarding the interstate share revolves around whether the end user should pay these costs for the option of accessing the toll carriers' networks, or whether the toll carriers should pay the costs for the option of accessing the local subscribers. The full debate is, of course, more complex and includes such questions as whether the subscriber line is traffic sensitive or non-traffic sensitive, who causes these costs, and in what direction subsidies are flowing, if at all.

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[4] In some cases the assignment is currently higher than 25 percent. This is because states with very high allocations prior to the move to a 25 percent allocation, were ordered to phase in the 25 percent allocation by lowering the previous allocation a maximum of 5 percentage points each year until a 25 percent allocation is attained.

The intrastate assignment of these costs among intraLATA services is subject to similar debate. The individual state's decision is likely to be a function of conditions within that individual state, including such factors as current rate levels, the degree of competition (including bypass), and the elasticities of demand for the various services for both residential and business customers.

If it is decided that some part of these costs should be borne by toll carriers, the debate then centers on how much of the costs should be apportioned to each service using the local loop. As mentioned, there is no one "economically correct" method for assigning common costs. Thus, many factors can enter into the decision. One approach which offers a logical framework for resolving this dilemma is the use of game theory. A discussion of the application of game theory to local loop costs can be found in an earlier NRRI report, A Study of Telephone Access Charges: An Empirical Analysis of Bell Companies in Five Regions.[5]

To the extent that any of these subscriber loop costs are assigned to intraLATA toll, route-specific costing policies would suggest that they be deaveraged on a location-by-location basis to determine individual route costs. There are several reasons for believing that loop costs vary among locations. Installation costs are a major determinant of loop costs and longer loops are likely to have higher installation costs. Offsetting this (to some unknown degree) are the installation costs of shorter urban loops that may require digging up city streets or installation in areas with confined access. The age of the loops in place also varies. Some are likely to be fully depreciated or nearly so. Those in new subdivisions and industrial parks are not yet depreciated. Age of the loops can affect their costs in other ways, by influencing both installation and maintenance costs. In addition, the actual costs of the distribution cable of the loop are affected by the traffic pattern, which influences the use of concentrators and other equipment on the line.

Conventional wisdom speaks to the high cost of the long loops in rural and sparsely populated areas as opposed to the low cost of shorter loops in

[5] Publication number 83-11 (Columbus, Ohio: The National Regulatory Research Institute, 1983).

urban areas. While this is an apparently logical dichotomy, more analysis is needed to determine the range of loop costs in each state and whether additional categories (beyond urban versus rural) might be more descriptive.

Performing route-specific cost analyses of subscriber loops would be tedious and expensive. Nevertheless, a sampling of such costs could provide insights for determining policy and would also indicate whether deaveraging the loop costs would contribute significantly to improvements in route-by-route costing results.

Transmission Facilities

The transmission facilities consist of all wire, cable, conduit, poles, microwave towers, earth stations, satellite transponders, and outside plant circuit equipment used to transmit traffic between switches. The same transmission path could be used for intraLATA toll, intraLATA access, intrastate interLATA toll access, and interstate interLATA toll access. In some cases, the same path or parts of it, may also be used for local calling between central offices. Therefore, conceptually, there should be no difference in the cost of a particular transmission path due to the jurisdiction of the traffic. However, where several trunks are in place between two points, individual trunks may be assigned to individual services, and it may be possible to identify separate costs for each trunk. Where more than one facility is in place between two points, the embedded costs may differ because of differences in the technologies used or dates of installation.

The investment costs for these transmission facilities are listed in accounts 212, 221, 241, 242, 243 and 244. Accounts 241-244 contain cable, conduit and pole costs. Microwave tower costs are found in accounts 212 and 221, with free standing tower costs located in 212 and towers mounted on central office buildings found in account 221. Antennae supporting structures are found in account 241. Some outside plant circuit costs are also found in account 221.

The separations process essentially assigns outside plant to exchange and interexchange categories on the basis of the number of pairs in use for each category or on the basis of equivalent pair miles by type of facility in use for each category.

To identify an intraLATA assignment of transmission facilities, cable engineering and assignment records can be used to identify the number of pairs in use for intraLATA toll. The accounting data will give aggregate investment of each type, to which the usage measure can be applied. Route-specific costs of these facilities can often be found from the continuing property records, and can be directly assigned to routes.

Central Office Equipment

Central office equipment (COE) includes all switching equipment (end office, tandem, toll), message recording equipment, test equipment, power equipment and circuit equipment. The investment costs for this equipment are recorded in account 221. In most cases, the separations process assigns these costs either directly or on the basis of some measure of relative use. Exceptions include the power and common equipment which are common costs and are assigned among categories in proportion to the assignment of other central office equipment.

Determination of intraLATA toll COE costs can also be done on the basis of a combination of direct assignment and relative use measures. There may be situations, however, where individual states would elect to assign switching costs to intraLATA toll on a different basis than is used for interstate assignments. For example, there has been some controversy over the allocation of digital switches, since a larger share of digital switches is thought to be nontraffic sensitive than is the case for nondigital switches.

In computing route-specific costs, it is important to attempt to directly assign individual switch costs to individual routes. Switching costs can vary because of the age of the switch, the size of the switch, the technology of the switch, and the technology mix of the switch and transmission facilities. Given this, failure to directly assign the switch cost of individual routes would result in masking some of the cost differentials among routes. Sources of information about individual switch costs would include continuing property records, records kept at the central offices, and other engineering records.

Land and Buildings

The land and buildings used in intraLATA toll would include primarily some portion of the land and buildings used for central offices; land and buildings used for warehouses, storerooms, and garages for vehicles and equipment used for maintenance, installations and repair; land and buildings used for accounting and other management functions; and land and buildings used for microwave towers and antennas.

Land is recorded in account 211 and buildings in account 212. Separations procedures assign building costs to eleven categories based generally on the number of square feet used for each functional category times an average cost per square foot. Land associated with buildings follows the building assignment. Land not associated with a building is directly assigned based on it use. Each category of land and building is then assigned to interstate and state uses by direct assignment or by relative use or on the basis of the assignment of the relevant plant investment. For example, land associated with central office equipment is assigned in accordance with the assignment of category 1 COE, or category 2 COE, etc.

Similar procedures could be used for development of the total costs of intraLATA toll. However, in developing route-specific costs, more precise measurements would be needed to pick up the cost variations among routes. For example, land and building costs for a central office in a large metropolitan area would be expected to be substantially higher than land and building costs for a central office in a small town. While the switch in the urban area is also likely to be more expensive (if for no other reason than that it is larger), it is unlikely that the differential in switch costs is the same as the differential in land and building costs. Thus, spreading the land and building costs in proportion to switch investments would again "mask" the differential and raise costs assigned to a switch in a small town.

Furniture and Office Equipment

Furniture and office equipment is recorded in account 261. Some amount is, of course, related to the provision of intraLATA toll.

Separations requires that these investment items first be divided into two groups: data processing equipment used primarily for one function, and "Other." The data processing equipment is assigned on the basis of the functional use of the equipment. The "Other" equipment is assigned on the basis of the separation of various wage expenses--maintenance (other than general office space maintenance), traffic, commercial, and revenue accounting.

Similar procedures could be used for developing an intraLATA toll revenue requirement. While the use of these items probably varies on a route-by-route basis, any such direct assignments would be nearly impossible without a complete inventory and some special studies, since furniture and office equipment is usually used in common for many services. Assuming the total cost of furniture and office equipment is small relative to the costs of other investment items, such detailed analyses are unlikely to yield benefits with respect to identifying specific route costs sufficient to justify the costs involved. Thus, some type of allocation factor could be used to assign these costs to each route.

Vehicles and Other Work Equipment

A part of the investment in vehicles and work equipment (account 264) is used for intraLATA toll services. These include, for example, such items as trucks and equipment used in installation, maintenance, and repair of outside plant or vehicles used by management while performing functions related to intraLATA toll. Separations assigns these costs in proportion to the assignment of the total of the costs of outside plant, station equipment, and materials and supplies.

Precise identification of the extent of use by the total intraLATA toll services would require extensive review of work records and, again assuming this represents a small amount of toll costs, the added benefits of precision in cost allocation may be much less than the cost involved. Thus, use of some factors such as those used by separations or ones related to work time may be appropriate. It is also possible that subaccounts kept by the company may allow a more accurate allocation. Similarly, precise route-by-route assignments would involve lengthy and costly studies yielding limited benefits with respect to identifying variations in route costs.

Revisions in Separations Procedures

The preceding discussion of investment costs utilizes the separations procedures in place prior to the revisions that became effective in January 1988 and thus does not include revisions in allocation procedures. Table 3-2 shows the relationships between pre-1988 USOA accounts and pre-1988 separations categories. Table 3-3 maps the relationships between the revised USOA accounts and the revised separations categories. This mapping of USOA accounts and separations categories is provided primarily because separations data may be useful for some cost analyses done on intrastate services.

Expense Accounts

There are several different expense accounts, all of which may have some impact on the cost of intraLATA toll. The major categories are maintenance, depreciation, traffic, commercial, general office expense, other operating expenses, and taxes. Depending on the scope of subaccounts kept by a company, it may be possible to assign directly some expenses to the total cost of intraLATA toll. In other cases the costs will need to be assigned in proportion to some appropriate allocation factor, as the result of some statistical analysis, or as the result of a special study.

In many cases the degree of variation among routes in a given expense is likely to be either very small or non-existent. In these cases the cost of the effort involved in detailed analyses is likely to be too great relative to the benefit gained to make the exercise worthwhile.

The following subsections describe each category of expense and identify the appropriate USOA account numbers. In each case the likelihood of the particular expense contributing significantly to variations in route costs is also discussed and suggestions for assigning the expenses are made. It should be noted that even if an expense cannot be directly assigned, it may still contribute to the marginal cost of both the total intraLATA toll costs and to the marginal cost of individual routes. Some type of statistical or econometric analyses of these relationships can be used to

TABLE 3-2

SUMMARY TABLE OF THE RELATIONSHIP OF INVESTMENT COMPONENTS AND PRE-1988 USOA ACCOUNTS AND SEPARATIONS CATEGORIES

Investment Component	Pre-1988 USOA Account Number	Pre-1988 Separations Category Number
Subscriber Line	232 - other than inside wiring	1.33*
	234 - other than inside wiring	1.33
	242 - subscriber line outside plant	1.33
		8.13 circuit equipment
Transmission Facilities	241 - outside plant-polelines	2.23
	242 - outside plant-cable	2.23
	243 - outside plant-aerial wire	2.23
	244 - outside plant-underground conduit	2.23
Central Office Equipment	221	1 Manual Telephone
		2 Dial Tandem
		3 Inter-Toll Dialing
		4 Automatic Message Recording
		5 Other Toll Dial
		6 Traffic Sensitive Non-Traffic Sensitive
		8.2 Circuit Equipment - interexchange
		8.3 Circuit equipment - host/remote
Land and Buildings	211, 212	1 Operating Room and Central Office Space
		2 Operators Quarters
		3 General Office Supervision
		4 Commercial Office Space
		5 Space Used by Another Company for Inter State Operations
		6 Revenue Accounting Space
		7 Garages, Storerooms, Warehouses & Pole Y
		8 Space Rental to Others

TABLE 3-2 (continued)

SUMMARY TABLE OF THE RELATIONSHIP OF INVESTMENT COMPONENTS AND PRE-1988 USOA ACCOUNTS AND SEPARATIONS CATEGORIES

Investment Component	Pre-1988 USOA Account Number	Pre-1988 Separations Category Number	
		9	General Office Space
		10	Antenna Supporting Structures
		11	Space Constructed at the Specific Request of Another Company for Interstate Services Only
Furniture & Office Equipment	261**		
Vehicles & Other Work Equipment	264**		

* Note: Category 1.3 contains the subscriber line plant recorded in accounts 232, 242. It has 3 other subcategories, as follows:

Category 1.31 is subscriber line OSP for state private line services.
Category 1.32 is subscriber line OSP used exclusively for interstate private line.
Category 1.34 is subscriber line OSP used exclusively for TWX service.

**For separations purposes, these investment accounts are allocated in proportion to the assignment of other investment accounts, and therefore do not have distinct separations categories.

Source: Separations Manual

TABLE 3-3

RELATIONSHIP OF INVESTMENT COMPONENTS, REVISED USOA ACCOUNTS AND REVISED SEPARATIONS CATEGORIES

Investment Component	Revised USOA Account	Revised Separations Categories	
Subscriber Line and Transmission Facilities (Cable Wire Facilities)	2416 (2411-2441)	Category 1	Exchange Line CCWF, excluding Broadband
		1.1	State Private Line and State WATS
		1.2	Interstate Private Line and Interstate WATS
		1.3	Subscriber Lines
		Category 2	Wideband and Exchange Trunk C&WF
		Category 3	Interexchange C&WF
Central Office Equipment	2210 (2211-2232)	Category 1	Operator Systems Equipment
		Category 2	Tandem Switching Equipment
		Category 3	Local Switching Equipment
		Category 4	Circuit Equipment
		4.1	Exchange Circuit Equipment
		4.2	Interexchange Circuit Equipment
		4.3	Host/Remote Message Circuit Equipment

TABLE 3-3 (continued)

Investment Component	Revised USOA Account	Revised Separations Categories
General Support Facilities Land & Buildings Vehicles & Work Equipment Furniture & Office Equipment	2110 (2111-2124)	Allocation on the Basis of the Separation of the Big Three Expenses*
Information Origination/ Termination (IOT) Equipment	2310 (2311-2362)	Category 1 - Other IOT Equipment Category 2 - Customer-Premises Equipment

* The Big 3 expenses are Plant Specific, Plant Non-Specific, and Customer Operations Expenses. They include accounts 6210, 6220, 6230, 6310, 6410, 6530, 6610, and 6620.

estimate marginal costs. As was the case with investment components, the discussion is based on the USOA in use prior to 1988. Table 3-4 shows the relationship of the pre-1988 and the revised USOA account numbers.

Maintenance Expenses

Maintenance expenses are found in USOA accounts 602, 603, 604, 605, 606, 607, 610, 611, and 612. Accounts 611 (Employment Stabilization) and 612 (Other Maintenance Expenses) are likely to represent a small amount of total costs. Thus, any reasonable allocator could be used for assigning these costs to the revenue requirement for intraLATA toll and for spreading them among the individual routes. Separations assigns these costs on the basis of the total assignment of costs in Accounts 602 through 610. An exception is made with respect to account 612 in the event that there is a substantial amount of expense in the account. In that case studies are done to determine the appropriate source of the cost.

