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FOREWORD

The objectives of the Eighth NARUC Biennial Regulatory Information Conference were to promote the sharing of knowledge and experience among the staff of NARUC member agencies and to introduce new concepts and techniques of regulatory analysis. With the participation of most NARUC staff subcommittees and the attendance of nearly 400 persons from 40 states and one foreign nation, the Conference, which was held in Columbus, Ohio, September 9-11, 1992, easily accomplished those objectives. The papers presented at the BRIC-VIII Conference are reproduced here in four volumes.

Volume I: Electric and Gas
Volume II: Telecommunications
Volume III: Multi-Utility
Volume IV: Water

Within each volume, papers are arranged by Conference session. I believe that you will find these papers to be of high quality and of great use to the regulatory community.

The success of the Eighth NARUC Biennial Regulatory Information Conference was due in good measure to the work of the co-sponsors which are, in addition to the NRRI, NARUC, the NARUC Committee on Finance and Technology, the Ohio Public Utilities Commission, and the NARUC Staff Subcommittees. Special thanks should be extended to Chairman Lawrence Ingram of the New Mexico PSC (the representative of the NARUC Committee on Finance and Technology), Chairman Craig Glazer of the Ohio Public Utilities Commission (the host commission), the chairpersons of the NARUC staff subcommittees who suggested the topics for sessions, the session chairpersons who selected papers, organized sessions, and provided on-site session management.

We would like to express our appreciation to Joseph Swidler and Chairman Steven Fetter of the Michigan PSC, who provided luncheon remarks. Our thanks for a job well-done are extended to Wendy Windle, Debbie Daugherty, Mike Milush, Julie Nicolosi, Brett Bergefurd, and Joan Marino of the NRRI staff. Without the support of these dedicated individuals, the conference would not have been possible.

David W. Wirick
The National Regulatory Research Institute

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PRICE CAPS IN NORTH DAKOTA: "TRICKLE-UP" ECONOMICS FROM US WEST

BY
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Introduction

In July of 1989, after extensive lobbying, advertising and marketing by US West, the North Dakota Legislature amended the telecommunications law by adopting Senate Bill 2320 (SB2320) to remove all telecommunication companies from "rate and rate of return" regulation by the Public Service Commission. The bill attempts to set forth a means of alternative regulation through the use of price caps. From its inception, the bill has been highly controversial and remains so today. Proponents of the bill, particularly US West, argued that traditional regulation was burdened with red tape which slowed unecessarily the introduction of certain "non-essential" services. By deregulating the ceiling price of the non-essential services while price capping the remaining "essential" services, US West and its supporters argued that SB2320 would result in reduced rates, more product diversity, increased competition, increased productivity, improved quality of service and stimulation of economic development. After three years of implementation by the Public Service Commission, quite the reverse has occurred. This article addresses the subject in two sections. The first section discusses the background and major events associated with SB2320. The second section presents the terms and conditions, technical makeup and results of the price-cap formula.

I. Trickle-Up Ratemaking: Background and Events

Since SB2320 was passed in 1989, basic local telephone rates in North Dakota have ratcheted upwards within the limits of the price cap while local rates in many other states have declined due to declining costs. Statewide retail long distance rates in North Dakota have also increased or remained significantly higher than other states after US West predicted they would decline with SB2320. Since profits of price-capped companies are immune from scrutiny under SB2320 and no profit sharing mechanism is required, US West and others have avoided tests of what direction their costs are trending in relation to their rates. However, extensive analysis in hearings and before legislative bodies has provided detailed confirmation of the rate comparisons cited above between North Dakota and other states, as well as among companies in North Dakota. Rates in North Dakota have been increasing and are expected to continue rising due specifically to the price-cap regulation provided for under SB2320.

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[1] The author was previously Director of the Public Utility Division in North Dakota and is now Director of Utility Analysis at the Indiana Office of Utility Consumer Counselor. Viewpoints expressed in this article do not necessarily represent the official position of either agency.

A Seller's Market

One event, the sale of a company, was particularly illustrative of rate increases under SB2320. In this case the stock market provided an independent measure of profit based on the gain on sale. With very low costs and rates ($5.00 for residential service) due to very high customer density, a company owned by Northern States Power Company was sold to Rochester Telephone Company at about three times the value of the market to the book value, about $48 million to $16 million. At the time of the sale, the company also exercised an option to switch from rate-of-return to price-cap regulation, which required examination of its initial rate level. The offered purchase price of $48 million from the buyer was a consequence of expected revenues from the price cap as well as an initial price and revenue level that reflected in excess of 30% return on equity. The sale was approved by the Commission. The sale transferred permanently the potential benefits of low costs and rates from ratepayers to stockholders of the selling company and the tax coffers of North Dakota.

The selling company, Northern States Power argued that under SB2320 it deserved the $32 million before-tax gain on the sale as an incentive reward for above-average performance. It claimed credit for the efficiency associated with the high density of customers and argued that the unusual low initial price level was a result of superior management while under rate-of-return regulation in prior years. Now that the company was under price-cap regulation per SB2320, it argued that the $32 million difference between the offered market price and the book value of the company corresponded with the significant difference between its low retail rates and the higher retail rates of other local exchange companies in the state. In other words, as long as rates were low, current excess profits should be allowed and in the case of a transfer, a $32 million capital gain should also be allowed. According to Northern States, this was the intent of SB2320.

The buying company, Rochester Telephone Company, argued that new administrative jobs would result from the sale. It also predicted increased productivity due to the buyer's extensive expertise in telecommunications. No new administrative jobs ever materialized after the sale. In a subsequent hearing associated with productivity and the price cap, Rochester claimed that it should receive a lower productivity rating (and higher price cap), generally the opposite of its claims made earlier when supporting purchase of the company. Meanwhile, Rochester management has repeatedly referred to some part-time minimum wage jobs associated with a centralized lodging reservation service as evidence of economic development caused by its advanced technology - primarily a digital switch - despite that that technology was there before the sale occurred and before the company was subject to price-cap regulation. In addition, several hundred thousand dollars from the gain on the sale had been set aside by the Commission specifically for economic development and was spent instead on consulting fees to lobby for the continuance of an air force base that was never threatened with cancellation anyway.

In sum, the ratepayers of Rochester (now Minot Telephone Company) under SB2320 have experienced and are guaranteed to see higher rates by financing a $32 million capital gain. Ratepayers have born the full risk of the transaction. Based on the $48 million purchase price, Rochester is under earning in the early years. Should it experience financial difficulty, it can always invoke the obligation to serve as a reason for raising rates even higher than the price cap limits. The Commission would have no recourse to the $32 million gain to offset the consequence. Most importantly, incentives and rewards associated with the price cap in this case have no resemblance to the common form of alternative regulation associated with price capping. Unlike potential gains from cost reductions or potential losses from cost increases, the interpretation of gains in this case results in an entirely different outcome - a gain instead that arises from conditions irrelevant to performance.

<u>The Price of a Pizza</u>
A common practice by US West when supporting SB2320 is to cite comparisons of its residential service rate to commonly known items such as the price of a pizza. This was particularly apparent when convening "community groups" to market alternative regulation in the form of SB2320. An interesting comparison of this practice is with the situation above, where Northern States compared itself to companies like US West to justify a claim to the $32 million capital gain. While US West claims that its residential rate is no more than a pizza, Northern States claims that its rates are effectively half that of a pizza. Both have strayed from profits towards arbitrary criteria to portray themselves as reasonable under price capping. If Northern States were held to the "pizza standard," then its rates appear to reflect superior performance (instead of high density) and the rates of US West appear about right (based on average performance). Of course this begs the question of whether US West is actually inefficient instead of Northern States being efficient. If so, then US West rates should be reduced instead of gains going to Northern States and the pizza standard should be rejected. The approach is obviously circular and will remain so as long as the intial price level is confused with the incremental price cap (by Northern States) or either is discarded and replaced by the price of pizza (US West).

<u>Monopoly is Competition</u>
Towards the end of the longest hearings ever held in the history of the Commission, US West sponsored a profound position associated with competition and non-essential services. After two years of extensive analysis in related, lengthy hearings to set the annual price cap for essential services, US West suddenly decided that the price cap was useless if competitive entry was allowed into the non-essential market (basically intra-LATA toll). US West claimed that its toll service was subsidizing local service. If entry was allowed into the non-essential market, US West threatened that essential service rates must be increased far beyond the current price cap to offset the subsidy. (Recently US West told a legislative committee that flat-rate local service would have to

increase to $35.) With this proclamation, US West revealed its plan to be an unregulated monopoly. Subject to serious competition only in the intra-LATA toll market, this meant there was no significance to the original division between capped "essential" services and uncapped "non-essential" services that formed the basis for the price cap and alternative regulation in the first place. In other words, US West had succeeded through SB2320 in deregulating its own non-essential prices but now intended to block entry by competitors. To demonstrate its sincerity, US West insisted that competition already existed in the non-essential market while also providing updated calculations of revenue losses caused from predicted loss of market share should market entry be allowed. Meanwhile, monopoly rates for essential services were locked in with periodic increases above costs under the auspices of a price cap. (Recently, the Commission ordered 1 + Equal Access throughout North Dakota. Not suprisingly, US West advised the Commission that it does not have the legal authority to issue this order.)

Passing Through

The issue of inside wire and US West serves up a most interesting before-after picture under SB2320. SB2320 came into being just after inside wire had been deregulated and its depreciation expense was accelerated and amortized over five years. Therefore the initial price level of US West included this depreciation expense. Under SB2320, the price cap of essential services was supposed to be changed up or down within thirty days to reflect any mandated cost caused by government mandate. Since US West first went under the price cap in 1989, the five-year depreciation expense period expired. An argument was made before the Commission that this expense reduction, worth about $2 million a year, was the consequence of a government mandate and should be passed through the price cap as intended by SB2320. US West countered that since the original mandate occurred before the price cap went into effect and appeared as an increase in cost, that the subsequent cost reduction was merely the last half of the full procedure. By counting first the increase and then the decrease as part of the same mandate, US West argued that the full effect of the mandate cancelled out and that no pass-through of the reduction was required. The Commission ruled in favor of US West and the price cap continues to reflect the annual $2 million despite the absence of the underlying expense on the books of US West.

Two-Bit Competition

An equally interesting before-after picture occurred with this company whose pay telephone rates were trapped in the price cap at $.15. The company is Rochester (Minot Telephone Company) described above. Before SB2320, the law allowed the entry of private pay phone operators into the market. With a few minor exceptions, Minot Telephone ended up with one major competitor, a single-person company who set up phones in high-traffic areas and charged $.25. It was a case of classic cream skimming because Minot Telephone was forced to serve everyone while the one competitor could pick and choose desirable locations. However, Minot Telephone charged only

$.15 because it knew if it attempted to request a rate increase for only its pay phones, its excessive rate-of-return on equity, around 30%, would be questioned by the Commission. Meanwhile, Minot Telephone converted from rate-of-return to price cap regulation which put the $.15 pay phone charge into an entirely different category, meaning in general that the rate was stuck at that level and could not be changed without an extensive hearing designed to deregulate the service in question based on effective competition. During this same period, Minot Telephone complained to the Commission that its only competitor was competing unfairly because it could charge a higher rate of $.25. The competitor was offering various owners of establishments such as bars and pizza parlors a commission from the $.25 charge. Minot Telephone could not compete because the percent offered from a $.15 charge was too small. SB2320 had succeeded in contributing to a situation where a company was losing market sharing due to its competitor charging more than it was for the same service.

Cross Subsidy Coup

Among the most obvious errors of SB2320 was a design that literally encourages the cross subsidy of non-essential and deregulated services by essential services, despite explicit language to the contrary. The error is immediate and obvious in the formula that sets the price cap, presented later, caused by setting the cap above the cost of essential services, however defined. With excess revenue over costs collected from the monopoly services, the stage is set for the classic subsidy of non-monopoly services, in this case non-essential and deregulated services. As if this contradiction is not confusing enough, consider two equally serious complications. First, the usual notion of using some version of long-run incremental cost as a price floor was entertained at length in the hearings, along with the near-impossible tasks of seperating common and joint costs under multi-product conditions. These are the types of solutions for cross-subsidy that tend rarely to develop beyond the initial idea, lost long before in a tangle of assumptions, application problems and legal snafus. Ironically, these are also exactly the type of problems that price-cap regulation was designed to solve instead of exacerbate. Second, US West has one-upped the entire issue anyway with a counter claim that the subsidy is indeed occurring, but in the opposite direction from non-essential to essential services. Although the law does not prohibit a subsidy in this direction, US West claims a threat to its financial integrity if the revenues from the non-essential services are threatened with competition. Since US West does not have to provide its profits necessary to prove whatever is occurring, it has scored a coup with the cross-subsidy issue. While claiming a subsidy in the opposite direction and blocking competitive entry, it can maintain excess rates of both essential and non-essential services. If competitive entry occurs, it can then practice cross subsidy from essential to non-essential services.

II. The Formula, Conditions and Results

All telecommunication services were seperated into two categories, essential and non-essential. Essential services were made subject to an annual price cap set by the Commission beginning January 1, 1990. The prices of non-essential services were deregulated. Essential services consist primarily of local service (flat rate) and toll access service to interexchange carriers. Non-essential services constitute primarily end-use intra-LATA toll service. Beginning price levels of essential services in effect as of July 1, 1989 were deemed fair and reasonable subject to a rebuttable presumption. All companies were subject automatically to price-cap regulation as of January 1, 1990, however, any company could actively elect to convert back to rate-of-return regulation.

For toll access service, the law covers all 29 local exchange companies in the state which have a total of 317,554 access lines. For local service and toll access service, the law covers three investor-owned companies with a total of 251,751 access lines. The local rates of 26 municipals are not regulated by the Commission. For 28 companies which have less than 50,000 access lines, the option to convert from price capping back to rate-of-return regulation is reversable. Subsequent options to switch back and forth are unlimited. For companies with more than 50,000 access lines, which is only US West with 227,808 lines, the option to convert back to rate-of-return return is a one-time, irreversible choice. Governmentally imposed surcharges must be reflected in essential service rates within thirty days.

Below is a comparison of the three investor-owned companies to the municipalities by number of access lines. For the two investor-owned companies under price-cap regulation, total annual operating revenue estimates and representative residential rates are included. Following that is a second comparison of annual revenue increments between the two price-cap companies.

IOU'S	ACCESS LINES/REVENUE/RES RATE
US WEST*	227,808/$64 MIL/$13.90
MINOT TELCO*	22,079/$4.4 MIL/$5.00
GTE	9,864
MUNICIPALS (26)	57,803

*SUBJECT TO PRICE CAP REGULATION

MAXIMUM INCREMENTAL ANNUAL REVENUE IMPACTS FROM PRICE CAPS FOR LOCAL SERVICE AND TOLL ACCESS SERVICE

	US WEST		MINOT TEL CO	
	LOCAL REV	TOLL	LOCAL REV	TOLL
'90	$1,048,675	$157,874	$52,130	$35,689
'91	$734,857	$110,630	$89,392	$61,199
'92	$870,845	$131,102	$105,934	$72,524

The price cap for essential services is determined by the following formula and definitions:

$$ETPF = ICI - (.50)PIA$$

ETPF = "ESSENTIAL TELECOMMUNICATIONS PRICE FACTOR"

= ANNUAL PERCENT CHANGE IN UNIT PRICE

ICI = "INPUT COST INDEX"

= ANNUAL PERCENT CHANGE IN UNIT COST

PIA = "PRODUCTIVITY INCENTIVE ADJUSTMENT"

= ANNUAL PERCENT CHANGE IN UNIT PRODUCTIVITY

An example of the price-cap formula applied to an initial price appears as follows:

ICI = .04

PIA = .02

INITIAL PRICE = $10.00

ETPF = ICI - (.50)PIA

= .04 - (.50).02

= .04 - .01

= .03

ANNUAL PRICE INCREASE = (.03)$10.00

= $.30

NEW ANNUAL PRICE = $10.00 + $.30

= $10.30

The actual values of the price cap for essential services and its determinants appear as follows:

ANNUAL% INCREASES: '90-'92

	ETPF	ICI	PIA
'90	.02005	.0463	.0525
'91(I)	.01405	.0428	.0575
'91(II)	.02124	.0428	.043125
'92(I)	.01665	.0454	.0575
'92(II)	.0238	.0454	.043125

* PIA"II" = 75% OF PIA"I"
ETPF(II) = ICI(I) - (.50)PIA(II)
ETPF(II) > ETPF(I)

The difference between PIA I and PIA II above is based on a conclusion by the Commission that the 26 rural municipal telcos have lower incremental productivity than the three IOU's, caused by significant differences in technology and demand.

Three Fatal Flaws

The price cap formula reflects three fatal design flaws and three other problems not necessarily fatal but very difficult to correct. The fatal flaws mean that the price cap cannot possibly function to achieve its stated regulatory goals at the outset and instead actually subverts these objectives - protecting consumers, fostering competition, stimulating economic development, increasing productivity and reducing regulatory burden. The fatal flaws appear as prima facia evidence of failure and need no time or test to be proven. The fatal flaws are:

1) Company-Specific Productivity

Argued vehemently by US West as the letter of the law, this assumption causes an absurd regulatory result. As company productivity increases, the price cap declines and as company productivity decreases, the price cap increases. Therefore the company is rewarded for being inefficient and penalized for being efficient.

2) The Flip-Flop Factor

Explained in the introduction, this is the description of a company's ability to switch back and forth between price-cap regulation and rate-of-return regulation (for 28 companies) or switch only once, back to rate-of-return regulation for US West. Again, the regulatory result is absurd. If a company incurs increasing costs, it can shift to rate-of-return regulation to recover all costs while earning normal profits. When costs are decreasing, it can shift to price-caps to recover above-normal profits. The risk for loss is always born by ratepayers which are also denied the opportunity of gains above normal profits.

3) The 50% Factor

The price-cap formula is designed to subtract 50% of the productivity increase from the input cost index when calculating the price cap. If 100% of the productivity was subtracted instead, the price cap could then reflect accurately the increase in costs under ideal conditions. Since only 50% is subtracted, the price cap rises significantly higher than costs each year, compounding geometrically upwards. Again, the regulatory result is absurd. Instead of reflecting changes in costs, the price cap formula generates a growing windfall of revenue above cost.

Other Flaws

These three fatal flaws preclude the price-cap formula in North Dakota from any serious consideration as a candidate for alternative regulation anywhere except North Dakota. To date, the Commission has overcome one of the flaws, that of company-specific productivity, by replacing it with a broader measure that prevents the absurd result when own-company productivity is used. However, the appelate court has ruled that company-specific productivity could have been allowed under the law. Even if this problem were resolved, the general issue of estimating productivity for the setting of the annual price cap has dominated all other issues in every respect; time, expense, controversy and use of expert witnesses. Where a measure of the input cost index (ICI) was readily agreed upon (the Gross National Product Price Index), the productivity incentive adjustment (PIA) emerged as an unending contenscious debate. In general, US West insisted on an historical measure, which yielded a lower estimate and higher annual increase in the price cap. The opposing witness for Commission staff insisted on a three-pronged approach that included history, the future and conditions specific to North Dakota, all of which resulted in a higher estimate and lower annual increase in the price cap. A second issue requiring less time, but no less contenscious, was the 50% factor. Charges were repeatedly exchanged that the productivity estimates were modified to offset this obvious flaw. Unbelievably, the 50% factor was presented to the legislature by US West as a "sharing" factor that split the savings from price capping between ratepayers and stockholders. Instead, it actually raised the price higher than would have occurred had there been no savings at all. Two other major problems with estimating productivity were; (1) the necessity of estimating together the productivity of essential and non-essential services together, when the correct specification was only essential services, causing a serious underestimate of the economies of scope associated with essential services; (2) the lack of total factor productivity estimates, which were replaced by biased employee productivity estimates.

Conclusion

The price capping of telecommunications services in North Dakota under SB2320 has proven to be an unambiguous failure by any reasonable standard of regulation. Had the law and subsequent implementation appeared with a cohesive purpose, structure and consistency, this article would have dwelled on the usual issues that stem from specification and estimation problems which usually surround price-cap issues. Instead, the focus was placed necessarily on the development of particular events and obvious design errors in an attempt to explain the bizarre outcome of the law known as SB2320. In hindsight, perhaps the most important missing factor was the lack of independent advocacy on behalf of North Dakota ratepayers to monitor and respond to the efforts of US West when lobbying the legislature for SB2320. US West essentially bypassed the Commission and ended up with a morass of detailed regulation embedded in legislation which paralysed and prevented the Commission from mitigating even the major damage caused by the bill. Perhaps an independent advocate could have moved freely and objectively to present the obvious evidence in time to modify or cancel the bill.

Despite its problems, two clear benefits of SB2320 may still appear. First, other states can heed the lesson and need not repeat the obvious mistakes of three years of price-cap regulation as practiced in North Dakota. Second, regardless of all the compound errors in SB2320, North Dakota may still redeem itself with a distinction as the first state in the nation to achieve true intra-LATA toll competition through 1 + Equal Access, in spite of US West claims that this is an illegal act by the Commission. Perhaps it is the only reasonable act left to salvage the impact of US West under SB2320.

COLLABORATION AS AN ALTERNATIVE TO REGULATION AND COMPETITION IN OHIO TELECOMMUNICATIONS NETWORKS

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Telecommunications technology, markets, and policy form a linked trio where changes in any one both affect and respond to changes in the others. We believe most observers have had two frameworks in mind for thinking about the future development of this trio; those frameworks are competition and regulation. In the US, the regulation framework has relied on notions of public goods, natural monopoly, private ownership, and judicial process. The competition framework has gained in strength as technology and markets have changed.

While regulation and market competition will continue to be dominant paradigms, we propose a third framework for thinking about the future development of telecommunications networks: collaboration and cooperation. We argue that this framework is appropriate in some circumstances and sometimes can lead to improved outcomes. Because our knowledge is richest about Ohio's experiences and because we wish to be as specific as possible, we focus on Ohio examples, but we believe the ideas would be widely applicable.

We first address the question of why consider cooperation and collaboration and when these are likely to be useful alternatives. We then discuss four types of collaboration and cooperation that are occurring in Ohio: collaboration between industry and government, particularly in the regulatory process; collaboration among telecommunications companies; collaboration among telecommunications users; and collaboration among telecommunication providers and telecommunications users. We also discuss a process we are exploring at CAST to use dialogue among government, telecommunications providers, telecommunicaitons users, university researchers, and citizens to encourage collaboration and cooperation.

We bring backgrounds as professors of industrial engineering and communications to these issues. Because we are not steeped in the traditions of regulation, we believe we may bring fresh perspectives.

Why cooperation and collaboration? -- And when?

The case for cooperation and collaboration can be argued simply as alternatives to regulation and market competition. Rather than relying on models that have not always worked, we should have other models in mind; just as regulation and competition are appropriate sometimes, so will be cooperation. However, this line of argument, requires that we would need to demonstrate situations where regulation or competition cannot work in order to make a case in support of collaboration.

We believe, rather, that a positive argument can be made for cooperation and collaboration, including the fact that better outcomes can sometimes be obtained by cooperating and the fact that cooperation and collaboration are more common than might appear at first glance.

Two books by Alfie Kohn provide evidence for these points. In *No Contest: The Case Against Competition* [1], Kohn presents evidence that most people work better without the pressure of competition. Recent management trends seeking to improve quality emphasize the use of teams of workers, and the elimination of work standards, annual reviews, and competitive bidding from one's suppliers. In *The Brighter Side of Human Nature: Altruism and Empathy* [2], Kohn argues that people are naturally more cooperative than we might think.

Both of these points may be more widely accepted as applying *within* an organization, but less so *between* organizations. The norm is cooperation within an organization and competition between organizations.

However, an examination of how companies actually function shows the latter norm is often violated. Organizations such as the Chamber of Commerce and trade associations provide evidence that companies recognize that they do need to work together on many issues. Chambers, and other organizations, are networks of businesses, even some that might be competitors. Often such groups focus on economic development, recognizing that a rising tide lifts all ships, that is, their

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1 Boston: Houghton Mifflin, 1986.
2 New York: Basic Books, 1990.

fates are linked. Increasing alliances among businesses, discussed later, also point to cooperation. Indeed, after one examines the way US companies actually operate, one might conclude that it is only the economists who believe that competition is what makes our economy work.

We do need to emphasize that when we suggest cooperation and collaboration as alternatives we are not condoning anti-consumer behavior such as price fixing. Nor do we advocate a centrally planned economy; reduction of competition doesn't mean the government must be involved. We are advocating voluntary cooperation, perhaps urged or at least not condemned by government, but not "forced cooperation."

Assuming we have established the case for considering cooperation and collaboration as alternative models to competition and regulation, when are they likely to occur? One conjecture we raise is that while competition usually occurs between similar organizations or individuals, collaboration is more apt to occur between organizations or individuals which are different.[3]

We also speculate that cooperation requires:
1. two or more participants,
2. mutually beneficial outcomes,
3. compromise and sacrifice distributed fairly among the collaborators,
4. work and responsibility clearly delineated and agreed on (although some haziness combined with trust may work well),
5. a solution (product, process, or issues) unattainable by any one participant,
6. a mutually agreed upon time frame,
7. an evaluation component for assessing the product, process, or decision, and
8. politeness, good faith, and mutual respect of participants.

These ideas are clearly preliminary; they begin to address when cooperation and collaboration may naturally occur, but not when government regulators might want to foster such behavior.

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[3] This point was suggested by Eric Rothenbuhler of the University of Iowa, CAST/NRRI Symposium "Collaborative Strategies for Developing Telecommunications Networks in Ohio: Examples & Frameworks, 2/18/92.

We now discuss four types of cooperation.

Collaboration between industry and government

Not surprisingly the regulators and the regulated approach collaboration and cooperation skeptically. In 1988 the Ohio General Assembly passed legislation which gave the Public Utilities Commission of Ohio (PUCO) authority to consider different ways of regulating local telephone companies. Local exchange carriers were asked to initiate proposals for new forms of regulation. To the PUCO's surprise, no serious proposals were offered. They had expected the LEC's to seek changes in rate structures and procedures known to be cumbersome and outdated. In some respects the siltation was like expecting students to take the lead on educational reform.

PUCO staff initiated its own study of better ways to regulate local telephone companies in 1989, with the help of new comers to the regulatory process, and some fresh thinking about the public interest. In the process they developed an extensive data base upon which measures of company performance could be made and upon which the public interest might be assessed.

In October 1991 the PUCO staff released a proposal for alternative regulation -- the lynch pin of this proposal was to encourage regulated companies to serve the public interest and to provide incentives to companies to meet the public interest objectives. Workshops were held where interested parties were invited to discuss alternative regulation. The first workshop had 65 attenders. The PUCO also initiated talks with individual companies after finding that the local carriers found it difficult to collaborate with each other. Most of the key industry players professed skepticism. The Commission set up small committees of industry groups and established an electronic bulletin board for discussion of the topic (an 800 number was used so that people from all over the state could participate). The PUCO also tried to alter the rules for participation in discussion during the process. Stances of individual participants were not be held against them alter in the process; people could change their position as new information and ideas are shared. This did alleviate the difficulty some individual had in wanting to participate, by not wanting to be thought of as holding an official teleco position. In terms of volume, the bulletin board should be judged a success -- 600 messages in five months.

Although the initial reaction by commission staff was hopeful, the outcome of this stage in a collaborative venture between government and industry was not successful. Consensus was NOT reached on most important points due in large measure to differences between the varying perspectives of the telephone companies of Ohio. Perhaps these companies were too similar to be able to collaborate with each other and with the PUCO on particular matters regarding industry growth.

The telephone companies then circled their own wagons. They made a cooperative attempt through the Ohio Telephone Association (OTA) to find a common ground regarding future regulation. They offered a process-oriented proposal to the PUCO. The essence of this measure was to provide specific guidelines regarding how any company could make a proposal and have the PUCO evaluate it. The companies identified their important dissimilarities in order to find ways to collaborate on an issue of mutual concern -- a change in the procedure for evaluating performance.

The PUCO staff accepted the OTA proposal and used it to propose new procedures for regulating large local exchange carriers in the state. They held hearings throughout the state on this process-oriented proposal. Disagreements remain among the local exchange carriers, between the PUCO and the LEC's and between both of these parties and the Ohio Consumers Counsel. None-the-less the result has been as close to a consensus policy that has ever been reached among the staff of the Public Utilities Commission and the regulated industries. The culture of a regulated company is unique. It is a culture where the norms of behavior and the business environment are dominated by an adversarial decision making processes. The regulatory framework which has developed over the past 50 years and more, is one where the roles of the participants, both regulated and regulator, have been developed with some predictability. Those who regularly participate in this process have told us that our views regarding collaboration in this environment just won't work, or are "way off the mark." Most certainly the attempts at collaboration initiated by Chairman Glazer of the PUCO and other key staff persons would be watched closely. Many collaborative technologies and processes were initiated and several proved valuable to the process.

The other government and industry cooperative processes are happening at the local and regional level. Here we refer to the joint commissions which are springing up across Ohio and elsewhere. These are partnerships and task-forces between government, local and regional businesses and telecommunications companies who are trying to plan for their region's telecommunications' future.

The success of these planning groups have been mixed. The Columbus Area Chamber of Commerce has one such working group that seems not to have made much progress. We have heard several reports that a similar committee/task force in Toledo,Ohio is making good progress.

Collaboration among telecommunication companies

Three separate industries focused on voice, data, and video are colliding. Our notion that differences promote cooperation means cooperation should be rampant, but it is not. We believe that many of the companies have not even realized they are increasingly in the same industry. Cooperation hasn't been common, but is growing.

Also, we argue that increasing emphasis on strategic alliances means that such collaboration is likely to grow. In his book *The Knowledge Link. How Firms Compete through Strategic Alliances* [4], John Badarraco of the Harvard Business School describes two types of knowledge:

*migratory knowledge, which can be packaged, moves easily, can't be protected, and on which a company can't build sustained competitive advantage; and

*embedded knowledge, which is knowledge resident in the people and systems of an organization. It can't be packaged and can't move easily.

Badarraco argues that strategic alliances allow companies to share embedded knowledge and create new embedded knowledge. This is especially important for competing in an economy characterized by uncertainty, short product cycles, and increasing world-wide economic competition. Knowledge links require companies to work closely and cooperatively. These notions may lead a company to rethink what it is: ``The twin principles that firms have boundaries and that these should be kept sharp are basic assumptions in much of our ordinary thinking about firms. They are also ideas whose time may have passed... ."[5]

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4 Boston, MA: Harvard Business School Press, 1991.

5 Badarraco, page 4.

An often cited example of such restructuring may be IBM's current changes. Some observers describe such changes as moving toward what is called a networked firm. In Ohio, the Columbus Cable Co-op has sought to promote collaboration within the cable industry. A local cable company has invested in the Columbus bypass company, although that investment is more an arm's length transaction than a strategic alliance. One recent national example is that IBM and a cable company are nearing collaboration on a two-way interactive information network. Industry forums, such as the Frame Relay Forum, function as alliances among many companies.

We believe that understanding the importance to companies of working together can give regulators an argument for telling companies who seek regulatory action that they haven't done enough for themselves. However, US companies may be deterred from working together informally by US antitrust laws which discourage such coordination, while allowing mergers. In Europe and Japan, bank-led industry groups of independently owned companies are more common.[6]

Collaboration among users

Collaboration among telecommunications users is occurring in professional societies for the purchase of telecommunications services. For example, contractors who are members of the Ohio Builders Exchange receive lower priced long-distance and cellular services by pooling resources. Also, organizations of telecom professionals are cooperative arrangements; in Ohio the Association of Telecommunication Professionals links the network managers of large companies, as well as vendors of telecommunication equipment.

One type of cooperation among users is noticeably lacking in telecommunications. In rate hearings on, for example, electric rates, utility commissions expect to hearing from users, individually and in user groups. This does not occur with telecommunications.

Collaboration among providers and users

Collaboration among telecommunication providers and users of telecommunications services and technology enables providers to become more oriented toward user needs and thus more successful. Undergraduate students in a

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[6] We thank Robert Loube, Telecommunications Economist, Public Service Commission, District of Columbia, for pointing out to us the possible effects of the differences in laws.

senior seminar in telecommunications have been documenting cases of collaboration in Ohio networks in three areas: distance learning, economic development and health care. Among the cases which we have identified are a collaborative demonstration project involving Ohio Bell, GTE, Ohio University and two school districts in Southeastern Ohio. This joint venture installed an interactive, fully digital distance learning network. The cable television companies throughout Ohio are promoting their new and expanded service of "Cable in the Classroom." Typical of these projects are the cable drops to all public schools in the Columbus School district by Warner Cable and Coaxial Cable companies in collaboration with each other and the school district.

Collaboration among telecommunication providers and users of telecommunications services and technology enables providers to become more oriented toward user needs and thus more successful. Undergraduate students in a senior capstone seminar in telecommunications (Communication 659) have been documenting cases of collaboration in Ohio networks in three areas: distance learning, economic development and health care.

Among the cases which we identified in distance education are a collaborative demonstration project involving Ohio Bell, GTE, Ohio University and two school districts in Southeastern Ohio. This joint venture installed an interactive, fully digital distance learning network. The cable television companies throughout Ohio are promoting their new and expanded service of "Cable in the Classroom." Typical of these projects are the cable drops to all public schools in the Columbus School district by Warner Cable and Coaxial Cable companies in collaboration with each other and the school district. Whittle's Channel One, a commercial news and public affairs network for high school students, was also investigated. With educational establishments in varying states of crises, a host of collaborative ventures to facilitate improvements in student learning have emerged. They will continue in the future.