TABLE 3-4

RELATIONSHIP OF REVISED USOA EXPENSE ACCOUNTS
AND PRE-1988 EXPENSE ACCOUNT NUMBERS

Revised Accounts	Pre-1988 Accounts
I Plant Specific Operations Expenses	
6110 Network Support Expense	702
6112 Motor Vehicle Expense	
6113 Aircraft Expense	
6114 Special Purpose Vehicles Expense	
6115 Garage Work Equipment Expense	
6116 Other Work Equipment Expense	
6120 General Support Expenses	604, 606, 630, 631,
6121 Land and Building Expense	706, 707, 709
6122 Furniture and Artworks Expense	
6123 Office Equipment Expense	
6124 General Purpose Computers Expense	
6210 Central Office Switching Expenses	604
6211 Analog Electronic Expense	
6212 Digital Electronic Expense	
6215 Electro-Mechanical Expense	
6220 Operators System Expense	
6223 Central Office Transmission Expense	
6231 Radio Systems Expense	
6232 Circuit Equipment Expense	
6310 Information Origination/Termination Expenses	605, 607
6311 Station Apparatus Expense	
6341 Large Private Branch Exchange Expense	
6351 Public Telephone Terminal Equipment Expense	
6362 Other Terminal Equipment Expense	
6410 Cable and Wire Facilities Expenses	602
6411 Poles Expense	
6421 Aerial Cable Expense	
6422 Underground Cable Expense	
6423 Buried Cable Expense	
6424 Submarine Cable Expense	
6425 Deep Sea Cable Expense	
6426 Intrabuilding Network Cable Expense	
6441 Conduit Systems Expense	

TABLE 3-4 (continued)

Revised Accounts	Pre-1988 Accounts
II Plant Non-Specific Operations Expenses	
6510 Other Property, Plant and Equipment Expenses 6511 Property Held for Future Telecommunications Use Expense 6512 Provisioning Expense	704
6530 Network Operations Expenses 6531 Power Expense 6532 Network Administration Expense 6533 Testing Expense 6534 Plant Operations Administration Expense 6535 Engineering Expense	603, 610, 621, 624, 629, 631, 665, 706
6540 Access Expense	646, 647, 657, 658
6560 Depreciation and Amortization Expenses 6561 Depreciation Expense - Telecommunications Plant in Service 6562 Depreciation Expense - Property Held for Future Telecommunications Use 6563 Amortization Expense - Tangible 6564 Amortization Expense - Intangible 6565 Amortization Expense - Other	608, 609, 613, 614, 673, 676
III Customer Operations Expenses	
6610 Marketing 6611 Product Management 6612 Sales 6613 Product Advertising	640, 642, 643
6620 Services 6621 Call Completion Services 6622 Number Services 6623 Customer Services	621, 622, 624, 627, 629, 631, 633, 634, 635, 645, 648, 649, 650, 662
IV Corporate Operations Expenses	
6710 Executive and Planning 6711 Executive 6712 Planning	661, 665, 675

TABLE 3-4 (continued)

Revised Accounts	Pre-1988 Accounts
6720 General and Administrative 6721 Accounting and Finance 6722 External Relations 6723 Human Resources 6724 Information Management 6725 Legal 6726 Procurement 6727 Research and Development 6728 Other General and Administrative	626, 627, 640, 642, 644, 662, 663, 664, 665, 668, 669, 672 675, 704, 747
6790 Provision for Uncollectable Notes Receivable	

Source: Part 36, Title 47 CFR Uniform System of Accounts for Telephone Services, and Conformed Separations: The New Part 34. Presented for United States Telephone Association, Hartman Associates, Inc., 1987.

Account 602--Repairs of Outside Plant is divided into eight subaccounts, seven of which each relate to a particular type of outside plant (e.g., pole lines, aerial wire, aerial cable, etc.). The eighth subaccount represents shop repairs and salvage adjustments.

Assignments to intraLATA toll could be made on the basis of the amount of each type of outside plant assigned to intraLATA toll. Similarly, assignments to individual routes could be made on the basis of the amount of each type of plant installed on each route. This would give an approximation of the true route-specific maintenance costs for outside plant, and is essentially the method used by separations. If subaccounts are also kept, e.g., relative to repairs of subscriber loop, interoffice trunking, etc., this would help make more precise assignments of costs.

Maintenance costs are likely to exhibit a fair amount of variation among routes due to differences in weather patterns, terrain, and other external factors. Thus, this type of expense may justify more detailed analysis in order to develop route-specific costs for maintenance of both transmission facilities and subscriber loops. Results of these analyses may also improve the assignment of the investment category--"Vehicles and Work Equipment."

Account 603--Test Desk Work is usually divided into at least two subaccounts: one for subscriber line and service order testing, and one for trunk testing.

For separations purposes, expenses associated with testing of subscriber lines and service order testing are first assigned to various services--message services, private line, TWX, and wideband services in proportion to the relative number of working subscriber loops in each category. The expenses allocated to message services are jurisdictionally allocated based on the allocation of outside plant category 1.33. Expenses associated with TWX are jurisdictionally assigned based on relative minutes of use. Test expenses associated with private line services are jurisdictionally allocated on the basis of the number of working loops of each type in each jurisdiction.

A similar method can be used for developing an intraLATA toll revenue requirement and for developing individual route assignments. Much of the data needed for the intraLATA toll revenue requirement may already exist in the separations studies.

Separations procedures for trunk testing expenses also first involve assigning the costs to particular services and then jurisdictionally allocating them on the basis of various factors. Again the separations procedures could be used for both the intraLATA toll revenue requirement and for individual route assignments.

Account 604--Repair of Central Office Equipment. Separations assigns these costs among services based on the separation of the investment costs of central office equipment. This is a reasonable procedure for the assignment of costs to the intraLATA toll revenue requirement. However, if this is a significant amount of the intraLATA toll costs, additional analyses would be needed for developing route-specific costs. COE repair costs vary with the age and type of switch in place. Thus, these costs could exhibit a sizable degree of variation among routes. One possible procedure would be to sample the work records and use statistical analysis to develop algorithms that explain the relationship between repair costs and the age and type of switch.

Account 605--Repair of Station Equipment contains the costs of repairs of CPE (customer premises equipment) and inside wiring. These costs should be treated in the same way as the investment costs of CPE and inside wiring. Since CPE and inside wiring are virtually deregulated, all such costs should be either in separate accounts or in separate subsidiaries. They have no relevance for intraLATA toll route costs. For this reason the CPE investment costs were not discussed in the previous section.

Account 606--Repair of Buildings and Grounds is assigned by separations in accordance with the assignment of the cost of buildings. This procedure can work well for assignments to intraLATA toll costs. However, this cost probably exhibits variation among routes since the cost, size, and nature of buildings varies among routes as discussed earlier. If special studies were done to assign building costs among routes, then these results could be used to assign building maintenance costs among routes.

Account 607--Repair of Public Telephone Equipment is assigned by separations in proportion to the assignment of public telephone equipment. For fully-distributed cost studies this allocation factor works well. Route-specific assignments would require either an estimate of the amount of Public Telephone Equipment on each route, or an assumption that it can be spread among routes in proportion to some allocation factor such as traffic on each route. For marginal cost studies, a decision must be made as to whether this cost is, in fact, relevant to the incremental costs of intraLATA toll.

Account 610--Maintaining Transmission Power is allocated in the same manner as central office equipment by the separations procedures. This method is a reasonable approach for assigning these costs both to intraLATA toll and to specific routes.

Depreciation Expenses

Depreciation expenses are contained in accounts 608, 609, 613, and 614. Ideally, depreciation expenses should be directly allocated to the intraLATA toll revenue requirement and to the individual routes, since the costs may vary significantly among types and ages of individual switches and transmission facilities. However, such refinement in allocation is probably not feasible given the nature of the record keeping available.

In general, separations allocates depreciation expense to the particular plant accounts and then assigns the expense to jurisdictions in proportion to the allocation of each plant account. A similar procedure can be used for both the intraLATA toll revenue requirement and for individual route allocations.

Commercial Expenses

Commercial expenses are found in accounts 640, 642, 643, 644, 645, 648, 649, and 650. Few expenses in these accounts can be directly allocated and these few will be the result of subaccounts that are kept by the individual companies. Even then it is unlikely that the subaccounts will allow a breakdown between intraLATA and interLATA intrastate toll. Therefore, some allocator is needed for fully-distributed cost studies. The separations procedures provide one set of reasonable approaches for these assignments. Data from the separations studies could be useful for alternative assignments to intraLATA toll. For marginal cost studies, some type of statistical analysis is needed in order to establish the nature of the relationship of these expenses to intraLATA toll, since they are relevant costs.

The actual assignment of these costs will depend on regulation and market conditions within the state and on the type of study being done. For example, one of these accounts (649) is Directory Expenses. For many companies, directory operations have been transferred to a subsidiary and each state has prescribed rules for treatment of these expenses and revenues. Thus, in many cases directory expenses may be irrelevant to intraLATA toll. Similarly another account--Public Telephone Commissions, Account 648--may also be deemed irrelevant to intraLATA toll, depending on the philosophy of the cost study and the regulatory status of public phones. The other commercial expenses are of two general types. Either they can be considered general overhead or they can be deemed to have a direct relationship to intraLATA toll services. Each of the remaining commercial expenses accounts is discussed below.

Account 640--General Commercial Administration includes such items as the pay and other expenses of those persons responsible for the management of commercial operations; the costs of surveys, forecasts, rate plan studies, and development programs; and the support costs for these activities. Separations assigns these costs in accordance with the assignment of Accounts 643, 644, and 645 combined.

This is an example of the type of expense which could be considered a general overhead common cost. For fully distributed cost studies some allocation factor is needed. For marginal cost studies some statistical analysis would be needed to determine the relationship to the marginal cost of intraLATA toll. Assignment of these costs to individual routes would need to be done by spreading them across the routes in proportion to some factor such as minutes of use or number of channels, or by making a determination as to whether and to what extent these costs affect the marginal cost of a given route.

<u>Account 642--Advertising</u> is frequently divided into subaccounts related to the type of advertising such as corporate, informational, sales (residence, long distance, business) and other subaccounts. The type of subaccounts kept will vary company to company. Inspection of the subaccounts will enable one to determine which are "general overhead common costs" and which have some direct relationship to intraLATA toll. Therefore, a differentiated approach could be used to assign the various subaccounts. The separation process allocates these costs on the basis of the current billing for local and toll services.

Advertising costs may vary route by route since it is reasonable to assume that advertising intensity would be greater on competitive routes then noncompetitive routes. However, the specific assignment of these expenses to individual routes would be difficult at best. Some factor such as minutes of use on each route could be used.

<u>Account 643--Sales Expense</u> is also frequently divided into subaccounts and contains the salaries and other expenses related to such activities as soliciting new business, promoting additional business from existing customers, and arranging for changes in services. The introduction of competition could make this account more relevant to intraLATA toll, as local companies seek ways to retain their existing customers. Since competitive routes are likely to generate more sales activity then non-competitive routes, some factor such as minutes of use could be used to assign these costs to individual routes. Separations makes its assignments on the basis of current billing for local and toll services. This is an

expense that is also relevant to marginal cost studies since sales activities can be presumed to increase with the advent of competition.

Account 644--Connecting Company Relations includes the expenses associated with dealing with other companies relative to such activities as traffic agreements, settlements, promotion of interexchange business. As such, the account is in very large measure related to toll services. The allocations of this account that need to be done are to divide the account among toll jurisdictions and among various toll services within those jurisdictions. Separations first assigns this account among services based on the settlements amounts assigned to each service. The service categories consist of Message Toll Service, TWX Service, Private Line Services, and Extended Area Service. EAS expense is directly assigned to the exchange category. MTS and TWX expenses are assigned in proportion to the current billings for state and interstate messages. Private line is assigned on the basis of net settlement amounts for the private line services.

Account 645--Local Commercial Operations contains salaries and other expenses related to such activities as preparing and handling contracts or service orders, collecting revenues, and other relations with customers. These activities are in large part local service activities. However, some parts of them will relate to billing for toll services and service orders related to private line and other toll services. In essence, separations first divides the account among services (message toll and telegram; exchange; directory advertising; TWX and private line) on the basis of the relative number of users. Exchange and directory advertising expenses are assigned to the exchange operation. Message toll and telegram expenses and TWX expenses are assigned in proportion to the number of billed messages (sent paid and received collect). Private line expenses are assigned on the basis of the number of private line accounts for each jurisdiction.

Account 650--Other Commercial Expenses represents any commercial expense that cannot be properly charged to other commercial accounts. As such, it would be difficult to make any direct assignments or to even know with certainty whether the account, in any given year, has any relationship to intraLATA toll. Thus, this account is another which fits the description of a general overhead common expense. The type of study done (fully distributed or marginal cost) will determine in what way any part of this account is assigned to intraLATA toll and to individual routes. The separations process assigns part of this account to the interstate jurisdiction in proportion to the amount of all other commercial expenses assigned to interstate.

General Office Salaries and Expenses

These expenses consist of Account 661--Executive Department, Account 662--Accounting Department, Account 663--Treasury Department; Account 664--Law Department, and Account 665--Other General Office Salaries and Expenses. Other than accounting expenses, these accounts also represent general overhead common expenses. Their allocation to intraLATA toll and to the individual routes can be made on the basis of some reasonable allocation factor for fully distributed cost studies. Marginal cost studies should also consider these costs. While one cannot directly assign any component of these costs to intraLATA toll or to individual routes, these types of expenses tend to grow with the size of a business and therefore may contribute to marginal costs. Econometric and statistical analyses would be needed to determine an appropriate contribution to marginal costs.

CHAPTER 4

IMPLEMENTING A ROUTE-SPECIFIC COST STUDY

The previous chapters presented building blocks of information that can be used to develop route-specific costs. This chapter outlines the procedural steps involved in performing route-specific cost studies and discusses some of the decision points encountered in the process of developing route-specific costs.

Specifically, seven fundamental steps are involved in performing a route-specific cost study. They are:

1. Determine total intraLATA toll costs
2. Select a study method for determining route-specific costs
3. Collect background information
4. Define routes and determine whether to cost all routes or whether to sample routes and estimate cost equations
5. Define the unit of cost
6. Determine the degree of precision to be used in associating costs with individual routes
7. Assign costs to routes

Relative to step 4, if the decision is made to sample routes and develop cost equations to estimate the costs of other routes, then some additional steps are needed. They are:

a. Select routes to be sampled
b. Develop model of causal relationships
c. Identify independent variables
d. Perform regression analysis
e. Apply resulting cost equations to routes not in the sample

The rest of this chapter deals with issues that arise relative to steps 2-6. Suggested methods for steps 1 and 7 were described in chapter 3 and will not be further discussed in this chapter.

Selection of Cost Study Method

The fundamental choice in selecting a cost study method is the choice between a fully-distributed cost study or a marginal cost study. Several variations of the concept of marginal cost (incremental, avoidable, long-run marginal, short-run marginal) are frequently referred to in regulatory proceedings. The basic concept of marginal cost is quite straight-forward and can be readily stated. In its simplest form marginal cost is the change in total cost resulting from the production of an additional unit of output. In the short run, this would essentially mean the change in variable costs, since economists define the short run as a time period long enough to change the level of output by changing the variable costs (typically expenses) but not long enough to change the level of output by changing fixed costs (typically the capital investment costs). The long run is defined as a time period long enough to change the level of output by changing all factors of production (or costs) which means that long-run marginal costs are the changes in both fixed and variable costs needed in order to produce an additional unit of output.

The terms incremental and avoidable costs have been used by various parties in many different ways. Yet, technically, incremental costs are the marginal costs of producing an additional unit of output, and avoidable costs are the costs that are saved if the level of production were reduced by one unit. In conventional usage, however, the terms incremental and avoidable costs often refer to "the average additional cost of a finite and possibly a large change in production...".[1] This conventional usage differs from marginal costs by referring to an average additional cost (or cost saving) and by referencing a possibly large change in output, rather than a small change.

While these concepts are easily defined, application of this concept to the telephone industry is not so easy. One reason is the difficulty in defining the marginal unit of production. Is it one additional call, one additional access line, or one additional trunk? Or, one of any number of

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[1] Alfred E. Kahn, The Economics of Regulation: Principles and Institutions, (New York, John Wiley & Sons, Inc., 1970), p. 66.

other possibilities? The precise choice may depend on the objective of the study.