In the area of economic development, two collaborative efforts between telephone companies and housing developers were singled out for study. In one project, Jefferson Meadows, Ohio Bell used glass fiber to bring broadband services to the home, while in New Albany, ISDN with twisted pairs of copper wire were used to bring enhanced service to this up-scale housing development. The collaboration between cable operators and telecos in Cleveland is another example of companies working together for the mutual benefit of users and service providers. These collaborations are seen by the participants as stimulating the economy, both for themselves as businesses, but for future applications as well.

In the health care area, students wrote case studies about several interesting collaborations between hospitals, physicians and patients. The Ohio State University's "ask a nurse" program connects people with needed information; OMEN and OMEN-TV are networks constructed to facilitate continuing education needs of physicians throughout Ohio. Internal hospital networks, like the one at Riverside Hospital, produce video tapes for patient education which can be shared with other facilities. We expect that there will be continued growth in collaboration in the health care field.

These three areas, economic development, health care and education, are the places to watch for increased activity and increased collaboration. They are areas where telecommunication firms can expand their businesses, but they will require strategic alliances with companies and governments who hold unique expertise and knowledge.

CAST's Symposia

In October 1991 and February 1992 CAST, The Center for Advance Study in Telecommunications at Ohio State University sponsored two symposia. The sponsorship was a collaboration with the National Regulatory Research Institute (NRRI). The first symposium was titled "Assessing Priorities for Ohio Telecommunications Networks." It provided a forum for examination of the possibilities for collaboration among Ohio telecommunication service providers, government leaders and academic researchers. The outcomes of this symposium included a proceedings document which features the work of six scholars[7]; an electronic bulletin board available to people throughout the state OH.CAST for continued dialogue on the problems and opportunities of telecommunications networks in Ohio and; increased interest and acknowledgement that there were projects, policies and issues of collaboration occurring in Ohio and elsewhere.

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7 Assessing Priorities for Ohio's Telecommunications Networks, Center for Advanced Study in Telecommunications (CAST), The Ohio State University, 1991.

In the second symposium, "Collaboration for Telecommunications Networks in Ohio" sought to provide examples of projects, policies and issues which were being implemented by Ohio companies and organizations. Chairman Craig Glazer talked about the PUCO's efforts in this regard and speakers from NRRI, the Consumers Counsel, Chamber of Commerce, cable and telephone industries provided analyses of specific projects and or processes. Eric Rothenbuhler, CAST scholar in residence, observed that actually two separate issues were being discussed -- one about cooperation or negotiated approaches to regulation, and one about cooperation or strategic alliances among businesses. We all learned that the processes of collaboration are difficult ones, particularly among competitors for similar services, and among participants who have had a long history of adversarial relations.

Our next step will be a third symposium, focusing on networks at Ohio State. We believe it is time to make our ideas more concrete and we think a focus on a particular set of networks might help. OSU's telecommunications infrastructure is a microcosm of the telecommunications world. OSU has voice, data, and video infrastructures, but often the technologies and the people in each domain function separately and sometimes at cross purposes. We face debates about who should pay for innovations to various networks and who will benefit. In our calls via CAST symposia to promote cooperation and collaboration in building Ohio telecommunications networks, we may have been slow to realize that our own backyard, even our front yard, are not in very good shape.

At our next symposium, we plan to use experts both on and off campus to advise us as to how our networks should be designed, employed, managed and financed. How should OSU be using wireless communications, perhaps for voice or data? How should the costs of large, central technologies be allocated among users? We believe business and government have much to offer us in designing our own telecommunications networks.

Finally, we hope that the loop can be closed and that, in helping OSU to develop processes and technologies top create an integrated telecommunications environment, the participants will then apply these lessons to Ohio, indeed to the world. We hope that CAST can help OSU to become a demonstration of how new telecom technologies can be integrated -- a demonstration which will show the value of collaboration as one process for building the future infrastructure.

Conclusion

When an industry's future is in turmoil, then involvement with a decision and all its implications and ramifications increases in importance and increases the time it takes to evaluate information pertinent to the decision. This should not increase the time it takes to be cooperative, though. The future demands that we plan carefully. History teaches us that in telecommunications, the actions of the present and past are embodied in the future. If anyone thinks that collaboration is a useful process, project, or issue for the future, than it needs encouragement and implementation now. A failure to pursue collaborative efforts now may close the door to collaborative efforts in the future.

Privatization And Regulation In International Telecommunications

BY

Labros E. Pilalis

INDIANA UTILITY REGULATORY COMMISSION

I. INTRODUCTION

The present paper deals with issues relating to the privatization and regulation of telecommunications services that are provided by government-owned enterprises in the international arena. Since the early-1980s, there has been an increased movement towards the privatization of government-owned telecommunications services providers in various countries. This movement has been prompted by the desire of various governments to modernize their respective national telecommunications networks and to meet the growing demand for various domestic and international telecommunications services in an economically efficient manner. Furthermore, various foreign governments have viewed the privatization of state-owned telecommunications service enterprises as a laudable political goal of economic liberalization that also incorporates substantial benefits for their respective governmental budgets.

The privatization of foreign government-owned telecommunications services providers has invariably been followed by the introduction of competition (or attempted introduction), in the telecommunications services markets formerly served by the state-owned enterprises. There is, however, a vital link between the economic viability of newly privatized state-owned telecommunications providers and the development of competition in individual national and transnational markets for telecommunications services. This link is the maintenance and enhancement of the "universal service" concept. In countries with low telephone penetration rates, and with state-owned telecommunications providers that are undergoing privatization, the presence of competition may pose a threat to the attraction of investment capital for network expansion and modernization.[1] Consequently, the international privatization of state-owned telecommunications enterprises and the development of competition in the provision of telecommunications services in various national markets are taking the character of a "managed transition."

This "managed transition" to privatization of government-owned telecommunications enterprises and competition is increasingly being undertaken with the oversight of national regulatory bodies. These regulatory bodies have been or are being created by foreign governments as a result of telecommunications privatization and competition laws. Such regulatory bodies are either structurally independent (similar to the Federal Communications Commission), or constitute an integral part of a national governmental ministry responsible for telecommunications. A similar approach appears to be taking hold even

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[1]The Economist: A Survey of Telecommunications, Vol. 321, No. 7727, October 5, 1991, p. 13 (hereinafter referenced as The Economist Telecom. Survey-1991).

when a state-owned telecommunications enterprise is restructured so that it attains financial and managerial independence while its governmental ownership is essentially maintained.[2] The establishment of these regulatory bodies as separate and distinct entities from the state-owned telecommunications enterprises is considered a key ingredient to the success of privatization and competition by the international investment community.[3]

These regulatory bodies are assuming an increasingly important role in the formulation and implementation of national telecommunications policies. Such policies tend to affect not only individual national markets for telecommunications equipment and services, but they also tend to create effects that transcend national boundaries. Correspondingly, certain national regulatory bodies are also called to implement transnational directives on telecommunications policy, e.g., such as the implementation of telecommunications policy directives of the European Economic Community (EEC) by its member states.

II. PRIVATIZATION AS AN ALTERNATIVE

The continuously evolving technology in computers and telecommunications and the international political and economic linkages have a paramount effect on the development of telecommunications policies by individual countries. Demand for telecommunications services and products from domestic and multinational users necessitate action on the part of foreign state-owned telecommunications providers and their respective governments. The problem of satisfying such demand is especially acute among developing nations without immediate access to investment capital and without an indigenous manufacturing base for modern telecommunications technology. For example, certain countries in Eastern Europe and Latin America have less than ten telephone access lines per 100 of population, while the comparable figures for the U.S., the United Kingdom and Japan are respectively 49.3, 38.9 and 40.7.[4] In addition, the provision of telecommunications services by state-owned telecommunications enterprises in a number of countries is often provided in an inefficient manner. Although in certain developing nations the number of access lines per 100 of population is less than one, the number of employees per 1,000 access lines of the respective state-owned telecommunications enterprises ranges from twenty to a hundred. In comparison, the modern telecommunications networks of New York Telephone Company and of Nippon Telephone and Telegraph (NTT) have approximately 0.2 employees per 1,000 access lines.[5]

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[2] Id., pp. 12-13; Marc Fossier, Marie-Monique Steckel, France Telecom: An Insider's Guide (Intertec Publishing) May 1991, pp. 9-10.

[3] Douglas Wight, Dynamics of the European Telecommunications Industry (Credit Suisse First Boston Ltd.) August 17, 1992, pp. 18-19.

[4] Timothy Kain, U.S. Telephone Companies Seek Fortunes Overseas (Fitch Investors Service, New York) June 29, 1992, p. 2.

[5] William W. Ambrose, Paul R. Hennemeyer, Jean-Paul Chapon, Privatizing Telecommunications Systems (The World Bank, Washington, D.C.) 1990, p. 13.

Foreign state-owned telecommunications providers often suffer from pricing structure inefficiencies and from undue governmental interference in their overall operations. These pricing inefficiencies often result from not basing service tariffs on some measure of cost.[6] For example, even sophisticated state-owned telecommunications providers with advanced networks, such as the Deutsche Bundespost Telekom (DBT), have been criticized on the pricing of certain international leased circuit services.[7]

Foreign government decisions that affect the operations, finances, network equipment procurement and modernization of state-owned telecommunications enterprises have often proven to be counterproductive. Foreign governments often view the monopolies of their respective state-owned telecommunications organizations as a source of revenues.[8] For example, since such a state-owned organization may have or may have had in the past some association with the postal service in a foreign nation, telecommunications revenues are used to subsidize ongoing or accrued obligations of the national post office. The result is that critical reinvestment of profits in the network of the state-owned telecommunications enterprise may not take place in a timely fashion. The unavoidable result is that network capacity cannot keep up with the growing and unserved demand.

A foreign government and its state-owned telecommunications enterprise always have the alternative of attempting to meet the domestic and international challenges of the modern telecommunications marketplace without following the privatization route. It is relatively easy to point at the industrialized societies, such as France and Germany, where state-owned telecommunications monopolies are "global players" in the international telecommunications arena. However, access to investment capital and indigenous telecommunications technology are not universally available as they have been and are available to France Telecom and the DBT. Thus, even if a foreign government were to commit to the restructuring of its state-owned telecommunications monopoly without a change of ownership, it may lack the necessary financial and technical resources to see this task to a successful completion. Furthermore, governmental goals of competition and economic liberalization may lead to the eventual privatization of state-owned telecommunications monopolies even if those have been successfully restructured in the interim, e.g., both British Telecom and NTT had been extensively restructured prior to the commencement of their respective privatizations in the mid-1980s.[9]

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[6]Organization of Economic Cooperation and Development (OECD), <u>Universal Service and Rate Restructuring in Telecommunications</u> (Paris, France) 1991, p. 115.

[7]<u>Id.</u>, p. 173; <u>The Economist Telecom. Survey-1991</u>, p. 28.

[8]Such revenue transfers take the form of "government dividend" payments. Hellenic Telecommunications Organization, <u>Annual Report 1990</u> (Athens, Greece) 1991, English ed., p. 53; Televerket Swedish Telecom Group, <u>Annual Report 1991</u> (Stockholm, Sweden) English ed., p. 16.

[9]John A. C. King, "The Privatization of Telecommunications in the United Kingdom," <u>Restructuring and Managing the Telecommunications Sector</u>, Björn Wellenius, ed. (The World Bank, Washington, D.C.) 1989, pp. 55, 57; Tsuruhiko Nambu, "Deregulation in Japan," <u>Changing the Rules: Technological Change, International Competition, and</u>

In a number of countries, the privatization of various state-owned telecommunications organizations since the mid-1980s has proceeded with the concurrent definition of respective national market structures and the establishment of national oversight regulatory agencies. It is interesting to contrast the privatization of British Telecom with that of NTT and the development of the corresponding telecommunications market structures and regulation in the UK and in Japan.

III. PRIVATIZATION, MARKET STRUCTURE & REGULATION

In 1985, Japan enacted new laws that determined the new structure of the domestic and international telecommunications services markets. At the same time NTT's privatization was commenced. The Japanese Ministry of Posts and Telecommunications (Japanese MPT), became the regulatory body that oversees the telecommunications market structure in Japan and exercises jurisdiction over telecommunications carriers and services.[10] Domestic telecommunications carriers were classified into "Type I" and "Type II" carriers. Generally, Type I carriers are akin to "facilities-based" carriers that can provide conventional local and long-distance telecommunications services. Type II carriers primarily offer valued-added network or information processing services. Both Type I and II carriers are subject to regulation by the Japanese MPT. Type I carriers, however, inclusive of NTT, are regulated under more traditional principles of public utility regulation. Such principles include the licensing of "market entry and exit," and the establishment of service prices that are based on both rate of return and fully distributed cost study parameters. Similarly, the Japanese MPT aggressively regulates the relationship between Type I carriers and Type II carriers that are subsidiaries or affiliates of fully regulated Type I carriers, i.e., the relationship between NTT and enhanced service affiliates or subsidiaries. Furthermore, NTT is under the continuous obligation to supply "universal" local telephone service, while its long-distance services have come under increasing competitive pressures. The structure of international telecommunications in Japan was initially based on the existence of a monopolistic carrier, the Kokusai Denshin Denwa Corporation (KDD). Under the 1985 laws, additional Japanese carriers have been permitted by the Japanese MPT to offer international telecommunications services in Japan[11] Although NTT has a stock ownership interest in KDD, NTT was not and is not engaged in the direct provision of international telecommunications services in Japan. Thus, NTT is not an active participant in a telecommunications services market segment that is exhibiting high growth and relatively

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Regulation in Communications, Robert W. Crandall, ed. (The Brookings Institution, Washington, D.C.) 1989, pp. 148-149 (hereinafter referenced as Changing the Rules)

[10]The new telecommunications market structure was defined by the Telecommunications Business Law. The privatization of NTT commenced under the auspices of the Nippon Telegraph and Telephone Corporation Law. Nambu, "Deregulation in Japan," Changing the Rules, pp. 149-150.

[11]Id., pp. 150, 151. See also, Nobuyoshi Mutoh, "Deregulation of Japan's Telecommunications Business and the Role of Kokusai Denshin Denwa," Restructuring and Managing the Telecommunications Sector, pp. 64, 65.

healthy profitability.[12]

In sharp contrast, the privatization and regulation of British Telecom, and the evolution of the domestic and international telecommunications market structure in the UK were premised on different parameters. When the UK government proceeded with the privatization of British Telecom in 1984, it was faced with the dilemma of not only making British Telecom attractive to private investors, but also in introducing competition in the UK telecommunications services market. Indeed, since the UK government would continue to be a shareholder in British Telecom for some time to come, it was imperative that the profitability of the soon to be privatized telecommunications entity should not be imperiled by either overburdening regulation or by strong competitive forces that could come into existence because of the UK telecommunications market liberalization.[13] The Telecommunications Act of 1984 defined the parameters of the telecommunications market structure in the UK, commenced the privatization of British Telecom, and established the independent Office of Telecommunications (Oftel) as the regulatory agency for telecommunications carriers and services.

Compared to the privatization of NTT in Japan, the UK government limited the competitive pressures on British Telecom. Although Mercury Communications, a facilities-based competitor, is interconnected with British Telecom's network, the high access prices do not permit Mercury to significantly underprice the long-distance services of British Telecom. Consequently, despite the evolving competition in the UK domestic telecommunications services market within the last eight years, British Telecom still retains a 95% share. In contrast, NTT's corresponding market share in Japan has decreased to 74% under competitive pressures from mainly three facilities-based carriers.[14] Similarly, unlike NTT, British Telecom never faced any prohibitions against the provision of international telecommunications services both in the UK and abroad. Thus, British Telecom is the principal provider of international telecommunications services in the UK, while British Telecom partnership ventures outside the UK are very aggressive in marketing worldwide private telecommunications networks to multinational corporations.[15] Furthermore, British Telecom is a competitor to state-owned telecommunications enterprises in countries that espouse free market entry for foreign-owned telecommunications organizations, e.g., in Sweden.[16]

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[12]Robert R. Bruce, Jeffrey P. Cunard, Mark D. Director, From Telecommunications to Electronic Services, (Butterworth Legal Publishers, Boston) 1986, pp. 399, 400. NTT International does provide telecommunications consulting services and acts as a "systems integrator." NTT, Annual Report 1990 (Tokyo, Japan) English ed., p. 29.

[13]Bruce, Cunard, Director, From Telecommunications to Electronic Services, p. 415.

[14]The Economist, "A tale of two telephone firms," May 23, 1992, p. 74.

[15]Nancy Hass, "The Whipping Boy," Financial World, Vol. 161, No. 18, September 18, 1992, pp. 48, 49.

[16]Televerket Swedish Telecom Group, Annual Report 1991, p. 9.

Oftel's rate regulation of British Telecom is based on the "price cap" method. Price changes within a "basket" of services (line rental, local and long-distance switched services) are governed by the level of the "Retail Price Index" (RPI) minus a productivity index that was initially set at 3%. Various categories of services, including private line and international long-distance services, were not subjected to "price cap" regulation.[17] Oftel's regulatory strategy permitted British Telecom to have wide pricing flexibility within the overall "price cap" constraints. Rate decreases for long-distance services that were under competitive pressures by Mercury Communications, price increases for local and short-distance rates, and significant productivity improvements through massive reductions in the labor force produced extremely healthy profits for British Telecom in the post-1984 years.[18] The Value Line Investment Survey estimates that the annual return on the common equity capital of British Telecom ranged between 20% and 30.4% during the 1984-1988 period.[19]

In sharp contrast, NTT, under the more traditional regulation of the Japanese MPT, has been unable to enjoy the pricing flexibility of British Telecom. Similarly, in the environment of Japanese employment practices, NTT has not proceeded with drastic labor force reductions. These events have impacted NTT's profitability and have stopped additional flotations of NTT stock by the Japanese government.[20] NTT generated annual returns on its average common equity capital in the 5.9%-6.6% range during the 1989-1991 period, while the corresponding range for British Telecom was 17.7%-20.4%.[21]

Oftel's "price cap" regulation of British Telecom has changed since its inception. The great profit levels of British Telecom, quality of service problems that surfaced when the carrier commenced a modernization program of its network, and the increased desire of the UK government to introduce additional competition in the telecommunications marketplace have led to a gradual tightening of Oftel's "price cap" regulatory scheme.[22] Although Oftel is considered as one of the pioneering governmental agencies to implement "price cap" regulation, it has nevertheless remained sensitive to the healthy profit levels and rate of return

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[17]Certain services were placed at an RPI+2 minus the productivity index price cap formula. Michael A. Einhorn, Price Caps and Incentive Regulation in Telecommunications (Kluwer Academic Publishers, Boston) 1991, p. 4.

[18]Id.

[19]Value Line Investment Survey (Value Line Publishing, Inc., New York) July 17, 1992, p. 784.

[20]The Economist, "A Tale of two telephone firms," May 23, 1992, p. 74.

[21]Financial Statistics of Public Utilities (C. A. Turner Utility Reports, Moorestown) 1991, 1992.

[22]Eli M. Noam, "The Quality of Regulation in Regulating Quality: A proposal for an Integrated Incentive Approach to Telephone Service Performance," Price Caps and Incentive Regulation in Telecommunications, Michael A. Einhorn ed., pp. 176, 177.

of British Telecom.[23] Consequently, Oftel has proceeded with periodic upward adjustments of the productivity factor in the "price cap" formula for British Telecom. In Oftel's most recent proposal under the direction of the outgoing Director General of Telecommunications, Professor Bryan Carsberg, British Telecom accepted a 7.5% productivity index (up from 6.25%) for the overall "price cap" formula. Furthermore, British Telecom agreed on accounting separations for its lines of businesses and on publishing details regarding its interconnection with other telecommunications carriers.[24]

Oftel's regulatory policies continue to reflect the desire of the UK government to protect British Telecom against uneconomic interconnection by competing telecommunications carriers while promoting competition. Oftel rejected the premise of incremental pricing for access to the network of British Telecom and the potential underpricing of its services by competing carriers, but did adopt the concept of access charge imputation for British Telecom's own services (prevention of anticompetitive practices).[25]

Although Oftel is the premiere regulatory body of telecommunications carriers in the UK, its true enforcement powers rest with the UK's Monopolies and Mergers Commission. In addition, Oftel exercises joint jurisdiction with the UK Cable Authority over carriers that operate cable television systems and also provide telecommunications services, inclusive of local telephone service. Interestingly, the UK government has permitted the development of cable television networks in the UK under the requirement that such networks can or will be able to switch telecommunications traffic.[26]

The "price cap" regulation of British Telecom, combined with its dominant position and profitability in the UK telecommunications market, are rapidly transforming British Telecom into a truly global telecommunications carrier. British Telecom has already commenced the development of a more than $1 billion worldwide network capable of handling voice, data and video communications for multinational corporations. The British Telecom global strategy is designed to offset any market share inroads that competing carriers may gain in the UK.[27]

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[23]Raymond W. Lawton, "Factors Affecting the Continuation of Price Indexing Systems for Regulated Utilities: An Examination of Four Historical Instances of Indexing," NRRI Quarterly Bulletin, Vol. 12, No. 1 (The National Regulatory Research Institute, Columbus) March 1991, pp. 20-23.

[24]Telecommunications Reports, Vol. 58, No. 24, June 15, 1992, pp. 5, 6; and Vol. 58, No. 33, August 17, 1992, p. 20.

[25]Id.

[26]Bruce, Cunard, Director, From Telecommunications to Electronic Services, pp. 443, 444, 451, 452.

[27]John J. Keller, "British Telecom Plans Billion-Dollar Global Network," The Wall Street Journal, August 18, 1992, pp. B1, B7.

A foreign government's decision to privatize its state-owned telecommunications organization is dependent upon many political, economic and financial parameters. As stated before, the primary reasons behind the privatization of state-owned telecommunications enterprises are the need for network modernization and the desire for restructuring the relevant markets for telecommunications services. Generally, private sector ownership and operation of a telecommunications services enterprise would be viewed as being economically more efficient since there would be a stronger incentive to cut costs. In addition, if the privatization decision is coupled with the restructuring of the relevant markets, e.g., ending the monopoly status of a state-owned telecommunications enterprise, then greater economic efficiencies are envisioned in the provision of services and products.[28] On the other hand privatization of state-owned telecommunications enterprises has economic costs. For example, if a state-owned telecommunications enterprise were to be acquired by foreign investors, the subsequent hard currency outflow of funds from a foreign country could prove to be a long-term economic cost if the privatized enterprise continued to earn excessive profits.[29]

The attempt to increase the economic efficiency of a foreign privatized telecommunications enterprise may also result in the imposition or simple transfer of certain economic costs to other sectors of the foreign economy. For example, if increased economic efficiency and profitability were to be achieved by drastic manpower reductions at the privatized enterprise, then, at least for the short-term, economic costs such as severance, unemployment and retraining benefits are likely to be borne by the foreign government in question.

The issues of privatization and modernization for foreign state-owned telecommunications enterprises are closely linked to the emerging market structure for telecommunications services and its transition under some type of regulatory oversight. Certain foreign countries, especially in Eastern Europe and within the Confederation of Independent States (C.I.S.), have simply opted for the attraction of U.S. and Western European telecommunications firms, and for the establishment of dedicated domestic and international telecommunications networks as well as cellular mobile telephony networks. At the same time, some of these countries, e.g., Hungary and Poland, are also in the process of privatizing their rather antiquated public switched networks while attempting to modernize them with imported telecommunications gear.[30] If foreign governments aspire to meet unserved demand for telecommunications services and the goals of "universal service," the successful privatization of their state-owned telecommunications enterprises will be in doubt if their most profitable services will be under selective competition by market entrants with superior technology. This is especially true when the same governments are attempting to

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[28] Ravi Ramamurti, Raymond Vernon, Privatization and Control of State-Owned Enterprises (The World Bank, Washington, D.C.) 1991, pp. 65, 66.

[29] Id., pp. 63, 64.

[30] John Williamson, Steven Titch, Peter Purton, "The Curtain Rises on Telecommunications in Eastern Europe," Telephony, Vol. 223, No. 1, July 6, 1992, pp. 26-33.

attract investors and telecommunications firms from industrialized nations in such privatization efforts.[31] Furthermore, the deployment of technologically asymmetrical networks in a foreign nation can easily lead to problems of connectivity. For example, although a privately owned digital cellular mobile telecommunications network can be deployed with relative ease, its interconnection with state-owned telecommunications enterprises that still utilize electromechanical switching technology may prove to be problematical.[32] In addition, more often than not, foreign state-owned telecommunications networks with older equipment lack the necessary devices to accurately measure and record units of telecommunications traffic. Thus, billing and collection of network interconnection fees (access charges) may depend in part on the compilation of traffic data by the competing privately owned carrier.[33] If access to the state-owned telecommunications network is underpriced, growing volumes of interconnection traffic may exacerbate existing capacity shortage problems in the conventional public switched network. Such problems cannot be easily overcome if a foreign government attempts to modernize a state-owned telecommunications network by extracting one-time "market entry fees" from competing telecommunications operators.[34]

National and transnational policies on telecommunications privatization, competition and regulation are increasingly focusing on the achievement of discrete transitional targets. Often, the privatization of a state-owned telecommunications provider will be preceded by fundamental legal and institutional reforms that will define the national market for telecommunications services. Such reforms include the establishment of distinct regulatory agencies, such as the FCC or UK's Oftel, that oversee not only the privatized state-owned carrier, but also police the development of the overall national market structure for telecommunications services. Since the rapid evolution of competition can easily damage the goals of privatization for state-owned telecommunications monopolies, national governments purposely delay the advent of significant competition until the newly privatized carriers have undergone sufficient technological modernization and capacity expansion. During such transition periods, the national regulatory agencies undertake the familiar tasks of establishing standards and monitoring the quality of service performance for the newly privatized carrier. Similarly, the same agencies determine prices for the various services of the privatized carrier and oversee the terms and conditions of interconnection with competing carriers. The 1990 privatization of Telefonos de Mexico (Telmex) followed that pattern. The Mexican government has effectively halted the development of meaningful competition for a six-year period. At the same time, Telmex must reach annual targets of access line installations in order to meet unserved demand and must undertake substantial

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[31]The Economist, "Eastern Europe on the line," February 8, 1992, p. 18.

[32]Jeff Cole, "In Quest for Billions GM's Hughes to Bring Phones to Tartarstan," The Wall Street Journal, August 21, 1992, pp. A1, A4.

[33]William J. Smilie, Establishing An International Cellular Operation, National Communications Forum, Chicago, Illinois, October 13, 1992.

[34]The Economist, "Telecommunications in Eastern Europe: Finding their voice," February 8, 1992, p. 74.

digital conversions of its network.[35] As in the UK, Telmex's services have been put under a "price cap" rate setting formula.[36] The Mexican Secretariat of Communications and Transportation is the primary regulatory agency that oversees Telmex's operations and gradually introduces additional competition in the Mexican marketplace.[37] Consequently, investment in Telmex has proven to be profitable for both Southwestern Bell and France Telecom, two of the main privatization participants.

It is apparent that government regulation of telecommunications enterprises will continue to play an important role in the global marketplace for telecommunications services and products. It is clear that the principles of public utility regulation in an environment of increasing competition are very applicable on issues of privatization for foreign state-owned providers of telecommunications services. The application of these principles is a key ingredient in the development of viable national telecommunications networks and of truly competitive markets for services and products.

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[35]Adrienne Hardman, "Private Lines, Public Lessons," Financial World, Vol. 161, No. 18, September 15, 1992, pp. 64, 65.

[36]Roberto Newell G., "So You Want to Buy A Telco?", Telephony, October 12, 1992, pp. 16, 18.

[37]William M. Berenson, "Developing the Regulatory Footprint for Newly Privatized Telecommunications Providers In Latin America," Federal Bar News & Journal, Vol. 38, No. 7, September 1991, p. 403.

2. TELECOMMUNICATIONS RATE STRUCTURES IN A CHANGING ENVIRONMENT

Chairperson: Karen Hardie

Ohio Office of Consumers' Counsel

Understanding the Economics of the Local Loop: Setting the Stage for Fiber and Radio in the Loop

by
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<u>Statement of the Problem in Local Loop Economics</u>: Investment in the subscriber loop is the largest category of plant investment for most local exchange companies (LECs), yet its cost structure is relatively unknown. By "unknown cost structure", what is meant is that LECs have not developed strategic planning systems for assessing the appropriate loop technology. LECs, vendors and Bellcore have developed tactical information systems designed to evaluate specific construction alternatives, such as CUCRIT[1], or only segments of the loop, such as EFRAP.[2] Strategic planning systems, even those that are empirically based, such as the joint Cincinnati Bell Information Systems (CBIS)/Probe Research LEAP system[3], generate strategic knowledge of the underlying cost structure of the subscriber loop. This cost structure is defined in terms of measurable cost drivers, such as wire pair density or wire pair length, as measured on a wire center level basis.

The reasons for the systematic lack of strategic knowledge of the subscriber loop economics is twofold: (a) the monopoly framework under which these older systems were developed is rapidly disappearing, with the emergence of Competitive Access Providers (CAPs), the spectrum allocation to Personal Communications Services (PCS) by the FCC in the next year or so, with CATV investment in CAPS and their strong interest in being a "carriers' carrier" for PCNs; and (b) the monopoly of copper over the subscriber loop is also rapidly disappearing.

The technology choices facing today's loop planner include:

A. Copper-based systems:
- o Copper twisted pair;
- o Copper with Digital Loop Carrier (DLC);
- o Integrated Services Digital Network (ISDN);
- o Asynchronous Digital Subscriber Line (ADSL);
- o High Bit Rate Subscriber Line (HDSL);

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[1] CUCRIT: Capital Utilization Criteria, a planning tool used to assess the economic value of a given project. CUCRIT was first developed by Bell Laboratories.

[2] EFRAP: Exchange Feeder Route Analysis Program, used for the development of the fundamental plan for the exchange feeder system. EFRAP was also developed by Bell Laboratories.

[3] LEAP: Loop Economic Analysis Program, economic analysis planning tool developed initially by Probe and now in commercial development by CBIS/Probe.

B. Fiber-base systems:
- o Fiber - passive systems;
- o Fiber - active systems;
- o Fiber with SONET transmission overlay;
- o Fiber with ISDN overlay;
- o Fiber with radio transmission;

C. Radio-based systems:
- o PCS;
- o Basic Exchange Telecommunications Radio Service (BETRS);

The mix of loop technologies, signaling protocols and transmission, overlaid upon a rapidly changing regulatory environment and competitive environment, is creating a world that is fundamentally different from the world of the loop planner only ten years ago. This new planning environment needs new tools, new approaches, a new understanding of the cost dynamics in the loop, and a new understanding of the linkages between loop technology and services, switching technology and services.

This paper describes the underlying economic model incorporated into the CBIS/Probe LEAP program and presents a set of results from its initial application to one large Bell Operating Company (BOC.)

<u>Analysis of the Cost of Copper Wire Pairs</u>:

Wire Center Orientation: The subscriber loop is the primary link between customers and the network, between markets and services. Local exchange carriers (LECs) require management information systems linking demographic/user databases, access market by access market, service capability databases (e.g., switch generics), and loop databases on revenues, maintenance expenses, and investment. These databases must be organized at ever finer levels of aggregation: it is simply not enough to have state-wide or company-wide summary data for the detailed planning a competitive business environment requires.

In a competitive environment it is not enough to have inventory records of physical assets, such as copper and fiber; LECs must be able to link the physical asset databases with revenue, expense and investment databases to uncover the cost and revenue drivers. Understanding the relationships between physical environments (wire pairs, switches) and demographic environments (high income, low income), and financial information (revenues, value, investment), LECs will be in a much stronger position to select the optimum technology to meet the market and the competition.

The physical link between the customer and the wire center, the subscriber loop, has a definable cost structure in terms of external parameters such as subscriber density or loop length, as well as in terms of the general technology deployed, copper, fiber, radio. Since LECs have not developed wire center level databases, they are generally unable to confront competition, technology deployment or both in real business terms.

This lack of consistently organized and easily retrievable critical cost and marketing information is glaring when it is contrasted with the importance of the wire center in telephony.

The importance of the wire center is four-fold:

- o The wire center is the repository of switching/intelligence;
- o The wire center is a node on the telco interoffice transmission network;
- o The wire center is the focus of telco plant investment;
- o The wire center is the organizing point at which customers are linked to the network.

These four key roles for the wire center, as the telcos face increasing competition, will become even more critical over time. What services will telcos deliver to what customers on what timeframe? How will their competitors be organized? How do telcos roll out new loop technology, which technology, when and where? The questions facing every loop planner in a telco are: what, when, where and how much, or: "what technology do I deploy, when do I deploy it, where do I deploy it, and for how much cost?" These questions sound so simple, yet their ramifications cannot even be remotely appreciated until all of the data required to make that decision is comprehended.

Many telco engineers have an intuitive feel about these cost relationships, but intuition and statistical analysis are two very different things. A telco engineer's intuition is not much use to a planner several levels removed from operations defining a long-term approach to loop technology deployment. Since most LEC loop planners cannot formulate in mathematical or statistical terms the cost structure of copper, meaningful comparisons between copper and new loop technologies cannot be made, except on a case-by-case basis.[4] Loop strategies are loosely formulated based only on limited data and real opportunities for plant modernization are squandered.

Analysis of the economics of the local loop at the level of the wire center, whether one deals with copper twisted pair, coax, fiber or wireless, begins with two distinct factors:

- o what is the historical cost of copper twisted pair?

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[4] Imagine the difficulty in science if the laws of physics are reduced to ad hoc analyses rather than synthesized into formulations applicable across a wide range of situations. The insight gained from developing mathematical formulations of physical law are demonstrable; on a smaller scale, mathematical formulations, using empirical data and statistical analysis, should likewise yield insight into the dynamics of the subscriber loop.

- o what are the cost drivers - size of wire center in terms of number of wire pairs, wire pair density, loop distance from serving office?

From these fundamentals virtually all else flows. Since the available investment data on LEC deployment of any loop technology is extremely scant, there has historically been very few thorough analyses of cost drivers at the wire center level. Data is traditionally kept at levels within a BOC somewhat higher than the wire center, such as at the exchange area or district level.

Probe undertook a study of the cost structure of the copper loop, with special emphasis on understanding the role of cost drivers, and how these drivers influence replacements costs for copper twisted pair. It was not the study's goal to demonstrate an economic preference for any particular loop technology; rather, to examine whether the premise of present-day loop technology deployment strategies by telcos, especially the BOCs, is fundamentally flawed. The flaws appear when one undertakes an in-depth analysis of copper twisted pair.

The Local Loop and Wire Center study and the LEAP system comprise four primary Tasks:

- o Task I: Copper Loop Historic Cost Analysis
- o Task II: Copper Loop Replacement Cost Analysis
- o Task III: Wire Center Cabling Plan and Investment Analysis
- o Task IV: Cost/Benefit Analysis of Copper

This paper will summarize results from Tasks I and II.[5]

The analyses of the historic or in-ground (also referred to as embedded) and replacement costs of the subscriber loop, and the cost/benefit analysis were performed for five different configurations of wire centers of one of the larger Bell Operating Companies (BOC).

1. 588 wire centers (WCs)
2. 388 exchange areas (EAs)
3. 10 Local Access and Transport Areas (LATAs)
4. 6 density groups (DGs)
5. 4 urbanization classes (UCs)

The analysis in Task I and all subsequent Tasks required the merging of several databases supplied by the BOC. These databases are identified below as to content and as to level of aggregation as supplied by the BOC.

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[5] One should refer to Probe's The Wire Center and Local Loop Study for a fuller discussion of the methodology and results.

Database 1: Level of Data: Wire Center:

- o working wire pairs (WWPs);
- o investment in the subscriber loop excluding structures (poles, conduits, etc.);
- o wire center code number: 10 digit alphanumeric identification of the wire center;

Database 2: Level of Data: Wire Center:

- o working wire pairs;
- o available wire pairs (AWPs);
- o defective pairs, idle pairs, etc.;
- o working wire pair fill rate;

Database 3: Level of Data: Exchange Area:

- o exchange area name;
- o exchange area service area in square miles;
- o exchange area access lines: residence, etc.;
- o monthly tariff for the use of the loop by access line category: residence, etc;

Database 4: Bellcore Local Exchange Routing Guide:

- o wire center/switch code numbers;
- o switch technology by wire center;
- o wire center zip code;
- o exchanges served by wire centers;

<u>Definitions</u>: The basic statistical relations among these variables and the cost per wire pair can be refined empirically through linear and multiple regression analyses of the data. After a preliminary investigation we settled upon the following specific definitions for the loop cost analysis:

Wire Pair: Wire pairs used for calculations are working wire pairs or available wire pairs. Neither one leads to the best statistical fit for all applications, especially as the issue of total network capacity is analyzed in Task III. The number of available wire pairs does not, strictly in statistical terms, provide as good a predictive level as working wire pairs for other applications. Finally, for some applications the relevant base must be working pairs since these are the only revenue producing ones, i.e., working pairs' users carry the burden for available pair capacity. Unless specified, the term "wire pair" can refer to either working or available.

Fill Rate: The fill rate is defined to be the ratio of working wire pairs to available wire pairs, i.e., excluding defectives. Fill rate = WWPs/AWPs. This is a simplified version since it introduces only marginal errors when one considers defectives.

Investment: Task I investment refers to historical or in-ground copper plant investment in the subscriber loop. It excludes: (a) all investment in structures: conduit, poles, ducts, etc.; (b) all loop electronics such as pair gain equipment.

Historic investment is gross book investment, not net investment, i.e., accumulated depreciation is excluded from the analysis and no adjustment is made for inflation to account for differences in the timing of investments. When replacement costs are considered in Tasks II-IV, structures' costs are likewise excluded; however, in Tasks III and IV, the impact of digital loop carrier deployment is factored into the analysis.

Average Wire Pair Length: This is a derived quantity in Task I and it is not until Task III where more realistic estimates of wire pair length can be made. The Task I and II estimates are based on mathematical models of simple wire center geometries and are functions of the area of the wire center, the specific geometry employed (circle, square) and the assumptions made on wire pair density (constant, lumpy, r-1 dependence). In the absence of a detailed statistical sample of loop lengths, one is forced to use mathematical or engineering models.

Total Length: Total length of all wire pairs is defined as the product of the number of available pairs and the average loop length in Tasks I and II. In Task III total wire pair length is derived from the cabling plan.

Wire Pair Density: Density is defined as the number of either working wire pairs per square mile or available wire pairs per square mile, whichever yields the best statistical fit, and this is referred to as the average density of the wire center. Regardless of the specific density function used for determination of loop length, the average density will always be the same for a given wire center.

The geometry of the wire center has a marked impact on the relative embedded costs of a twisted pair, and presumably this impact will translate into the replacement or current costs of a twisted pair. Specifically, the operating assumption of this study is that the relationship between investment per working wire pair and the geometric variables is defined through one or more variations of standard multiple regression relations.

This basic assumption is crucial for the development of the replacement cost models of Task II. If the regression analysis yields strong statistical relationships between the historic investment per wire pair and one or more of the geometric variables, then one has a useful and valid approach to the analysis of the replacement cost per wire pair. In general, one of the primary goals of this study was to define the cost drivers in the local loop, and regression analysis of telco data was the most powerful tool available.

This approach stands in contrast to the unstated assumptions made by many vendors and operating companies underlying assertions that the average cost (replacement) of a copper loop is $X, where X is some number, $1,500 or $1,800, for example. The unstated assumptions are that wire pair costs are normally distributed around that mean and that the standard deviation is rather small. If one can make the assumption that costs are normally distributed and if one can specify the mean and standard deviation for that distribution, then one has completely defined the issue.

Our analyses of the data indicate otherwise and the regression analyses in Tasks I and II yielded some rather interesting results discussed in later sections.

Time Dependence: By using a set of simple, reasonable assumptions concerning time dependence, it is possible to model in-ground investment per wire pair values as a function of one of the geometric variables and time. Once a cost-driver relation is employed, i.e., one or more of wire center size, wire pair density and average wire pair length as the regressor variables, time dependence can easily be introduced in a theoretical sense.

Table 1 contains a summary of the major findings from Task I and II alone of this study of one large BOC's loop plant. This chart contains only a brief summary of the more than 250 outputs that have been generated at the wire center level and now capable through the LEAP program. Since the data can be aggregated at the wire center, exchange area, LATA, density group and urbanization class levels, the actual number of outputs for this study exceeds 1300.

Table 1
Summary of Major Findings

Data Element	Quantity
In-Ground Investment	$6,299.7M
Working Wire Pairs (WWPs)	13.548M
Available Wire Pairs (AWPs)	22.137M
AWP Fill Rate (WWPs/AWPs)	61.27%
Service Area in Sq. Miles	51,054
WWP Density (WWPs/SM)	265.38
AWP Density (WWPs/SM)	433.60
In-Ground Inv./WWP - Average	$464.97
In-Ground Inv./AWP - Average	$284.58
Replacement Cost (RC) - Before DLCs	$27,642.6M
Replacement Cost/WWP - Average - Before DLCs	$2,062.38
Replacement Cost/AWP - Average - Before DLCs	$1,262.27
Replacement Cost - After DLCs	$22,360.8M
Replacement Cost/WWP - Average - After DLCs	$2,062.38
Replacement Cost/AWP - Average - After DLCs	$1,262.27
Wire Pair Length Total (Feet) - Before DLCs	418,460.0M
Wire Pair Length Total (Feet) - After DLCs	182,359.9M
Average Wire Pair Length (based on "Before DLCs")	21,951
Replacement Cost/WP-Foot - Before DLCs ($/Ft)	$0.066775
Replacement Cost/WP-Foot - After DLCs ($/Ft)	$0.122619

Task I: Historic Investment Analysis: The primary focus in Task I was to examine statistical relationships between investment per wire pair and wire center "geometric" parameters or variables. Twenty-six basic data elements for each wire center were identified:

- o wire center identification number (3 digit)
- o exchange area identification number (3 digit)
- o LATA identification number (2 digit)
- o WWP initial density group (1 digit)
- o AWP initial density group (1 digit)
- o initial number of working wire pairs (WWPs)
- o initial WWP ranking
- o WWP Fill Rate (WWP/AWP)
- o initial number of available wire pairs (AWPs)
- o initial AWP ranking
- o wire center area
- o wire center area ranking
- o initial total wire center wire pair investment
- o initial investment ranking
- o initial modeled average wire pair (loop) length
- o initial modeled average wire pair length ranking
- o initial modeled total wire pair length
- o initial total wire pair length ranking
- o initial historic (embedded) investment/WWP
- o initial historic investment/WWP ranking
- o initial WWP density (WWP/Area)
- o initial WWP density ranking
- o initial historic investment/AWP
- o initial historic investment/AWP ranking
- o initial AWP density
- o initial AWP density ranking

The data in the Table 2 shows that virtually none of the data elements displays a normal distribution. The mean and median values are so far apart in all instances that it is foolish to speak of a mean value of the cost of a wire pair as if that number represents how the values are distributed around that mean. A normal or even a symmetric distribution would have roughly 50% of the items above the mean and 50% below the mean. In the case of the investment per wire pair, using the average value for each wire center as representative of all of the wire pairs in that wire center approximately two-thirds of all working wire pairs have below average values for investment/WWP. If one assumes that within the larger wire centers the investment profile follows that of the wire center distribution in general, then an even higher percentage of wire pairs are below the average.

Wire Center Level Data Summary: The most useful and critical sets of analyses were performed at the wire center level. A total of 588 data points are available for analysis, providing sufficient cross-sectional information for rigorous statistical analysis. Six linear regressions were run using data on working wire pairs. The regressions can be run on available or working pairs, and both give strong, useful correlations. The advantage of WWPs in the analysis is to correlate the cost of providing access to an actual customer in-use pair (the customers carry the cost of all capacity); the advantage of using available wire pairs is to determine the cost drivers for bringing on a unit of capacity. Both analyses are valid and both yield strong correlations. Table 3 below is based on WWPs.

Table 2
Basic Data Summary

Data Element	Standard Deviation	Mean	Median
Working wire pairs	27,354	19,866	6,324
WWP fill rate	10.14%	61.27%	57.04%
Available wire pairs	45,245	32,423	11,639
Wire center area (SMs)	94	87	56
Total WP investment ($)	7,959,627	7,626,995	4,229,364
Average WP length (ft)	8,756	11,619	14,861
Total WP length (ft)	481,587,470	376,711,178	173,073,70
Investment/WWP ($/WWP)	457.74	383.92	680.75
WWP density (WWP/SM)	4,457.41	228.80	93.87
Investment/AWP ($/AWP)	312.30	235.23	378.58
AWP density (AWP/SM)	8,059.19	373.42	163.93

Table 3
Summary of R^2 Values from Regressions: Wire Centers

Independent Variable	Dependent Variables	R^2
Working wire pairs	WWP density	.8441
"	Average WP length	.1995
"	Investment/WWP	.8236
"	Total WP length	.8850
"	Total WP investment	.9646
"	WWP fill rate	.4907
Average WP length	WWP density	.5831
"	Investment/WWP	.5015
"	Total WP length	.0169
"	Total WP investment	.0918
WWP density	Investment/WWP	.9359
"	Total WP length	.5422
"	Total WP investment	.7098
"	WWP fill rate	.3964
WWP density & WWPs	Investment/WWP	.9381
"	Total WP length	.9901
"	Total WP investment	.9876
"	WWP fill rate	.4920

The highest level of correlation between the historic or embedded investment per WWP and the regressor variables is the combination of WWP density and WWPs, with an R^2 of .9381. However, WWP density (note: average wire center density) is a calculated field and is defined mathematically as WWP/Area, thus auto-correlation effects are involved.[6]

The three most useful regression equations using working wire pairs are listed below: investment/WWP as functions of WWPs, WWP density, and WWPs and WWP density. In the formulas N is used for WWPs and D is used for average working wire pair density. The exponential notation is also shown.

Eq. 1 $C_{WC}(N) = 8271.74N^{-0.2927} = 8271.74e^{-0.2927\ln N}$

Eq. 2 $C_{WC}(D) = 1911.03D^{-0.2252} = 1911.03e^{-0.2252\ln D}$

Eq. 3 $C_{WC}(N,D) = 2365.16N^{-0.0387}D^{-0.1995} = 2365.16e^{(-0.0387\ln N-0.1995\ln D)}$

An examination of Eq. 3 shows that historic investment per WWP declines faster with increasing density than it does with increasing wire center size when both variables are used. The use of these regression relations can provide some insights into the cost structure of the loop, even at this rather early stage of the development of the analysis. Figure 1 shows the relation between the raw data and the regression curve for embedded cost.

Urbanization Classes: The most difficult analytical task was allocating the 588 wire centers into a meaningful classification based on an intuitive understanding of how density correlates with the level of urbanization, and, therefore, how investment/WP correlates with the level of urbanization. The process we used here employs the lognormal distribution statistical analysis. The analysis yields some interesting and useful insights into how urbanization and investment/WWP are related.[7] Figure 2 shows four normal distributions derived from the lognormal analysis. Figure 3 shows the summation of the four normal curves into one distribution.

The lognormal distributions have yielded a useful breakdown of the working wire pairs into four general urbanization classes: urban, suburban, small town and rural. This breakdown is potentially more useful than density groups since density groups have no clear boundaries as to what is rural, what is small town, etc.

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[6] The correlation between density and wire pairs is quite strong, with an R^2 of .8441. The R^2 values for investment/WWP versus WWPs and WWP density respectively are .8236 and .9359. The degree of correlation between investment/WWP and (1) WWPs, and (2) WWPs and WWP density is virtually the same (R^2 of .9359 versus .9381); adding WWPs as a regressor variable to WWP density provides little additional predictability to historic investment/WWP.

[7] Refer to The Wire Center and Local Loop Study for a full explanation of the mathematics behind this derivation.

Table 4
Urbanization Classes Summary

Area	Category	Value
Urban	Working wire pairs	8,041,813
	Area (SMs)	3,319
	Investment/WWP ($/WWP)	286.97
	Average WP length (ft)	8,357
	WWP density (WWP/SM)	2,422.96
Suburban	Working wire pairs	1,754,269
	Area	3,168
	Investment/WWP	452.63
	Average WP length	13,631
	WWP density	553.75
Small Town	Working wire pairs	1,514,809
	Area	14,139
	Investment/WWP	654.58
	Average WP length	21,606
	WWP density	107.14
Rural	Working wire pairs	370,349
	Area	30,248
	Investment/WWP	1,056.58
	Average WP length	25,709
	WWP density	12.17

Task II: Replacement Cost Analysis: Task II covers the replacement cost of the copper twisted pair subscriber loop plant. Replacement cost is defined as the investment in twisted pair cable and wire required to duplicate the wire network as it would be configured if no fiber in the loop had been deployed. It does not include the cost of structures, such as poles and conduit, or any costs associated with rights-of-way, or any loop electronics and pair gain equipment. Replacement costs parallel in definition the embedded or historic investment costs developed in Task I.

There are two primary concerns in Task II:

- The magnitude of the average replacement cost of a copper twisted pair;
- The variation of replacement costs with the wire center geometric variables: size in terms of the number of working or available wire pairs, average wire center wire pair length, and wire pair density, either working or available.

The first part of this Task is an explanation of the derivation of the replacement costs. The remaining parts of Task II parallel in format that of Task I, i.e., how replacement costs are distributed by wire center, exchange area, LATA, density group and urbanization class.

Derivation of the Replacement Cost Function: Since the only data available on a wire center basis are the number of working and available wire pairs, the total embedded or historic investment still surviving, and the area served by the wire center in square miles, the derivation of the replacement cost function by wire center necessarily requires making several assumptions and deriving some related quantities. The derivations used in this report, while seemingly complex, are straightforward analyses incorporating data from depreciation studies, from the BOC Annual Report Form M, and other BOC statistical data.[8]

A more desirable situation would be to have several additional data items, such as growth rates in historic investment and wire pairs by wire center. Since these were not available these elements had to be modeled. The process used in this analysis incorporates the following major steps:

- o Estimation of the overall growth rates in available wire pairs, working wire pairs and total embedded or historic investment in wire pair plant.
- o Depreciation study analysis to determine the amount of investment in twisted pair plant surviving from each year over a 30+ year period.
- o Estimation of the portion of total annual investment dedicated to the expansion of the number of wire pairs as opposed to investment for modernization or replacement of already existing wire pairs.

As shown in this section, the replacement cost per WWP is directly related to the embedded cost per WWP for the same year. Thus, the time dependent formulation of embedded cost per wire pair, both working and available, must be determined.

A non-uniform growth rate case yields an excellent fit between embedded cost per working wire pair (WWP) and WWP density in units of WWPs per square mile. In mid-1985, the base year, the regression had an $R^2 = 0.9359$ and for EOY 1990 $R^2 = .9371$. Regression analysis yields additional information in terms of the regression constants. The regression relation is:

Eq. 4 $C_{Wj} = k(t)D_{Wj}(t)^{a(t)}$

This is a rewrite of the relation from Task I with the one major change being that the regression coefficient, a, is also now a function of time. This will lead to a slight change in the shape of the regression curve over time.

While we will not devote space to the derivation of the following, it is interesting to note the factors that lead to growth in the modeled values for embedded investment

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[8] Refer to The Wire Center and Local Loop Study for the details of this analysis.

per WP. (Modeled values refer to the results of the regression analysis of the data.) Using the regression result in Eq. 4, and substituting in for the various functions[9], and doing some algebra, the following relation for historic investment per WP growth rates holds for each wire center j and for the ensemble average:

Eq. 5 $r_{Cj} = (1+r_j)\ [(1+r_{Dj})^{a(t)}]D_j(0)^{\ (a(0)r_a)} - 1$

There are three factors which contribute to the growth rate in the modeled values for investment per WP. The first one, $(1+r_j)$, was discussed above and it is a reflection of the impact of changes in labor rates, copper pricing and any other "externality" such as installation techniques. The second factor, $(1+r_{Dj})^{a(t)}$, measures the impact of the incremental change in wire center WP density on the growth rate. The third factor, $D_j(0)^{\ (a(0)r_a)}$, is a measure of the change of curvature in the regression curve and its contribution to the change in embedded cost per WP.

The General Form of The Replacement Cost Function: The general form of the replacement cost function by wire center requires some additional information. First, the available data by wire center was described in Task I. There is no comprehensive data set for replacement costs either per working pair or per available pair. Therefore, we must model the replacement cost function.

Second, the only data we can use are the embedded cost per wire pair, especially the projected values, and BOC-wide data that can help narrow the range of values for replacement costs. These were enumerated earlier and include data from depreciation studies and construction report analyses. The end result of the derivation is shown in Eq. 6 below.

Eq. 6 $R_j(t) = [z(t)/z(0)]q(t)C_j(t)[(1+r_{Aj})/r_{Aj}]$

where:

- r_{Aj} is the average annual growth rate in AWPs in WC j;
- q(t) is the percent of total embedded investment I that is derived from the latest year's surviving investment;
- z(t) is the percent of the latest year's incremental investment in the loop plant that is targeted for expansion;
- z(0) is the percent of the test year's incremental investment (test year defined in depreciation studies) that was targeted for expansion;
- $C_j(t)$ is the projected value for the embedded cost per AWP in WC j.

The average value per AWP and WWP for the ensemble and the standard deviation for each set are shown in Table 5 below.

[9] The substitutions are: $k(t) = k(0)\ (1+r_j)^t$, $a(t) = a(0)\ (1+r_a)^t$, and $D(t)\ D(0)\ (1+r_D)^t$ and $C_W(t) = C(0)\ (1+r_C)^t$,

Table 5
Ensemble Average Replacement Costs per Wire Pair

Replacement Cost/AWP	Upper	Lower	Average
Smeared Data:	1,376.52	1,138.47	1,257.50
Standard Deviation:	1,250.85	1,034.54	1,142.69
Regressed Data:	1,381.74	1,142.80	1,262.27
Standard Deviation:	1,192.60	986.36	1,089.48

Replacement Cost/WWP	Upper	Lower	Average
Smeared Data:	2,246.59	1,858.08	2,052.34
Standard Deviation:	2,889.96	2,390.19	2,640.08
Regressed Data:	2,255.12	1,865.14	2,060.13
Standard Deviation:	2,754.29	2,277.99	2,516.14

The reason the figures for WWPs show a higher standard deviation is due to the variability in the working wire pair fill rate. The available wire pairs show a tighter distribution around the mean than working wire pairs do and this is due entirely to the fill rate; hence the distributions of replacement costs per AWP and WWP will exhibit similar tendencies.

Discussion of Replacement Cost/WWP: When vendors and operating companies discuss the cost to install an access line, the implicit reference is to working wire pairs. Access lines are, by definition, lines in service and therefore cost references imply an association between the cost to deploy the network capacity and charging that cost to what is actually in service. This is standard practice for operating companies since ratemaking procedures charge total investment dollars to the lines in service, not to theoretical capacity.

What does this analysis show? First, the ensemble averages are generally higher than those discussed in the industry. The lowest value in the set of six values above is $1,858.08/WWP; the highest value is $2,255.12/WWP. Standard industry references are to a range of $1,500-1,800/WWP. The higher numbers shown in this analysis do imply more breathing room for proving in fiber over copper since the reference target is higher. If, however, industry parlance is implicitly referring to the cost for installing a copper loop of capacity (as opposed to in-use), then the total costs are distributed over the larger set of wire pairs and, therefore, the average cost per loop is substantially less. In this instance, fiber in the loop vendors are facing a tougher set of economics in a POTS environment.

Before fiber in the loop vendors become overjoyed, there is the problem of the distribution of these replacement costs as well as the common practice of deploying loop carrier systems to reduce per WWP costs. For replacement costs per WWP the standard deviation is larger than the ensemble average, which means significant variability in the distribution of these values. For example, if one uses the mid-point values for replacement costs per WWP using the regression curve data in Eq. 6 then data on the five most expensive and five least expensive wire centers, and the number of working wire pairs can be compared; these are shown in Table 6.

Table 6 shows that the five least expensive wire centers, with over 6.2% of the WWPs, have very low replacement costs per WWP. The most expensive wire center is 36.9 times more expensive than the least expensive WC. The average cost in the two least expensive WCs hovers around four hundred dollars per working wire pair, a number very tough to beat. (If we were to use available wire pairs, then we are dealing with values in the range of $200-300 per AWP, even tougher to beat.) With numbers this low, and given the number of WWPs in these WCs, it is likely that some of these WWPs have replacements costs of less than $100 each and the AWP replacement costs will be less than $60-70 per pair!

Table 6
Ensemble Average Replacement Costs per Wire Pair
Five Most Expensive and Five Least Expensive WCs

Wire Center No.	Replacement Cost/WWP	WWPs
105	14,376.20	117
292	13,570.52	22
23	13,197.63	110
569	12,025.99	220
39	11,898.79	138
259	922.15	80,328
137	911.54	85,466
481	703.07	160,730
472	405.88	300,174
254	389.52	270,528

Ratio of replacement costs: WC_{105}/WC_{254} = 36.9

Total WWPs: 13,548,687
Most exp. WCs' WWPs % of total WWPs = 0.0045%
Least exp. WCs' WWPs % of total WWPs = 6.6222%

The geometric analysis employed here allows one to get behind the ensemble averages and look more closely at the distribution of costs as they are affected by geometric variables, such as density.

Table 7
Basic Data Summary

Data Element	Standard Deviation	Mean	Median
Working wire pairs	32,721	23,042	7,233
WWP fill rate	10.14%	61.27%	57.04%
Available wire pairs	54,833	37,648	13,316
Wire center area (SMs)	94	87	56
Total WP emb. inv. ($)	11,157,956	10,713,824	5,953,884
Total WP repl. inv. ($)	48,358,011	47,521,399	27,697,139
Average WP length (ft)	8,756	11,522	14,861
Total WP length (ft)	555,687,635	433,760,363	204,498,023
Repl. Inv./WWP ($/WWP)	2,516.14	2,060.13	3,889.33
WWP density (WWP/SM)	5,733.59	265.38	107.51
Repl. Inv./AWP ($/AWP)	1,089.48	1,262.27	2,106.58
AWP density (AWP/SM)	10,451.71	433.60	195.96

Tables 8 and 9 contain summary data for replacement costs: regression R^2 values and an urbanization summary. Figure 4 shows the replacement cost curve.

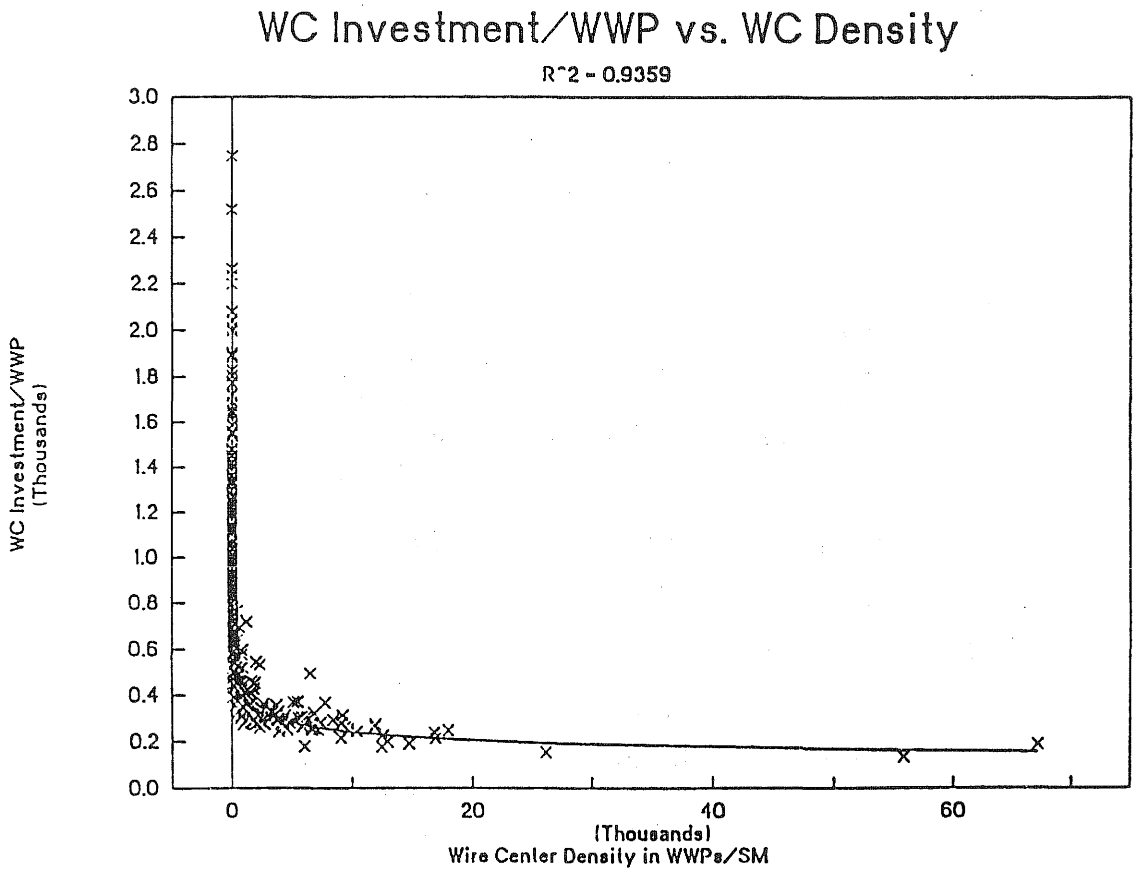
Summary: The results briefly summarized here indicate that a strategic view as to the replacement cost of a copper loop is required. Since cost varies with density and the areas where LECs will face competition - the dense wire centers - are the same ones with very low copper costs, fiber in the loop economics must be assessed in a new light. No longer satisfactory are statements from telcos that fiber is competitive with copper; the planning tools are sufficiently developed to make such claims. Furthermore, the analysis shows that the use of average values for any purpose other than the calculation of total replacement costs, is essentially useless. Telcos have a long road ahead of them in the analysis of the loop plant and understanding its cost structure is the first step.