A second difficulty lies in precisely delineating the short run versus the long run, in terms of fixed and variable costs. For example, on an existing 50-pair cable, circuit equipment can be added for each pair to create 24 channels out of each wire pair. Circuit equipment would typically be installed only on the number of pairs expected to be "in use."[2] Thus, perhaps 30 pair are in use and for the 30th pair, only 16 of the 24 channels are actually in use. At this point, the short-run marginal cost of using channels 17 through 24 would be nearly zero and would include only power costs, billing costs, and other such expenses generated. To produce output beyond the 30 pairs, however, additional circuit equipment would be needed to convert additional pairs to T-carrier status. This circuit equipment is a fixed cost and a capital investment, and this could be considered a long-run marginal cost. Yet, capacity can be expanded even further (i.e., beyond the 50 pair converted to T-carrier), by the installation of additional cable, and this also would be a capital investment and a long-run marginal cost. This latter, of course, would be a much larger additional cost than would be the case for merely the addition of more circuit equipment. Treating both types of additional costs as long-run marginal costs could be misleading when discussing marginal costs of alternate routes. In this particular example, it might be useful to define an "intermediate" time period for instances when additional output can be produced with the addition of relatively small, quickly installed capital equipment.

Finally, the actual application of marginal cost principles to the telephone industry is complicated by the presence of many common costs, i.e., costs used in the production of several different telephone services. In the case of intraLATA toll, several services (intrastate WATS, 800, extended area service, interLATA access) may use the same point-to-point link. These and other costs may be used in common with local services. The difficulty is to determine the increment in common costs caused by increased

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[2] "In use" means activated or assigned.

production of one service as opposed to increments in common costs caused by increased production in other services.

Despite the difficulties associated with marginal costs, there are many sound arguments in favor of using them.

An embedded cost study differs from a marginal cost study in that it is a costing method that seeks to recover and allocate all costs booked or recorded by the utility. It, accordingly, uses actual historical data to determine cost. A projected cost, such as the marginal cost of adding capacity, is generally not recorded. All booked costs (including common costs) are allocated to each service or account based on various formulas that proportionately assign cost based on some relevant factor, for example, use. Cost recovery is the central feature of embedded cost studies. Dispute over allocation procedures--since all allocation schemes are essentially arbitrary--is a second prominent feature.

The Debate Over Marginal and Fully-Distributed Embedded Costs

One argument in support of fully-distributed embedded cost studies is that they are based on "booked" costs and therefore, rates developed from their results will insure that a company's revenue requirement is recovered. In addition, use of a fully-distributed cost study allows common costs to be shared by all services. However, this involves the use of some kind of allocation formula, and such allocations themselves become a point of contention when fully-distributed cost studies are used.[3] An additional point in opposition to fully distributed embedded cost studies is that they do not send correct price signals in a competitive market. That is, a competitive market calls for the use of prices based on marginal costs.

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[3] For a discussion in opposition to fully distributed costs, see, for example, William J. Baumol, Michael F. Koehn and Robert T. Willig, "How Arbitrary is Arbitrary? - or Toward the Deserved Demise of Full Cost Allocation," Public Utilities Fortnightly, September 3, 1987. Others, however, have found that the efficiency gains of Ramsey pricing relative to fully distributed cost pricing may be modest. See Stephen J. Brown and David S. Sibley, The Theory of Public Utility Pricing (Cambridge: Cambridge University Press, 1986), p. 193, and, generally, Chapters 3 and 7.

Proponents of marginal cost studies argue that competitive prices reflect the marginal costs of production, and therefore regulated companies that are faced with competitors must price on the basis of marginal costs. This presumes that prices based on fully-distributed costs would be higher than prices based on marginal costs and, thus, the unregulated competitors would be able to underprice a regulated company required to price on the basis of embedded costs.

Opponents of marginal cost studies argue that prices based on marginal costs may not recover the revenue requirement. They also contend that marginal cost studies can be just as arbitrary as fully-distributed cost studies and require judgmental adjustments to recover the revenue requirement. Further, marginal cost pricing for one service may result in other services bearing a disproportionate share of common costs.[4] In addition, there are many unresolved issues related to the definition and measurement of marginal cost for telephone services.

In spite of the problems associated with either type of cost study, both types of studies are useful for making informed judgments regarding rate designs and, at a minimum, can provide benchmark figures for judging the reasonableness of rates.

Specific Problems in Developing Marginal Costs

Some specific problems arise when performing marginal or incremental cost studies. Some of these problems are grounded in defining the route's location, as will be discussed below. Others revolve around the definition of the marginal or incremental unit, as was referenced in the previous section. These problems can generally be resolved by collecting and analyzing some detailed information on specific routes. If this is not

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[4] Thus far, it is rare for marginal cost studies to attempt to determine the marginal common costs for a competitive service. Noncompetitive services have typically been left to pay all residual costs.

done, there are likely to be misleading cost study results. Some examples of the complexities involved are cited in the following paragraphs.

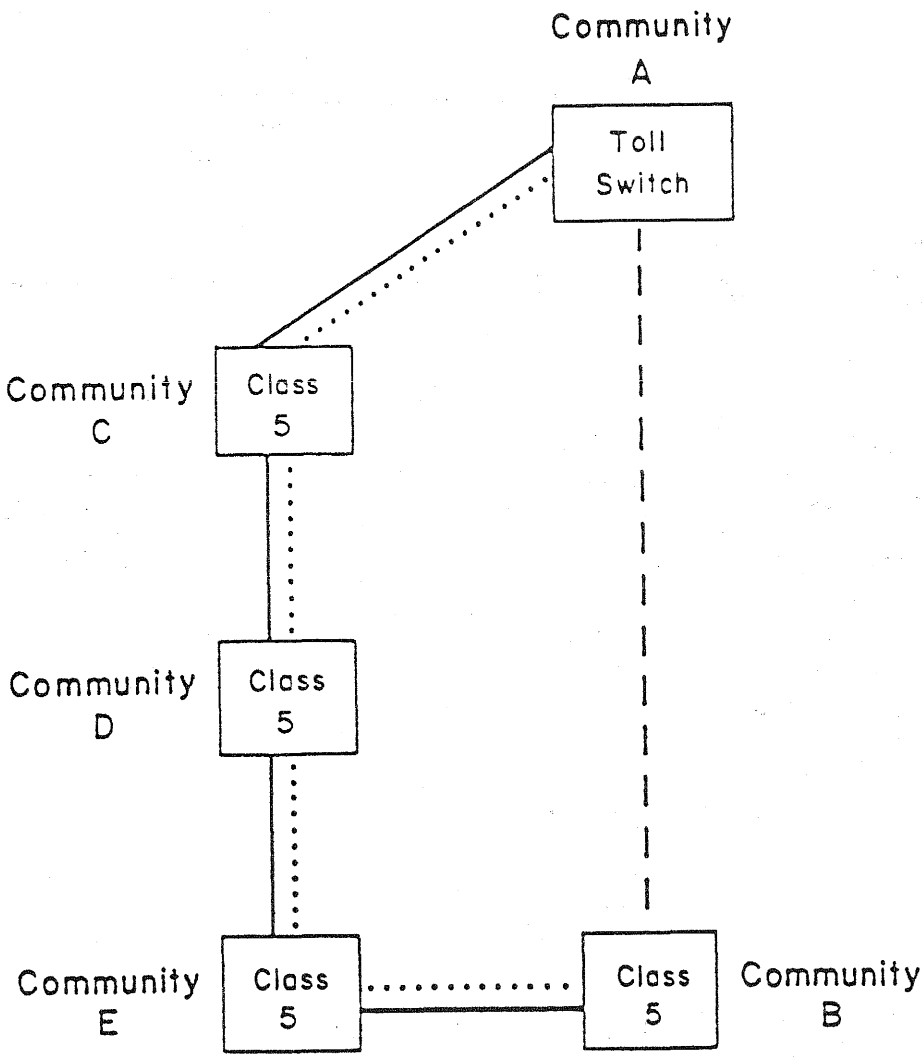
Often when analysts speak of incremental or marginal costs they define the costs as being either the cost of replacing the existing facilities with the latest technology, or the cost is defined as the cost of adding capacity on a given route. The former definition is often described as representing the costs a competitor would have to pay to enter the market and thus, this is considered by many to be the "correct" cost to be used in establishing prices for the regulated company.

Both of these definitions usually implicitly assume that additional capacity for a route would be installed in the same location as the existing route. Two examples follow illustrating that this, in fact, may not be the case.

Example 1 (illustrated in figure 4-1) is the case of a company that needs to add capacity for toll calling between points A and B. One choice is to add trunks on the direct route between A and B (represented by the dashed line in figure 4-1). This would meet the immediate needs of the increased traffic volume between A and B. However, if the company also forecasts future increased traffic between points A, C, D, and E as well as B, an alternative would be to add trunks from A through E and from E to B (shown as dotted lines in figure 4-1). The choice will, of course, be based on the relative costs of the alternate installations and the forecasted growth in demand. A valid marginal cost estimate must be based on the actual location of routes or additions to routes.

Example 2 is illustrated in figure 4-2 and involves a situation in the transition to intraLATA competition. The local companies have previously been using each other's facilities to complete calls, and the use of these facilities will now be priced on the basis of the individual facility's costs under an originating responsibility plan (as opposed to the previous pooling arrangements).

In this example, communities A, B, and C are served by company X and community D contains a toll switch of company Y. Prior to the introduction of competition and the use of the originating responsibility plan, calls from A to C were routed through the toll switch (D) of company Y, since there were no connecting facilities between company X's toll switch (B) and community C. Now, in the absence of pooling, company X must pay the cost-

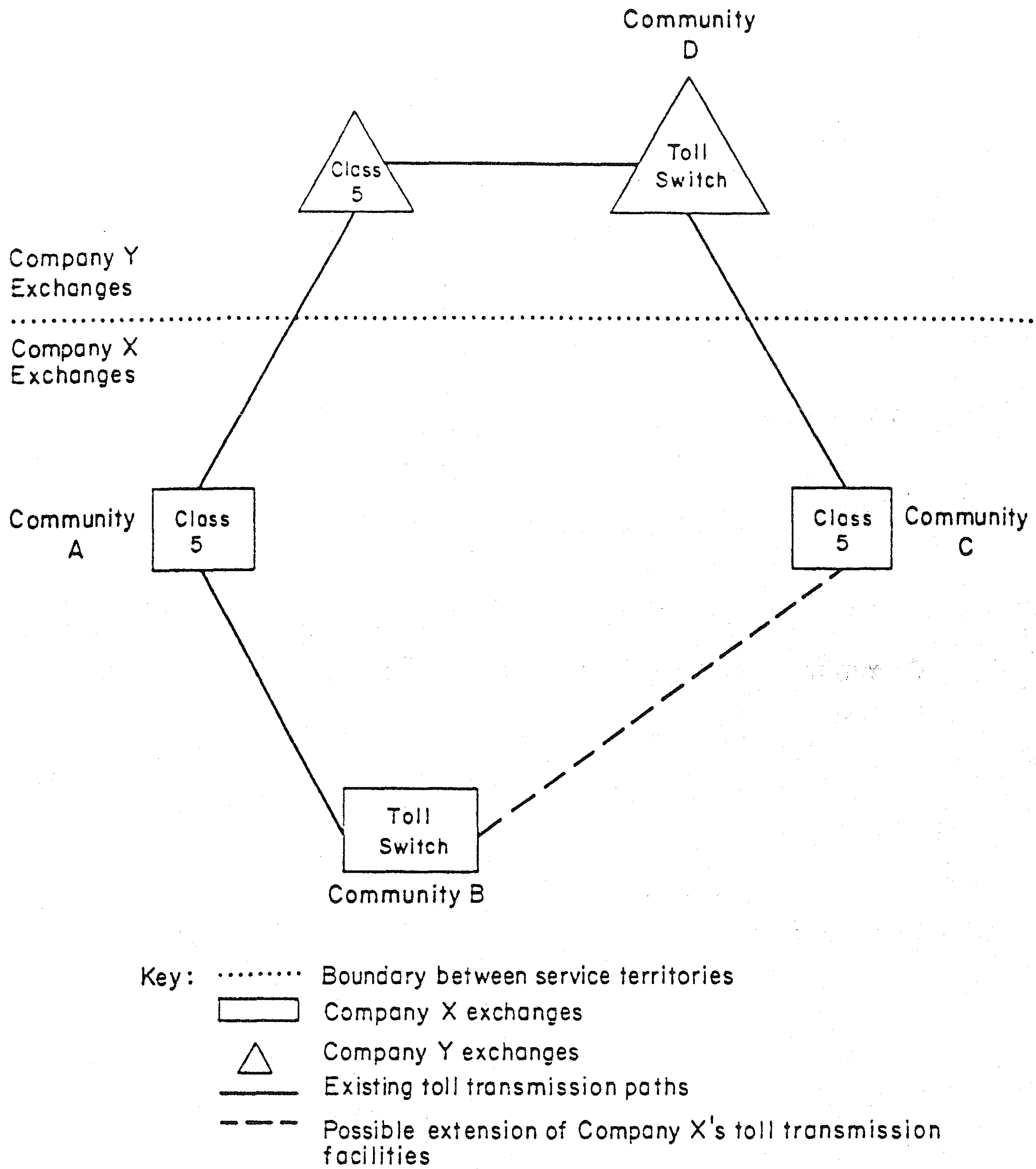


Key: Solid lines represent existing toll transmission facilities.

Dotted lines and the broken line represent two alternatives for adding transmission capacity between Community A and B.

Source: Authors' construct

Fig. 4-1. Alternatives for adding capacity on an intraLATA toll route



Source: Authors' construct

Fig. 4-2. Illustration of alternate routing with intraLATA route-specific costing in place based price for the use of toll switch D and the facilities connecting to communities A and C. If there is existing excess capacity on the link from A to B, company X may find that the lowest cost alternative is to add a transmission link between C and B (dotted line) rather than pay the actual cost of using company Y's switch and facilities.

In a similar vein, it is not at all certain that the established company's incremental or marginal costs reflect the costs a competitor would pay. At least two situations cast doubt on this. First, the competitor's facilities may well be installed in a different location creating either higher or lower costs. The precise location will be largely a function of the location of the competitor's existing switch and facilities. Thus, the competitor may well incur right-of-way costs not incurred by the regulated carrier, especially if the regulated carrier should choose to add capacity on existing route facilities. Only when the competitor uses facilities of the regulated company is there a high likelihood that the costs for each company will be comparable. Two, if the established company has excess capacity on a route, its marginal cost will be much lower than the marginal cost of a competitor installing new capacity.[5]

In summary, accurate measurement of marginal or incremental costs for specific routes requires a knowledge of where additional capacity will be installed and where existing excess capacity exists. Existing routes with excess capacity will, of course, have low marginal costs. Data on spare capacity will need to be collected in order to refine route-specific marginal cost studies.

Collection of Background Information

There are three broad categories of background information that will be helpful both in implementing a route-specific cost study and in applying the results for policy purposes. They are: the company's network design; the

[5] Excess capacity can take many forms. There may be excess capacity in the T-carrier circuit equipment for a given wire pair. There may be excess cable pairs requiring only additional circuit equipment. There may be excess conduit space so that new cable can be installed at a relatively low cost.

technological characteristics of the network; and the geographic, demographic, and customer characteristics of the service area.

A set of detailed maps of the toll network is a helpful tool for understanding the company's network design. These maps provide a clear understanding of the toll network and are useful in identifying some important specific items of information. These information items include:

1. The individual exchanges accessed by the company's intraLATA toll routes
2. The specific routes that require the use of another local company's facilities in order to complete a toll call
3. The routes for which alternate routing exists
4. The locations of the company's toll centers
5. The locations of host-remote switches
6. The distance between communities

Technological characteristics refer primarily to the type of technology used for transmission facilities and switching. It also includes information on the composition of the cable links between two communities (referred to in this report as a point-to-point link). Typically, a point-to-point cable link may consist of several segments representing different types of installation and different capacities. For example, the first segment leaving the central office may be aerial cable with several hundred channels. This could be followed by a segment of underground cable with fewer channels as some of the initial channels branch off to other locations. This second segment, in turn, may be followed by a segment of buried cable with the same or a differing number of channels, and such variations in cable type and capacity may continue throughout the point-to-point link until its termination point is reached. This variation in the capacity and installation type of the segments of a point-to-point cable length reflects two features of network design. One, the type of installation used at any particular time (aerial, underground, buried, or submarine) will generally be (or is presumed to be) the least-cost method (including calculations for maintenance expenses) for the particular terrain, climate, and traffic features involved. Two, traffic exiting a central office will go to several different locations and traffic entering a central office will represent aggregations of traffic from several locations, thus causing differences in channel capacity along the point-to-point link. This dispersion and aggregation of traffic may also occur at several points throughout the point-to point link, and not just at its originating and terminating points.