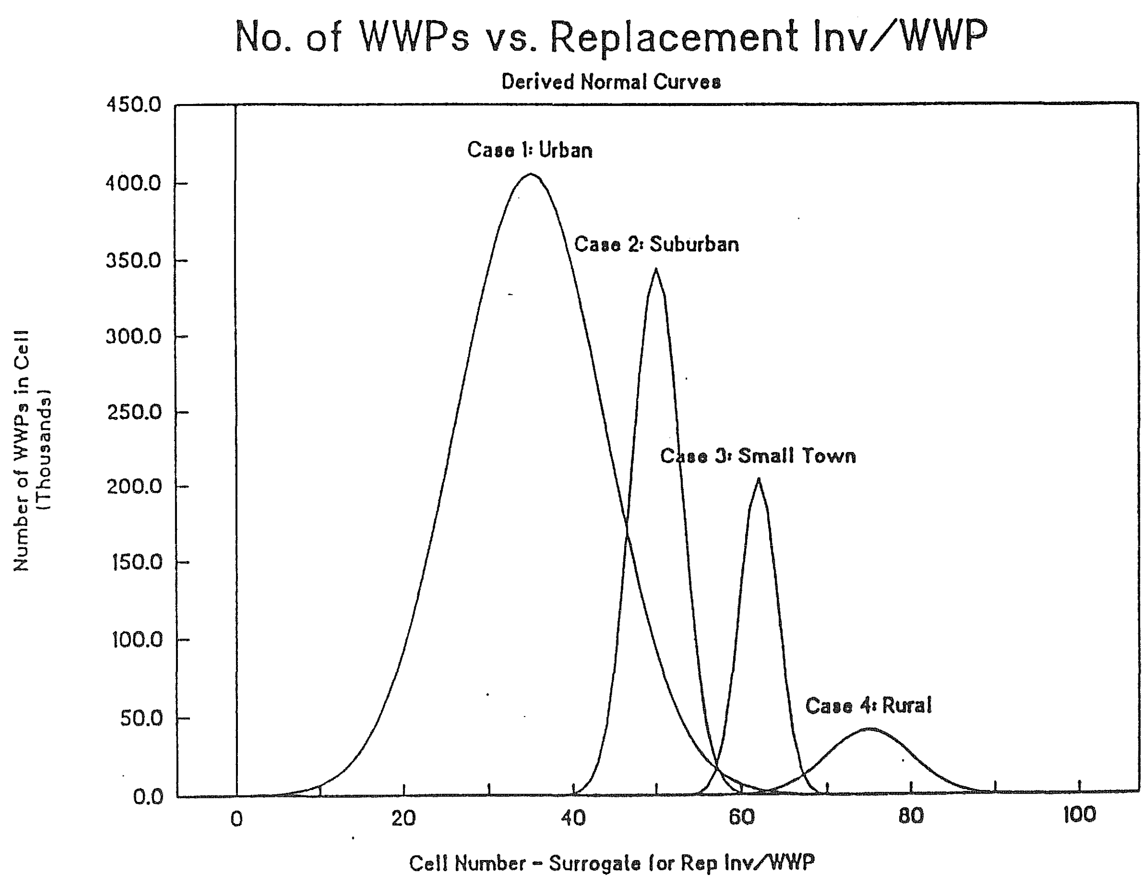
Table 8
Summary of R^2 Values from Regressions: Wire Centers

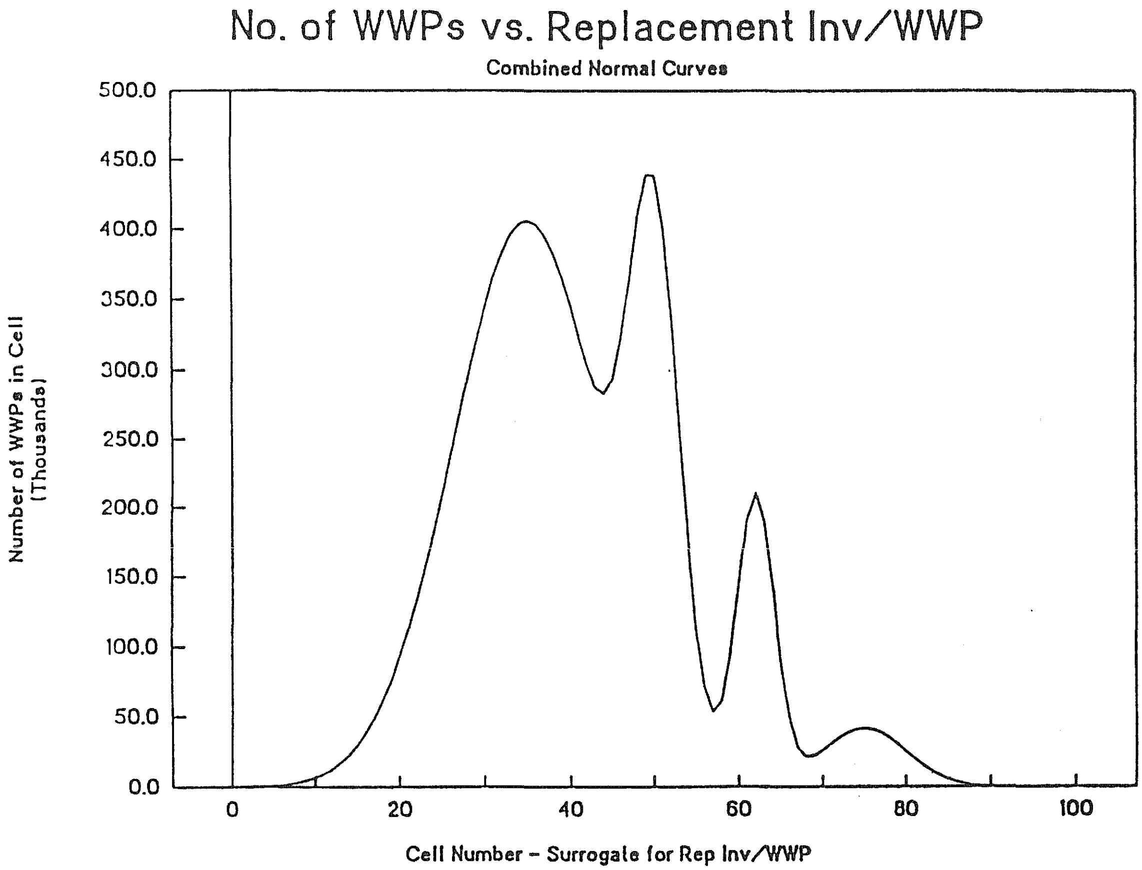
Independent Variable	Dependent Variable	R^2
Working wire pairs	Repl. Cost/WWP	.8283
Average WP length	Repl. Cost/WWP	.5953
WWP density & WWPs	Repl. Cost/WWP	.9939

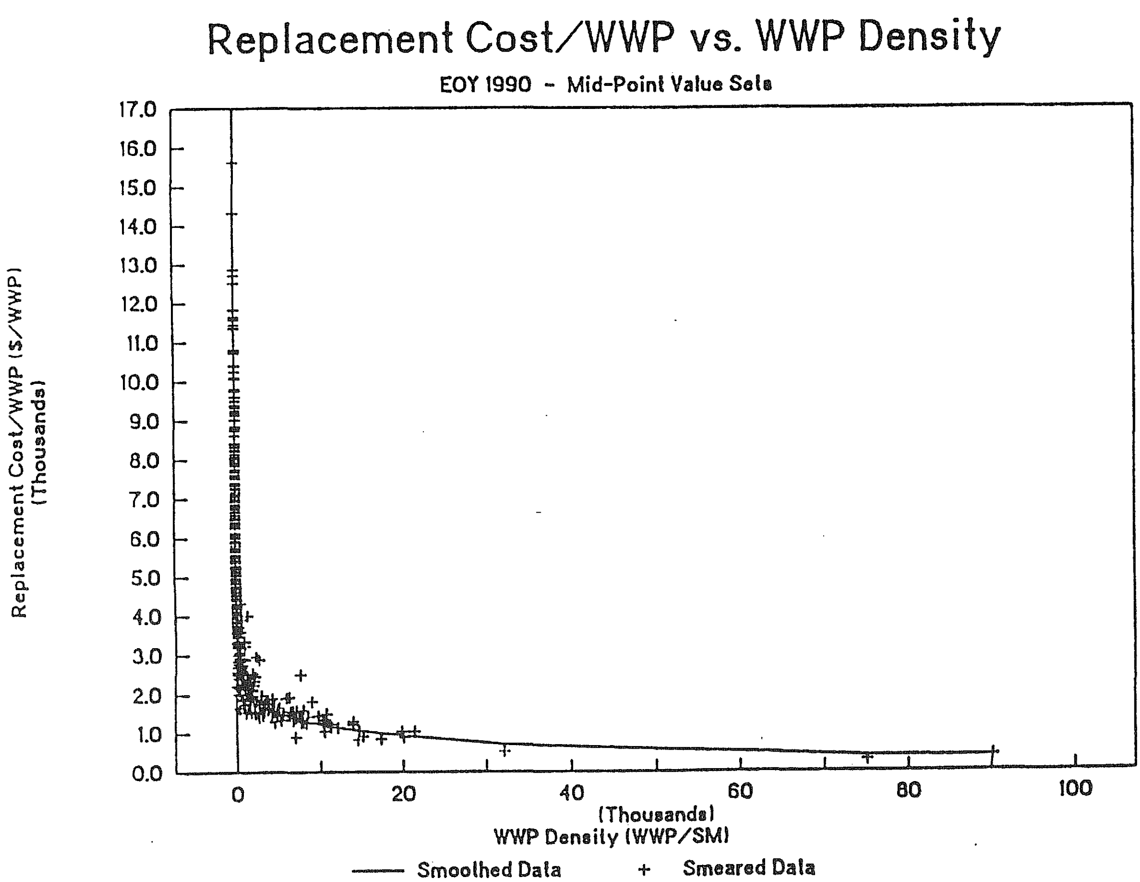
Table 9
Urbanization Classes Summary

Area	Category	Value
Urban	Working wire pairs	8,161,932
	Area (SMs)	1,682
	Repl. Cost/WWP ($/WWP)	1,408.09
	Average WP length (ft)	6,960
	WWP density (WWP/SM)	4,851.94
Suburban	Working wire pairs	3,476,587
	Area	4,499
	Repl. Cost/WWP	2,415.88
	Average WP length	14,600
	WWP density	772.78
Small Town	Working wire pairs	1,303,283
	Area	9,578
	Repl. Cost/WWP	3,628.41
	Average WP length	22,782
	WWP density	136.07
Rural	Working wire pairs	606,885
	Area	35,295
	Repl. Cost/WWP	5,473.92
	Average WP length	26,334
	WWP density	17.19


WC Investment/WWP vs. WC Density
R^2 - 0.9359
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
WC Investment/WWP
(Thousands)
0
20
40
60
(Thousands)
Wire Center Density in WWPs/SM


No. of WWPs vs. Replacement Inv/WWP
Derived Normal Curves
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Number of WWPs in Cell
(Thousands)
Case 1: Urban
Case 2: Suburban
Case 3: Small Town
Case 4: Rural
0
20
40
60
80
100
Cell Number - Surrogate for Rep Inv/WWP


No. of WWPs vs. Replacement Inv/WWP
Combined Normal Curves
Number of WWPs in Cell (Thousands)
500.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0
20
40
60
80
100
Cell Number - Surrogate for Rep Inv/WWP


Replacement Cost/WWP vs. WWP Density
EOY 1990 - Mid-Point Value Sets
Replacement Cost/WWP ($/WWP) (Thousands)
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
20
40
60
80
100
(Thousands)
WWP Density (WWP/SM)
Smoothed Data
+ Smeared Data

RATIONAL LOCAL SERVICE PRICING IN AN ERA OF INCREASING COMPETITIVE PRESSURE

BY
BROOKS B. ALBERY[1]
United - North Central

United North Central (UNC) has historically set basic local service rates using a combination of residual rate making and value-of-service pricing. Under value-of-service pricing, UNC charges higher rates to customers with larger calling scopes.[2] The rationale for this pricing method is that the more telephone subscribers accessible under the customer's flat rate local service, the higher the value of that customer's local service. This pricing methodology has led to ten different local service pricing bands for UNC in the state of Ohio as identified in Table 1. The fundamental question addressed by this paper is whether these local service rates show any relationship to the underlying costs of providing these services.

Table 1

Local Rate Bands and Rates

Rate Band	Calling Scope (000s)	Res. Rate	Business Rate	Key Rate	PBX Rate
1	0-2	$13.30	$25.70	$38.55	$64.25
2	2-4	13.85	27.75	41.65	69.40
3	4-6	14.40	30.10	45.15	75.25
4	6-12	14.95	32.45	48.70	81.15
5	12-25	15.50	34.65	52.00	86.65
6	25-50	16.05	36.80	55.20	92.00
7	50-100	16.50	39.05	58.60	97.65
8	100-200	17.05	41.25	61.90	103.15
9	200-500	17.60	43.45	65.20	108.65
10	over 500	20.25	51.95	77.95	129.90

This paper consists of three sections. The first section analyzes the underlying cost structure of providing basic exchange telephone service and compares this cost structure to the rates UNC currently charges for basic exchange service. The results of the study are also compared to the findings of the 1990 Rand study *Incremental Costs of Telephone Access and Local Use*, (the RAND study).[3] Section two of

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[2] "Calling scope" refers to the geographic area a local service customer can call without incurring usage sensitive rates.

[3] Bridger M. Mitchell, "Incremental Costs of Telephone Access and Local Use," The RAND Corporation, R-3909-ICTF, (1990).

the paper identifies new basic exchange rate structures that are more consistent with underlying costs. The effects of implementing the new rate structures are then discussed. These effects include: the potential changes in penetration levels in urban and rural areas, the effect on UNC's competitive positioning within the market, and the potential effects on rural infrastructure investments. Section three of the paper briefly discusses the policy implications of altering UNC's basic exchange rates.

Basic Exchange Service Costs

The first challenge in analyzing whether a price structure is economically rational is to determine or estimate the costs of providing the service in question.[4] The great majority of costs associated with providing basic local access and calling are represented by the costs of installing and maintaining central office equipment and outside plant. As a result, measurements of central office and outside plant investment levels should provide a reasonable proxy for local service costs.

The goal of this study is to determine the relationship between average investments per loop and the size of central offices as measured by local service loops. To accomplish this, average central office and cable and wire facilities (C&WF) investments per loop were identified and used as proxies for the costs of providing basic local service.[5] Prior to modeling the relationship between investment per loop and the size of the central office, it was hypothesized that economies of scale would produce an inverse relationship between investments per loop and central office size. Under this hypothesis, as central office size increases, average total investments per loop within the central office should decline. In other words, larger central offices will have lower average investment levels per loop and will therefore have lower average costs per loop.

An additional consideration regarding investments per loop is the relationship between the central office in question and the total company network. Specifically, if the central office in question performs tandem functions or provides operator services for larger portions of the company's network, it is necessary to identify and separate out the investments associated with these functions. For example, if a central office serves as a tandem for 10 subtending offices, then the investment associated with the tandem

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[4] For the purposes of this paper, prices which reflect the underlying cost structure of the service are considered economically rational. A lengthy discussion of what constitutes "economically rational" pricing is beyond the scope of this paper. For additional information on utility pricing theory see Stephen J. Brown and David S. Sibley, *The Theory of Public Utility Pricing*, Cambridge University Press, (New York, New York, 1986), and Edward E. Zajac, *Fairness or Efficiency*, Ballinger Publishing Company (Cambridge, Massachusetts, 1978).

[5] These proxy costs do not incorporate separations, carrying charges or other considerations relevant for regulatory uses. As such, these proxy costs are useful only in the context of this study.

function must be separately identified and accounted for in order to make a meaningful comparison between the investment per loop of the tandem office and the sub-tending offices. Additional relationships between central offices and their functions within the network include remote and host switches.

A regression model was specified and estimated to measure the relationship between central office size (SIZEINDX) and average investment per loop (INVPLOOP). To control for the effects of central office network functions and characteristics, the binary variables TANDEM, REMOTE and HOST were included in the model. The following model was estimated

$$\text{INVPLOOP} = \alpha + \beta_1\text{SIZEINDX} + \beta_2\text{TANDEM} + \beta_3\text{REMOTE} + \beta_4\text{HOST}$$

where:

where:	SIZEINDX -	number of lines within the central office divided by the average number of lines within UNC Ohio central offices;
	INVPLOOP -	total central office and C&WF investments divided by the number of lines within the central office;
	TANDEM -	binary variable identifying whether the central office performs tandem functions;
	REMOTE -	binary variable identifying whether the central office is a remote switch; and,
	HOST -	binary variable identifying whether the central office is a host switch.

As noted above, network engineering considerations indicate that the variables SIZEINDX and REMOTE should have inverse relationships with INVPLOOP. Economies of scale in central office investment suggest that the larger the central office in terms of lines (the larger SIZEINDX) the greater efficiencies achieved and the lower INVPLOOP. In addition, large central offices generally serve more densely populated areas. As a result, C&WF investments per loop are also likely to be inversely related to SIZEINDX. For these reasons, β_1 is expected to be negative.

The variable REMOTE is also expected to be inversely related to INVPLOOP. Remote switches are designed to conserve investments in central office equipment by concentrating switching functions (and investments) in host switches. As a result, remote switches should have comparatively lower central office investments and β_3 is expected to be negative. For similar (but opposite) reasons, the variable HOST is expected to have a positive relationship with INVPLOOP and β_4 is expected to be positive. And lastly, performing tandem functions increases the level of central office and C&WF investments located within a central office. Thus, β_2 is expected to be positive.

The model was estimated on 175 Ohio central offices and the following results were obtained[6]

$$INVPLOOP = \alpha - \underset{(32.4)\ (7.2)}{330.9*SIZEINDX} + \underset{(3.8)}{1040*TANDEM} - \underset{(2.8)}{265*REMOTE}$$

The variable HOST failed to enter the equation significantly and was dropped. The reasons for the failure of this variable have not been investigated. With this exception, the model results are consistent with prior expectations and the regression itself is very strong statistically. The coefficient estimate for SIZEINDX, β_1, has the expected sign and is highly significant. This result strongly supports the hypothesis that there are economies of scale associated with central office and C&WF investments. Thus, larger central offices have comparatively lower costs per loop than smaller central offices. The coefficient estimates for TANDEM and REMOTE, β_2 and β_3 respectively, also have the expected sign and are statistically significant. As noted above, the success of these two variables allows the model to control for the effect of these network functions on investment levels while estimating economies of scale related to the SIZEINDX variable.

Having estimated the underlying cost structure for basic exchange service, a comparison between basic exchange rates and the estimated cost structure must be performed. To accomplish this, an estimate of average investment per loop which controls for network functions and varies with central office size must be determined. To accomplish this, total central office and C&WF investments associated with the TANDEM and REMOTE network functions are calculated by multiplying the total number of lines in the central office by the β_2 and β_3 coefficients. The average actual investment per loop is now controlled for the tandem and remote switch functions by taking existing actual central office and C&WF investments and subtracting the estimated TANDEM and REMOTE related investments. The resulting figure is then divided by the number of loops within the central office to obtain an average investment per loop which pertains only to the size of the central office.

In addition to estimating central office and C&WF investments per loop while controlling for tandem and remote switch investment, average local service rates for differing central office sizes also had to be calculated. As discussed above, little relationship exists between central office size and the current local service price bands which are based upon calling scope. To calculate average local service rates for differing central office sizes, each central office was categorized by calling scope (consistent with the current banding structure) and the corresponding local service rates were identified. Central offices were then sorted by size and separated into ten different size categories. Average local service rates and central office and C&WF investments per loop were then calculated for each of the new size categories. The results are presented in Figure 1.

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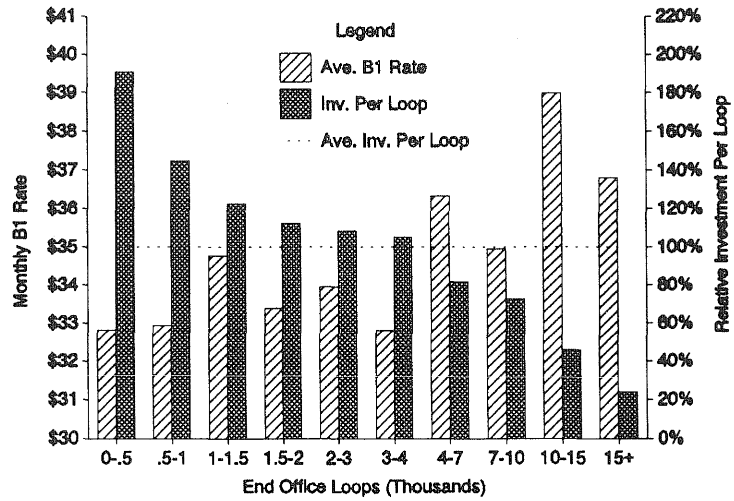
6 The t-statistics for the estimated coefficients are provided in parenthesis.

Figure 1 compares average existing single line business rates (Ave. B1 Rate) to the estimated average central office and C&WF investments per loop generated by the model (Inv. per Loop).[7] As can be seen in this figure, average B1 rates bear little relationship to the size of the central office. If fact, the data indicate that the existing B1 rate structure follows an inverse relation to underlying costs. In small central offices, investments per loop (and therefore carrying costs per loop) are high while local service rates are low. In large central offices, the opposite situation exists - investments per loop (and therefore carrying costs per loop) are low while average basic local service rates are high. A review of rates and investments in central offices with 0-500 lines (.5 in the figure) and in central offices with 10,000 to 15,000 lines or more (15 and 15+ in the figure) clearly displays the pricing problem that UNC faces.

Figure 1

Loop Investment Analysis



While there are some significant differences between the RAND study identified above and the basic exchange service costs estimated in this paper, the RAND study provides a useful comparison for the analysis developed in this paper. The RAND study estimates the incremental costs of adding new basic exchange subscribers to an existing network under three different subscriber density conditions: 1) small urban and low growth; 2) average urban and medium growth; and, 3) large urban and high growth. The estimated costs are based upon new technology, present day prices and do not reflect any overhead expenses, sunk costs, or fixed costs which are not directly attributable to adding the new subscribers to the network.[8] The study breaks basic exchange service into three major components: the local loop, local switching, and interoffice trunking. For each component, a separate cost model is estimated.

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7 Other basic local rates have not been included to keep the figure uncluttered and interpretable. However, all of UNC's local service rate structures follow the same general pattern as B1 rates. As a result, conclusions regarding the relationship between B1 rates and underlying costs are equally valid for the other basic local service rates.

8 In recognition of the very limited focus of the study, the authors note that the study cannot be used to test for the existence of rate subsidies (Id note 2 at page 4).

In addition to the incremental facilities and investment costs associated with basic exchange service, the RAND study also estimates the incremental costs of basic exchange traffic (or usage) per line.[9] The study identified that usage costs are directly related to the type of switch and the busy-hour conversation minutes. Other, less critical factors in usage expenses are busy-hour call attempts and the percentage of calling which is interoffice. A summary of the RAND study findings is presented in Table 2.[10]

Table 2

Average Incremental Costs of Access and Usage (Dollars per year)

	Small Urban	"Average"	Large Urban
Residence			
Access	$152-169	$67-80	$53-66
Usage per line	5-10	13-24	14-27
Access plus usage	158-179	79-104	67-93
Business			
Access	$111-126	$62-75	$46-59
Usage per line	7-15	14-27	21-39
Access plus usage	118-141	76-102	67-98

Source: reprinted from Incremental Costs of Telephone Access and Local Use by Bridger Mitchell, (Rand R-3909-ICTF).

As can be seen in Table 2, the RAND study identified significant cost economies associated with high growth urban areas. It is important to note that the cost economies identified in the RAND Study occur in the access portion of basic exchange service which is directly consistent with the findings of the model estimated in this paper.

Experimental Rate Design

Having identified the disconnect between existing basic exchange rates and the underlying cost structure of these services, new rate structures need to be developed and implemented. As discussed above, a rational rate structure will mirror the underlying cost structure. Figure 2 depicts new B1 and R1 rate structures which accomplish several goals. First, these rate structures follow the cost pattern of decreasing as central office size increases. Second, these rate structures produce the same level of revenues as existing rates. And lastly, these rates structures maintain the same percentage spread between the highest rate and the lowest rate as the existing rate structures. The last characteristic of the new rates was based upon the hypothesis that if the existing rate structures were simply inverted, a more economically rational rate structure would result.

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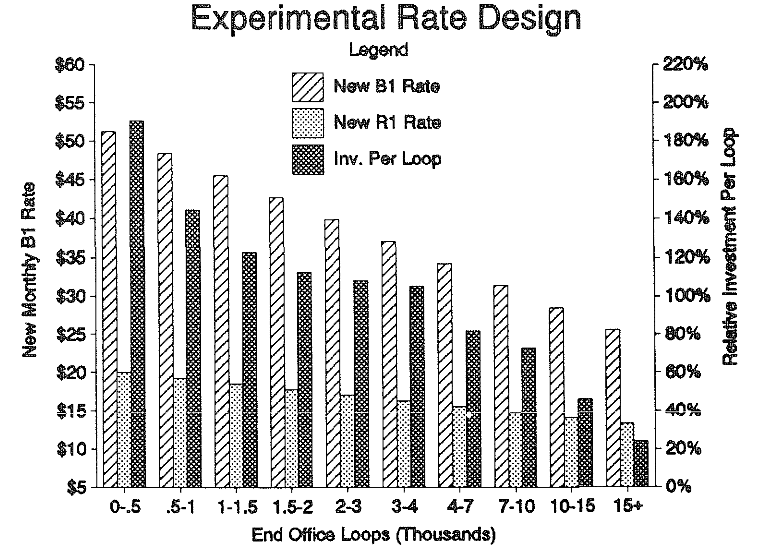
9 Id note 1 at page 45.

10 Table 2 is a reprint of Table 12 found on page 48 of the RAND study.

Requiring the new rates to maintain the existing spread should also make the new rates more palatable to consumers and regulators. A by-product of this characteristic, however, is a failure of the new rates to display the magnitude of the scale economies apparent in the loop investment estimates. As Figure 2 displays, relative loop investments display a 9 to 1 differential between the smallest and largest central office size categories. The new R1 and B1 rate structures, however, maintain only a 1.5 to 1 and a 2 to 1 differential respectively.

Figure 2



The new rate structures depicted in Figure 2 are not based upon the existing calling scope banding approach. The decision, therefore, has to be made whether to abandon the existing banding approach in favor of price banding based upon central office size or an alternative approach. Investment costs have clearly been related to central office size. As such, a pricing approach based upon central office size appears to be theoretically appealing. In a practical sense, however, pricing based upon central office size is likely to be confusing to customers and potentially lead to customer complaints. For example, in situations where small central offices share local calling areas with large central offices, a pricing structure which charges noticeably different rates would likely generate complaints from customers and pressure from regulatory commissions.

New rate structures which maintain the existing banding approach based upon calling scope avoid the likely customer confusion and complaints associated with pricing based upon central office size. To accomplish this, the new rate structures developed to reflect central office size were translated into the existing rate bands based upon calling scope. The translation was performed by identifying the new rates for each central office based upon size and then sorting the central office back into their original pricing bands based upon calling scope. A weighted average B1 rate for each calling scope band was then calculated. The new B1 average rate structure is depicted in Figure 3. Once again, the new average B1 rate structure (New B1) displays the fact that central office size shows little relationship with calling scope.[11] The trend from higher rates for very small calling

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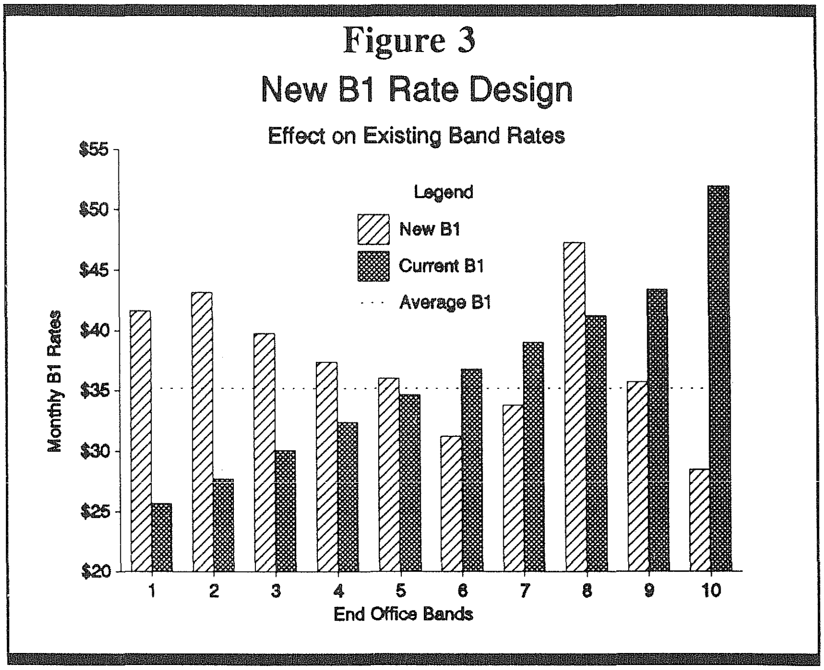
[11] If a strong relationship between end office size and calling scope existed, the new averaged rates depicted in Figure 3 would show a more uniform pattern in relation to

scopes to lower rates for the highest calling scope is fairly well behaved with the exception of bands seven, eight and nine. It is possible that smaller central offices which have obtained access to large calling scopes through EAS arrangements has produced the higher investment per loop (and hence average rates) in these bands. This EAS effect (higher average loop investment and price in bands 7, 8 and 9) has produced a translated rate structure that is relatively flat in relation to calling scope.



Implementing the "translated" rate structure identified in Figure 3 would represent only a small step in solving United's local service rate design problem. The most egregious flaw with this rate design is that it retains the existing calling scope rate bands. The new rates do represent average rates which were derived to mirror underlying costs, and hence the new rates do reflect differences in average investments per loop across the existing bands. However, since loop investments are unrelated to calling scope, a new rate structure which fails to eliminate pricing based upon calling scope must still be viewed as flawed.

An alternative to both the existing rate structure and the newly developed rate structure which may address the customers' and regulators' needs while moving United's rate structure more into line with underlying costs is to simply eliminate banding altogether and charge a statewide averaged rate. It has already been noted that the new rates structure is relatively flat across the existing calling scope bands. As a result, an averaged rate structure which eliminates calling scope bands is not grossly inconsistent with underlying costs and, in fact, represents a substantial improvement over existing rates which are inversely related to costs. While it is true that customers served by very small central offices would face the same rates as customers served by very large central offices, at least the perverse result where high cost customers receive a price break relative to low cost customers would be eliminated.

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the calling scope bands.

In addition, there are several policy advantages to an averaged rate. First, given that current rates are inversely related to costs, a move to averaged rates rather than rates which closely follow costs will reduce any potential rate shock. A move directly to a structure which charges higher rates in small end offices would produce a much larger change in rates than a move to averaged rates. As a result, the averaged rate structure represents an interim step which should prove much more politically acceptable to regulators. Second, as noted above, averaged rates will produce fewer customer complaints than rates based upon central office size. Consumers will not face a new rate structure that is confusing and difficult to explain. And finally, in relation to the first policy advantage, a portion of the subsidy for small rural central office customers would remain. The viability of this subsidy would be addressed as competition continues to expand into the local exchange carrier business. As an interim step, however, the averaged rates eliminate the obstacle presented by the existing structure based upon value of service pricing and calling scope. In recognition of these policy advantages and the potential difficulties of moving directly from today's rate structure to a structure which strictly follows underlying costs, a movement to averaged rates appears the most sensible course of action.

Policy Discussion

Prior to the emergence of competition in the telecommunications industry, the practices of residual ratemaking and value-of-service pricing for basic local services did not place UNC's services at risk to competitive alternatives. Today's telecommunications environment, however, is characterized by expanding competitive alternatives. In the face of these new competitive realities, UNC is challenged with aligning its rate structures with the underlying costs of providing services. Absent realignment of rates, UNC will be vulnerable to eroding demand for its products as competitive and private networks are built into and around UNC's local operations.

Altering UNC's local service rate structure to more closely reflect underlying costs will be difficult in the current regulatory environment. The rural population has strong advocates at regulatory commissions as well as within the legislatures. In addition, political opposition to raising any local exchange service rates is wide spread. As a result, UNC will be required to make very forceful and well supported arguments in order to accomplish local service rate restructuring.

Increasing Competition

Examples of how competition is expanding into the telecommunications industry are numerous. Changes in both technology and regulatory policy are facilitating the emergence of competitive pressure in all portions of local exchange telephone company operations. Examples of technological changes include the development of personal communications systems, digital cellular service which will allow data transmission, the expansion of competitive access providers in major metropolitan centers, development of dedicated terminating access capabilities by interexchange carriers, and the introduction of transmission equipment and terminal devices which allow simultaneous telecommunications and cable television over CATV facilities.

Changes in regulatory policy are also serving to open the telecommunications industry to increasing competition. Recent dockets before the Federal Communications Commission are either explicitly designed to foster competition for switched and special access services or are receiving thorough review by the FCC to ensure that competition is not hampered. FCC dockets of particular importance include the expanded interconnection docket (91-141) which looks to un-bundle special access rate elements and allow CAPs to interconnect directly with local exchange carrier facilities, docket 91-213 which is designed to restructure the increasingly competitive local transport portion of switched access, and the ONA proceeding (docket 89-79) which seeks to un-bundle switched access rate elements. The FCC's intentions in docket 91-141 were clearly stated in the following quote: "The action proposed in this notice is a measured step toward broader competition in the provision of interstate access services and facilities. The improved arrangements for interconnection with LEC facilities which we are proposing will substantially expand the universe of customers who can be serviced by the new competitive entrants, and increase the scope of LEC offerings subject to competition."[12] While the FCC dockets pertain to access services rather than basic exchange service, which remains within the oversight of state regulatory commissions, the trend toward increasing competition is clear. At the state level, the state of New York has issued an expanded interconnection order which requires local exchange carriers to allow collocation with CAPS. In addition, the concept of creating "telecommunications free-trade zones" within the state of Illinois has been discussed by the Illinois Commerce Commission. In summary, regulatory policy at both the state and federal level is moving in the direction of increasing competitive pressure on local exchange carriers.

Universal Service

A primary area of concern regarding a rate restructuring will be the effects on universal service. Because the proposed rate restructure is revenue neutral, however, stimulation and repression of local service demand will offset.[13] The elasticity effects will not, however, be uniform across urban and rural areas. Because average rates for the underpriced rural areas will increase while urban prices decrease, the preponderance of repression will occur in rural areas while demand is stimulated in urban areas. The public policy question which arises from this is whether the repressed demand in rural areas needs to be addressed. Rural customers which are pressured to drop off the network due the increase in price may qualify for reduced rates under UNC's existing lifeline assistance program. Customers which drop service and do not qualify for the lifeline rates do not perceive the value of their local service equaling the new rate levels.

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[12] *Notice of Proposed Rulemaking and Notice of Inquiry*, CC Docket No. 91-141 (Released June 6, 1991) paragraph 4.

[13] Stimulation and repression refer to changes in the quantity of a product demanded when price is changed. A measurement of the relationship between price and demand for a particular product is commonly referred to as the elasticity of demand. For additional information on this topic, see the references provided in footnote 4.

Under the admittedly cold science of economic theory, dropping service by these customers is the correct choice for both society and these customers.

In urban areas where basic exchange service prices will decrease, stimulation of usage will occur. Businesses may take advantage of reduced rates to add lines. Residential customers may choose to add a line for a teenager. And finally, pressure on urban poor to choose lifeline service will decrease.

Rural Investment

An additional concern regarding differences between urban and rural customers relates to investments in rural telecommunications infrastructure. Declines in rural income and population have sensitized politicians and regulators to the needs of rural areas to attract and retain businesses. Policies and rhetoric designed to stimulate investment in telecommunications infrastructure are becoming more commonplace. The current pricing structure for UNC's basic local service provides UNC with a **dis-incentive** for investing in rural infrastructure. UNC's primary policy incentive under the current structure is to reduce urban local service rates - the underpricing of rural local service rates and the unpopularity associated with raising any local service rates makes this difficult to accomplish. In addition, increasing UNC's investments in rural telecommunications infrastructure without altering the existing local service rate structure will increase UNC's pricing dilemma.

Price Signalling

The existing rate structure sends an improper signal to the market regarding competitive opportunities. In rural areas where costs are high and calling scopes (and thus rates) are low, potentially viable opportunities for competitive entry using existing technology or the introduction of new services using new technologies may be prevented. The opposite effect, where "uneconomic" investment is stimulated, may occur in urban areas under the existing rate structure. With rates set at high levels relative to the underlying cost structure, potential entrants into the market may perceive opportunities which could quickly evaporate once the local exchange carrier is allowed to adjust its rates. If changes regulatory policy or advances in technology provide for competitive opportunities in the local service market prior to UNC redesigning its local service rates, competitors and regulators may face a situation where a new competitive offering (and associated investment) becomes unsustainable when pricing flexibility is allowed for basic service rates. Only a redesign of the current basic exchange rate structure or a regulatory ban on competition can mitigate this possibility.

Conclusion

The objective of this paper is to quantify a design problem in UNC's basic local service price structure. This has been accomplished through the modeling efforts discussed above. In order to foster economically viable competition in the telecommunications market, UNC in concert with regulators must design rates with realistic relationships to underlying costs. To meet this need and address potential customer confusion and rate shock, a rate structure based upon a simple averaging of existing banded rates is proposed. While not theoretically perfect, a simple averaging approach provides a significant improvement over existing rates by more closely aligning prices with costs and eliminating outmoded practice of basing local service rates on calling scope.

Failure to correct UNC's basic exchange rate structure will subject portions of UNC's telecommunications services to competitive pressure and will continue to send inappropriate pricing signals to the market. Correcting the rate design problem, however, will require the regulators and UNC to face the difficult and politically charged challenge of altering basic exchange rates.

Price Cap Regulation and Cross Subsidization

by
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Introduction: Cross-subsidization is the support of one service by other services. Throughout the history of telephony there have been many claims that cross-subsidies are used to support universal service or suppress competition. Local Exchange Carriers (LECs) currently face the threat of loss of access markets to alternative access providers (ALTS).[2] The transport market is the first market that the ALTs enter. Clearly, the LECs have an incentive to cross-subsidize their transport access service in order to diminish or demolish this threat to their long term dominance of the industry. The purpose of this paper is to investigate if, under the regime of price cap regulation, LECs have the ability to cross-subsidize the transport market.

It is claimed that price cap regulation, because it allegedly eliminates the incentive to shift costs among services, reduces the possibility of cross subsidization. The FCC has also determined "that the adoption of price cap regulation for the LECs constitutes an effective complement to cost allocation, reporting and enforcement safeguards, to reduce BOC incentives to cross-subsidize."[3]

This paper will examine (1) whether the theoretical arguments in favor of price cap regulation for the purpose of limiting cross-subsidization are reasonable; (2) whether price cap regulation as it has been established by the FCC can eliminate cross-subsidization in practice; and (3) is price cap regulation useful once alternative firms are allowed to enter selective markets.

Price Caps and the Incentive to Cross-Subsidize: Under price cap regulation, individual service prices are no longer tied to cost of service studies. Instead, prices are allowed to rise with

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[1] The views expressed in this paper are those of the author and do not necessarily represent the views of the Public Service Commission of the District of Columbia or its Staff.

[2] The term, ALTS, refers to alternative access providers. The term, CAPS refers to competitive access providers. The term, ALTS, is preferred to the term, CAPS, because it is not clear when or if the alternative providers will become effective competitors.

[3] Computer III Remand Proceedings: Bell Operating Company Safeguards and Tier I Local Exchange Company Safeguards, Report and Order, CC Docket No. 90-623, released December 20, 1991, para. 13.

inflation and decline due to productivity offsets. Specific allowances are also made for extraordinary items that can affect utilities in a manner different from the rest of the economy. These items are referred to as exogenous factors.

The separation of price from cost eliminates the need to develop elaborate cost studies for rate making purposes. It is argued the utility no longer needs to artificially increase costs to support a desired price increase, and no longer needs to artificially reduce costs to support a desired price decrease. Under price cap regulation, a utility's request to increase a price because the cost study shows that price is below cost is irrelevant.

However, this separation does not eliminate the incentive to selectively alter prices. The desire to alter prices is a function of the desire to capture monopoly rents and to combat alternative providers. For example, in a market where demand is relatively price inelastic, the utility often desires to increase prices. To justify the higher price, the utility would shift costs to that service. Regulators who desire to set price according to cost would allow the price to rise. Of course, before authorizing the higher price, the regulator would examine the cost study to verify if it accurately represented the cost of service. In order to ensure that the regulator concludes that the study is accurate, the utility has the incentive to prepare elaborate studies to build an aura of authenticity around the resulting cost. What is important to remember is that the purpose of the elaborate cost study is not to win an intellectual debate similar to the debate over how many angels can dance on a pin head. Instead, the purpose of the cost study is to support a pricing strategy.

If price cap regulation allows for selective price changes then price caps will also allow utilities to develop cross-subsidizing pricing strategies. Moreover, without a cost study to use as a yardstick for reasonableness, the regulator has a more difficult task of determining if a cross-subsidy exists.

Price cap regulation allows for selective price change under two scenarios. First, if prices for services are not compelled to match the cap, then the utility has the incentive to set the price of service A at the cap and the price for service B below the cap. If the cap is above the cost of service, the utility would be able to earn monopoly rents in the market for service A which can be used to subsidize service B. In order for this scenario to be realized, the utility must have monopoly power in market A, and the price cap mechanism must allow price to exceed service cost.

In the second scenario, the price cap is applied to an average price of a group of services. If there is a large number of services within the group and the price of any individual service is not kept from fluctuating, it would possible for one of the services within the group to subsidize another service in the group even if the average price for the group is reasonable. Therefore, price cap regulation does not alter the ability to cross-subsidize. It simply changes the mechanism through which the subsidization is accomplished.

Cross-Subsidization: Scenario 1: The two basic assumptions that must be true for cross-subsidization to occur are: (1) the utility must have monopoly power in one market, and (2) the price cap must exceed service cost. This paper will not address the amount of monopoly power still retained by telephone utilities. It will be assumed that such power exists in a significant number of high revenue markets. If that power is not restrained by regulation, the utility could raise rates to generate excessive revenues.

This paper will also examine how the price cap mechanism can depart from the cost of service. This possibility will be shown by comparing the price cap mechanism to market prices, productivity trends, and input price trends.

Market prices can measure the departure of the price cap mechanism from cost of service where competitive markets exist. In such instances, the market price should follow the cost of service. A market price that is below the price cap's maximum price represents a situation where the cap does not reflect the cost of service.

A recent example of the departure of the market price from the price cap mechanism occurred under the guideposts established by the Natural Gas Policy Act. This Act allowed the price of regulated gas to rise in accordance with an inflation factor and real cost factor. The Act separated natural gas by vintage, location and depth. A price cap mechanism was determined for each type of gas. The most common mechanism used was to set the price at $1.75 on April 20, 1977 and allow the price increase by the change in the Gross National Product price deflator plus 0.2 percentage points.[4]

The history of the price cap mechanism and average well head prices is depicted in Chart 1. The Chart shows the price cap maximum price starting at $1.75 and rising due to increases in the GNP deflator. The price of regulated gas rises following the cap until 1983. Then the price falls dramatically. The price of all gas, regulated and deregulated, rises until 1983 and falls faster than the price of regulated gas. If the price cap mechanism had been enforced through 1990, and the gas companies could have maintained the price at the cap, then the 1990 price would have

[4] A summary of the price cap mechanisms is provided in Charles F. Phillips, Jr., The Regulation of Public Utilities, Public Utilities Reports, Inc., Arlington Va., 1984, pages 588-9.

been $3.52 instead of $1.71 per MCF.[5] This example shows how a mechanical price cap mechanism can easily diverge from market realities. Moreover, if the gas companies had been operating in two markets, and could have sustained the price cap maximum in one market, it is clear that the gas companies could have easily subsidized the second market.

To determine if the price cap mechanism used to regulate telephone markets track telephone costs, it is necessary to examine those formulas and compare the variables in the formulas to telephone costs. The FCC price cap formulas allow prices to increase according to changes in the fixed weighted GNP deflator and to decrease according to a productivity offset. The productivity offset, in theory, measures the difference between the productivity of the telephone industry and the productivity of all industries in the United States.

The formulaic derivation of this relationship begins with the following three equations:[6]

1) $\Delta P^{t}_{o} = \Delta P^{t}_{i} - \Delta TFP^{t}$

2) $\Delta P^{US}_{o} = \Delta P^{US}_{i} - \Delta TFP^{US}$

3) $\Delta P^{US}_{o} = \Delta GNPDF$

where: Pi = input prices, Po = output prices, TFP = total factor productivity, GNPDF = the GNP deflator, t indicates the telephone industry, and us indicates the US economy.

By subtracting equation 2 from equation 1, substituting the GNP deflator for US output prices and rearranging, the following equation is derived.

4) $\Delta P^{t}_{o} = \Delta GNPDF + [\Delta P^{t}_{i} - \Delta P^{US}_{i}] - [\Delta TFP^{t} - \Delta TFP^{US}]$.

By assuming that the changes in telephone industry input prices equal the changes in US input prices, equation 4 is transformed into the price cap equation:

5) price cap = GNP deflator - the productivity offset.

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[5] Table 24. Projected Volumes and Prices of Wellhead Purchases by NGPA Category, <u>Natural Gas Monthly</u>, Energy Information Administration, U.S. Department of Energy, Washington D.C., Selected Issues.

[6] This formal presentation was first suggested by William Taylor. See William Taylor, "Productivity Measurements in the Price Cap Docket," Opposition of the United States Telephone Association to Petitions for Reconsideration, CC Docket 87-313, Attachment A, filed December 21, 1990.

Several observations can be made from these transformations. First, the reasonableness of the price cap formula is dependent on the understanding that the formula includes one factor that represents cost increases and another factor that represents expected cost decrease. That understanding is wrong. The factor that represents cost increases, the GNP deflator, is really an output price measure, not a measure of input costs. However, since the GNP deflator has been interpreted as a measure of cost, it is useful to compare it to telephone industry cost changes.

Second, the realism of the price cap formula depends on the assumption that changes in the input prices of the telephone industry match changes in input prices for the entire economy. A measure of US input price change is the difference between changes in the GNP deflator and the total factor productivity. Thus, it is necessary to compare changes in telephone industry input prices to changes in the difference between the changes in the GNP Deflator and the total factor productivity.

The best available measure of telephone industry input prices are the New York Telephone Company's Telephone Plant Indices. These indices are developed for different plant purchases such as fiber cable and digital switches, and labor prices. The individual indices are combined to form a composite total company Telephone Plant Index. In Chart 2, the total company index is compared to the GNP Deflator, and the GNP Deflator - TFP. This comparison shows that telephone industry's input price changes are less than the changes in the other variables for every year under observation.

If the transformation of equation 4 into equation 5 had used the correct assumption, that telephone industry price changes are less than US input price changes, then the allowed price changes under a price cap regime would be reduced. This result indicates that the price cap mechanism contains a bias towards excessive price increases. Therefore, the conditions for cross-subsidization under price caps have been incorporated into the FCC approved price cap formula.

The other piece of the price cap formula is the productivity offset. The FCC uses either a 3.3% or 4.3% offset, depending on LEC commitment to particular price changes.[7] This range is based on judgment and consideration of various conflicting estimates of the productivity offset. For example, the Bell Companies asserted that their average offset is 0.74%. The range across companies

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[7] In the Matter of Policy and Rules Concerning Rates for Dominant Carriers, CC Docket 87-313, Second Report and Order, Released October 4, 1990, at 125-26.

starts from a low of -2.61% to a high of 6.59%.[8] A negative offset indicates that the companyies experienced a lower productivity growth rate then the entire nation. AT&T asserted that the LEC productivity offset should be 7.1% or 9.9%.[9] Other parties examined these estimates and found numerous errors and biases. Many of these problems result from the methods used to measure productivity. These results indicate that there is pressing need for the FCC to collect and compile information that would allow for more accurate measures of telephone industry productivity.

Cross-Subsidization: Scenario 2:

Price cap mechanisms can allow cross-subsidization within baskets of services. A price cap basket is a group of services subject to the same price cap formula. The subsidy can take place within a basket when the price of one good increases and the price of another good decreases, even though the set of prices for the entire basket remains in compliance with the price formula.

Under the FCC LEC price cap rules, the service baskets are: (1) common line, (2) traffic sensitive, (3) special access, and (4) interexchange. The traffic sensitive basket includes: local switching, equal access, information, and transport.[10] In an effort to prevent service cross-subsidy within a basket, the FCC established an elaborate set of rules that limit annual rate changes for individual services. The most important aspect of this rule is the limitation of service band indices annual price to 5% plus and minus the change in service basket price cap index.[11]

The first step in determining the effectiveness of the FCC rules to prevent cross-subsidies is to examine the current price indices for the RBOCs. Chart 3 compares the service band indices for local switching and local transport for Bell Atlantic, Bell South, and Pacific Bell. In each instance, the index for local switching is at the upper limit, while the index for local transport is at the lower limit. Also note that the band limits for switching are higher than the band limits for transport. These difference cannot be explained by differences in productivity, inflation or exogenous factors because transport and switching

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[8] In the Matter of Policy and Rules Concerning Rates for Dominant Carriers, CC Docket 87-313, Report and Order and Second Further Notice of Proposed Rulemaking, Released April 17, 1989, at 702.

[9] Id., at 672.

[10] CC Docket No. 87-313, Second Report and Order, Appendix B at 3.

[11] 47 CFR 61.47.

services are in the same basket. Instead, the differences are the result of the cumulative nature of the pricing strategy. That is, if the price is set at the low end of the service price band in year one, then service price bands in year two will be lower than the bands associated with a price set at the upper end of the service band in year one. Over time this effect will allow the prices in the two markets to steadily diverge. Therefore, the FCC rules for preventing of cross-subsidization did not prevent the RBOCS from instituting a cross-subsidizing pricing strategy. The strategy lowered price in the transport market, the market that alternative providers are entering. Without additional information pertaining to the cost of service, it not possible to determine if a cross-subsidy is occurring. However, compliance with the FCC rules does not appear to prevent cross-subsidization.

<u>Price Caps and the Entry of Alternative Providers</u>: The entry of alternative providers has caused many industry participants to question the viability of price cap regulation. The National of Regulatory Utility Commissioners' (NARUC) Committee on Communications established an Access Issues Working Group (AWIG) to investigate current problems with the Part 69 rules. A common complaint with the current prices is that they are too high. Major users do not want to pay the high price. LECs realize that the high price is an incentive for users to shift to alternative providers.

The reasons given for the high price are that (1) the price caps started from inappropriate prices established under the Part 69 rules; (2) the prices reflect obsolete technologies; (3) the prices are averaged across a study area; and (4) the price cap rules do not allow for major shifts in prices. Each of these problems will be discussed below.

First, it is asserted that the Part 69 rules allocate excessive amounts of revenue requirement to transport services and away from common line service. The primary causes of this misallocation are the rules associated with general support facilities and central office equipment expenses. If these rules were changed, it would be possible to significantly reduce transport rates.[12] These reductions would benefit the LECs and discourage entry.

Second, the current prices allow the LECs an opportunity to recover the investments in obsolete technologies. However, if the entrants only have the newer technologies which are cheaper on a per unit basis, a competitive market will not allow the LECs to recover the costs of the old technology, regardless of the regulatory intent. Therefore, if effective competition arrives in the transport market, LECs must either write-off the investment in the obsolete technologies, or recover their costs in alternative

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[12] Southwestern Bell Telephone Company, CC Docket No. 91-213, Ex-Parte: Analysis of the Residual Interconnect Charge.

markets. Currently, there is no method for either writing-off the investment or transferring their costs to other markets.

Third, prices are currently averaged across a LEC study area. However, if costs are sensitive to customer density, and customer density is not even across a study area, then there will be subdivisions of the study area with lower than average costs and other subdivisions with higher than average costs. An entrant that does not have the responsibility to provide ubiquitous service in the study area will opt to serve only the low cost area. The entrant can attract customers as long as his rate is beneath, the LEC study area wide rate. The situation could occur where the entrant has higher costs but lower rates than the LEC in the more dense subdivision of the study area. In this case, entry would be inefficient, but profitable.

Fourth, price caps restrict the annual change in prices to remain within the limits set by the service band indexes. While these restriction, as noted above, do not prevent LECs from adopting a gradual cross-subsidizing pricing strategy, they do prevent massive changes in the price. The only way to achieve a massive price change is through the exogenous factor. However, realignments in prices caused by exogenous factor changes are time consuming and the results are unpredictable.

This review of the problems of price cap regulation in light of the entry of alternative providers should not be interpreted as an endorsement of any alternatives presented by participants in the AWIG process. Instead, the review stresses the failure of price cap regulation to meet the challenge of current events.

<u>Price Caps and Efficiency</u>: One of the main reasons for turning to price cap regulation is the desire to provide LECs with the incentive to provide services in a more efficient manner. It is believed that because LECs could pass through all of their expenses under rate of return regulation, LECs would purchase excessive resources. Under price cap regulation, LECs cannot automatically pass through expense increases, and thereby, have an incentive to purchase in a relatively more efficient manner.[13]

Recent RBOC employment policies suggest that telephone companies are responding to a host of different incentives that are not captured by the simple logic of the price cap mechanism. The RBOCs, under rate of return regulation, have instituted massive reductions in force. Chart 4 shows that between 1984 and 1990 the RBOCs reduced their workforce by 111,003 workers, representing 20% of the 1984 workforce. However, if a company knows that price cap regulation is to be adopted in the near future, then its profit maximizing strategy would be to retain the workers until regulation switched from rate of return to price cap regulation, and then

[13] CC Docket No. 87-313, <u>Report and Order</u>, at 14.

reduce its workforce. This review of labor policy does not prove that price cap regulation is superior or inferior to rate of return regulation. The RBOC efficiency effort could have been the result of a multitude of other factors. However, these events shows that rate of return regulation, in practice, has not prevented the RBOCS from achieving their efficiency goals.

Price Caps and Consumer Benefits: Price cap regulation, because it provides incentives for firms to become more efficient should lead to consumer benefits. One measure of consumer benefits is price reduction. Chart 5 shows the percentage change in prices for interstate and state toll services as measured by changes in the Consumer Price Index (CPI). Following divestiture, interstate toll rates decreased in every year from 1984 through 1990, the years associated with rate of return regulation. Rates increased in 1991 and the first half of 1992, the years associated with price cap regulation.

Conclusions: It is alleged that price cap regulation would prevent cross-subsidization. This paper has shown that cross-subsidization can occur under price cap regulation as long the telephone company retains monopoly power in at least one market. If that conditions is true, then the telephone company can engage in a pricing strategy that will lead to cross-subsidization within a price cap regime.

In addition, it is alleged that price cap regulation would provide incentives for telephone companies to become more efficient, and share the efficiency gains with consumers. The post divestiture history appears to conflict with these assertions. Telephone companies significantly reduced their work forces prior to the adoption of price cap regulation, and long distance rates have increased since the adoption of price cap regulation. Finally, the long term viability of price caps has been challenged due to price caps' inability to provide a framework that addresses the question of entry in era of technological change.

Chart 1: Natural Gas Price Caps

NGPA Guidelines

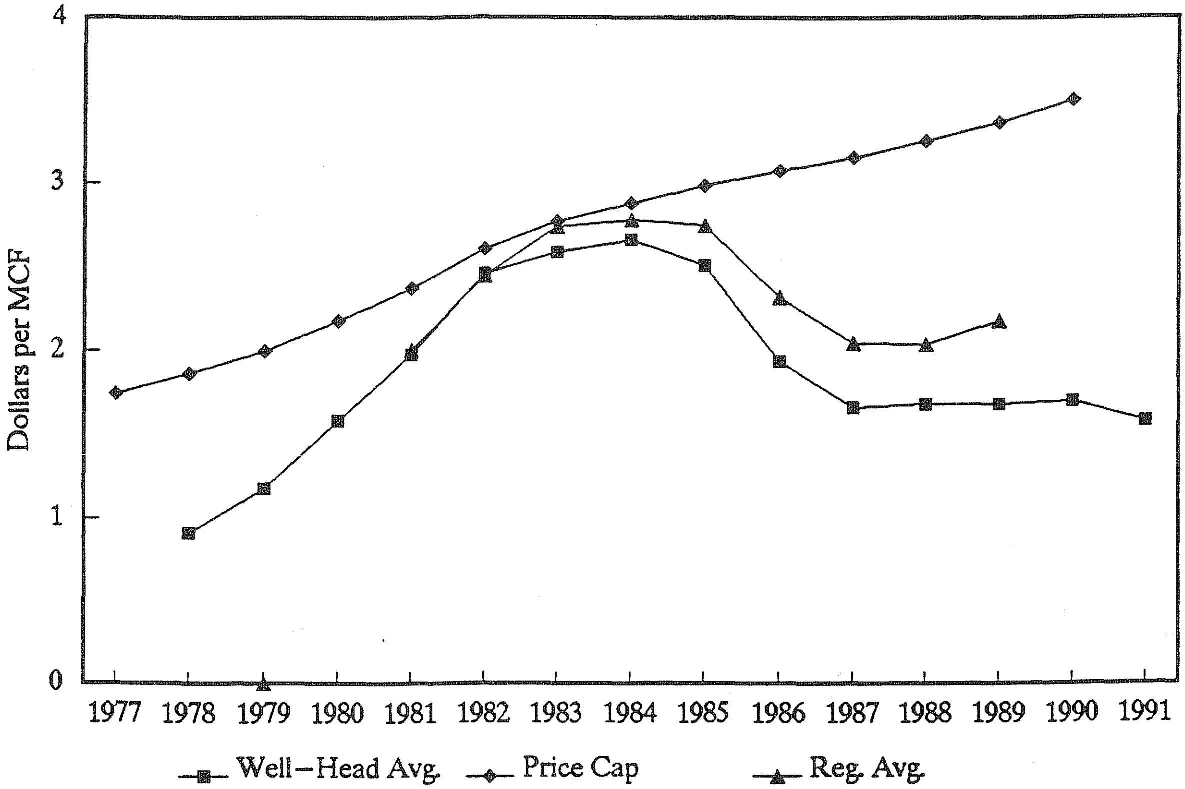
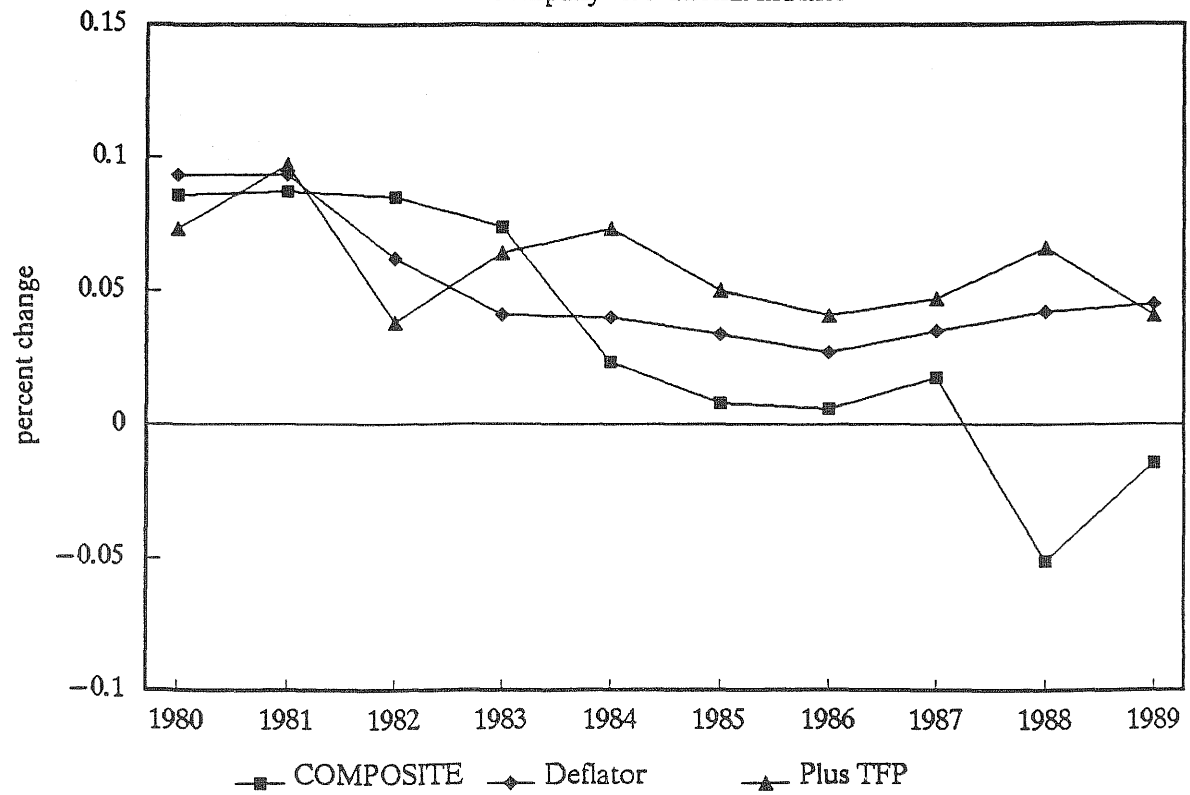


Chart 2: Inflation Rates

Company vs. National Indexes



UNBUNDLING OF LOCAL EXCHANGE NETWORK FUNCTIONS AND RELATED COSTING ISSUES

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Competition recently has begun to develop for certain local exchange transport functions previously the exclusive domain of the local exchange carrier (LEC). The FCC has adopted in principle a policy objective of the development of an open and unbundled network, and several states also have adopted this approach. While implementation of the FCC's Open Network Architecture (ONA) policies has been disappointing to date, these policies, if fully developed, may eventually open certain switching functions to some degree of competition. Looking further ahead, the implementation of Advanced Intelligent Network (AIN) by the BOCs may make it possible for service providers other than the LECs to program services outside the physical confines of the LEC's switch. At the same time, recent decisions by the FCC have explicitly required the development of interfaces necessary to permit the development of competition in the provision of interoffice transport services, and in the provision of interconnection between customers and the LECs' networks.

In such an environment, a need is rapidly developing for costing and pricing principles which will permit regulators to deal both with a network which increasingly is unbundled and open to competitive entry, and with the resulting potential for the emergence of competition for various network functions. If the objective of the regulatory agency is to permit and indeed to encourage the development of competition, while at the same time protecting the interests of those LEC customers who remain without alternatives for essential telecommunications services, conventional costing and pricing methods may be seen to be inadequate to the task.

Where competition exists, certainly, pricing flexibility, subject to safeguards to prevent anti-competitive pricing, is warranted and desirable. Where competition does not exist, however, pricing flexibility can only result in a lessening of regulatory oversight of services which do not face the discipline of the marketplace. Given that the primary purpose of regulation is to serve as a substitute for market forces, where such forces cannot operate effectively, it is difficult to see the benefit of lessening of regulatory oversight in the absence of competition.

A clear dividing line between competitive and monopoly services does not exist in some cases because the services provided by the LEC contain some network functions which are at least potentially competitive as well as other network functions which are not subject to competition. There is no question that, due to technological innovation and regulatory changes, some segments of the telecommunications industry have become more competitive. It also is true that LECs continue to enjoy an effective monopoly for certain network functions which are essential both for the LEC's end user customer and for its competitors or potential competitors.

The problem with many proposals for pricing flexibility is that they fail to distinguish between those functions which are truly competitive or subject to competition and those functions for which the LEC continues to enjoy a virtual monopoly. Finished services which may face competition in most cases are a bundle of competitive and non-competitive functions. Any proposal for pricing flexibility should distinguish between competitive and non-competitive functions, and permit pricing flexibility only for those functions for which the LEC is not able to exercise market power.

LEC proposals for flexible pricing typically establish a range of rates for those services deemed to be competitive, within which the LEC may change prices at will, sometimes with a cap at some percentage above the current rate, and in most cases with a price floor at the incremental cost of the service. Other services provided by the LEC are either capped at current levels, or subject to periodic increases tied to a measure of price inflation. The result of such proposals is that the use of monopoly network functions may be priced differently when used as part of the LEC's "competitive" service offerings than when used as part of a "basic" service offering. Monopoly ratepayers therefore may pay a higher rate for the use of non-competitive network functions than would customers of the LEC's "competitive" services. At the same time, the LEC would have the ability to discriminate between the use of non-competitive network functions in its own service offerings and the identical use of those network functions by its competitors, thus creating a price squeeze.

Incremental Costing Standard

The concept of incremental cost is subject to a wide range of interpretations. In general, an incremental cost study attempts to measure the change in the company's cost which results from some increment in the amount of service provided. While there is general agreement in the economics profession that incremental costs are the most appropriate basis for the setting of prices, there is little agreement as to how incremental costs should be measured.

In order to perform an incremental cost study, it is first necessary to determine the increment of demand against which changes in the company's costs will be measured. Studies of incremental cost have used demand increments ranging from very small increases in demand to the entire quantity demanded of a particular service.

In studying the costs imposed upon the company by the offering a service, it is most appropriate to study the costs caused by the total demand realized or anticipated for the service. In offering a service, certain costs may be incurred which do not vary with small increases in demand. If rates established for a service reflect only those costs which vary with small changes in demand, significant costs which are caused by the provision of the service will not be recovered by the revenues generated by the service, and will be left for other services offered by the telephone company to recover. Put another way, if the price established for a service does not exceed the difference between the costs of the company if the service is not offered and the costs of the company if the service is offered, the service can fairly be said to be subsidized by other services. Thus, the appropriate pricing floor for services is the total service incremental cost of the service in question.

The concept of total service incremental cost is identical to the concept of Average Incremental Cost (AIC) advanced by Baumol in *Superfairness.* Baumol defines average incremental cost the incremental cost of a service *i* divided by the output of *i*, or:

$$\mathrm{AIC}_i = [C(y_i, y_2, \ldots y_n) - (C(0, y_2, \ldots y_n)]y_i$$

That is, the difference between the total cost of the firm if a given quantity of service *i* is produced and if none of service *i* is produced, divided by the quantity of *i* produced. Baumol concludes that if prices are to be equitable to all customer group -- if they are to satisfy the criterion of "anonymous equity" -- then they must equal or exceed the greater of average incremental cost or marginal cost.[1]

Another issue is what type of costs should be measured in relationship to the change in demand studied. As a general principle, incremental cost studies should

1 Baumol, William J., *Superfairness*. (Cambridge, The MIT Press, 1986.), at 115-125.

be forward-looking. That is, they should not reflect the embedded base of facilities which the company already has in place, but rather should account only for the most efficient and cost-effective means of meeting the increase in demand. A related issue is the planning horizon which should be used in determining what types of costs to study in performing the incremental cost study. If the planning horizon used in studying costs is short-term, the study may capture only the expenses incurred in providing the service, and may ignore the cost of capital investment used in providing the service. In order to capture all the costs associated with the provision of a service, the planning horizon used in measuring costs should be long-run enough to encompass replacement of all capital investment used in providing the service.

The planning horizon used should be long enough to contemplate the replacement of all capital investment used in the provision of the service. As I noted earlier in this testimony, the primary purpose of regulation is to serve as a substitute for competition where competitive forces cannot operate. A competitive firm generally must take the market price as a given, and must adjust its costs to attempt to meet the market price. As the competitive market operates, prices will reflect the use of the most modern and efficient technology which can be used to provide a service. If the firm operating in a competitive market cannot meet the price imposed by the marketplace because its embedded investments reflect an older, less efficient technology, it must write off a portion of the value of its investment in order to meet the market price. Thus, the competitive market will permit the firm to recover the value of its capital investment only to the extent that that investment represents the most efficient technology available for the provision of the service.

If the incremental cost floor for LEC services is to result in prices which reflect the outcome of a competitive market, therefore, the cost studies performed should disregard any embedded plant which the LEC currently has in service, and account only for the investment which would be required if the LEC essentially were "starting from scratch" as it provides each of its services. The correct approach is to assume that all investment used in the provision of a service is replaced with forward-looking technology.

LEC cost studies are inconsistent in this respect. Some cost studies appear to account only for forward-looking technology. More frequently, the LEC attempts to project the mix of investment which will be in place during the rate planning period. A cost study which is designed to determine the forward-looking incremental cost of a service two years in the future, for example, will attempt to determine the plant which will be in place during that period. As such, the investments studied will consist of a mix of embedded and forward-looking plant.

Service-Specific vs. Building Block Cost Studies

In order for a costing standard to be useful, each of the issues outlined here must be resolved, and the costing standard should explicitly state the increment of demand to be studied and the planning horizon to be used in determining costs. In addition, as competition begins to develop for the services provided by the LECs, the costing methodology must ensure that costs for services which use the local exchange network in the same way are treated consistently. There are several ways in which services which use the local exchange network in exactly the same way can be attributed different levels of cost in the LEC's methodology, but generally, these differences occur because the LEC studies the cost of ***services***, rather than the costs of the fundamental network ***building blocks*** from which services are constructed. LECs have a very large number of services in their tariffs. The way in which the services are packaged and priced gives the appearance that each is a distinct service offering, with unique characteristics. In reality, however, the array of services offered by the LEC are constructed from a rather more limited set of basic functions. The consequences of a focus on the cost of services rather than on the cost of network building blocks are several.

First, a service-specific costing methodology does not ensure that identical uses of the local exchange network will be attributed the same level of cost. Because such studies are designed to determine the average cost of usage on a service-by-service basis, and because the form of outputs of the studies are driven by the format of the tariffs which the cost studies are designed to support, services which utilize the network in exactly the same way will be attributed different levels of cost. Secondly, inconsistencies in the way in which the usage of various network resources by various services is measured may result in differences in cost, even where such differences do not otherwise exist. Finally, the timing of cost studies may introduce differences in the cost attributed to various services, due to changing usage patterns, changes in the technology mix deployed by the LEC in its network, and changes in the relative amount of usage by various services.

When the LEC performs a cost study for a service, many of the calculations require the LEC to specify the average usage characteristics for the service. These characteristics include such factors as the average length of the call, the average distance which the call is carried in the local exchange network, the average number of times the call is switched through a tandem switching office, and the average time-of-day distribution of calls for the service. Naturally, because the traffic studies underlying the development of these factors are based on samples of traffic specific to the service, the factors will differ from service to service. The automated cost models, such as Switching Cost Information System ("SCIS"), used by the BOCs in performing cost studies also require a determination of the average usage of, for example, primitive resources in switching equipment, such as processor time, bytes of memory, and so forth.

Certainly some of the differences in network resource usage which appear in service-specific cost studies are the result of legitimate differences in the way that different services are provided. An 800 service call, for example, inevitably will utilize more central office switch resources than a regular MTS call, since the processing of the call must be suspended for a time while the 800 number is translated or screened for routing to an interexchange carrier. Other differences which appear in service-specific cost studies, however, are purely artifacts of the categorization performed by the LEC in determining the cost of services, and do not represent real differences in the utilization of network resources.