Costs may vary as a function of the types of installation, and this is one of the questions explored in the following chapter. Thus, identifying installed cost includes understanding the various segments of the point-to-point link and adjusting for the variations in channel count among the segments of a point-to-point cable link.

Geographic and demographic information includes population statistics, geographical characteristics, and industrial/employment characteristics for the communities. This latter item involves factors such as whether a small town contains a university, has one major industrial employer with high long distance usage, is a vacation/recreational area, or is a farming community. Useful customer data include the number of access lines and traffic information on business customers for each community. This type of information helps to create a thorough picture of the types of communication traffic carried and customers served, and any special transmission or technological needs. Such contextual understanding can have indirect and intangible benefits in designing a cost study and developing models most appropriate to the company in question.

The Definition and Selection of Routes

There are a large number of intraLATA routes interconnecting the communities within a LATA. Theoretically, the number of possible routes is represented by the following formula:

$$R = \frac{N(N-1)}{2}$$

where:

R = total number of theoretically possible routes

N = total number of communities within a LATA

In this formula, R is defined as the theoretically possible number of routes in that it represents the total possible number of routes between two communities.[6] In reality, the total number of intraLATA toll routes is likely to be less than R, since some connections between communities may be either extended area service, host/remote connections, or local calls. These non-toll connections can be identified and eliminated from the set of possible routes.

Identifying the costs of each route can be a tedious and time consuming exercise if the number of routes is very large. An alternative would be to take a random sample of routes and determine the cost of each of them. A cost equation could then be constructed by applying regression techniques to these results. This cost equation could then be used to estimate the costs of routes not included in the sample.

If it is decided to sample the routes and fit a cost equation to use for estimating the costs of the remaining routes, data need to be collected on the variables against which the costs will be regressed. These variables should represent those factors which are thought to be most significant in determining route costs.

The precision or "goodness of fit" of the regression may be improved by stratifying the sample. In deciding whether to stratify the sample, information collected on population, distance, terrain, and industrial/ employment characteristics can be useful. This kind of data will indicate the degree of homogeneity among routes. It will also suggest relevant stratifications where there appears to be significant diversity among routes and will also be helpful in selecting independent variables for use in regression equations.

Defining what to include in a route is another matter that adds complexity to the cost study. One issue to be resolved is how to treat the costs of alternate routes. Many intraLATA toll routes may have no alternate routing capabilities. However, when they do exist, their costs should be

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[6] It should be noted that a route between two communities does not necessarily consist of direct trunking between them. It may require point-to-point links between several communities in order to connect the communities of origination and termination.

considered in defining the costs of a route between two communities. One way of doing this is to combine the cost of the primary route with a portion of the cost of the alternate. The share of the alternate route's cost to be included would represent the relative use of the alternate.

A second issue is whether the cost of a specific route should include the averaged or deaveraged costs of the subscriber loops at the points of origination and termination. This decision rests on whether there is significant variation in loop costs among locations. Conventional wisdom holds that loop costs in rural or sparsely populated regions are higher, and this seems intuitively logical given the longer distances. Yet, a full investigation of loop cost differentials has not been made in the public arena, and many questions remain unanswered. For example, is installation of new loops in a congested urban area more expensive? Are maintenance costs in an urban area with continual construction activities higher than in rural areas? What is the effect on loop cost of traffic concentrators and other equipment added to urban or suburban loops? Do background noise and other terrain characteristics require higher quality of materials for local loops in urban areas? Do rural loops tend to be older and thus more fully depreciated than urban loops? These questions are representative of the information needed in order to develop a full understanding of loop cost differentials among communities.

Defining the Unit of Cost

The unit of cost under study may be defined as either (1) the total cost of the route at full capacity or at the in-use capacity, (2) the cost per channel of each route, (3) the cost for an average calling volume, or (4) some other measure.

For cable transmission facilities, it is generally necessary to first make some adjustments to the embedded cost of each route or of a point-to-point link. As discussed previously, there are variations in channel capacity among the cable segments of a point-to-point link between communities, and not all channels are used for toll services. Failure to adjust these costs for the non-toll channels will result in overstating the costs of intraLATA toll. There are at least two possible ways to make the adjustment. One is to obtain from the company precise identification and measurement of the traffic on each segment. These traffic measures can then be used to allocate the cost of each segment among services using the individual segments.

An alternative that requires much less traffic measurement, is to calculate the total cost of the maximum number of through channels of a point-to-point link. The procedure for doing this is to first divide the total cable cost per segment by the number of channels in use in that segment. Then the maximum number of through channels between the two points needs to be obtained. The per channel cost of each segment is then multiplied by the number of through channels in use to give the total cost of each segment to be assigned to the link. The sum of these costs for all segments on a point-to-point link represents the total in-use cable costs for that link.

Expressed more simply, for point-to-point link A, the procedure is:

$$TC_A = \sum_{i=1}^{N} X_i Y_A$$

where:

TC_A = Total cable cost of the point-to-point link
X_i = Cable cost per channel for segment i of point-to-point link A
Y_A = Number of through channels for the point-to-point link A
N = Number of segments

The total cost of a point-to-point link derived in this manner includes not only the cost of intraLATA toll channels, but also the cost of channels used for intratate interLATA toll access and for interstate toll access. Thus, to compute the costs of intraLATA toll only, the total cost must be converted to a per channel cost, and this amount multiplied by the number of channels used for intraLATA toll. This procedure results in the same cost per channel for intraLATA toll as for interLATA access. Only the total cost of each type will differ, as a function of the number of channels used for each type of service. This seems a reasonable result since as stated earlier in this report there is no reason to believe the costs per channel of transmission facilities should vary simply as a result of the regulatory jurisdiction of the traffic. Also, this procedure results in the costs of any excess capacity being shared proportionately by all services.

A similar process can be used to compute the total costs of intraLATA toll routes made up of more than one point-to-point link. Since different links have differing numbers of channels, the cost needed is the cost for the number of through channels available on any given route. For example, a route from community A to community C through community B, consists of the point-to-point links from A to B, plus the point-to-point link from B to C. If link AB has a maximum 600 channels and link BC has a maximum 1200 channels, there are 600 through channels for route A to C. To find the total cost, the per channel costs of AB and BC are found, and each is multiplied by 600 and then added together to arrive at the cable cost for route AC. This total is then converted to a per channel cost and multiplied by the number of channels used by intraLATA toll. Alternatively, as was mentioned with respect to usage on cable segments, one could request traffic measurements and identification for each point-to-point link on a route, and use these data for allocations.

If routes are sampled and estimation techniques used, it is also necessary to decide whether to use real costs or nominal costs. Nominal costs are booked costs, while real costs are nominal costs adjusted for price changes over time. This adjustment is done by using an appropriate price index. For example, telephone costs can be adjusted by use of the Handy-Whitman index of utility prices. Real costs are useful for analyses when the primary goal is to identify underlying cost relationships, absent the effect of price changes. The use of nominal or book costs is appropriate for analyses that are intended to see that existing costs are appropriately assigned among routes and among services so as to prevent cross-subsidies.

Determining the Degree of Precision to be Used in Assigning Costs to Individual Routes

A question that will arise frequently in performing a route-specific cost study is, "How much precision should there be in the derivation of route costs?" Practical considerations suggest that some cost averaging or cost allocation across routes may be needed. This is because the cost of achieving complete, precise route-by-route cost determinations for each category of cost is prohibitive, even if it were in all cases possible.

The analyst needs to develop criteria to determine the trade-off between achieving route-specific precision for a particular category of cost and the costs (in both time and money) involved in doing so. Three factors seem most important in deciding this trade-off. They are the type of records that exist, the amount which a specific cost contributes to the total cost, and the probability that the particular cost element will vary significantly among routes.

The major categories of costs that can be expected to vary among routes are:

1. Switch and circuit equipment
2. Transmission facilities
3. Subscriber loop
4. Land and buildings
5. Maintenance expenses
6. Some commercial expenses
7. Depreciation
8. Local taxes

To determine which cost category contributes significantly to the total cost of intraLATA toll, the total of each category assigned to intraLATA toll can be taken as a percentage of total intraLATA toll costs. If these data are not available, similar percentages for interstate toll can be computed from separations data, and used as estimates for intraLATA toll.

The greatest precision will come with directly assigning costs to each route. However, the records necessary to do this are likely to exist only for major investment components and not expense items. Many investment items are likely to vary route-by-route and also are likely to contribute significantly to the total cost of a route.

For costs that cannot be directly assigned, two choices exist for making the assignment. They can be assigned by the use of some appropriate allocator, or by some type of special study to determine the assignment. For example, sampling and estimation techniques can be used to derive cost equations for those costs and the results used to assign the costs. The decision to undertake special studies can be based on the probability that the cost will vary significantly among routes and on the amount that a particular cost element is expected to contribute to the total cost of a route.

Those costs not deemed to be sufficiently significant to justify special studies can be handled in a variety of ways. In some cases, costs can be assigned on an average basis.[7] In other cases costs can be grouped together and a statistical relationship between the costs and some independent variable (e.g., distance, volume) can be determined.

In summary, route-specific cost studies are feasible. They are complex to perform and may require several iterations over time. Absolute precision will not be obtained, but the results can be acceptable for policy and rate-making purposes.

[7] See, for example, the discussion of pole costs in chapter 5 (infra).

CHAPTER 5
A PARTIAL ANALYSIS OF INTRALATA TOLL ROUTE COSTS

Introduction

Thus far, this report has laid out the basic information needed to do a route-specific cost study and has discussed some procedural issues that arise in implementing such a study. This chapter contains an analysis of certain intraLATA toll route costs provided by a local exchange company. It has a twofold purpose: (1) to begin to identify and document factors that determine the level of costs on individual routes and (2) to provide an example of some descriptive statistical analyses of these embedded route-specific costs that can be useful in evaluating alternative regulatory policies.

A local exchange company made available to the NRRI the 1985 embedded costs of selected intraLATA point-to-point links used for intraLATA toll and interLATA access. The data provided are proprietary and had been derived for internal company purposes. Therefore, data on individual routes are not being published in a way that would allow routes to be identified.

Since these data analyses represent a study of one company only, generalizing the results must be done with care. In particular, the descriptive statistics regarding point-to-point links and intraLATA toll routes should not be generalized. Instead, they serve to illustrate the types of analyses that can be done with relative ease and can be useful in resolving policy issues related to rate design and competitive entry policies. These types of descriptive statistics, if computed on a sufficiently large, random sample of intraLATA toll routes, can give a good indication of the range of rates that would result if rates were deaveraged and the extent to which a universal service fund might be needed. They can also give insight into the magnitude of marginal costs and the likelihood of a truly competitive market developing.

The service areas under study were relatively homogeneous in terms of climate and terrain, and consisted of many small communities with some medium to large communities scattered throughout the area and relatively short distances between communities. T-carrier and microwave transmission technologies were most prevalent. Analyses of companies with significantly different structural characteristics might yield different results. For example, companies with different network design standards or different geographic parameters such as companies operating in single LATA states, or in LATAs with fewer exchanges and greater distances between exchanges may well exhibit different costs relationships.

The data available were unseparated, route-specific embedded costs for transmission facilities and circuit equipment. Therefore, the total cost of intraLATA toll could not be determined. However, the research goal here is simply to describe the embedded cost characteristics of selected routes and to present an example rather than to conduct a full-fledged cost study.[1] The decision was made to use a set of routes rather than cost all routes primarily because cost data on all routes were not readily available. Since the original date base for this analysis was not specified by NRRI and consisted of the data made available by the company, it cannot be considered a true random sample. However, evaluation of the geographic locations of the point-to-point links indicates that they reflect numerous exchanges scattered throughout the company's service territory and are representative of the varieties of locations and the different sizes of exchanges served by the company.

The costs under study are embedded book costs assigned on a fully-distributed basis. Marginal cost procedures were not used in part because it is thought that the proper assignment of existing embedded costs among routes is an important regulatory tool, to ensure adequate cost recovery. Embedded cost data can also be used to identify existing cross-subsidies and to implement procedures to prevent future cross-subsidies among routes. However, route-specific embedded cost data can be used in conjunction with marginal cost calculations. For example, a commission could compute both route-specific embedded costs and route-specific marginal costs. Rates based on the marginal costs could be derived and the resulting revenues

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[1] For actual ratemaking purposes the data necessary for determining the total costs of intraLATA toll do exist and can be collected.

estimated. These revenues could then be compared to the fully-allocated embedded costs to determine whether all costs will be recovered with marginal cost pricing, or whether some or all routes would fail to recover their embedded costs if priced at marginal costs. For similar reasons, the analysis is done on nominal or book cost as opposed to real or adjusted costs. Analyses of book cost are of particular importance for regulators making decisions regarding rate design issues and the segregation of existing costs between competitive and noncompetitive service.

The data were examined at three levels of aggregation: the individual cable segments,[2] the point-to-point links, and actual routes. Descriptive analyses were undertaken at all three levels. The descriptive analyses identify factors that affect intraLATA toll costs and illustrate types of information that are particularly useful for analyzing different regulatory policies regarding intraLATA toll competition and rate design.