As an example, consider two services which require the provision of local loops — residential and business local exchange service. When the LEC conducts a cost study to determine the cost of residence local exchange service, it will take a sample of all residential loops in the state, and determine from the sample the average length of a residential loop, the average cable size used to provide the loop, the average distribution of aerial, buried, and underground conduit facilities used to provide the loop, and perhaps some other factors. In performing a cost study to determine the cost of business loops, a separate sample will be taken, and averages will again be calculated for each of the factors I have mentioned.

It is not surprising that differences in the two services will result from the two separate samples. Typically, residential loops will be shown to be more expensive, as they tend to extend further from the serving central office and to be located in less densely populated areas. The conclusion drawn from the cost study is that residential loops are more expensive than business loops.

Suppose that two customers — one a business customer and one a residential customer — located in adjacent buildings each ordered local exchange service from the LEC. The cost to the LEC of providing a loop to each customer would be exactly the same, because the loop length and facilities used to provide the loop to each customer is the same. According to the service-specific cost study conducted by the LEC, however, the cost of providing the loop to the residential customer would be more than the cost of providing the loop to the business customer. From this it may be seen that the cost difference between the services which appears in the LEC's cost study does not represent any real difference in the cost of providing the two types of loops. The difference occurs only because the cost study incorrectly studied the cost of ***services***, rather than study the basic network building block in terms which reflect the cost drivers of that building block.

A more correct approach would be to take samples of local loops based on loop lengths or facility type (e.g., to sample all loops between 500 ft to 1000, 1000 feet to 5000 feet, and so forth), and to determine the cost of loops in terms of the factors which drive differences in the cost of providing loops. Such an approach would more correctly reflect the principle of cost causation, and would correctly reflect that two customers who purchase different services, but who utilize the network in the same way, impose the same costs upon the LEC. The problem identified here in service-specific costing is pervasive in LEC cost studies, and exists not only in studies of the cost of loops, but also in switching and interoffice transport cost studies.

As noted above, differences in measurement of service resource usage and differences in the timing of cost studies may result in inconsistent treatment of identical usage of the network from service to service. By and large, LEC cost studies are driven by the tariff structure of the service being studied. If a service is priced in the tariff at a flat per-monthly rate, the object of the cost study will be to determine the monthly cost per customer of the service. If the service instead is priced on a usage-sensitive basis, on a time-of-day sensitive per-minute basis, for example, the cost study will geared toward producing a per-minute cost by time of day. The result is that the costs developed will correspond to the cost structure of the functions being provided only to the extent that the tariff structure reflects the underlying cost structure. In addition, services which make similar or identical uses of basic network functions may be attributed different levels of cost simply as a consequence of the rate structure of each service. For example, if switched access is tariffed on a flat, per-minute basis, and MTS service is priced on a time-of-day sensitive per-minute basis, the cost attributed to switched access will reflect a 24-hour average usage characteristics for switched access service, while the cost attributed to the LEC's MTS service will reflect the usage characteristics of MTS service by daypart. This in turn will create distortions in the retail market, as IXC long distance services in offered in off-peak periods will have to bear a higher, averaged cost (and price) determined for the service, while the MTS service will bear the lower cost of off-peak usage determined in the cost study supporting rates for that service.

The timing of cost studies is an issue where the cost providing network functions changes over time. If, as is widely believed, the cost of providing interoffice transport is both declining over time and becoming less distance-sensitive over time, the timing of a cost study for a particular service which uses interoffice transport may be crucial in affecting the cost determined for the service. A cost study performed for a service at an early date would reflect higher costs and more distance-sensitivity for interoffice transport than a cost study performed for a different service at a later date. If the two services in question represent a "competitive" LEC retail service and an access service provided to the LEC's competitors, the competitive consequences of the sequence in which cost studies are performed is obvious.

The factors outlined here strongly suggest that only an approach based on determining the cost of generic network functions, or building blocks, rather than an approach based on determining the cost of finished services, can insure that the costing process does not lead to incorrect conclusions regarding the relative cost causation of various services, and that the results of cost studies do not lead to pricing decisions which will distort competitive markets or prevent the development of competition.

Pricing of Network Building Blocks and LEC Services

The LEC offers both monopoly services — services for which there is no effective competition — and a number of services for which competition has begun to develop. In establishing any standard for the pricing of LEC services, it is essential to recognize that the LEC's potential competitors are dependent upon the LEC for access to the local exchange network. With few exceptions, the LEC is the monopoly provider of the exchange access functions needed for interexchange carriers and other service providers to access telephone subscribers. Because the LEC controls this access, it has the ability and strong incentives to price exchange access functions at higher levels than it implicitly charges itself when it uses those same functions in providing its own services. If such pricing is permitted, the LEC will be able to subject its dependent competitors to a price squeeze, and the development of competition will be impaired.

A price squeeze may exist even in the absence of a cross-subsidy. If a service is priced above its properly determined total service long run incremental cost (TS-LRIC), then it is not receiving a subsidy from other services. Pricing above TS-LRIC, however, is a necessary but not a sufficient condition to prevent anti-competitive pricing. In order to ensure that anti-competitive pricing will not occur, it is necessary to examine the prices charged implicitly to the LEC for exchange network functions used in provision of its services through its cost studies, and to compare those prices to the prices charged to competitive service providers for their use of the same functions. If the use of the network is the same in both cases, the price charged to the LEC and its dependent competitors also should be the same.

It is not necessary that the cost variables used in determining the cost of a network building block be reflected in the tariff for particular services. In the example used earlier, that of local loops, it would not be necessary to have loop length reflected in the tariff for general exchange services, although such a tariff structure would correctly reflect the cost of providing loops. Rather than adopt a tariff structure which distinguished loops by length, the telephone company could instead choose to price all loops the same.

At the same time, however, unnecessary bundling of network functions is a potential source of discrimination. If separable network functions are combined in a single tariffed offering and made available to the LEC's dependent competitors, while the LEC is itself free to use network functions on an unbundled basis, the LEC's competitors may be forced to purchase network functions which are not needed for the provision of their services, and may be unable to price their services competitively. Accordingly, as a general principle, the basic network building blocks should be made available on as unbundled a basis as is practicable.

If the regulator requires only that the price charged to customers for services are set above the incremental cost as determined by the LEC's service-specific cost studies, anticompetitive pricing may occur for those services where the LEC's competitors must purchase access to the local exchange network in order to provide services which compete with those offered by the LEC. Because LEC cost studies aggregate usage on a service-by-service basis, and determine the average cost of usage for each service, services which use the network in the same way may be attributed different levels of cost.

That each service recover the cost of its usage of network building blocks is a necessary but not a sufficient condition to ensure that anticompetitive pricing does not occur. Even if the network usage costs for various services were determined in exactly the same way, such that identical uses of the network were attributed the same level of cost, competitors of the LEC's services could still be subjected to a price squeeze if the price for their access to essential network capabilities is set above the level of cost attributed to LEC's identical use of the network.

As a general principle, a pro-competitive pricing policy would require that competitive entrants and their customers must be able to use bottleneck monopoly inputs from the LEC on the same terms on which the LEC uses those same network components in its own service offerings. This in turn requires both rigorous non-discrimination in the pricing of network functions and unbundling of network functions to the greatest extent practicable.

Several steps would be required in order for an LEC to perform its cost studies in accordance with the principles outline here.

First, it would be necessary to identify the fundamental network functions, or building blocks, from which services are constructed. In some cases, building blocks will correspond to the factors which drive costs in the network and in the LEC's current cost studies. In other cases, it will be necessary to combine cost components to form a building block which performs a coherent function. In either event, it will be necessary to define the building blocks and to determine the appropriate unit or units of measurement of cost for each block.

Second, the total service long run incremental cost of each network building block will need to be determined. In some cases, existing automated cost models may be used in determining the cost, although the inputs used by the model may differ from those used in the LEC's current cost studies. In other cases, the automated cost models which the LEC currently uses are so intimately linked to a service-costing orientation that revision of the models may be required.

Third, the costs determined for each building block should be translated into tariffed rates for the services provided to the LEC's dependent competitors and into price floors for the services which the LEC provides to end users. In some cases, the existing tariff structure may be used. It should be anticipated, however, that a greater degree of unbundling than currently exists in the LECs tariffs may result from this process.

The tariffed rates for LEC services need not always correspond to the TS-LRIC cost as determined by the cost studies. A pro-competitive rate structure does not require that all services be priced at the lowest economically justifiable level. All that is required is that the basic network functions be priced ***the same*** both for the LEC and for its competitors. Because pricing all services at incremental cost would not permit the LEC to recover those costs which are truly common costs of the company, some variance from incremental cost will be required. In addition, the regulator may choose for public policy reasons to require that the prices for certain services vary from incremental cost.[2]

2 It should be noted that the sum of the TS-LRIC for all building blocks and services and all groups of building blocks or services, should be a close approximation of the total economic cost of the firm. Stated another way, this value would represent the cost which would be faced by the most efficient new entrant which could enjoy the same economies of scale and scope enjoyed by the incumbent. To the extent that the LEC's revenue requirement is greater than this value, the "gap"

In such cases, the regulator may still maintain a pro-competitive rate design by requiring that the price of the basic network building blocks — rather than the price of various services — be "marked up" above incremental cost to the extent deemed necessary. In today's rate structure, various services provide varying levels of "contribution." There is no assurance that the "contribution" obtained from each of the LEC's services is consistent or that anticompetitive pricing does not result. By marking up the price of basic network building blocks in order to obtain "contribution," the regulator can ensure consistency, prevent anti-competitive rate design, since all services using the network function would pay the same level of "contribution," and more readily identify the sources of contribution.

Where a network building block provided by the LEC is shown to face substantial competition, such that the LEC does not possess market power in the provision of the function, the LEC may be permitted to recover the costs of the non-monopoly building block in any way that ensures that no other service will be responsible for the recovery of those costs. The test, then, for anti-competitive pricing of LEC retail services is whether the rates for each service are greater than the price established for any monopoly building blocks used in the provision of the service, and in addition result in sufficient revenue to recover the cost of any non-monopoly building blocks used in the provision of the service plus the long run incremental cost of any service-specific functions, such as advertising, marketing, and billing and collecting revenue for the service.

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represents non-economic costs in the LEC's rate base. The question arises whether the LEC should be permitted to selectively "pretend" that it is the most efficient firm (when pricing competitive services) when in fact it may not be the most efficient firm. To the extent that the "gap" may be measured (and no ready methodology currently exists for determining the "economic" level of common costs), a means must be developed to eliminate the gap over time, if competitive entry is not to be precluded and if monopoly ratepayers are not going to be left with sole responsibility for the recovery of non-economic costs.

In this way, the building blocks approach to costing and pricing services ensures that the LEC has sufficient pricing flexibility to respond to the development of competition for its services, while at the same time ensuring that monopoly functions are not priced in such a way as to prevent the development of competition or to harm monopoly ratepayers.

The most important first step that the regulator can take is to adopt the principles of rigorous nondiscrimination in the pricing of basic network building blocks and the unbundling of network building blocks to the greatest extent practicable.

Following this step, the regulator may wish to convene a series of workshops between the LEC, the staff of the regulatory agency, and other interested parties. Cost studies are a complex matter, and resolution of the issues identified here will best be accomplished in a non-adversarial framework. However, the regulator should impose a definite timetable for the development of cost studies for the network building blocks, and require frequent progress reports. Finally, the regulator should require the LEC to file its revised cost studies and proposed tariffs for the regulator's consideration in a public proceeding.

The general procedure described here currently is underway in Oregon and North Dakota. In each of those states, the principles of nondiscrimination and unbundling have been adopted, and parties are actively engaged in developing a Building Blocks approach to performing cost studies.

Conclusion

In an environment where regulators must deal both with a need for a more unbundled network structure and with the potential for entry and greater competition for some components of the network, a new approach is needed in determining the cost of the basic functions of the local exchange network, and of services consist of a bundle of monopoly and competitive network functions. It ensures that LEC prices may be flexibly set where competitive entry has occurred, while at the same time ensuring that LEC prices for monopoly services do not deter the development of competition and do not harm monopoly ratepayers.

What Are Telecommunications Building Blocks And How Should Their Long-Run Incremental Cost be Estimated? The Oregon Experience

by

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Introduction

This paper presents a status report on the Oregon Public Utility Commission's (OPUC) telecommunications workshops. These workshops, which have been ongoing for the last few years, have as their objectives the development of: identification of elemental services known as "building blocks"; principles for estimating the long-run incremental cost of providing building blocks; a cost study based on the adopted principles; and consideration of a broad set of pricing issues such as unbundling, uniform pricing, non-discriminatory access, and imputation.

Before diving into the progress report itself, we would first like to discuss how and why these workshops began. One of the hotly-debated issues in a 1989 OPUC general-rate review of U S West Communications (USWC) (docket UT 85) was identifying the appropriate basis by which to develop prices for telecommunications services. A few aspects of this debate were the merits of marginal-cost pricing and defining the appropriate principles for marginal-cost estimation. Many parties offered various concepts by which to develop cost estimates, but no single approach was universally supported. Not only could the parties not agree on what cost-estimation method should be used, the parties could not agree on whether the current tariff offerings were the proper universe of telecommunications services from which to estimate costs. In addition, at the OPUC hearing, many pricing-related concerns were discussed such as non-discriminatory access, unbundling and deaveraging of current telecommunications service offerings, universal service, efficient use of the telecommunications network, and general competitive market pressures.

The Oregon Public Utility Commission, in its review of the record in docket UT 85, Order No. 90-920, decided that an incremental cost approach was more meaningful than other cost concepts. However, given that there was no universally-recommended approach, the Commission deferred adopting any specific incremental cost-estimation method. Rather, the Commission directed its staff to hold a series of public workshops with the goal of developing consensus among the parties on the previously-mentioned cost- and price-related issues.

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* The views and opinions of the authors do not necessarily represent those held by the Oregon Public Utility Commissioners or U S WEST Communications.

Workshop Milestones and Objectives

The first public workshop was held on August 28, 1990. Since that first workshop, monthly one-, two-, or three-day workshops have been held. Participants in the workshops have often included representatives of AT&T; GTE; MCI; Pacific Telecom; TRACER, a business interest group; OPUC staff; United; and USWC. The initial workshops were mostly non-technical discussions which focused on developing the cost principles. Once the principles was adopted, the focus on the workshops shifted to technical discussions on identifying conceptual and facility demarcation points for building blocks, and various cost issues. In late 1991, two technical subgroups were formed to better handle the technical aspects of this investigation. One technical subgroup was formed to identify building blocks and their respective cost drivers, the other to develop principles to relate operating expenses to building blocks. These technical subgroups have been chairing the Oregon workshops since early 1992.

Along with the activities regarding building block identification and cost estimation, known as Phase I of OPUC docket UM 351, efforts have also begun on analyzing pricing issues. In August of 1992, Phase II (the pricing phase of this investigation), of docket UM 351 was formally opened, and workshop discussions commenced. The initial discussions involved various parties presenting their pricing philosophies.

The schedule of future events and work products anticipates cost estimates for the major categories of building blocks by year-end 1992. One objective of this phase of the investigation is to develop a matrix of building blocks, with each cell of the matrix occupied by its respective cost estimate. In addition, a mapping will be constructed relating current tariff offerings to building block cells. This mapping will allow a comparison of the differences in price to cost to be made among current service offerings. The second phase of the investigation, namely pricing, unbundling, deaveraging, and imputation issues, will begin in earnest in 1993. While informal workshops will be held to achieve as much progress as possible, formal hearings will likely take place by the summer of 1993, with a Commission order issued late 1993.

Cost Principles
of Telecommunications Building Blocks

The following several pages discuss the cost principles adopted by the Oregon cost-study workshop participants. These principles are designed to create a framework which meets the following goals:

- develop costs at a building-block level;
- recognize all costs associated with the provisioning of a service (a service is a tariff offering, and is either a building block or bundled set of building blocks);
- identify costs with services using the principle of cost causation;
- reflect the currently available least-cost technology;
- differentiate between volume-sensitive and volume-insensitive costs; and
- mirror a cost floor based on the level incurred if a new entrant were allowed to install the latest technological facilities needed to provide the entire service demanded for that building block or group of building blocks.

The principles outlined in this document represent a guide for conducting cost studies. While much work has gone into developing and reaching agreement, the workshop participants understand that there could be other approaches to achieve the same goals. It is also understood that reasonableness and judgement will be exercised in the specific application of the cost principles. When resources or data constraints make exacting adherence to the cost principles prohibitively expensive or burdensome, reasonable proxy methods may be utilized. Any such departures from the cost principles should be explicitly documented and accompanied by a discussion which demonstrates that the cost-study goals cited above have been met.

Cost principles for estimating the costs of telecommunications building blocks were developed, by consensus, to address the following issues and concerns:

1. Definition of "long run";
2. Choice of technology;
3. Principle of cost causation;
4. Locations and design of telecommunications systems;
5. Concept and identification of building blocks;
6. Choice of increment; and
7. Factors and loadings.

These issues and concerns led to the consensus that cost estimates of telecommunications building blocks should be based on the following set of cost principles, and shall be called long run incremental cost (LRIC) estimates:

Cost Principles

1. LONG RUN: "Long Run" implies a period long enough that all inputs are avoidable.

2. LEAST-COST TECHNOLOGY: LRIC estimates should reflect the overall least-cost technology for the network.

3. COST CAUSATION: Costs will be associated with a building block or group of building blocks to the extent costs are incurred in offering the service in general (both new and existing services), or providing additional service. Any difference in cost between the overall least-cost technology and the least-cost technology for a major function of the firm should be attributed to the building block or group of building blocks which cause the selection of the overall least-cost technology.

4. ASSUME LOCATION OF, OR PLANNED CHANGES TO, EXISTING NETWORK PATTERN: The LRIC methodology will assume the location of, or planned changes to, existing network "hubs" and "spokes," and assumes the complete replacement of existing facilities with the overall least-cost technology as required by Principle #2.

5. BUILDING BLOCK AND SERVICE COSTS: LRIC estimates will be developed at the building block level. A building block is the smallest level of network functionality which feasibly may be tariffed and offered as a service. The cost of a building block is based on the cost elements associated with the network functionality. The cost of a particular service is determined by combining the appropriate building block costs and all other costs caused by the decision to offer the service (e.g., product management for 800 service).

6. INCREMENT: The concept of LRIC is based upon an increment which is large enough to capture all relevant changes in the total cost of the firm caused by the decision to offer the service or provide the building block.

7. FACTORS AND LOADINGS: In order to capture costs associated with the provisioning of a building block, factors and loadings on building blocks or cost elements will be used. Factors and loadings consist of annual cost factors and investment loadings.

Issue #1: Definition of "long run"

Principle adopted:

LONG RUN: *"Long Run" implies a period long enough that all inputs are avoidable.*

This definition prevents the possibility of subsidization by ensuring that cost estimates include all of the costs associated with providing a service to a customer. Examples of such costs are the installation, housing, and maintenance of telecommunications facilities; service development; and other getting-started efforts related to the provisioning of a service. To be sure that these costs are reflected in the cost estimates, the definition of long run reflects a period far enough into the future so that no costs are considered sunk.

An alternative to this definition, which is commonly employed in other forums, is to adopt a specific planning period, such as five or ten years. Under this alternative, the selection of the planning period should be long enough to allow, if warranted, investment changes to take place for any reason. The most common reasons for making changes in telecommunications plant are to replace non-optimal plant, and to add additional plant in response to changes or increases in consumer demand. (In choosing the optimal mix of plant addition, planning-period models normally need to be scrutinized and results adjusted if the results reflect non-economic decisions given that planning-period models may "think" the world ends at the end of the planning period.) Under a planning-period approach, demand is forecasted and additional investments, if any, are identified. To the extent current excess capacity exists, additional investments can be postponed. This excess capacity is reflected by a lower marginal cost estimate than would be produced if no excess capacity existed. One might view the planning-period method of marginal cost estimation as one which reflects short, intermediate, and long-run costs.

Given the objective of having marginal cost estimates reflect the full cost of the least-cost technology which would be chosen today to supply the entire customer demand for telecommunications services, marginal cost estimates should not be dependent on the current relationship of capacity to demand. Marginal cost estimates should not be driven by equipment selection choices which are influenced by the existing stock of equipment. Rather, the equipment selection should be based on a cost minimization problem with no constraints on the selection of current technology to serve the customers' demand for telecommunications services. (See section on locations and design of telecommunications systems.) Therefore, a sufficiently long-run perspective is adopted.

This principle is linked with the other cost principles as well as the pricing principles. How, and to the extent, the cost principles are inter-related will be discussed with each issue and corresponding principle.

Issue #2: Choice of technology

Principle adopted:

LEAST-COST TECHNOLOGY: *LRIC estimates should reflect the overall least-cost technology for the network.*

Another issue relates to the choice of technology which should be analyzed in the cost-estimation studies. This principle requires that the technology analyzed should reflect the overall least-cost technology which is presently available. The term "overall" means the total set of telecommunications services which are being provided by a telecommunications utility. (In the section which discusses cost causation, analyses would also be required to identify the least-cost technology for a major function of the firm if it appears that different technologies would be selected depending on the major function which is being analyzed.)

The choice of technology being analyzed includes equipment currently available and either presently in service or scheduled to be placed. However, due to timeline constraints, the cost studies do not include some emerging technologies. For example, one such technology which is not analyzed or included in the present cost studies is the signaling-system 7 (SS7) technology. Future studies will take into account the effects of SS7 and other emerging technologies such as SONET.

As we move to the future, it is anticipated that the least-cost technologies for each network element will continue to evolve. However, at the present time, the relevant least-cost technologies for the major network elements are defined below:

Network Access Channel: A mix of pair gain and copper facilities will be utilized. Generally speaking, for basic-level Network Access Channels (NACs), copper represents the least-cost technology for shorter loops while pair gain is economic for longer loops. Also, digital facilities are required to support high bandwidth subscriber access (i.e., DS-1 and DS-3). Depending on the density, bandwidth, and distance factors, fiber or copper facilities are used to provide high-bandwidth access.

Switching: An all-digital switching system will be utilized.

Interoffice Transport: An all-digital interoffice network, with fiber and digital radio, will be utilized.

For example, for USWC the mix of digital and analog outside plant, for basic-level network access, was chosen from technical studies which analyzed the total combined cost of switching and outside plant for various percentage mixes of analog and digital outside plant equipment, while maintaining 100% digital switches. The mix selected was that which produced the overall least cost for both switching equipment and outside plant.

Again, the least-cost technology selected would be that technology which would be chosen to supply all of any major group of telecommunications services. This approach requires the assumption that all existing equipment, if warranted, is replaced by this overall least-cost technology. The selection of the least-cost technology is not based on the economics of adding to the current stock of telecommunications equipment providing service today, but rather assumes no equipment is currently in service and a completely new network is to be installed. (See discussion to Issue #4.)

Issue #3: Principle of cost causation

Principle adopted:

COST CAUSATION: *Costs will be associated with a building block or group of building blocks to the extent costs are incurred in offering the service in general (both new and existing services), or providing additional service. Any difference in cost between the overall least-cost technology and the least-cost technology for a major function of the firm should be attributed to the building block or group of building blocks which cause the selection of the overall least-cost technology.*

This issue addresses the desire to associate costs with selected services based on the principle of cost causation. The concern is the possibility of subsidizing "discretionary", perhaps competitive, broadband services by local exchange voice-grade services.

Conceptually, the process that is followed is first to determine the overall least-cost technology to serve all of the demands for telecommunications services. Once this is accomplished, incremental cost estimates would be established for all building blocks. The incremental cost estimates for building blocks, themselves, would be based in part on cost elements which are derived from the overall least-cost technology chosen (e.g., copper facility cost for basic-level NAC).

However, these cost estimates should be considered maximum incremental cost estimates for major groups of telecommunications functions. It could be that for a major function, a lower-cost technology is available. If this is the case, then the incremental cost estimates for this major function would only reflect the lower-cost technology. In this regard, one could consider this approach when such a method would result in a lower (not higher) incremental cost estimate than that derived by analyzing the overall least-cost technology.

The building block or service which was responsible for the selection of the overall least-cost technology, which is of higher cost than needed to supply only the major function, would have its rates reflect at a minimum both the volume-sensitive costs of the overall least-cost technology and the difference in costs between the two technologies.

For example, consider local exchange service and video services. If the overall least-cost technology selected included fiber-to-the-home in order to provide video services, then the concern would be present that local exchange voice-grade services may inappropriately bear costs which should be associated with other services. This concern would arise because a fiber-to-the-home technology is not required to provide voice-grade services. To analyze this concern, the least-cost technology to provide only voice-grade services would be identified. The difference in the cost of these two technologies, assuming they are different and fiber-to-the-home being more expensive, would then be associated with video services, and the cost of voice-grade services would reflect the cost of technology required to provide only voice-grade services.

During the discussions which led to the adopted principle, the concern was raised that if this test was applied with no constraints on its applicability, then, in unison with the least-cost technology principle, the test would require the least-cost technology to be identified for each and every building block or group of building blocks. From the workshop's perspective, such a requirement would be too burdensome to allow the entire marginal cost study ever to be completed and is therefore impractical. Therefore, application of this type of analysis is limited to isolated circumstances which deal with major network investment decisions such as the fiber-to-the-home example.

Issue #4: Locations and design of telecommunications systems

Principle adopted:

ASSUME LOCATION OF, OR PLANNED CHANGES TO, EXISTING NETWORK PATTERN: *The LRIC methodology will assume the location of, or planned changes to, existing network "hubs" and "spokes," and assumes the complete replacement of existing facilities with the overall least-cost technology as required by Principle #2.*

Another adopted concept relates to the starting point of the analysis. In coming up with the overall least-cost design of a telecommunications system, one could assume that no telecommunications system exists today and everything would be built from scratch. This framework was not adopted because it was felt that it would be too difficult and time consuming to solve a completely unconstrained cost minimization problem. This would be a very complex problem, which others have attempted to solve, which would seek to optimize the number and location of switches as well as corresponding outside plant.

Because the "built from scratch" approach has an intuitive appeal, a variant of that approach was adopted. The locations of existing or planned network facilities (termed "hubs" and "spokes") are not changed. In addition, the existing facilities, where they do not conform to the general technology standards set forth in Principle #2, are completely replaced with the least-cost technology available today. This means that all current equipment is assumed to be replaced by the least-cost technology as part of the analysis. Again, it should be emphasized that assuming the locations of the switches and transport does not mean that any costs associated with land, building, and conduit, for example, should be considered sunk. Rather, all costs associated with the installation and maintenance of these items, as well as the cost of the items themselves, needs to be included in the analysis.

An illustration of how this principle affects the cost study follows. Assume facilities consist of twenty trunks, two-wires per trunk, which are being fully utilized, and demand growth requires from a capacity perspective an additional 2-wire trunk. From a growth perspective, the marginal cost would reflect the cost of the 2-wire trunk and the change in demand. Under the complete replacement, and least-cost technology perspective, the entire set of twenty-one 2-wire trunks would be replaced by a set of twenty-four trunks on 4-wires, and the marginal cost estimates would reflect the twenty-four trunks on four wires' investment costs and the total demand required.

Issue #5: Concept and identification of building blocks

Principle adopted:

BUILDING BLOCK AND SERVICE COSTS: *LRIC estimates will be developed at the building block level. A building block is the smallest level of network functionality which feasibly may be tariffed and offered as a service. The cost of a building block is based on the cost elements associated with the network functionality. The cost of a particular service is determined by combining the appropriate building block costs and all other costs caused by the decision to offer the service (e.g., product management for 800 service).*

The cost methodology requires the cost estimates to be developed at the building block level. Building block is defined as "a cost element or group of cost elements representing the smallest feasible level of unbundling capable of being tariffed and offered as a service (e.g., a minute of use of a switch after call setup.)" Building blocks encompass all of the telecommunications network functions/facilities, not just monopoly or potentially-competitive tariff offerings. Therefore, building blocks will be identified, and have their costs estimated, for all of the telecommunications network functions/facilities, which fall under the building block definition.

The term "service" means a tariff offering; "service" does not exclude facilities from being building blocks. (A common example of a facility which is a building block is the network access channel.) Some might argue that an unconnected network access channel provides no service. However, the term "service" is not meant to be interpreted in such a narrow manner, but rather represents something that feasibly could be offered in the marketplace.

In connection with the pricing phase of this generic investigation, there is no presumption or requirement that all building blocks would be tariff offerings. The Oregon Commission, after receiving input from the parties, will decide which building blocks should be made tariff offerings, and in some cases, which building blocks should remain tariffed on a bundled basis. The first steps of the Oregon cost-study workshops are to identify building blocks and estimate their costs. The issues of the level of unbundling which should be reflected in tariffs, and the pricing of building blocks, will be intensively addressed after building block costs have been estimated.

Issue #6: Choice of increment

Principle adopted:

INCREMENT: *The concept of LRIC is based upon an increment which is large enough to capture all relevant changes in the total cost of the firm caused by the decision to offer the service or provide the building block.*

Because of the concern to capture all of the costs incurred in supplying the service, the size of the increment needs to be large enough such that it captures all relevant changes in the total cost of the firm caused by the decision to offer the service. (A service is a tariff offering, and is either a building block or a bundled set of building blocks.) However, in selecting such a "large" increment, the costs will no doubt include costs which vary with output (i.e., volume-sensitive costs) and costs which do not vary with output, even in the long run (i.e., building block-specific volume-insensitive costs).

This raises the issue regarding the pricing policies of costs which are volume insensitive. Building block-specific, volume-insensitive costs are costs which do not vary with the quantity supplied, but are caused by the decision to offer the building block. Examples of costs which would be building block-specific volume-insensitive costs are data base start-up costs and building block development costs. An example of a group-related volume-insensitive cost is the portion of the switch which is, on average, held as a planning reserve for growth in demand. The cost and pricing treatment of these volume-insensitive costs would be to identify the costs separately and not include them in the estimate of the variable (i.e., volume sensitive) per unit cost. Specifically, for example, it would not be appropriate to divide the volume-insensitive costs by the number of units sold and include this "per unit" cost in the incremental cost of the service. The building block-specific volume-insensitive costs are considered in the overall pricing question by requiring, at a minimum, that the revenues received from the service be no less than its volume sensitive and volume-insensitive costs.

This handling of volume-sensitive and volume-insensitive costs allows an accurate reflection of the long-run cost of providing that service from an economic viewpoint. The advance or delay of costs, in the long run, are the volume-sensitive costs. Costs which are incremental with the building block or service, but are not volume sensitive, represent the volume-insensitive costs.

Issue #7: Factors and loadings

Principle adopted:

FACTORS AND LOADINGS: *In order to capture costs associated with the provisioning of a building block, factors and loadings on building blocks or cost elements will be used. Factors and loadings consist of annual cost factors and investment loadings.*

Factors and investment loadings should be used when the identification of direct costs is impractical. These factors should be designed such that they reflect cost causation and provide reasonable estimates of prospective costs. Annual-cost or investment-loading factors should only be used where they provide reasonable estimates of the relevant costs. In cases where reasonable cost estimates cannot be developed using factors, then other means should be employed to include the relevant costs in the incremental cost study.

The following discussion details the adopted principles for relating operating expenses and investment loadings to telecommunications building blocks and is consistent with all of the principles established above.

Principles for Relating Operating Expenses to Building Blocks*

This portion of the report results from discussions among the operating expenses subgroup participants. Application of the guidelines and suggestions depends upon the specific problem the LRIC study addresses. This text provides a bridge between Long-Run Incremental Cost (LRIC) principles and its application. Many of the examples used in the discussion result from actual experiences developing cost estimates from accounting and other data.

In this section of the report, the terms "operating expense" and "expense" are used synonymously. The term "investment" refers to gross investment; "capital cost" refers to the annualized cost of investments; and "cost" refers to a combination of operating expenses and capital costs. In some cases, operating expenses will be directly related to gross-investment costs. In other cases, more sophisticated estimates of investment will include annualized investment and directly assigned expenses. Caution should be employed to relate these costs in a logical and consistent manner.

Guidelines

Economic and accounting principles occasionally clash in this paper. Where these principles clash, preference has been given to economic principles. This choice reflects the concept that it is more important to be "economics" close than "accounting" precise.

LRIC looks toward the future. LRIC operating expense estimates must reflect the technologies of the LRIC plan. For example, LRIC switching maintenance should be consistent with investments analyzed from a technology perspective. These principles do not examine the financing cost associated with purchasing capital equipment. (This was introduced earlier in Cost Principle #7 above, and is discussed in detail in the Operating Expense and Investment Loadings Principle #1 later in this text.) In this discussion, however, LRIC capital costs do include capitalized expenses such as the labor cost involved in installing a new switch.

LRIC operating expense principles balance the need for accuracy (i.e., reflecting cost causation) and the practical aspects of developing the estimate itself. Cost causation guides the development of the estimates. Accounting definitions and methods need not be changed to reflect LRIC ideas. Cost accounting studies, traffic engineering studies, and other "ad hoc" investigatory techniques may be used to replace accounting data. The Uniform System of Accounts should be used where appropriate.

LRIC estimates depend on a solid accounting foundation. Unless otherwise known it is assumed that today's costs reflect the future.

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* This section of the report is still considered a "draft" version by the workshop participants, and will likely be revised as building blocks become better identified through the cost-estimation process.