When cost analyses are undertaken, a useful first step is to develop a theoretical model of causal relationships that can be used as a framework for determining appropriate analytical approaches and, in the case of regression analysis, for identifying independent variables for testing hypotheses regarding cost relationships.[3] Figure 5-1 is a schematic of the model used here and illustrates the assumptions made regarding major factors affecting costs. It begins with the assumption that both supply and demand factors influence the cost of a segment. On the demand side, population size and characteristics, along with income levels and prices, are major determinants of the level of usage. The level of usage, both current and projected, determines the number of channels installed since telephone

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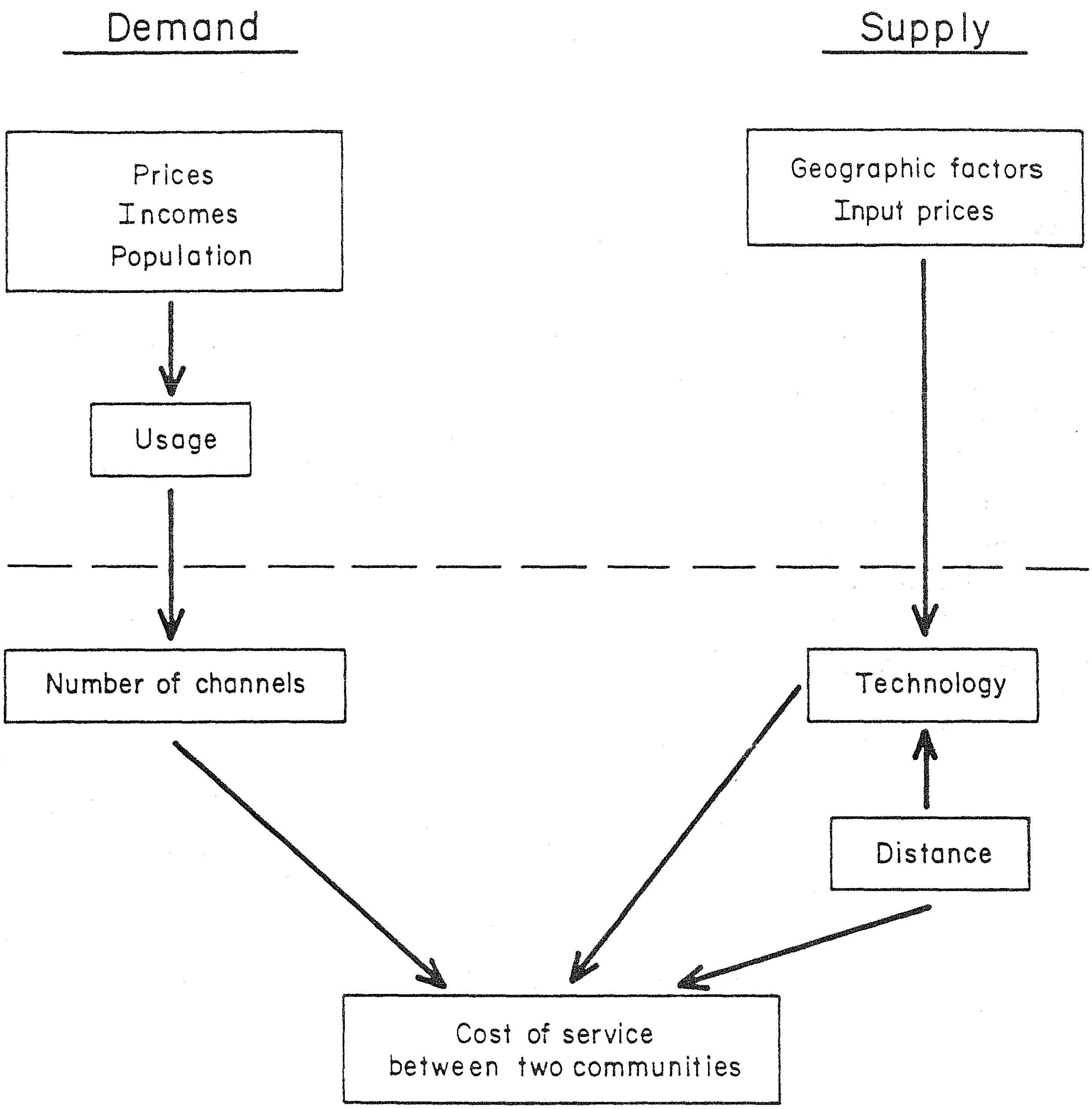
[2] Recall that segments are the individual lengths of cable that go to make up a point-to-point link.

[3] While regression analysis is not used here, it can be an important analytical tool for route-specific costing. For example, a sample of routes can be taken and the total cost of each determined. Then, using appropriate independent variables, regression equations of total cost can be derived and assuming a "good fit," can be used to estimate the costs of routes not in the sample.



Source: Authors' construct.

Fig. 5-1. Factors affecting intraLATA toll costs engineers use estimates of peak usage to determine the number of channels needed.[4] The number of channels directly affects costs since costs are assumed to increase with increased numbers of channels (though perhaps at a decreasing rate). The number of channels has a second effect also since long-term capacity needs may influence the choice of technology used.

Similarly, the supply "column" shows that input prices and geographic factors such as terrain, climate, and soil conditions affect the choice of technology, as does the distance between the two cities. Finally, the technology chosen and the distance involved both directly affect costs.

The analyses in this chapter examine only the three factors below the dashed line: number of channels, technology, and distance. Here technology refers to the transmission facilities (microwave or cable; aerial, buried, or underground cable).

The Assignment of Costs to Routes

The following paragraphs describe the procedures used by the local company to identify route-specific outside plant and circuit equipment investment costs. These procedures represent one reasonable method for approximating route-specific investment costs for these two classes of plant.

To determine outside-plant cable, conduit, and pole costs, the footage for each segment of a point-to-point link was identified from "stick maps." Stick maps are detailed company maps showing location, length, and type of cable for each cable installation. Each segment was further identified as to the year of installation; type of installation (aerial, underground buried, or submarine); the number of channels in use; and type of technology (T-carrier, paired wire, cable, or fiber optics). The cost for each cable segment (as well as the costs for those microwave towers recorded in account 241) was taken from the outside plant continuing property records and includes both material and installation costs.

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[4] For a description of how telephone engineers use usage data see Bell Laboratories, Engineering and Operations in the Bell System (Murray Hill, NJ: Bell Telephone Laboratories, 1977), Chapter 14, pp. 473-516.

Conduit costs (for underground cable) were derived on an average basis. That is, the ratio of total investment in underground conduit to total investment in underground cable and fiber was determined. This percentage was then applied to the total underground cable/fiber cost of each segment to develop the conduit cost per segment. This procedure masks some information about costs of laying conduit since it averages the costs per mile over all segments.

Pole costs for aerial cable were also calculated on an average basis. An average cost for a typical pole was calculated. The number of poles for each segment of aerial cable was found by dividing the total footage of aerial cable on a segment by 150 feet--the average distance between poles. This calculation of average pole costs represents a good example of the type of decision making that will be called for frequently in doing route-specific cost studies--that is, making a trade-off between the degree of precision in the analysis and minimizing the time and expense in performing the study. Realistically, one can assume that pole costs differ and thus contribute to differences in costs among routes. They may differ due to age or due to the size or type of pole involved. However, developing costs for individual poles is a lengthy and expensive activity--if it is even possible. When it does not seem likely that differences in pole costs will contribute significantly to total route cost differentials, then some form of average costing seems to be an appropriate trade-off. If, however, there is reason to believe pole cost differences are significant among aerial cable installations, more precise calculations would be needed. For example, if it became apparent that certain routes consistently required a type of poles that is above average (or below average) in costs, then perhaps poles could be grouped into two or more categories and an average price determined for each category.

Circuit equipment costs were developed for each point-to-point link. Each point-to-point link was studied to determine the type and number of units of circuit equipment that were used, (e.g., span terminal, carrier termination, span equipment through a location). The central office equipment continuing property records for each location were reviewed and an average unit price for each type of circuit equipment was developed. The cost of circuit equipment added to create private line services is omitted from analyses in this report. Costs for span terminal units included the costs for the shelf and repeater units. The carrier termination unit cost is the cost of a fully equipped carrier terminal shelf. The span equipment for usage through a location or node includes the costs of the shelf and repeater units, with these costs being divided by two to show one-half of the cost being applied to each direction. An average cost for repeater mounting and line repeaters was calculated and the quantity of repeaters determined by one repeater per mile (an industry standard for T-carrier). All microwave circuit and tower costs not included in account 241 were developed in a similar manner using central office continuing property records for each location. Finally, ratios for test equipment, power equipment, and common equipment were developed from separations studies and applied to the circuit equipment costs.

The result of all these calculations is a good approximation of route-specific outside plant and circuit equipment investment costs for selected point-to-point links. It is this data base that was used for the analyses of cable segments, point-to-point links, and intraLATA toll routes reported in the following sections of this chapter.

Analysis of Data on Individual Cable Segments

The data base used in these analyses included 361 cable segments, all T-carrier. These were composed of 100 segments of aerial cable, 193 segments of underground cable, and 68 segments of buried cable. The analyses of the cable segments were directed to finding what can be learned and documented regarding the effect of distance and technology--as represented by type of installation--on costs. A more complete analysis of these segments within the framework of the model of causal relationships in figure 5-1 would also include analysis of the relationship between the channel capacity and the costs of the cable segments. However, data on the capacity for each segment were not available. Only the number of channels in use on each segment was available. Therefore, the analysis of cable segments involved examining:

1. The relationship between cost and distance, and
2. The relationship between cost per foot and type of installation (i.e., aerial, underground, buried).

Using the data provided, and stratifying for type of installation, the SAS[5] univariate analysis was run to identify key statistics on length and cost.

The cable segments exhibited great variability in length, ranging from 6 feet to 91,590 feet. Underground cable segments were typically much shorter than either aerial or buried segments. Table 5-1 reports the key statistical measures on the length of the cable segments. As the table shows, the mean, median, and upper limit of the range are much smaller for underground than buried or aerial cable.

TABLE 5-1

CABLE SEGMENT LENGTHS BY TYPE OF INSTALLATION
(in feet)

Type of Installation	Mean	Median	Range	Standard Deviation
Aerial	13,812	8,016	29 - 71,225	15,252
Underground	1,504	225	6 - 24,878	3,117
Buried	12,953	7,861	83 - 91,590	15,871

Source: SAS Univariate Analysis

The cost per foot ranged from a low of \$0.73 to a high of \$65.93.[6] The cost per foot used in this univariate analysis was the cost of cable installation only, and did not include the costs of poles or conduit. The cost per foot also exhibited great variability and a higher concentration of observations at the lower values of cost per foot than at the higher values. Table 5-2 contains some statistical values on the cost per foot for each type of cable installation.

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[5] Statistical Analysis System, a computer programming package.
[6] This was for a 12-foot length of underground cable.

TABLE 5-2

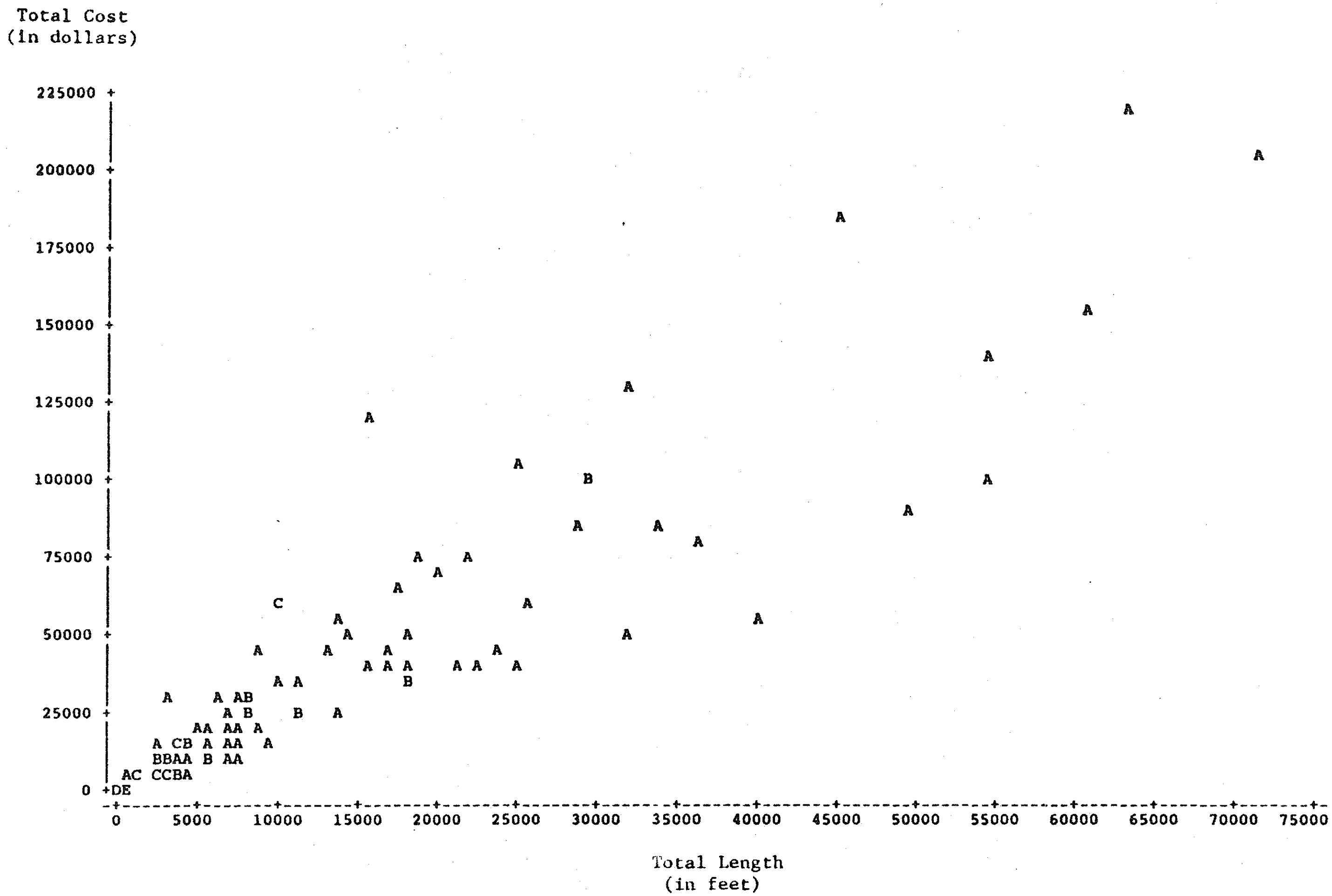
CABLE COST PER FOOT BY TYPE OF INSTALLATION
(in dollars)

Type of Installation	Mean	Median	Range	Standard Deviation
Aerial	2.73	2.36	.73 - 9.55	1.46
Underground	8.24	8.39	1.07 - 65.93	6.35
Buried	2.10	1.87	.85 - 5.00	.81

Source: SAS Univariate Analysis

Plots of total cost (as opposed to cost per foot) versus distance show a strong positive relationship between cost and distance for all three types of installations. Figures 5-2, 5-3, and 5-4 contain plots of the total cost of each type of cable installation versus the distance involved. These plots show that for all three types of T-carrier cable installation, total cost tends to increase with distance. Thus, these provide a first stage confirmation for the assumption in the underlying model that distance is an important factor contributing to the total cost of intraLATA toll routes. The coefficients of correlation provide additional confirmation. Their values are .909, .840, and .850 for aerial, underground, and buried cable segments respectively. It is important to note that these conclusions apply only to the transmission facilities. Circuit equipment will be included in the analyses in the next sections, and switching costs and all other costs have been omitted from all the analyses.

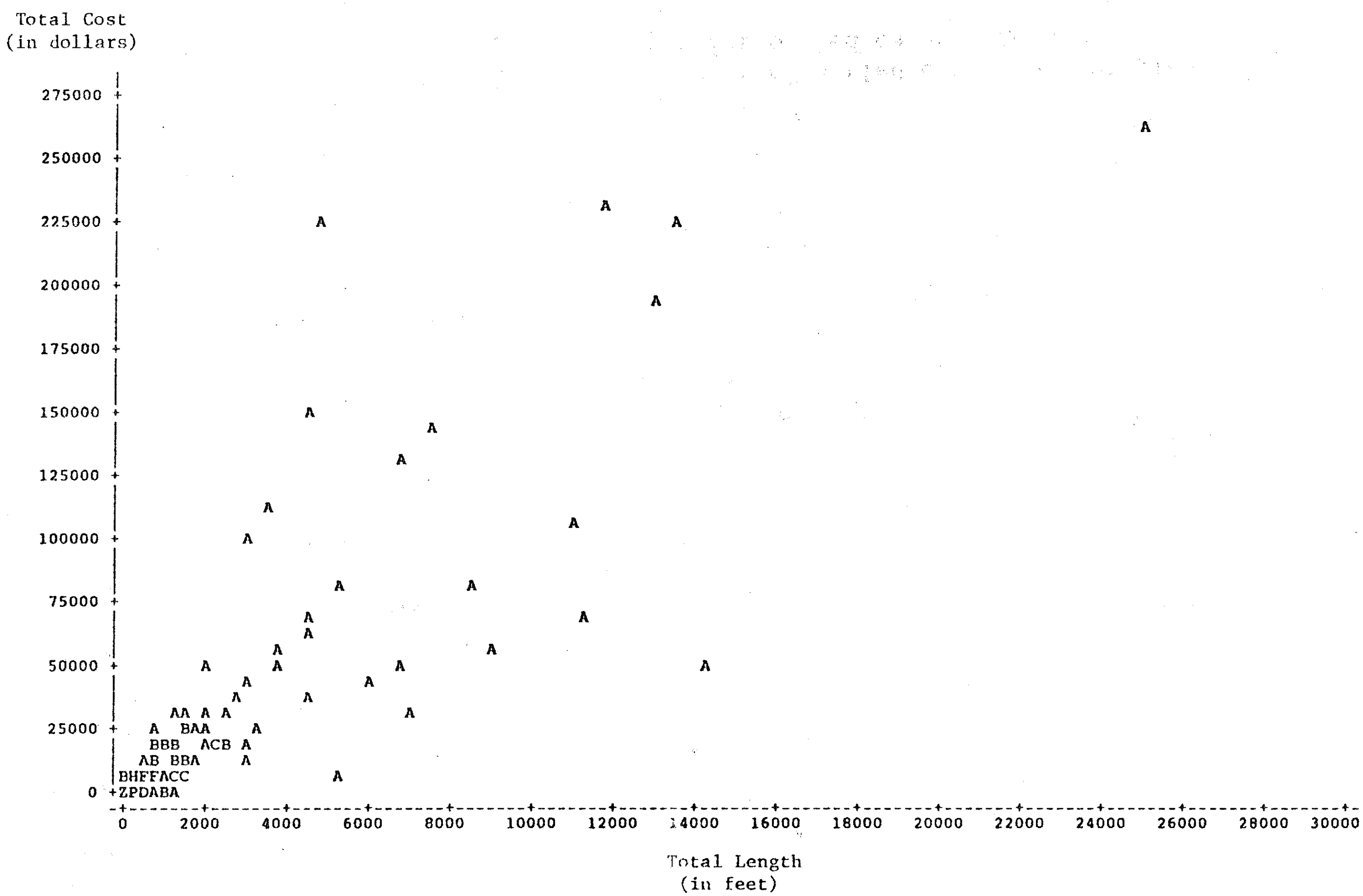
The next analytical step was to test the assumption that technology is a factor in determining costs. With respect to the individual cable segments in this data base, the technology in question refers to the technology of installation, i.e., aerial, underground, or buried cable. Referring back to table 5-2, it can be seen that the cost per foot for



Note: A = 1 observation; B = 2 observations, etc.

Source: SAS program

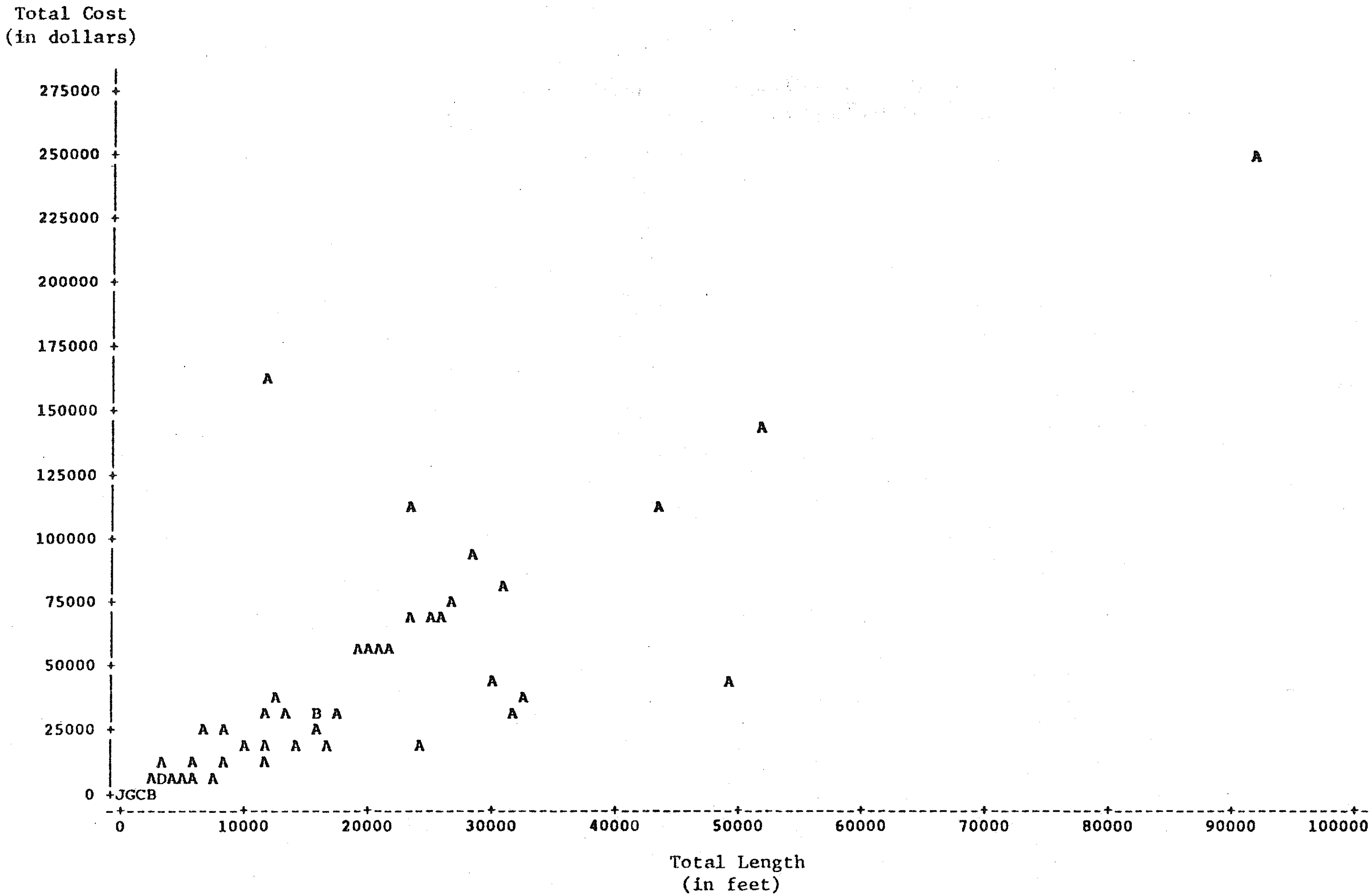
Fig. 5-2. Plot of total cost of aerial cable outside plant against length of aerial cable segments



Note: A = 1 observation; B = 2 observations, etc.

Source: SAS Program

Fig. 5-3. Plot of total cost of underground cable outside plant against length of underground cable segments



Note: A = 1 observation; B = 2 observations, etc.

Source: SAS program

Fig. 5-4. Plot of total cost of buried cable outside plant against length for buried cable segments.)

underground cable appears to be substantially higher than the cost per foot for either buried or aerial cable. This is intuitively logical, since underground cable is generally the installation of choice in difficult locations (such as under city streets) where the cost of installation would be expected to be higher. To determine whether these differences in costs are statistically significant, a Tukey's Studentized Range Test was performed. The results, contained in table 5-3, confirm that the cost per foot for buried and aerial cable are significantly lower than the cost for underground cable. Further, the analysis shows that there is no significant difference in costs between aerial and buried cable.

TABLE 5-3

RESULTS OF TUKEY'S STUDENTIZED RANGE TEST FOR CABLE COSTS

Cable Comparison	Simultaneous Lower Confidence Limit	Difference Between Means	Simultaneous Upper Confidence Limit	
2 - 1	4.1344	5.5051	6.8759	***
2 - 3	4.5678	6.1367	7.7056	***
1 - 2	-6.8759	-5.5051	-4.1344	***
1 - 3	-1.1171	0.6316	2.3802	
3 - 2	-7.7056	-6.1367	-4.5678	***
3 - 1	-2.3802	-0.6316	1.1171	

Source: SAS computer program

Key: Cable 1 = Aerial; Cable 2 = Underground; Cable 3 = Buried
Note: *** indicates the differences in costs between types of cable are statistically significant at the 95 percent confidence level

The costs of conduit and poles were added to cable costs for underground and aerial cable respectively and converted to costs per foot. The same type of analysis was then run to see if this altered the results. Again, the underground costs were significantly different than those for buried or aerial cable. Even with the addition of pole costs, there was no significant difference in cost per foot for aerial versus buried cable. These results can be found in table 5-4, and support the hypothesis that choice of technology (as represented by type of installation) is a factor influencing total costs.

TABLE 5-4

RESULTS OF TUKEY'S STUDENTIZED RANGE TEST
FOR CABLE, POLES AND CONDUIT COSTS

Cable Comparison		Simultaneous Lower Confidence Limit	Difference Between Means	Simultaneous Upper Confidence Limit	
2	- 1	8.2406	10.4834	12.7262	***
2	- 3	8.7184	11.2854	13.8523	***
1	- 2	-12.7262	-10.4834	-8.2406	***
1	- 3	-2.0591	0.8020	3.6631	
3	- 2	-13.8523	-11.2854	-8.7184	***
3	- 1	-3.6631	-0.8020	2.0591	

Source: SAS computer program

Key: Cable 1 = Aerial; Cable 2 = Underground; Cable 3 = Buried
Note: *** indicates the differences in costs between types of cable are statistically significant at the 95 percent confidence level

Descriptive Analyses of Selected Point-to-Point Links

The cost data used for the descriptive analyses of point-to-point links were composed of the embedded costs of transmission facilities and circuit equipment, plus an allocated amount for common equipment, test desk equipment, and power equipment.[7] These costs represent a significant share of intraLATA toll costs but do not include all costs.[8] Nevertheless, for purposes of this report, the total of these costs will be referred to as total costs.

The point-to-point links used in these analyses consisted of 23 microwave links and 71 T-carrier links. Each of these two types of links is examined in turn in the following two subsections. In each subsection, the analysis is directed toward two questions: (1) What are the key physical and cost characteristics of these point-to-point links? and (2) What can be learned from these data that is relevant to policy questions related to rate deaveraging and to competitive entry?

Microwave Point-to-Point Links

There were twenty-three microwave links available for analysis. Table 5-5 represents some key statistical measures of the physical characteristics for these links. Data in this table indicate the microwave links have a substantial amount of excess capacity.

TABLE 5-5

SUMMARY STATISTICAL VALUES OF KEY CHARACTERISTICS OF MICROWAVE POINT-TO-POINT LINKS

Variable	Mean	Median	Standard Deviation
Length	18 miles	18.2 miles	4.98 miles
Channel Capacity	1,744 channels	1,344 channels	610 channels
Number of Channels In Use	537 channels	505 channels	270 channels

Source: Authors' calculations

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[7] The derivation of these costs was described in an earlier section of this chapter.

[8] Costs omitted include switching, urban interoffice trunks, subscriber loops, operating expenses, and taxes.

The total cost of the microwave links varied significantly. The link with the highest total cost had a total cost more than ten times that of the link with the lowest total cost. Some of this difference may be due to variations in capacity among the links. The coefficient of correlation between total cost and total capacity is .527. However, there must be other factors that also cause differences in the costs of microwave links. Possibilities include vintage, the technology of the microwave unit, and whether the towers are free standing or located on a building roof. Distance does not seem to be a significant factor for microwave point-to-point links. In this data base the coefficient of correlation between total cost and distance of microwave links is .217.

If all microwave links in the data base were operating at full capacity, the average embedded investment cost per channel would be $235.52. However, since there is a significant amount of excess capacity on most of these links the average cost per channel in use for all microwave links is much higher, $1,049.38. There is, however, considerable variation among the microwave links. Table 5-6 contains data illustrating this.

The cost date in table 5-6 represents group averages, and gives some indication of the range of rates needed to recover costs of these links. In fact, the range is much greater. There is a differences of approximately $3,200 between the lowest cost-per-channel in use and the highest cost-per-

TABLE 5-6

AVERAGE COST PER CHANNEL IN USE AND NUMBER OF OBSERVATIONS BY PERCENT OF CHANNEL CAPACITY IN USE FOR MICROWAVE POINT-TO-POINT LINKS

Percent of Channel Capacity in Use	Average Cost Per Channel in Use	Number of Observations
76-100%	$71.66	1
57- 75%	$461.68	5
26- 50%	$633.93	7
0- 25%	$1,731.83	10

Source: Authors' calculations

channel in use. If all links operated at full capacity, the difference in cost per channel between the links with the lowest and highest cost per channel would be only $502, and seventy four percent of the links would have a cost per channel within $200 of each other. This emphasizes the importance of increasing the "fill factor" in reducing revenue requirements and reducing the size of the differences in unit costs among these links.[9]

T-Carrier Point-To-Point Links

The cost data used for the T-carrier links was composed of costs of transmission facilities and circuit equipment, plus an allocated amount for common equipment, test desk equipment, and power equipment. Before the analyses could be done,some adjustments were needed to the raw data in order to compute the total cost of each link. First, the number of in-use channels was calculated. The segments of a point-to-point link may differ in number of channels since any one segment may be used as part of a transmission path to more than one termination point. As described in chapter 4, the maximum number of through channels was used as the channel count for point-to-point links.

Using the number of channels in use on each segment (and other data supplied by the company), the number of through channels in use for each point-to-point link was determined. The outside plant cost for each segment was divided by the number of channels in use in each segment. These per channel costs were then multiplied by the number of through channels in use for the relevant point-to-point link and these numbers were then summed for all segments on a point-to-point link in order to get the total outside plant cost for that link. The costs of the existing circuit equipment including an allocated amount for test desk equipment, power equipment, and common equipment on each link were added to the outside plant costs to determine the total cost of each link.

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[9] It should be noted that a low fill factor does not necessarily imply over-investment. The existing capacity may be the result of either minimum efficiently-sized installations or forecasted demand or both.

In addition to determining the number of channels in use on each point-to-point link, the total number of possible through channels was also determined. This was defined to be the maximum number of channels available to transit point A to point B. This number was derived from telephone company data and throughout this report will be referred to as channel capacity.

The total cost used might be described as an "in-use" total cost. This is not necessarily the total cost that would be incurred if the full channel capacity of the link were "in use." The difference between total cost at full capacity and total cost at the in-use channel quantity occurs because certain carrier circuit equipment is not added to a carrier cable link until additional channel capacity is needed. For example, a 50 pair cable link may carry circuit equipment to convert 30 pair of cable to T-carrier capability, and the other 20 pair would be converted as needed. By contrast, the microwave links are equipped with circuit equipment up to the limit of their capacity.

The 71 T-carrier links used in the analysis are typically composed of several segments representing different types of installations. Table 5-7 contains data on the length and capacity of these links. As the data indicate, the T-carrier point-to-point links are relatively short and do not have particularly large amounts of channel capacity. These characteristics may be explained by the fact that the LATAs represented in this data base

TABLE 5-7

SUMMARY STATISTICAL VALUES OF KEY CHARACTERISTICS OF T-CARRIER CABLE POINT-TO-POINT LINKS

Variable	Mean	Median	Standard Deviation
Length	6.48 miles	5.9 miles	4.56 miles
Channel Capacity	1,481 channels	1,200 channels	1,047 channels
Channels in Use	756 channels	576 channels	686 channels

Source: Authors' calculations

contain many small communities, frequently within short distances of each other.

As was the case with microwave links, there is a large amount of excess capacity on most T-carrier point-to-point links. However the range in costs per channel in use is smaller for the T-carrier links. T-carrier links have an average cost per channel for channels in use of $235.54 as compared to slightly over $1,000 for microwave links. Table 5-8 contains data on costs per channel, length, and number of channels for the average T-carrier link and for the top 25 percent and the lowest 25 percent of links, as ranked by cost per channel in use.