Comparisons between current and future operating expenses provide a test of reasonableness. This stems from the basic assumption that the firm makes prudent economic choices. Without strong evidence to the contrary, the Commission should base LRIC estimates on current industry practices. An exception to this occurs when one technology replaces another. For example, current industry maintenance practice supports a mix of switch technologies. LRIC estimates should focus on the least-cost technology. LRIC expense costs must match the LRIC investments used.

Another issue in developing LRIC estimates is the treatment of Research and Development (R&D) expenses. R&D on broad areas of technology cannot be associated with specific building blocks. R&D on specific areas of technology can be related to building blocks or groups of building blocks. For example, testing of CLASS services (Caller Identification) relates to that group of building blocks. R&D on equipment which is uniquely related to specific building blocks should be accounted for in developing LRIC estimates for those building blocks.

LRIC operating expense principles should be understandable. Complex allocation methods must be avoided. (Examples of complex methods are those used in separations and settlements procedures.) In documenting LRIC estimates, a clear explanation of the causal relationship and the method by which it is derived must be provided.

The need for accuracy must be balanced with the cost of producing LRIC expense data. Operating expense costs which have little effect on the results should be excluded. Complex cost "allocations" that cannot be directly linked to changes in demand should be excluded as well. Operating expense costs should be included in the appropriate LRIC cost. For example, apply social security taxes to labor expenses and switch maintenance expense to switch investment.

The application of LRIC expenses to LRIC investment costs does not involve measurements of use or capacity. When the total LRIC costs are brought together, the analyst should consider the appropriate units of production to ensure consistency with expense estimates. Costs which vary with volume should be included in the estimates of volume-sensitive costs of the building-block, and costs which are incremental with the offering of the building block or group of building blocks should be classified as volume-insensitive costs.

LRIC cost estimates are contextual in nature. Estimates must be made in a consistent manner. Estimation of LRIC for new services, including the effects of operating expenses, should be made in a consistent manner with the most recent LRIC study of all services.

Principles

In this section we examine twelve issues:

1. Capital-carrying charges;
2. Non-regulated expenses;
3. Common expenses;
4. Identification of direct labor and other labor expenses;
5. Administrative expenses;
6. Support investments;
7. Nonrecurring service order activity expenses;
8. Investment-related expenses;
9. Other taxes;
10. Levels of supervision;
11. Billing expenses; and,
12. Documentation.

1. Capital-carrying charges In translating capital costs into annualized expenses, annual cost factors will be utilized. One annual cost factor relates to the utility's cost of capital. This annual cost factor is based on the utility's nominal incremental cost of capital. In deciding to use nominal-levelized capital carrying charge rates (NLCCCR), consideration was also given toward using real-levelized capital carrying charge rates (RLCCCR). The technical literature views RLCCCR as the appropriate method to economically express a capital investment in an annual charge: workshop participants agreed that RLCCCR is the conceptually-correct method.

Both the RLCCCR and the NLCCCR each present their own difficulty for analysis. The drawback of RLCCCR is the requirement of having forecasts of both price inflation and technological progress for the telecommunications equipment. It became evident that this information needed to develop RLCCCR is either highly judgmental or unavailable. Although the RLCCCR is the correct method for annualizing capital investment costs, the practicality or improvement in accuracy of this approach is uncertain because of the data requirements. Using NLCCCR assumes that technological progress is exactly offset by inflation. Despite the arbitrary nature of this assumption, the differences between RLCCCR and NLCCCR may be small. Because the information needed to calculate the RLCCCR was not currently available, capital carrying charges are to be calculated using nominal carrying charge rates.

Recent analysis by the staff of the Oregon PUC has also concluded that discount, or present value, rates should be based on the after-tax rate of return. The after-tax rate of return means the cost of equity is adjusted to reflect the effects of the corporate income tax, and the cost of debt is reduced for its tax shielding properties. The after-tax rates of return will be used to discount costs or revenues.

2. Non-regulated Expenses Expenses related to non-regulated activities should be segregated and excluded from expense accounts. Where appropriate, LRIC principles should use Federal Communications Commission rules procedures (Part 64). Joint or common costs that are not separable based on cost causation principles should be excluded.

Use as a test the question, "Does this cost change if specific levels of regulated activity change?". Use fully-distributed cost principles only when it is related to cost causation.

USWC suggests another approach, to first relate expenses to investment, and second, to relate investment to regulated and non-regulated building block categories. This approach separates regulated and non-regulated in a consistent manner. This approach is reasonable when operating expenses relate to investment.

3. Common Expenses Expenses that cannot be directly related to building blocks, components of building blocks, or services should be excluded. For example, the expenses of the personnel department that do not vary with the number of employees should be excluded. However, the expenses of the personnel department that vary with the number of employees as an employee expense should be included.

Specific problems arise when a cost is common to a number of building blocks. There are some costs which are group-related volume-sensitive costs (e.g., a right-to-use fee per line which supports more than one switch function). Care and judgement must be made to ensure that costs which are associated with a group of building blocks are not automatically classified as common. The aggregate revenue of all the building blocks that contain a common cost must recover that cost. (Assuming that this cost would not be incurred if the building blocks were not produced.)

4. Identification of Direct Labor and Other Labor Expenses Separately identify labor and non-labor expenses. Labor expenses should include relevant labor-related non-labor support expenses, taxes, health, vacation, retirement, and other benefits. Company direct-labor expenses include supervision expenses that vary with direct labor. Contract labor reflects the contract price. Include all overheads in contract-labor costs.

5. Administrative Expenses If part of an administrative expense varies directly with an expense being related to a building block, then add that expense as a cost of that building block. For example, personnel department may vary (80%) with the number of employees. Then, 80% of the personnel costs could be assign as a direct overhead to all labor expenses. When applying an expense as a ratio to investment or costs, relate it to all LRIC investment or costs. Expenses associated with customer services, sales, product management, marketing, and advertising should be directly assigned to building blocks and services to the extent possible. Separate cost factors for costs not directly assigned that reflect cost causation should be developed.

6. Support Investments Capitalized support expenditures related to LRIC investments should be included in LRIC estimates. This would include the expenditures associated with engineering, furnishing, and installing a new switch, equipment sales tax, etc.

7. Nonrecurring Service Order Activity Expenses The expenses of nonrecurring activities should be separately identified. Use labor rates with loadings and amount of time spent on order activities to relate these expenses to building block and existing service LRIC estimates. Nonrecurring service order activity expenses for building blocks should be identified and incorporated in the analysis.

8. Investment-Related Expenses The relationship between investment-related operating expenses and investments needs to be estimated at the building block and service level, accounting for cost causality. (Examples of investment related expenses are property taxes, expenses associated with equipment installation, and expenses associated with equipment maintenance.) Property taxes should be assigned in the manner by which the tax is levied. Expenses associated with equipment maintenance should be based on the relationship between maintenance expense and equipment investment amounts.

9. Other Taxes LRIC includes taxes directly related to service levels, but excludes taxes that do not relate to services. For example, cities in Oregon levy franchise taxes of 7% of tariffed local service rates for line access only. The effect of franchise taxes collected should be included in LRIC estimates for the taxed services.

10. Levels of Supervision Aggregation of costs at and beyond the third level of supervision generally results in the inappropriate assignment of costs. Without compelling rationale, utilities should avoid assignment of costs related to the third level of supervision and above to services or building blocks.

11. Billing Expenses Billing expenses should be related to the appropriate customer classes. For example, the expense of running billing programs for carriers should be related to carrier customer costs. The expense of measuring residential local usage should be related to local measured service LRIC. Billing expenses that do not vary with the number of customers, customer demands, or with the general offering of the service should be excluded. Some aspects of billing are defined as a service. Measurement costs need to be accounted for at the building block level. For example, writing bills and mailing them are a part of the billing service (or a part of the customer building block if that building block is defined).

12. Documentation Telecommunications utilities using LRIC shall provide the Commission, unless otherwise exempted, by June 30 of each year, with updated fully-loaded labor rates (i.e., includes pensions and payroll taxes, but excludes overhead loading) and factors used in developing LRIC expense estimates. That documentation will include actual rates and factors for the previous two years and estimates for the current year.

When estimating all the LRIC costs, actual operating expenses should be reconciled with LRIC operating expenses. The LRIC analyst must reconcile the amount of expense included and excluded in a complete LRIC study. The reconciliation provides a reality check, explaining part of the difference between LRIC expense estimates and actual expenses. LRIC estimates that result in an unbalanced relationship should be further reviewed (an analyst would want to know why 90% of the maintenance account was attributed to LRIC but only 2% of the marketing account).

Other Topics

The few remaining pages of this report present the pricing principles adopted by the workshop participants, as well as the set of definitions of commonly used workshop terms. The pricing principles were developed in the cost-estimation phase (Phase I) of the investigation. These principles will be substantially expanded in the pricing phase (Phase II) of the investigation.

Pricing Principles

Recognizing that Commission Order No. 90-920 in docket UT 85 requires the implementation of a rate design which accomplishes a number of objectives, one of which is the prevention of subsidy, the workshop participants developed the following pricing principles to ensure that services are not subsidized. The workshop participants recognize that other pricing requirements are not addressed by these principles. These other requirements will be addressed in the Phase II pricing workshops in UM 351.

GENERAL PRICING GUIDELINES:

The per unit price of each service must cover its building block-specific volume-sensitive costs. Exceptions to this requirement must be identified and justified.

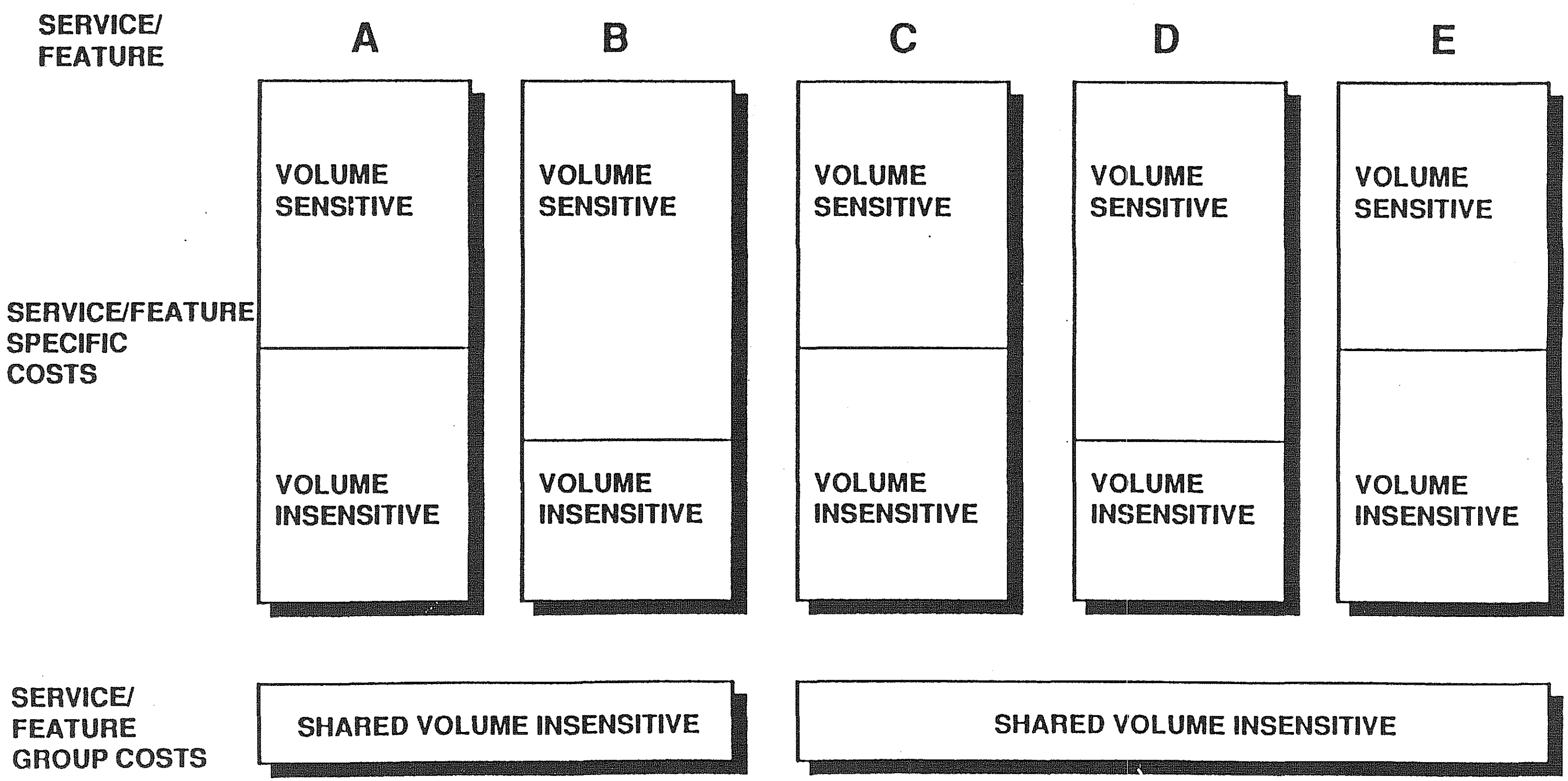
Revenues from each service shall cover building block-specific, volume-sensitive and volume-insensitive costs. Revenues from groups of services shall cover building block-specific volume-sensitive and volume-insensitive costs of all the building blocks of the group, and group volume-insensitive costs. Exceptions to this guideline must be identified and justified.

The pricing guidelines establish requirements for the rate design for a building block, and group of related building blocks. The first pricing guideline establishes the floor per unit price of a service offering. The per unit price can be no lower than the building block-specific volume sensitive cost of the service. Exceptions would be permitted; however, one would surmise that exceptions would likely be due to public policy concerns such as maintaining universal service.

The second paragraph of pricing guidelines relates to an overall revenue requirement for a building block or groups of building blocks. Revenues captured from a building block need to be no less than the total of the building block-specific, volume-sensitive and volume-insensitive costs. How the revenues are captured is left as a rate design issue, with the sole exception being that the per unit price must be no less than the per unit building block-related volume-sensitive costs. The last requirement is that revenues from a group of related services must be sufficient to cover the group volume-insensitive costs.

The chart on the following page graphically displays the concepts discussed above. The chart displays five different services or features, each of which has its own specific volume-sensitive and volume-insensitive costs. The bottom row of the chart illustrates that there can be volume-insensitive costs related to the offering of a group of services or features. For example, if either service "A" or "B" is offered, or both, the shared volume-insensitive costs will be incurred.

COMPANY LRIC COST STRUCTURE



DEFINITIONS

A definition of significant terms follows:

<u>ELEMENT</u>:
Basic input used in telecommunications (e.g., labor, line card.)

<u>BUILDING BLOCK</u>:
A building block is the smallest level of network functionality which feasibly may be tariffed and offered as a service. The cost of a building block is based on the cost elements associated with the network functionality.

<u>SERVICE</u>:
A tariff offering.

<u>VOLUME-SENSITIVE COSTS</u>:
Volume-sensitive costs reflect costs which vary or are avoidable by changing the volume of the building block provided.

<u>BUILDING BLOCK-SPECIFIC, VOLUME-INSENSITIVE COSTS</u>:
Building block-specific, volume-insensitive costs do not vary with changes in volume, but are avoidable by not offering the particular building block.

<u>GROUP-RELATED, VOLUME-INSENSITIVE JOINT COSTS</u>:
These costs are incurred if at least one of a group of related building blocks is supplied. Group-related, volume-insensitive costs are avoided if all building blocks within a group are not offered.

<u>VOLUME-SENSITIVE COMMON COSTS</u>:
These costs vary by the size of the firm.

<u>RATE SPREAD</u>:
The concept of "rate spread" refers to an allocation of revenue requirements to a building block or group of building blocks.

<u>USAGE-RELATED RATES</u>:
The term "usage-related rates" refers to pricing a building block on a per unit of use basis (e.g., rate per minute of use or a charge per call.)

<u>RATE DESIGN</u>:
"Rate design" refers to the combination of usage-related rates and non-usage charges, i.e., charges which are volume sensitive and charges which are volume insensitive. A standard rate design practice is to develop a combination of usage- and non-usage-related charges which are expected to generate revenues equal to the allocated revenue requirement as established by the rate spread.

Restructuring of Local Exchange Carrier Access Tariffs Concurrent with the Introduction of IntraLATA Competition in Kentucky

by
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Introduction. On May 6, 1991, the Kentucky Public Service Commission authorized intraLATA facilities-based toll competition. The Commission also accepted parts of the Joint Motion filed by a Coalition of Local Exchange Carriers and Interexchange Carriers. The approved Plan included a three step phase-in of intraLATA competition. The first step consisted of approval on a permanent basis of Interexchange Carrier Services previously permitted on a conditional basis. Examples of these service offerings are AT&T Megacom, MCI Prism, and US Sprint UltraWATS. It also included the unblocking of 10XXX carrier access code dialing. This phase began on March 3 of this year. On September 3, 1992, six months after the first phase, intraLATA competition was expanded to provide intraLATA private line services, statewide WATS and 800 services. An Industry Task Force has been created to examine the availability of switching equipment and software generics necessary to the implementation of intraLATA equal access and 1+ presubscription. The report of the Task Force is to be completed by November of this year.

Today, to provide a basis for comparison, I will describe the access rate tariffs charged to the IXCs by the LECs prior to and after intraLATA competition. I will also describe the restructuring of the non-traffic sensitive revenue collection mechanism as presented by the Coalition. I will summarize the rationale for the Commission's modifications, and will comment on the economic implications of the new system.

Post Divestiture Decision. The access tariffs in place prior to authorization of intraLATA competition in Kentucky were developed concurrent with the AT&T divestiture. The tariffs were designed to recover revenue associated with intrastate interLATA toll services that the (LECs) no longer provided. The revenue requirement presented by the LECs stemmed from the old system of toll separations and settlements, and was essentially calculated to maintain the LECs in a revenue position comparable to that experienced under the previous system prior to divestiture.

In its post divestiture decision the Commission concluded that it was entirely appropriate that interLATA toll services be priced to make a contribution to the common cost of LEC non-traffic sensitive (NTS) plant. The Commission rejected any intrastate flat rate end user charges similar to the Customer Access Line Charge at the interstate level. The Commission also denied proposals to recover all NTS costs with usage sensitive rates similar to the Carrier Common Line Charge (CCLC) because it could result in substantial bypass and inefficient utilization of the network of some local exchange carriers. It did permit partial recovery of NTS by authorizing a Carrier Common Line Charge that mirrored the federal rate.

The Commission in the post divestiture decision determined that the appropriate method to recover residual NTS costs from Interexchange Carriers was to use flat rate charges. This rate structure was referred to as the Universal Local Access Service (ULAS). The relative share of the toll-related NTS costs to be paid by each IXC was determined by each carrier's total installed capacity relative to the capacity of other interLATA carriers. The measure of capacity was based on voice equivalent channels and was set quarterly. The Commission rationale was that the level of residential telephone penetration would be maintained and increased in areas where universal service had not been achieved by adopting the ULAS tariff.

With regard to traffic sensitive rate elements, there existed no evidence to indicate that a departure from the interstate structure and rates was warranted. The Commission approved the traffic sensitive tariffs which mirrored interstate rates. It also determined that facilities-based carriers would pay discounted access charges for Feature Group A and Feature Group B access and that such charges would mirror the discount authorized by the Federal Communications Commission (FCC) for interstate access rates at that time.

In the same order the Commission established the interLATA and intraLATA revenue requirement to be $170 million and an additional $6.2 million for Cincinnati Bell which is not associated with any LATA. In the absence of cost separations, the only basis on which to determine the revenue requirement was the revenue necessary to maintain "business as usual" operations among the LECs using the former separations and settlement process. This approach allowed the Commission to maintain revenue stability among the LECs which was a priority of the Commission. A pool was established to assure efficient recovery and disbursement of the residual interLATA revenue requirement. All other charges were on a "bill and keep" basis. Funds for intraLATA pool compensation were generated through toll service schedules that applied in the intraLATA market. All LECs concurred with these toll service schedules developed by South Central Bell which served as the pool administrator.

The Commission indicated that intraLATA pool compensation would occur in the following order:

1) IntraLATA access compensation based on each LEC's access service tariff traffic sensitive, billing and collection, and special access rates,

2) In the cases of cost schedule LECs, intraLATA network and administrative expense reimbursement, and
3) An intraLATA LEC-specific compensation rate designed to residually match each LEC's intraLATA revenue and revenue requirement.
4) Any remaining intraLATA funds were distributed among the LECs in proportion to their share of intraLATA subscriber access lines. This system allowed the LECs to share rewards and risks in the intraLATA market.

Of course there are many more details concerning the calculations and assumptions that were used to establish actual rates. However, my goal today is to provide a general overview of the post-divestiture access compensation process.

Current Access Tariffs. Now I want to discuss the system that has been implemented in Kentucky, due to authorization of intraLATA competition. Initially the Coalition made a motion that the Commission adopt its proposed method of managing non-traffic sensitive revenue. The Coalition was motivated by its recognition of increased competition in both the inter and intraLATA markets and the associated consumer benefits of such competition. However, the industry was also aware of the concerns of regulators and local exchange companies about the impact of expanded competition on local service rates.

The Plan advanced by the Coalition was designed to accomplish the following objectives:
1) To allow the expansion of competition in the intraLATA markets in stages
2) To ensure that expanded competition did not place upward pressure on existing local rates nor on the intraLATA or interLATA toll rates
3) To provide the Commission with a process to easily and effectively monitor the level of NTS revenue requirement levied on toll services and flowing to each local exchange company by approving the NTS revenue level per access line;
4) To provide the Commission with a mechanism to approve the level of toll support provided to any local exchange company without impacting the level of toll support flowing to any other local exchange company;
5) To promote universal service

Conceptually the coalition plan for management of the non-traffic sensitive revenue requirement is an expansion of the Universal Local Access Service concept. As with ULAS, the non-traffic sensitive revenue requirement applicable to toll services is determined and administered uniquely for each LEC. However, unlike ULAS, the coalition plan incorporated both an interLATA and intraLATA non-traffic sensitive revenue requirement. This combined non-traffic sensitive revenue requirement is recovered individually by each LEC from toll service providers serving its operating area based on each access user's terminating minutes of use.

The Coalition's proposal for traffic and NTS recovery was based on the following principles:
1) Initially, the non-traffic sensitive revenue derived from the aggregate of intrastate toll services was computed for each LEC to yield a revenue neutral result. The formula was the sum of interLATA and intraLATA carrier common line revenue, ULAS revenue, and the revenue impact of changing interLATA access service rates and intraLATA toll settlement rates to mirror current interstate access service rates. Subsequently, the annual non-traffic sensitive revenue requirement will be computed for each LEC based on the number of access lines in service and the tariffed non-traffic sensitive recovery rate per access line. This allows non-traffic sensitive revenue to grow as a function of access line growth.
2) Non-traffic sensitive revenue derived from interLATA and intraLATA toll services should be the same per unit of traffic and should not vary with minutes of use.
3) Initially each LEC computed its non-traffic sensitive revenue requirement per access line per month as specified in the motion and filed the resulting rate with the Commission as part of its intrastate access services tariff.
4) In these plans intraLATA traffic sensitive elements included all intraLATA settlement elements except network compensation, billing and collection settlements, carrier common line charges, and residual disbursements.
5) Non-traffic sensitive recovery should be based on terminating minutes of use. Billing by LECs to access users is based on either each access user's relative percentage of total minutes of use, or a rate per minute of use designed to recover the authorized non-traffic sensitive rates in the future by mirroring interstate tariffed rates, or by documenting proposed changes with an intrastate-specific cost-of-service study.

The Commission modified the Coalition's proposal as follows:
The Coalition's Joint Motion did not explicitly address changes in non-traffic sensitive cost. None of the signatory parties that addressed this issue had any objection to the understanding that non-traffic sensitive revenue requirements should be allowed to change as non-traffic sensitive costs change. This understanding was incorporated into the plan. The Commission indicated it would not allow automatic mirroring, due to potential impacts on overall revenue requirements.

As a result of the Joint Motion, intraLATA toll pool settlement rates changed. The LECs were required to file revised settlement contracts with the Commission for review and approval.

In addition, further residual settlements ceased upon initial implementation of the Joint Motion. Accumulated residual funds were targeted at intraLATA toll rate reductions, pending any further order of the Commission restoring residual settlements. This action prevented the LECs from realizing any revenue windfall due to implementation of the Coalition's Joint Motion. The Commission also proposed a slightly different timetable allowing time for suspension of the tariffs and possible intervention.

The LECs filed tariffs in September, 1991. The South Central Bell Tariff required reporting of customer billed minutes as well as terminating switched access minutes. AT&T challenged this requirement on rehearing. The Commission permitted SCB to maintain this requirement because it could serve as a valuable cross-check on terminating switched access minutes of use. Any statistically significant difference would be clear indication of terminating access bypass. Such bypass would unfairly skew allocations of non-traffic sensitive revenue requirement. These were the only comments received from the parties concerning the tariff filings.

The tariff filing of GTE South also raised the issue of the appropriate charges for billing and collection services. In the case of billing and collection services, the Coalition's Joint Motion specified that "existing rates and quantities" would be used to calculate revenue starting points. The Order on Rehearing acknowledged that this provision in the Coalition's Joint Motion failed to recognize that interLATA and intraLATA rates for billing and collection services were different. The principles of the Joint Motion supported the position that rate parity between these market arenas was as desirable as it was in the areas of switched and special access services. The Commission indicated that in the future it would allow the Local Exchange Carriers to mirror their rates for interstate billing and collection services on an intrastate basis.

Duo County Telephone's access services tariff filing mirrored the National Exchange Carrier Association's 1991 interstate access services tariff for traffic sensitive and special access rates. Duo County is an average schedule company that serves 8,646 access lines. This tariff was also issued by the other independent telephone companies in the state. Carrier Common Line Charges and the new non-traffic sensitive revenue requirement recovery mechanism were state specific. These tariff changes did result in customer billing changes for intraLATA private line and foreign exchange customers.

Revised Toll Settlement Agreement. On February 12th of this year South Central Bell filed the revised intraLATA toll settlement agreement and memorandum of understanding on behalf of all local exchange carriers, except Cincinnati Bell. (Cincinnati Bell as previously discussed is not affiliated with any LATA and did not participate in the prior agreement.) The new agreement eliminated the existing intraLATA pooling arrangement. To replace the pool it created two categories of companies. A category "A" company is defined as one that provides the tandem switching function necessary to the provision of intraLATA toll on both an intracompany and intercompany basis. A category "B" company is defined as one that does not provide a tandem switching function on an intercompany basis, but may provide it among its own exchanges on an intracompany basis. South Central Bell is the only category "A" company in Kentucky at present. All other local exchange carriers are category "B" companies.

According to the settlement agreement, South Central Bell receives all revenues from its toll services and all revenues billed by the other local exchange carriers under South Central Bell's toll tariffs. In turn, the other local exchange carriers are paid based on their respective rates for access functions provided to South Central Bell. These include switched and special access services, billing and collection services, and non-traffic sensitive revenue requirement recovery. For purposes of rate application, the agreement assumes Feature Group C access service and that a point of presence exists at the end office side of each toll tandem switch for each end office served by the switch. All payments are made monthly.

The agreement allows the other local exchange carriers to complete intracompany toll calls instead of routing them to a toll tandem switch. South Central Bell compensates the local exchange carrier for intracompany network functions based on a per minute charge for toll switching computed from cost data furnished to the National Exchange Carrier Association or its own per minute toll switching cost. The agreement was effective simultaneous with the new access tariffs and will terminate when 1+ presubscription is implemented.

The Commission approved the settlement with several conditions. Any local exchange carrier that decides to exercise the option of becoming a category A carrier must seek prior Commission approval. This will give the Commission an opportunity to evaluate the impacts on market relationships and revenue requirements. The Commission again emphasized that it expected a transition toward rate parity for interLATA and intraLATA billing and collection services. Finally, the Commission reminded the companies that compensation rates for intracompany network functions should be filed with the Commission as tariffs or as part of the settlement plan. Under this agreement South Central Bell assumed an access relationship with the other local exchange carriers essentially the same as their access relationship with the interexchange carriers.

The rate impact varied among companies. In the aggregate, intrastate switched access revenues decreased $21 million to $56 million. Intrastate special access revenues, including intraLATA private line, foreign exchange, and WATS, decreased $1.6 million to $15 million. The total revenue decrease was $23 million. Since the Joint Motion was revenue neutral at the starting point, the difference between the existing and proposed switched and special access revenues was shifted to the non-traffic sensitive category. Net of adjustments, intrastate non-traffic sensitive revenue requirements increased by $23 million to $126 million. Cincinnati Bell experienced a $4.9 million increase in non-traffic sensitive revenue requirements.

It is always difficult to write a conclusion, especially when a system has only been in place six months. For this reason I will close with several observations. These changes were transparent to the end user and were implemented with relative ease. We have seen a 43 million dollar decline in toll prices and a 13 million dollar decline in access prices charged by South Central Bell, however these changes were part of an incentive regulation plan. The LECs are also more conscious of improving operating efficiency due to the pressure of competition. Beyond these tangible results it is simply too early to tell what the impact of this system of access tariffs will be.

Maintaining Subsidies in an Era of Emerging Competition

by
Peter R. Jahn
Public Service Commission of Wisconsin[1]

Wisconsin has been regulating telephone companies for over 85 years. Put another way, the state has been interfering with the telecommunications market for almost a century. During this time, countless economists and pseudo-economists have pointed out that such interference stifles innovations, distorts price signals and creates vast inefficiencies and poor resource allocations. This is true. Nonetheless, Wisconsin - and other states, persist in regulatory behavior.

The beliefs of some intervenors notwithstanding, the State does not indulge in regulation because of a predilection to masochism or a belief that regulators can allocate resources, etc., better than the market. Telephone rates are regulated only because the market will not offer service to all households at affordable rates. A market will offer service, but only at rates that cover the cost to provide the service. If those rates exceed what some customers are able to pay, those customers will not be served.

Regulation exists to make sure that telecommunications services are offered to those customers at distorted - but affordable - prices. This distortion is justified because the services are provided are considered necessities - and have been since before the Commission's enabling legislation was passed. The "art" of regulatory ratemaking has been to juggle the subsidies[2] necessary to maintain this distortion in ensure that service is universally available. The eternal challenge for regulators is to limit those subsidies to only those necessary to preserve universal service.

<u>**Competition and Subsidies:**</u> Competition, as the old saw goes, drives prices to cost. Cost, in this statement, means the underlying cost of providing the service - excluding the cost of subsidies, monopoly rents, or other price distortions. Wherever prices exceed true cost, competitors or new entrants will have a financial incentive to enter the market. Where rates for one class of customers are overpriced and another underpriced, the competitor will compete for the overpriced customers. Moreover, unless the price distortion is abandoned, the competitor will probably win market share.

If rates for an underlying service provided by a monopoly carrier are set to extract a subsidy, competitors will have an incentive to find a technical means of bypassing the service. Even if this is impossible, they will attempt to end the subsidy by bringing political pressure on the appropriate regulatory body. Not only will eliminating the subsidy reduce price, thereby stimulating demand, but the elimination of the subsidy will accentuate the price differences

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1 The views and opinions of the author are not necessarily those of the Commission, individual Commissioners or staff.

2 Throughout this paper I will use the term subsidy to refer to the revenues collected from a set of rates deliberately set above market levels in order to reduce another set of rates. This use of subsidy is not strictly accurate in an economic sense, since not all the "subsidized" rates described are offered below their incremental cost, nor are the rates providing the subsidies necessarily above fully allocated costs.

between the competitors' products. The competitors can also earn short-term profits between the time when underlying costs are reduced and the market adjusts accordingly.

Where competition is limited or non-existent, the producers can earn a significant return and recover a greater portion of overhead costs. When competition is introduced, competitors will be driven to shift cost recovery to less competitive services. The history of telecommunications is rife with examples of emerging competition forcing firms to move costs to the least competition markets.

The modern era of telecommunications competition began in 1959, when the FCC issued its "Above 890" decision. "Above 890" allowed private parties to construct and use microwave communications links and compete directly for private line service. Faced with the threat of bypass, AT&T introduced telpak, a volume discount plan, which dramatically reduced the price of private lines.[3] The cost of the price reduction was shifted to AT&T customers in non-competitive markets.

The same sequence occurred when MCI was allowed to compete in the switched toll services. The "seven-way cost study" performed by AT&T in 1965, showed that the return earned by WATS services was 10.2% - the highest return of all seven product categories. (Telpak - the competitive private line service - earned the lowest, a 0.3% return.)[4] Competition for MTS and WATS is now a reality, and recent debate centered on whether AT&T was offering these services below incremental cost. The margins for these services, especially for large customers, are much smaller.

Major Subsidies in Support of Universal Service: The federal government has established four direct subsidy programs designed to foster telephone service. Two, the Rural Telephone Bank (RTB) and the Universal Service Fund (USF) are aimed at making telephone service available in rural areas by supporting smaller local exchange carriers (LECs.) The other two, the Lifeline and Link-Up America programs, are aimed at providing telephone service to low income subscribers. Many states have established similar programs. The most important subsidy mechanisms currently supporting local service are not direct programs: they are the policies of charging more for business service than for residential service, of providing support through access charges and of geographically averaging of toll rates. The last two are inextricably linked, and all of these policies are at considerable risk as competition enters the telecommunications marketplace.