TABLE 5-8

AVERAGE VALUES OF COST PER CHANNEL IN USE AND OTHER KEY CHARACTERISTICS FOR THE UPPER AND LOWER QUARTILES AND THE MEAN OBSERVATION OF T-CARRIER CABLE POINT-TO-POINT LINKS AS RANKED BY COST PER CHANNEL IN USE

	Average Cost Per Channel in Use	Average Length	Average Percent in Use	Average Channel Capacity
Upper Quartile channels	$460.17	10.75 miles	43.29%	1,196
Mean Observation channels	$235.54	6.48 miles	51.05%	1,481
Lower Quartile channels	$ 82.57	3.76 miles	70.66%	1,932

Source: Authors' calculations

These data show that the 25 percent of the links with the highest cost per channel in use have an average cost per channel nearly 6 times that of the average cost per channel in use of the 25 percent with the lowest costs. It is interesting to note that the highest cost links are, on average, much longer, have a smaller channel capacity and operate at less than 50% of capacity, as compared to the low cost links. The relationship between cost per channel and length, support the assumption that costs increase with distance. The fact that average cost per channel falls as the percent of capacity in use rises, represents the ability to spread fixed costs over larger numbers of units, thus creating falling average costs. The fact that lower cost links typically have a larger channel capacity suggests the possibility of economies of scale with respect to capacity, though further research is needed to confirm the extent of this.

Surveying all 71 links with respect to cost per channel in use, the difference in cost between the most expensive and the least expensive is slightly over $1,000. However, the lower 60 percent are within $200 of each other in cost per channel in use, and the lower 83 percent are within $300 of each other. This suggests that if these same results hold when all costs are computed (i.e., switching, operating expenses, etc.) and converted to rates then deaveraging rates on those links could result in fairly similar rates.

Descriptive Analyses of Selected IntraLATA Toll Routes

The point-to-point links were combined to create 62 intraLATA toll routes. A route is defined as the set of links connecting the community of origination, through a toll center, with the community of termination for a call. In some cases, a route consisted of one link; in others, as many as seven links. The average number of links for these routes was three. The 94 point-to-point links discussed in the previous section were located in several LATAs and all routes that would require crossing a LATA boundary were eliminated. Similarly, routes that required a point-to-point link of another company in order to complete a call were also eliminated.

As was done with the T-carrier links, the number of in-use channels was computed by finding the maximum number of through channels in-use from the point of termination. A similar calculation was done to compute the channel capacity of the routes. Descriptive statistics of the length and capacity of these routes is found in table 5-9.

There is a substantial amount of excess capacity on these routes with the average percent of capacity in use being less than 50 percent. Again the channel capacity is comparatively small, with the average route having a capacity of slightly over 1,200 channels.

TABLE 5-9

SUMMARY STATISTICAL VALUES OF
KEY CHARACTERISTICS OF INTRALATA ROUTES

Variable	Mean	Median	Standard Deviation
Length	27.47 miles	26 miles	12.47 miles
Channel Capacity	1,208 channels	1,200 channels	4,858 channels
Channels in Use	505 channels	504 channels	247 channels
Number of Links	3.16 links	3 links	1.59 links

Source: Authors' calculations

The cost per channel in use varies significantly with the average cost of the upper 25 percent of the routes (high-cost routes) being $1,453.08 as compared to $380.78 for the lowest 25 percent (low-cost routes), as ranked in order of cost per channel in use. Table 5-10 contains these data along with the average values of relevant characteristics for these two groups of routes and the mean observation.

Data in table 5-10 show that the high-cost routes are nearly 2 1/2 times as long as the low-cost routes. In addition the coefficient of correlation between total cost and length for all routes is .604. Thus it seems clear that for this set of data, distance is a major factor in determining costs.

It is interesting to note that while the low-cost routes have a higher average fill factor and a higher average channel capacity, the difference between the high and low-cost routes for these variables is only four percentage points. Further research is needed to pin down the effect of factors other than distance on the costs of intraLATA toll routes.

TABLE 5-10

AVERAGE VALUES OF COST PER CHANNEL IN USE AND KEY CHARACTERISTICS FOR THE UPPER AND LOWER QUARTILES AND THE MEAN OBSERVATION OF INTRALATA TOLL ROUTES AS RANKED BY COST PER CHANNEL IN USE

	Average Cost Per Channel in Use	Average Length	Average Percent of Capacity in Use	Average Channel Capacity
Upper Quartile	$1,453.08	39.63 miles	42.86%	1,260.8 channels
Mean Observation	$915.01	27.47 miles	42.00%	1,208 channels
Lower Quartile channels	$380.78	15.91 miles	46.97%	1,438.40

Source: Authors' calculations

The difference in cost per channel in use between the lowest cost route and the highest cost route is approximately $1,650. Cost variations among the routes are, in general, greater than that for the point-to-point links, with only 11 percent of the routes being within $200 of the lowest cost route, as compared to 60 percent for the T-carrier point-to-point links. Forty percent of the routes have a cost per channel in use within $500 of the lowest cost route. It should be pointed out, however, that $500 in investment costs when converted to a revenue requirement and then to a monthly or a per call rate is not likely to be a very significant differential. It is also important to remember that the costs and cost differentials discussed here do not represent the full costs of a channel used for intraLATA toll. The addition of switching costs, land and buildings, operating expenses, and other costs may increase or decrease the cost differentials among routes, and may also change the identity of the high and low-cost routes.

Several interesting observations stem from looking at the identity and characteristics of the individual low and high-cost routes used in this study. The high-cost routes cannot be identified as being all rural routes connecting small communities. In fact, in both groups, high-cost and low-cost routes, only approximately one-third of the routes connected small communities. Another one-third of the routes in each group were between small and medium-sized communities. The final one-third of the routes in each group were between a large city and a small community, with the small community often being in close proximity to the large city.

Thus, for this data set it would be inaccurate to characterize low-cost routes as urban routes and high-cost routes as rural routes. However, there may be some relationship between location and high-cost routes. Nearly half of the high-cost routes in this data base were served by the same toll center. No such pattern existed for the low-cost routes. More work is needed in order to correctly identify the factors associated with high and low-cost routes. In particular, the full costs of the routes need to be computed and then statistical and econometric techniques such as regression analyses could be used to determine the factors most responsible for causing the differentials in route costs, and thus defining high and low-cost routes.

Summary and Conclusions

At all levels of aggregation--cable segments, point-to-point links, and routes--distance appears to play an important part in determining costs. That is, the total cost of transmission facilities and circuit equipment tends to increase with increases in distance. The one exception is the microwave point-to-point links, whose costs are not significantly related to distance.

In most cases, the point-to-point links (T-carrier and microwave) and the individual routes have significant amounts of excess capacity. Thus the marginal costs of these links and routes will typically be low. If these links and routes were priced at marginal costs, the question then arises as to whether any competitor could successfully compete on prices for those routes with excess capacity.

The presence of this amount of excess capacity may well be the norm for many companies, though this remains to be documented. Given that the LATA definition allows for only one Standard Metropolitan Statistical Area within a LATA, LATA is unlikely to have many major population centers. The presence of many small communities, whose transmission needs are less than the minimum efficiently-sized installations of transmission facilities may account for the excess capacity. This excess capacity also means that rates could be reduced if usage were stimulated and the fill factor increased.

The cost per channel in use for the routes in this data base show a difference of approximately $1,650 between the lowest cost and highest cost route. This suggests there might be significant rate differentials if rates were deaveraged. However, the analysis presented here is not sufficient to definitely assess the impact of rate deaveraging. Additional work needed includes: (1) Converting these investment costs to a revenue requirement and adding in all other investment costs associated with each route, (2) computing all expenses associated with each route and adding this to the investment cost revenue requirement, and (3) computing rates for each route based on the total revenue requirements of the individual routes[10]. Usage data for each route is needed to convert the revenue requirements to rates. Variations in usage (the rate at which channels are utilized) among routes is as important as variations in costs per channel in determining the ultimate impact of cost-based pricing. If differences in rates are not significant, consideration needs to be given to the question of whether the analytical costs, billing costs, and customer confusion associated with rate deaveraging are justified.

Finally, analysis of this data base raises questions about what variables do, in fact, define high and low-cost routes. The high-cost routes were typically longer than the low-cost routes, with distances ranging from 13 miles to 56 miles for high-cost routes as compared to a range of 8 to 28 miles for low-cost routes. Also, the high-cost routes have, on average, more links than the low-cost routes, though there were some high-cost routes composed of only 1 or 2 links. However, the high-cost routes, as measured on a cost per channel in use basis, cannot be explained on the basis of fill factor, because the average percent of capacity in use (42.86) was not very different than the average percent of capacity in use for low-cost routes (46.97). High-cost routes were not all rural routes,

[10] Since total costs and the necessary usage data were not available for this project, these steps were not undertaken.

nor were the low-cost routes all operating at full or nearly full capacity. These results cannot be generalized to other companies, or other LATAs. Also, when all costs are known and converted to rates, the results may change. However, these results do show the need for more research into what defines a high-cost or low-cost route within a LATA.

CHAPTER 6

POLICY AND PRICING ISSUES RELATED TO ROUTE-SPECIFIC COSTING

Competition and the IntraLATA Toll Market

Route-specific costing is considered in order to derive cost-based prices for each route (i.e., deaveraged toll rates). Cost-based rates are generally considered either when there is the prospect of emerging competition or when a market is deemed to be competitive. Thus, the decision to do route-specific cost analyses is closely related to decisions regarding the market structure for intraLATA toll. It is frequently contended that the competitors (or potential competitors) will price their services at cost and thus the regulated carrier will be at a disadvantage unless its rates are also cost-based. The case is often made that cost-based rates are particularly important for high-density routes, because those are the routes in which competitors are most interested. These contentions have some merit, though there are some additional aspects to the issue. Competitors may or may not have cost-based prices. There is no way for regulators to know the extent to which there may be cross-subsidies in the pricing structure of multiproduct competitors. Second, while competitors may have the greatest interest in high density routes, it is plausible to contend that many competitors are also interested in being able to advertise as full-service providers (providing interstate, intrastate interLATA, and intraLATA services), and thus they will have some interest in all routes.

In reality, the case for cost-based rates rests on a stronger foundation than is generally put forth. It is only with cost-based rates in place that correct price signals will be given to potential entrants. Only that entry (or lack of entry) occurring in response to correct pricing signals will determine whether a market is, in fact, a competitive market. There currently is no clear evidence regarding whether intraLATA switched toll services are capable of developing into workably competitive markets, or if this is only possible for selected LATAs or selected routes. The presence of cost-based toll rates would, over time, elicit good information on the extent to which competitive carriers may choose to enter the LATA.

The Revenue Impact of Competitive Entry

The impact of competition on the revenues of the regulated company will depend largely on the way in which competitors deliver their traffic. If the competitors build their own facilities then, in the absence of growth in traffic, there can be a significant loss in revenue to the regulated company. However, if the competitors deliver their traffic by using facilities of the regulated company, the impact will be much less. It seems reasonable to assume that some mix of these two alternatives would be employed. Given the cost involved in building toll facilities, the low volume of traffic on some routes, and the existence of excess capacity on others, it would not appear cost effective for a competitor to duplicate all existing intraLATA toll facilities. Such duplication would be financially reasonable only when the cost of using the regulated company's facilities exceeds the cost of new construction.

The impact on the local exchange company could be significant if the competitor enters the market primarily to provide service to large customers and offers special access that bypasses the local company. How serious this impact would be depends, of course, on how many customers are lost and what proportion of total intraLATA toll revenues they represent. The impact may be quite severe, for example, for a small telephone company with only a few large business customers.

The impact of competitors on the regulated company's revenues will also be influenced by changes in market demand. That is, if total market demand for intraLATA toll services increases, then it is entirely possible that the regulated company will maintain or even increase its level of revenues. The result will depend in part on the prices in place as a result of competition and on the elasticity of demand. If competition forces prices down and the demand is elastic, total revenues will rise. Conversely, if the demand is inelastic and prices fall, total industry revenues will fall and the impact on each individual firm will depend on their individual market shares. It is important to note that the price elasticity of demand faced by an individual firm may be different than the price elasticity of demand for the market as a whole. Total market demand may be relatively inelastic, but faced with alternative suppliers, the customer may switch between firms due to price differences. Thus, the presence of competitive firms increases the degree of price elasticity faced by any one firm.

Is the IntraLATA Toll Market Capable of Competition?

In addition to being concerned about the revenue impact of competitors, regulators are also interested in whether the intraLATA toll market is capable of becoming workably competitive. The presence of one or more competitors does not, in itself, assure that a market will act in a competitive manner. To be workably competitive, the market forces need to be fairly broadly distributed so that all firms have the incentive to price based on marginal cost, thus providing the product at the lowest possible cost and promoting economic efficiency.

One of the parameters often used to indicate the degree of competition is the number of firms participating in a market and their market shares. In considering the number of potential competitors, attention is generally focused on existing interLATA carriers. However, in many LATAs there may be other potential entrants. In LATAs with more than one local exchange carrier (LEC), the individual LECs may compete for some routes or for selected customers of other local companies, especially if they already have nearby facilities or if particular exchanges of one company frequently call specific exchanges of another.

Another factor that influences whether a market is capable of competition is the cost structure of the product or service. That is, is the output produced under conditions of increasing costs, constant costs, or decreasing costs? When the cost structure is one of decreasing costs over the relevant market size (i.e., cost per unit declines with increases in output), the market structure will be one of monopoly, since one firm can expand its output to produce enough for the entire market and do so at the lowest possible cost.

This project was not designed for the purpose of analyzing the market's overall cost structure. However, in the course of the analyses some insights were gained regarding the subject through a review of the excess capacity on the point-to-point links. There was a high level of excess capacity on the links included in this data base. The average number of in-use cable channels (756) was only slightly larger than the average number of cable channels not in-use (754). For microwave links, the ratio of the average number of excess channels to the average number of in-use channels was more than 2:1, there being an average of 537 microwave channels in use and an average of 1,206 excess channels. There were some significant exceptions, of course, with some links being near or at full capacity.

It would be necessary to analyze many LATAs to see if excess capacity is a typical characteristic of many or even most intraLATA toll routes. However, there is some reason to believe it might be. LATAs were defined to include only one Standard Metropolitan Statistical Area. Therefore, one would expect other communities within the LATA to be small or medium-sized communities. Wire pairs between communities were likely to have been originally installed in groups of 25, 50 or 100 or multiples of these with the actual number being influenced by the traffic volume between communities. The use of T-carrier facilities greatly increases the channel capacity of these wire pairs and probably in excess of the needs of the communities. For example, many very small communities have 200 or fewer access lines. A 25-pair cable between two such communities has the potential for 600 channels (25 x 24) if fully converted to T-carrier facilities, a capacity far in excess of the needs of these communities. Given the capability to increase existing wire pair capacity at a minimum ratio of 24:1[1] through T-carrier facilities, one would expect to find excess capacities. Routes without substantial excess capacity would be expected to be found between communities that have experienced great growth in population, access lines, and traffic volume.

The presence of significant amounts of excess capacity on particular routes could indicate a condition of decreasing costs for the relevant market size for that route. The marginal cost of additional channels should be quite low. Thus, the local exchange company would be likely to have a cost advantage over any competitor, and it is unlikely that any broad based competition would develop for these routes.

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[1] Continued improvements in circuit equipment may further increase this potential.

The question of whether intraLATA toll services can be workably competitive may well depend on the characteristics of the particular LATA. Those LATAs with several high-density routes that have little excess capacity distributed throughout the LATA are likely to have a better chance at developing a fully competitive market. LATAs with only one or a few high density routes are more likely to have spotty competition, i.e., a few locations with significant amounts of competitive pressures, and a great many locations with either no competition or very limited competitive force. This latter situation gives rise to the possibility that if intraLATA toll were deregulated, these low density routes might be overpriced in order to underprice competitive routes.

One Possible Scenario for IntraLATA Competition

It is a reasonable hypothesis that the intraLATA toll market in LATAs with few high density routes and existing excess capacity will fragment. That is, there will be, in effect, several markets with varying degrees of competition.

Low-density routes and routes with significant excess capacity may see little or no competition. High-density routes are likely to see more competition, but how successful it is will depend on the rate structure of the local company, the structure of access charges in place, and whether equal access is available.

A further fragmentation of the market is likely to occur with respect to toll services. Absent equal access, competitive entrants will have difficulty competing for switched services. Further, it is probable that the cost advantage lies with the local company for two reasons. First, to the extent that the local company has excess capacity, its marginal cost may be lower than the marginal cost of the competitor installing new facilities. Second, access charges essentially represent the costs of the intraLATA toll network. Where this is the case, the local company's costs for toll services are equal to the access charges. Competitors would incur both access charges and their own costs such as the costs of their points-of-presence.

Competitors may find it more advantageous to compete on private line services and to compete selectively for the large customers. If so, the market will fragment between switched and private line services and between large and small customers.

The effect of this market fragmentation will depend in large part on the regulatory structure in place. A fragmented intraLATA toll market could allow the profit maximizing firm to adopt policies of price discrimination. If deregulated, the submarkets with limited or no competitive alternative would then face high rates while the submarkets with competitive alternatives would face lower rates. A commission that so concludes may choose not to deregulate LATAs that are likely to develop such submarkets. Regulation alternatives would include not opening the LATA to competition or opening only selected submarkets to competitive entry and allowing some form of flexible pricing for the local exchange company in these submarkets. Route-specific cost studies are particularly useful if such flexible pricing is under consideration.

Pricing Issues and Implications

Pricing Individual Routes

Once route-specific costs have been determined, the question then becomes whether each route shall be priced based on its costs. Within the context of competitive market theories, the answer would seem to be a clear yes. That is, if each route is priced at its cost, correct pricing signals will be given to potential market entrants and a true test of the competitiveness of the market will occur.

Pragmatically, however, there may be reasons why cost-based pricing for each individual route may be less practical than theory might indicate. This is not to argue against cost-based pricing, but rather to suggest that in some circumstances, a policy of approaching or approximating cost-based pricing may be more practical than would be a policy of fully implementing such pricing for each route.

The argument goes like this: pricing each route individually may lead to customer confusion. If customers cannot reasonably estimate the price of various calls, it is possible that some calls may simply not be made, thus leading to reduced usage of fixed facilities. Additionally, it is possible in some circumstances that for two sets of locations that are the same distances from each other, one set of locations (originating and terminating) will pay a higher rate for calls than will another. One factor influencing costs is the distance of a location from the toll switch, since toll calls must be routed to the toll switch for recording and delivery. Two locations 20 miles apart but each at some distance from a toll switch will pay higher rates (based on costs) than would two locations 20 miles apart where one is the toll center, or where both are located very near the toll center. Situations such as these may be perceived as inequitable by customers and lead to negative reactions.

Another factor to consider in deciding whether to price each route individually is the programming and billing costs for the company. When numerous routes are involved, programming the billing procedures will be expensive, and increasingly so for changes in rates--particularly if rate changes are not "across-the-board" changes. Across-the-board rate changes will be unlikely to occur if true cost-based rates are to be fully implemented. How expensive the billing procedures will become depends largely on the capacity of existing computer systems. If new systems are needed, billing costs may increase for all services. Additionally, the bills will be harder for customers to monitor, thus increasing customer confusion and creating external diseconomies.

Finally, to the extent that competitors are entering the market for reasons partly unrelated to individual route costs and prices, the value of route-specific pricing as an indicator of the competitive nature of the market is blunted. For example, competitors who offer service on low volume routes may be doing so primarily to market themselves as full-service carriers, i.e., carrying calls to and from any point in the country. The marketing advantages of this may be perceived to outweigh other considerations of price and cost.

An alternative to pricing each individual route according to its cost is to group routes of similar costs and price each group on a cost-related basis. Several possibilities exist for identifying reasonable groupings. In identifying groups or classifications of routes, one goal would be to identify those characteristics that cause routes to have similar costs and group the routes accordingly. A second consideration would be to identify classifications that would reduce customer confusion. That would involve designing rate groups that are perceived as reasonable or logical to consumers and that allow customers to estimate calling costs and monitor bills with relative ease.

Several possible bases for classification exist. For example, all routes within the same LATA could be grouped together; or routes could be classified by distance; or routes could be grouped based on their distance from the toll center; or the grouping could be based on geography, i.e., all routes within a county or specific geographic area. In deriving a rate group scheme, the first step would be to isolate factors that may be closely correlated to route costs.

The analyses reported in chapter 5 indicate that distance is one factor that influences toll route costs (for cable routes) and therefore should be considered in any grouping of routes for rate-making purposes. Additional research that includes all costs of intraLATA toll is needed in order to definitively determine whether distance continues to be a significant factor, or whether other parameters are more important. Similarly, more research is needed for routes utilizing other transmission technologies. It is the distance that the call travels, however, not the distance between the points of origination and termination, that thus far appears to be significant. This is the reason for suggesting that one reasonable grouping would be distance from the toll center.

Pricing routes on the basis of subsets of routes represents a form of rate averaging, and thus precise cost-based rates are not achieved for each route. The choice of this procedure would be justified if the subsets were determined in a way related to costs and if the costs and customer confusion associated with pricing each route individually were such that this alternative was considered a reasonable trade-off in terms of cost/benefit analyses.

Another alternative--in addition to pricing each route individually or developing cost-related subsets of routes--is to individually price only those routes deemed to be capable of competition. For LATAs in which broad scale competition is not expected to develop, route-specific cost studies can be used to develop either banded rates or minimum rates for the competitive routes and for those specific services that are deemed subject to competitive pressures.

Route-Specific Costs vs. Prices

A number of difficulties arise if cost studies compute costs on a per call basis. Among other things, it would be necessary either to specify the length of the call and the time of day, or to specify a time distribution of calling since call durations and time of day are variable among customers. A hypothetical case would need to be constructed, and this may not be a good fit for all routes.

A more important problem is that calculating costs in terms of a cost per call usually results in a confusion between supply and demand parameters and may in turn lead to misdirected policy decisions. Supply conditions or parameters are a function of the actual costs involved in supplying a service. This includes both fixed costs for a given level of capacity and the variable costs associated with the existing level of output, which may be a different level than the capacity level. For intraLATA toll routes these costs include cable; circuit equipment; microwave towers; switching equipment; maintenance, billing, testing, and power expenses; and other common administrative expenses. The sum of all of these costs represents the cost of supplying a specified capacity and a given level of output.

Demand conditions are a function of the level of calling volume at various price levels. When costs are expressed as a cost per call, what is really being discussed is the revenue per call needed to recover all costs of the route at a specified level of calling. This is not conceptually the same as discussing the cost of the route.

This distinction may appear to be a tedious one, yet it is important in order to prevent misunderstanding or misconceptions regarding costs of different routes. The following discussion may be helpful in increasing understanding of this point.

Conventional wisdom holds that rural routes with low calling volumes are high-cost routes and urban routes with high calling volumes are low-cost routes. However, little investigation has been undertaken of the true cost differentials for various types of routes. It could be hypothesized that the capacity cost per channel is lower on some rural routes due to ease of installation (i.e., no city streets to dig up or other urban obstructions to overcome) and the fact that buried cable (rather than underground) can be used for long stretches.[2] On the other hand, it could be hypothesized that urban costs per channel are lower because of the economies of scale inherent in larger sized trunks. Another consideration is that a rural location in close proximity to a toll switch may have lower costs than a more urban location some distance from a toll switch. The point of these comments is that it is not clear that routes can be classed as high cost or low cost based only on their classification as rural or urban. Variations in costs may occur within each group.

The reference to low-volume rural routes as high cost is really a reflection of the demand parameters more than the cost characteristics. That is, for low volume routes, the revenue or price per call required to recover the costs is higher than it would be at a high volume of calling. In fact, this reference to the high cost of low volume routes is a statement relative to the <u>average cost</u> of a call. If competitive conditions are such as to require <u>marginal cost</u> pricing, then these routes may not be high cost. That is, the marginal cost for a low volume route with excess capacity could be much smaller than the marginal cost of a high volume route where additional capacity would be needed to provide an incremental unit of output.

The foregoing is, of course, not meant to contend that costs are always lower on low-density routes. Rather, (1) it is important not to confuse the concept of costs with the prices needed to recover costs, thus confusing causal factors; and (2), it is reasonable to assume there are variations of low- and high-cost routes within the urban/rural classifications, and more detailed examinations of route costs may be needed.

Elasticities

Route-specific pricing will change the prices of most routes that are currently priced on the basis of averaged costs. This has implications both for universal service and for a company's toll service revenues. If demand is inelastic, an increase in price will increase the company's revenues; if

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[2] Analyses presented in chapter 5 indicate that cost per foot is significantly higher for underground as opposed to buried cable.

elastic, decrease. Thus, the degree of price elasticity becomes another factor to consider when determining a deaveraged rate structure.

Commissions facing the question of deaveraged rates are concerned about rural areas where intraLATA toll calls may be considered part of universal service because calls to employers, local government agencies, needed services, and social calls may be toll calls.

These rural routes are generally considered high-price routes because the volume of calling is limited relative to route capacity and thus the rates needed to recover costs are high. Analytical results may indicate that these rates should rise if rates are deaveraged. Yet, if the demand on these routes is elastic, then the problem will be exacerbated, as calling volume will drop off and create even more excess capacity, while at the same time creating revenue shortfalls for the company. Therefore, in circumstances of high excess capacity and an elastic demand, consideration might be given to either maintaining rates or lowering them. Lower rates may stimulate call volume and lead to more efficient use of the network. Given an elastic demand, total revenue from the route would rise with a fall in price and thus the company would continue to recover its costs. If demand is inelastic, lower rates would still tend to stimulate traffic volume, but not in sufficient quantity to fully offset revenue lost from the rate decrease.

An interesting aspect to the problem of low-volume routes that result in high rates per call is that the marginal cost of a call on these routes may be relatively low and certainly lower than the average cost. For example, a 50-pair cable route using carrier equipment contains the potential for 1,200 channels (each pair being converted to 24 channels). If currently 721 channels are "in use," there is excess capacity of 479 channels. Assuming the carrier equipment is added only as additional units of 24 channels are needed, the existing equipment is capable of providing 744 channels and the marginal cost (of the transmission facilities and circuit equipment) for call volume requiring an additional 23 channels (744 minus 721) is virtually zero, consisting primarily of minimal power costs. For an additional 24 channels to provide 745 to 768 channels, the marginal costs will consist of the carrier equipment needed to convert another pair of wires to carrier facilities. A route with this type of excess capacity will have low marginal costs and will have average costs that tend to decline over the range of the cable capacity. By comparison, marginal costs on routes of high volume and limited excess capacity may have entirely different dimensions, depending in large part on the costs of providing additional facilities.

Access Charges and Intra-Company Settlement Procedures

The costs involved in intraLATA toll are essentially the same type of costs assigned to interstate access charges. They are also the same costs, in most cases, that would be considered in computing intraLATA access charges. There are, of course, some exceptions. For example, transmission facilities used between two exchanges in two different towns for a call that is considered a local call would be part of the transport element of the intraLATA access charge, but because a local call is involved, would not be part of a toll route cost for the local exchange company.

Access charges for intraLATA toll will be needed if competition is allowed into the LATA. To prevent price discrimination among competitors, these access costs must also be assessed against the local exchange company for its intraLATA toll services.

The procedures used for determining access charges need to be uniform among the local exchange companies since they may compete with each other for some routes. Even if competition is not allowed within the LATA, route-specific cost studies done in a uniform manner by all local companies may be needed, depending on the type of intercompany settlements procedure in place.

An originating responsibility plan (ORP) calls for the local company that originates the call to collect the revenue and, in turn, pay other local companies for the use of any of their facilities that the call travels over. Implementation of this plan involves pricing each segment of each local company's intraLATA toll facilities so that each company is fairly compensated. Thus, commission-approved route-specific analyses are needed.

It should be noted that some degree of pooling is compatible with route-specific costing. Specifically, if it is determined that an intraLATA universal service fund is needed, then that assessment can be collected from all firms using the toll facilities in addition to the actual costs. Route-specific cost studies will enable a commission to identify whether such support is needed, where it is needed, and how much is needed.

In most states (those that have allowed intrastate interLATA competition) there currently exist two levels of access charges--one for interstate toll and one for intrastate interLATA toll services. The institution of intraLATA competition will mean a third level of access charges is needed. It is administratively easier to set all three levels of access charges at the same level. This may ease enforcement and measurement problems related to identifying access revenue due from each type of service. In addition, since all three toll jurisdictions essentially use the same facilities in the same way, it is economically sound to charge the same rate for access. However, neither political level (state or federal) is likely to allow the other jurisdiction to set all access charges.

The option exists, of course, for state regulatory commissions to duplicate the existing interstate access charge for intraLATA purposes. But it is not at all certain that this is a reasonable course for several reasons. First, the legal responsibility of the state commission is to see that regulated companies recover their costs in a just and reasonable manner. Differences in market forces and other factors among states may mean that the interstate access charge may not reflect individual state cost conditions in all cases. Second, legitimate differences of opinion may exist regarding the proper definition and calculation of these costs. Third, rates of return and depreciation rates may be different in the state and federal jurisdictions. These reasons argue in favor of states deriving intraLATA access charges based on state-derived costs. Finally, it is also useful to note that the current level of interstate access charges when translated into rates for intraLATA calls, may generate rates that do not equal existing intraLATA toll rates. That is, rates for some routes may be higher than current rates, and for other routes lower. Therefore, using the interstate access charge rates would bring about changes in intraLATA toll rates that did not result from cost studies defined by the state regulatory commission.

Conclusions

Route-specific cost studies can be performed in various ways with many different degrees of precision. In general, consideration is given to performing route-specific cost analyses when the question of competitive entry arises. Yet, there are other reasons and uses for route-specific cost studies. An important use is simply to provide good information regarding the existing cost-price relationships. Performing such a cost study also gives a commission staff broader knowledge of exchange company operations which is useful for many policy questions. Route-specific cost analyses may also be useful for designing and implementing systems of intra-company settlements. They will provide information on whether pooling is needed and, if so, to what extent, and will give good definitions of high cost and low cost routes in each LATA..

Finally, route-specific cost analyses may provide good data on whether a LATA has demand and cost conditions such that it is likely to develop a competitive market that can ultimately be deregulated, or whether it is more likely to have only limited entry on selected routes or for selected services.[3]

Markets require a long time period to develop to a stabilized structure. Therefore, if a policy of open entry is adopted it should be recognized that it will be several years before definitive information is available to determine whether there is a competitive market, or an essentially monopoly market with some fringe competitive activity. Given the time required for a market to develop to its stabilized structure and the probability that initial competitive activity will occur primarily in selected submarkets, open entry should not be considered to imply a need for deregulation. Deregulation of a market that is not fully competitive creates the potential for price distortions, cross-subsidies and loss of

[3] A report by the California Public Utilities Commission, Competition in Local Telecommunications (May 1987), addresses the use of scenario modelling as a technique for estimating the effect of various regulatory strategies. This is a case where route-specific cost data would be particularly important as input data to the models.

economic efficiency. A policy of open entry accompanied by reduced or flexible regulation, however, can achieve some positive goals.

An open entry policy for LATAs that might be capable of competition will allow the commission to develop data bases and track the activities of competitive entrants, thereby developing the information needed to make a final decision regarding the nature of the market. Retaining regulatory oversight gives the regulator the tools needed to prevent cross-subsidies and predatory practices. Flexible regulatory and pricing policies for the local exchange company give the regulated company a more equal footing on which to compete. Flexible pricing involving banded rates or minimum rates will give proper price signals to competitors and give good information on competitive activity, but only if the prices are reasonably related to actual costs. Route-specific cost studies, whether fully distributed or marginal cost, will be particularly helpful in setting new and flexible rate structures. This report is intended as a start in those directions.