Rate Differentials: The policy of charging business customers markedly higher rates than residential customers for essentially identical services is a venerable one. A 1907 order by the Wisconsin Railroad Commission, later the Public Service Commission of Wisconsin, supported differential rates on the basis that "a lower residency rate is necessary in order that a sufficiently large number of subscribers may be secured to make the telephone valuable to business

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[3] Henck, Fred W. and Bernard Strassburg A Slippery Slope: The Long Road to the Breakup of AT&T, Greenwood Press, New York, 1988, pages 85-91

[4] *ibid*, page 113

subscribers."[5] To some extent, the difference in price is driven by a difference in usage: business usage is typically twice that of residential customers. Even where usage is charged for separately, however, the difference in base rates continues.

Competition should change this. The FCC's support for switched access interconnection is raising the specter of competitors providing local loops. Business customers are generally located in towns and cities, the same areas that usually house LEC switches, making loop costs low. In addition, business customers tend to have higher calling volumes. Both of these factors make them more likely prospects for competitive offerings than residential customers. Under these circumstances, it is unlikely that LECs can retain business customers at rates set to subsidize residential service. With this in mind, the more forward looking LECs have been proposing reducing the differential between business and residential rates. In its current rate case, GTE calls this proposed change a "pro-competitive revenue shift."

Even at present rate levels, and in the absence of competitive switched interconnection, large customers are seeking means of bypassing local service. Some have eliminated local service and completing all local calls over their special access links to the IXC: in effect making toll calls to subscribers located in the same exchange. Other customers are using intraLATA WATS services, priced at around $.06 per minute, to avoid local call charges of $.10 per call for short duration calls.

Access Charges & Separations: Costs have been shifted between local and toll services by means of access charges, and before that the settlements process, since long distance was introduced. Until 1950, AT&T settled on a board-to-board basis. Under board-to-board, toll rates recovered the costs of the toll switchboard and toll plant, but none of the local exchange costs which were caused by the toll traffic. Under this method, local rates were unquestionably supporting toll. After 1950, AT&T began using the station-to-station approach, which assigned all traffic sensitive costs caused by toll services to those services.[6] Toll did not, however, provide any contribution to the cost of common lines.

From the 1930 onwards local service rates were increasing while interstate toll rates were falling. Between 1950 and 1980 state regulators successfully argued that interstate toll revenue surpluses should be used to cover common costs, instead of being used to reduce interstate toll rates. The result was a series of increases in the amount of common line (nontraffic sensitive or NTS) costs allocated to interstate toll services. Figure 1 shows those allocations. Most of the changes in allocation are identified by the location of the Joint Board meeting which recommended the increase.

The separations process has been tweaked in other ways to produce subsidies for smaller companies. The most notable tweak is the weighting factor for allocation of the cost of switches. LEC switching equipment is classified as Category 3 Central Office Switching Equipment, and

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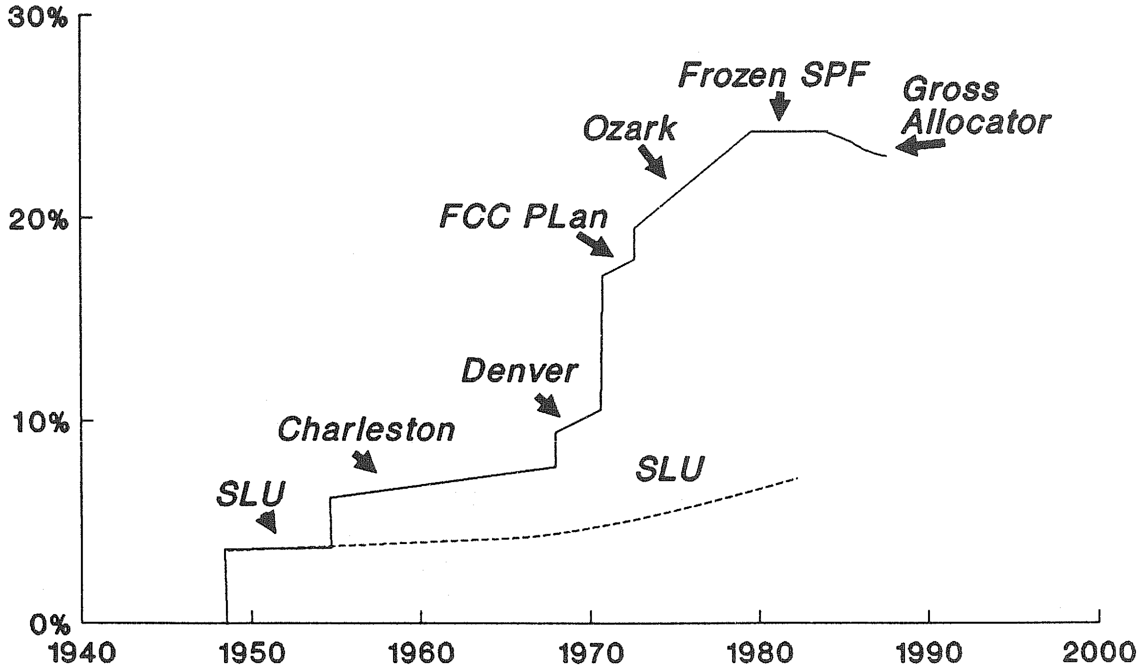
5 *Free and Reduced Rate Telephone Service Rendered in the State of Wisconsin, Being an Investigation by the Commission on Its Own Motion* (2. Wisconsin Railroad Commission Reports, 521)

6 Gables, Richard Development of Separations Principles in the Telephone Industry Institute of Public Utilities, Michigan State University, 1967, page 44



Source: Paul Hartman lecture, 1988 **Figure 1**

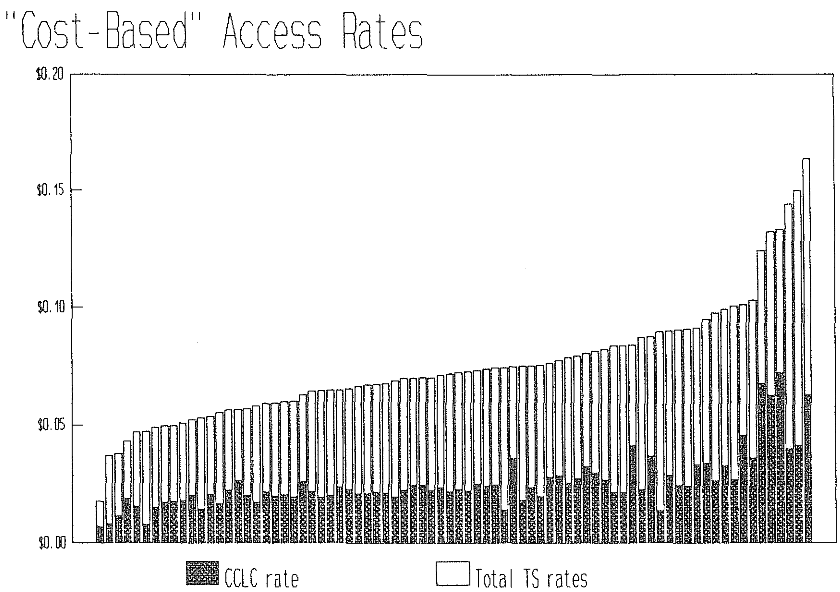
is allocated based on the Dial Equipment Minutes (or DEM) factor. For companies with less than 50,000 access lines, DEM is weighted: for very small companies, the weighting factor is 3. Thus if a small company finds that 25% of the minutes on its switch are interstate, then 75% of the cost of the switch is allocated to interstate access. Wisconsin also uses the FCC separations methodology to develop intrastate costs and for some Wisconsin LECS the portion of local switching costs allocated to access - intrastate and interstate combined - is greater than the total cost of the switch.

Beginning in 1980, competitive pressures reversed the practice of shifting NTS costs to interstate access and costs flowed back to the intrastate jurisdiction. (see Figure 1.) The FCC also shifted some interstate access costs from access rates to a monthly end user common line charge (EUCLC.) The Wisconsin experience is similar. From 1984 to 1990, Wisconsin mirrored interstate access rate for interLATA access, while Wisconsin Bell, Inc. (WBI) administered an intraLATA settlements pool. During this time, WBI twice argued successfully that the NTS payment to the intraLATA settlements pool should be reduced. Also during this period, average Wisconsin intrastate access costs were less than the current average rates, so the IXCs lobbied hard for a change to rates based on company-specific costs. Beginning in 1990, Wisconsin adopted rates based on company specific Part 32/36/69 costs for access services. Despite this, the Commission is under continuous pressure from interexchange carriers (IXCs) and large customers to reduce access rates further.

Access rates, at least for small companies, provide subsidies for residential customers at the expense of toll users. Since business customers tend to use more toll than local customers, shifting cost recovery from access to local service shifts costs to residential customers. Given this subsidy, one would expect to see business customers seek less expensive options, to utilize other products, and to see new competitors enter the fray. All of the above are occurring. Most interestingly, the price distortions involved in access rates have resulted not only in customers bypassing the LECs, but in LECs building facilities to bypass those of other LECs.

Geographical Toll Rate Averaging: The third major source of support for universal service is the policy of averaging rates across an entire company or across a geographic area, regardless of underlying costs. This policy has a long history. AT&T formally adopted averaged toll rates under Theodore Vail's "One System - One Policy - Universal Service" policy around the time it began interconnecting independent networks.[7] In Wisconsin, all regulated carriers are required to charge a single set of toll rates for all areas of the state.

This policy creates a subsidy flowing from urban to rural areas. Rural areas, with low population density, have greater average loop lengths and more loops that require repeaters or line conditioning, resulting in higher average loop costs. The investment required of an IXC to serve the scattered rural exchanges is also much greater. Likewise, rural exchanges frequently have fewer subscribers than urban exchanges, leading to lower total demand. Figure 2 shows the difference in intrastate access cost[8] per unit of demand between the different Wisconsin LECS. The total spread is almost an order of magnitude.



Source: Author's Construct

Figure 2

7 Dordick, Herbert S., *Towards a Universal Definition of Universal Service* in Universal Telephone Service: Ready for the 21st Century? Institute for Information Studies, 1991, page 115

8 Wisconsin develops intrastate access costs using Part 32/36/69 procedures, but using intrastate frozen 1982 SPF instead of the FCC gross allocator.

Requiring companies to serve all exchanges at rates which recover average costs means that the rates will provide a surplus on low-cost routes, with the surplus supporting usage on high-cost routes. Under such a system, wise competitors will choose to serve only low-cost routes. A competitor serving only low-cost routes will have a distinct cost advantage and can charge considerably less. If resale and interconnection are required or allowed, that competitor can resell service provided by the ubiquitous rival, thereby obtaining universal coverage without incurring the cost of serving high-cost areas.

On the interstate side, the access tariff and pool administered by the National Exchange Carriers Association (NECA) supports geographical rate averaging. By charging a single set of rates, and pooling the revenues, the NECA system hides the differences in underlying costs. In Wisconsin, access rates are based on company specific costs, but a series of rate ceilings apply. These rate ceilings also serve to disguise the difference in costs.

Despite the rate ceilings, Wisconsin access rates do vary significantly between companies and between exchanges. Competitors have responded as expected: the marketing of services appears to have been less energetic in high-rate areas and the bulk of the competition has occurred in low-cost urban areas. Wisconsin does not regulate the rates of resellers, and Wisconsin's largest reseller - Schneider Communications, Inc. - has already deaveraged its toll rates. Some resellers have also withdrawn from areas with high access rates: in one case, a proposed increase in access rates caused a reseller to remove itself from an equal access ballot after it had begun its advertising campaign.

Wisconsin Bell, Inc. (WBI) is also responding to this difference in access costs. In recent dockets it has proposed treating ICO (independent companies - meaning all LECs except WBI and GTE North) originated toll as a separate product line, with separate rates set to reflect the cost of providing the service. Absent that change, Bell proposed converting all shorthaul toll - the bulk of it ICO toll - to local service by approving EAS arrangements between all exchanges less than 26 miles apart. WBI has also discussed eliminating the provider of last resort requirement, which could allow it to abandon service in high-cost exchanges.

This pressure to deaverage toll rates is not unique to Wisconsin. Illinois has gone farther in eliminating subsidies than most other states. It has already divided the state into 18 MSAs and has allowed different toll rates to apply in each. Illinois has also shifted all NTS cost recovery to local rates. Despite this, the Illinois LECs are pressing for complete deaveraging of toll rates within the MSA and elimination of provider of last resort requirements.[9]

The Need for Subsidies: The effect of unrestrained competition is predictable: the lowest possible prices for major customers, a wide variety of services for those willing and able to pay for them, and no affordable service available to high-cost, low-usage customers. The deregulated transport market provides a good example: the number of planes, trains and busses going from Madison to Chicago is far greater, and prices lower, than before deregulation. On the other hand, service to many areas of Wisconsin - areas which were served under regulation - has ceased.

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[9] *Local Competition and Interconnection: A Staff Report to the Illinois Commerce Commission Commerce Commission*, Illinois Commerce Commission, July, 1992

Telecommunications markets could follow the same path. If not restrained, pressures to deaverage rates will result in route specific pricing. Competitive local loop provision and interconnection will force repricing of customer classifications, and may drive the reintroduction of zone or mileage charges. Volume discounts on local service pricing for multi-line customers are probable. Finally, competition will force firms to shift all possible costs to the least competitive market - rural residential customers. These changes do wonders for economic efficiency, but could make phone service unaffordable in rural areas.

One of the Commission's main reasons for existence has always been to ensure that all customers - even rural ones - receive telecommunications service at reasonable (affordable) rates. To that end, it will impede competition where necessary. The question, of course, is whether that will be necessary.

In Wisconsin, economic development of rural areas is of critical importance. Many communities that rely on volunteers for fire protection, and on the county sheriff for police protection, employ a full time economic development coordinator. One of the tools used by these communities to recruit businesses to rural areas is the availability of the same level and quality of telecommunications services found in urban areas. Geographic deaveraging of toll prices would eliminate this benefit. Under deaveraging, these areas would see higher toll rates - potentially toll rates several times those of urban areas.

Each summer, the governor takes the state government goes on the road and conducts business in some rural community for two weeks. This is done primarily to stress the importance of rural areas and rural economic development. Rural economics is a powerful political issue in Wisconsin. Given this political reality, geographical toll deaveraging will not be acceptable.

To prevent it, the Commission will have to adopt policies that minimize difference in costs between areas. This will mean near uniform access rates. Moreover, these rates will have to be low enough to be competitive with the offerings of competitive access providers on the high-volume, low-cost routes. This will not eliminate all cost differences between rural and urban areas - the carriers will still see the differences in their own network costs - but it will limit those differences.

Given the apparent intention of the FCC to approve local interconnection, it is unlikely that the Commission will be able to maintain the differential rates between local and business rates. Business rates will fall to at least parity. Competition may also force local rates to reflect differences in loop cost, perhaps leading to the resurrection of zone or mileage charges for local rates.

The impact of these changes will hit hardest on rural subscribers. Quantifying this impact directly is not possible, since Wisconsin does not require LECs to file separate cost information for rural and urban customers. Fortunately, a good proxy does exist. Wisconsin has 96 LECs. The ICOs (all LECs except Wisconsin Bell and GTE North) serve about 15 % of the state's subscribers, but almost half of the state's area. Modeling the impact of these changes on the ICOs will provide a good indication of what will happen to rural customers statewide.

The Model: It is possible to model the level of local rates, assuming access rates are dropped to uniform, competitive levels, and that business and residential rates reach parity. Such a model is described below. The model assumes that the interstate separations formulas and factors, and levels of interstate USF funding, will continue. It also assumes that IXCs will flow all reductions in access costs through, on a dollar-for-dollar basis, as toll rate reductions. The PSCW has required the major IXCs to make such flowthrough reductions; market forces should force the other toll providers to follow suit.

The model has the following steps:

Step 1: Determine the intrastate revenue requirement for each company. The Commission staff has developed a series of models that use inputs from the LEC annual reports to generate total company and intrastate revenue requirements. These spreadsheets were used to produce the revenue requirements used in this model. For companies that use cost studies to perform interstate separations, the model developed an intrastate revenue requirement. For interstate average schedule companies, the model developed a total company revenue requirement, then subtracted interstate revenues. In both cases, the model developed a 1991 revenue requirement.

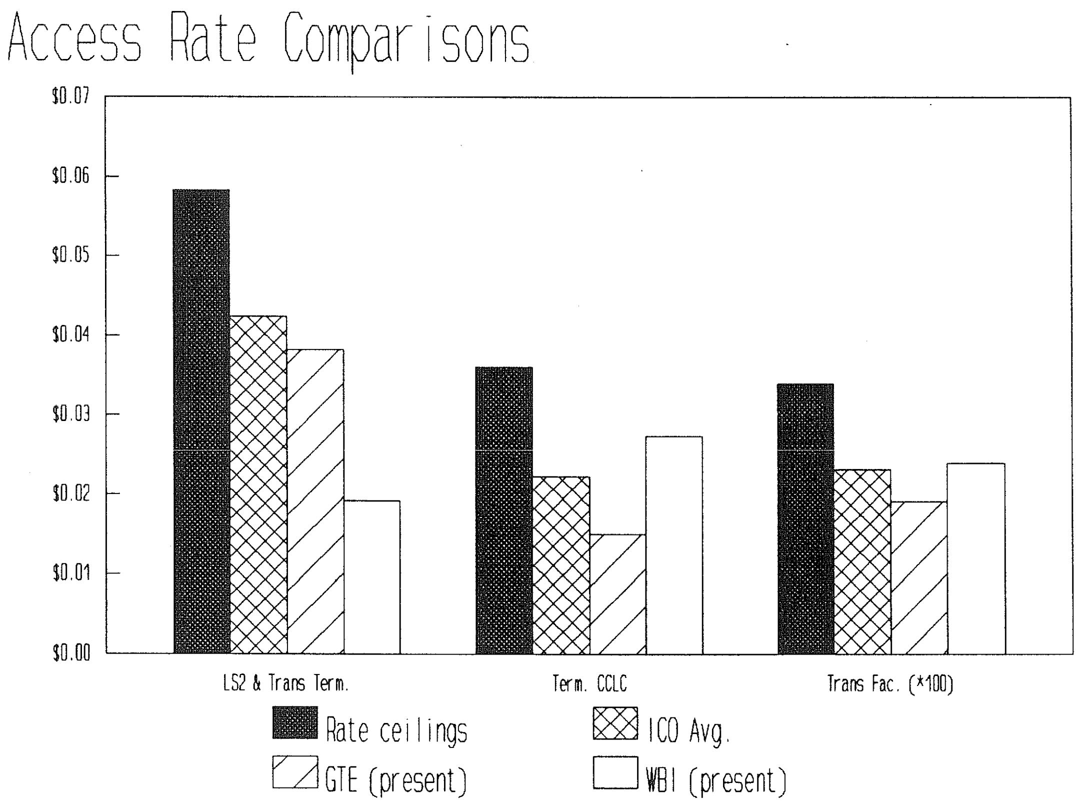
Wisconsin statutes develop a table for calculating allowable rates of return for LECs under 9,000 access lines, based on the LEC's equity level. The model used these statutory rates of return in producing revenue requirements. The three companies with negative equity levels were excluded from the model. Likewise, cooperatives were excluded because some of the required information was not readily available.

Step 2: Subtract interstate universal service fund (USF) funding. The model used 1992 fund payment levels.

Step 3: Subtract revenues from miscellaneous and optional services. In rate cases, staff rate analysts develop rate designs for nonrecurring charges, off-premises extensions, volume controlled handsets, coin phones and all the other miscellaneous services LECs provide to local subscribers. Rates for these services are usually moved to fairly standard levels: e.g. coin phone rates are almost always set at $.25. Based on data from the last half dozen rate cases, the mean revenue per access line from these services was $23.00 per year, with a standard deviation of $3.70. The model estimates annual revenues from these services for a company by multiplying the average revenue per access line by the number of access lines served by the company.

Step 4: Subtract special access (SA) revenues. Data on the intrastate special access revenue stream for most companies are not readily available. The model uses the Part 32/36/69 intrastate SA revenue requirement as a proxy for the intrastate SA revenue stream. Since most Wisconsin LECs exercise their option to mirror interstate SA charges, this assumption will slightly underestimate the SA revenue requirement, and may therefore overestimate the final residential rate level. Based on those companies for which data is available, the error should be less than $.25 per month.

Step 5: Determine switched access rate levels. Access rates consist of three main areas: carrier common line charge (CCLC), traffic sensitive (TS) and billing & collection (B&C), which is still a regulated service in Wisconsin.



Source: Author's Construct **Figure 3**

CCLC rates are set to recover an arbitrarily determined portion of a LEC's nontraffic sensitive costs. The IXCs have put constant pressure on both the state and federal commissions to eliminate the CCLC rates, and both WBI and GTE have filed proposals to reduce the rates in their rate cases. It is unlikely that the "subsidy" inherent in this rate can be maintained once access competition is a reality. The model assumes that CCLC rates are reduced to zero.

TS rates can be segregated into two main groups: transport facility rates and everything else. Transport facility rates recover transmission line costs and are priced on a per minute-mile basis. Other rates, including local switching and transport terminations, cover central office features and are priced on a per minute basis. The present rates for these services, plus the current interstate rate, are shown in Figure 3.

The model assumes that the per minute cost of local transport will have to fall below WBI's current rates, since the current rate is based on the average cost of providing access services in all WBI exchanges, including the few rural ones. Competitive access providers will concentrate on high-volume, low-cost exchanges, and WBI would have to meet that competition. Based on this assumption, the per minute cost of switched access was set at $.015. The transport per minute-mile rate was set at $.0001 for similar reasons.

Billing and collection services are regulated in Wisconsin, but companies may enter into individual contracts for B&C services. Most of the ICOs have just recently filed for that authority. Although no contracts have yet been filed with the Commission, rumors call for a reduction in per message B&C cost of about 40 % for the first round of contracts. The average per message cost, under the existing tariffs, is $.15. The model sets the expected B&C rate at $.09 per message.

Step 6: Determine the total reduction in access costs. For any given company, the reduction in access revenues is the revenue stream at current rates minus the revenue stream at the rates described in step 5. The total reduction is simply the sum of these reductions, including reductions made by Bell and GTE.

Step 7: Determine AT&T's[10] portion of this savings. AT&T's portion of the total savings in access costs is total savings multiplied by the ratio of the interLATA market to the total intrastate market multiplied by AT&T's portion of the interLATA market. Since all these figures are considered confidential by the utilities involved, I cannot include them.

Step 8: Allocate the reduction in access costs between toll services. The portion of AT&T's reduction going to each toll service (e.g. MTS, WATS, SDN, etc.) was based on the proportions used by AT&T in past flowthrough filings.

Step 9: Determine the percentage reduction in toll rates. The percentage reduction in rates for each toll service was determined by dividing the reduction allocated to that service by the intrastate revenues produced by that service. The model showed that customers could expect a 19.3% reduction in MTS rates, with greater reductions in other services, especially WATS services. The weighted average reduction was 26.6%.

Step 10: Calculate the average monthly toll savings for residential customers. Since the purpose of the model is to look at the impact on residential customers, it is necessary to calculate the average monthly toll savings. IXCs do not track toll usage according to the arbitrary classifications used to price local service (e.g. residential, business, etc.) The factors used to allocate toll savings for various toll services (e.g. MTS, WATS, Megacom) to the various rate classifications were estimated based on personal knowledge, the input of industry representatives and other Commission staff. The model estimates that the average residential customer should see a toll reduction of $3.37 per month. Single line business customers should see toll savings of about $7,25 per month. Larger business customers should see considerably higher savings.

Step 11: Calculate stimulation in toll demand. The model uses a stimulation factor of .5 (a 10% reduction in price results in a 5% increase in demand). Stimulated demand is found by multiplying this factor by the percentage reduction for the service found in step 9 and by AT&T's

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10 Current information on the intraLATA market was not readily available. Information on AT&T services, revenues and minutes of use (MOUs) was, because of a pending docket on market share. For that reason, the interLATA market was used as a proxy for the total intrastate market.

MOU for the service. The stimulation in MOU for AT&T must then be grossed up to statewide levels by reversing the procedure in step 7.

Step 12: Calculate the value of additional calling per month due to toll stimulation. The value to residential customers of the stimulated calling is equal to the amount of stimulated toll revenues for each toll service multiplied by the allocation factors described in step 10. The average residential customer will use additional intrastate toll services worth $ 1.36 per month.

Step 13: Calculate access demand levels. Traffic sensitive demand levels were grown by the weighted average stimulation for all services. B&C demand was grown by the MTS stimulation factor, since most IXCs bill large customers directly.

Step 14: Calculate the access revenue streams. The access revenues streams are calculated by multiplying the rates developed in step 4 by the demand levels developed in step 13.

Step 15: Calculate the local revenue requirement. The local revenue requirement is developed by subtracting interstate USF funds, miscellaneous service revenues and access revenues from the intrastate revenue requirement.

Step 16: Calculate the average residential flat rate. The residential rates, assuming that rates are uniform for all classifications, is the (residual) local revenue requirement divided by 12 and by total access lines.

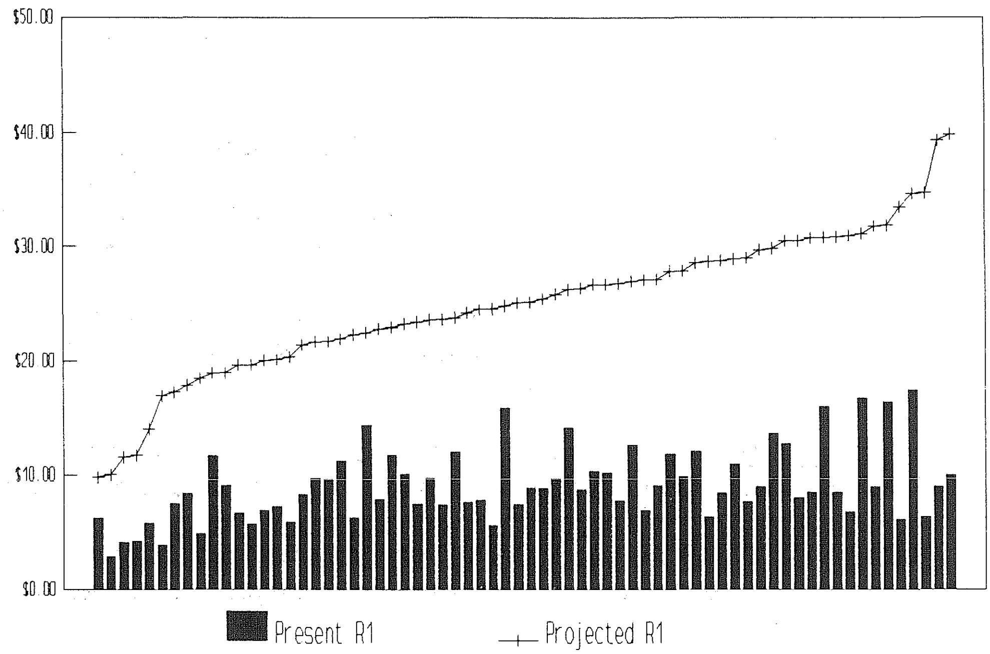
Results of the Model: The results of the model are shown in Figure 4. The bars represent the current one-party, residential flat rate[11] for the various ICOs. The current average rate is $9.13. The maximum authorized residential rate is $20.40, the minimum is $2.90. (These numbers do not include the $3.50 FCC EUCLC.)

The line in Figure 4 shows residential rates after competition has squeezed out these subsidies. The average rate under the model is $24.90 per month, excluding the FCC EUCLC, with a maximum rate of $39.85 and a minimum of $9.81. Residential rates are projected to rise an average of $15.77[12], an increase of 192.5 %.

Some of this local rate increase will be offset by intrastate toll savings. For the average residential customer, toll savings will total $3.37 per month. Even adding the value of stimulated calling - since the caller presumably derives some value from the call, or it wouldn't be placed - total toll benefits are only $4.73 per month. The net impact on the average rural, residential customer's cost of phone service will be an increase of over $11.00 per month. In general, rural customers will not see a net benefit from competition in the telecommunications marketplace.

11 When different rates are authorized for a LEC's different exchanges, the rate shown is the unweighted average of all residential rates authorized for the company.

12 About $3.75 of this increase is due to equalizing business and residential rates, the remainder is due to the changes in access rates.



Source: Author's Construct **Figure 4**

Rate Shock: One of the more popular topics in telephone regulation literature is proving that the elasticity of demand for telephone service is very low[13], but increases of this magnitude - an average increase of 192.5% and a maximum increase of 446.1 % - could have a significant impact on local service penetration. On the other hand, local rates for some companies have already increased by up to an order of magnitude over the last few decades. Telephone penetration is also higher. A rate increase of the magnitude discussed above will not, therefore, automatically result in customers dropping off the network. The key to keeping the customers on the network is to minimize the rate shock associated with these increases. This can be done by mitigating the increasing: raising rates in a series of small steps.

The Wisconsin Commission has found such mitigation plans to be very effective in balancing customer needs with a need to redress rate imbalances. Where large local rate hikes were required, the Commission has implemented the local rate increase in phases (e.g. one third of the increase each year for three years.) In order to keep the company whole during the phase in period, the Commission has approved either surcharges for other services (usually those being reduced in the rate rebalancing) or temporary payments from an intrastate universal service fund.

Effect on Low Income Customers Of greater concern is the impact on low income customers. Figure 5 shows the current penetration levels for low income customers of different racial groups. With overall penetration below 75 % for those with the lowest income levels in all groups, and

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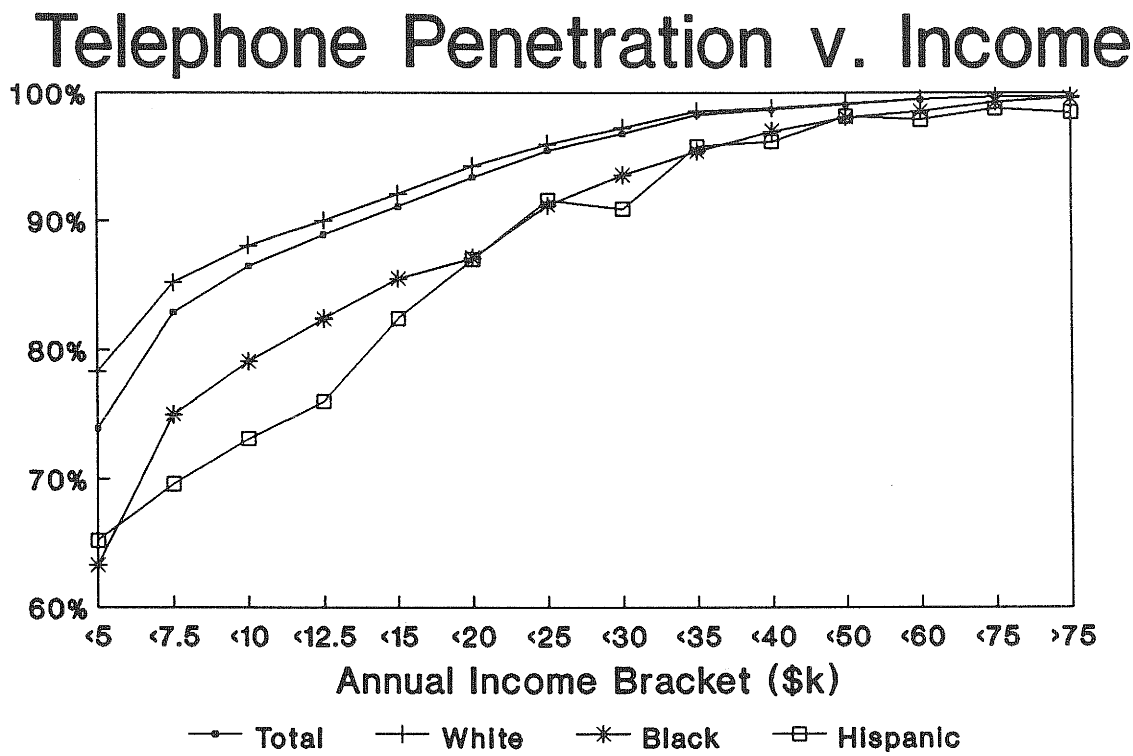
13 For an overview of the elasticity studies prior to 1985, see Kenneth Gordon and John Harrington, "*Do Recent FCC Telephone Rate Reforms Threaten Universal Service*" in Changing Patterns in Regulation, Markets, and Technology: The Effect on Public Utility Pricing, Patrick C. Mann and Harry M. Trebing, editor, Institute of Public Utilities, Michigan State University, East Lansing, 1984



Source: FCC Monitoring Reports **Figure 5**

below 70% for some particular groups, it is clear that some customers are already unable to afford telephone service. Increasing rates in rural areas by a factor of three is unlikely to change this basic fact.

Assistance for low income customers is necessary now, and will be critical in the future. Life-line programs, which provide a reduction in the local monthly rate, and link-up programs, which provide a waiver of service connection charges, should be universally implemented. Both programs have a proven track record (see the paper by Jan Walters, elsewhere in this publication), are partially financed by federal funds, and can be easily administered. Some jurisdictions, including California, use self-identification to qualify participants. Wisconsin bases eligibility on enrollment in one or more income assistance programs. LECs can verify a customer's eligibility in real time via modem: the state allows the LECs access to the programs' databases solely to verify that the customer's social security number does appear in the list of recipients.

Effect on Universal Service: Most rural customers can expect to pay more for telephone service under competition. The next question is whether the increases in cost of service will be enough to force the average rural customer to discontinue service. If that is the case, these customers will also require some form of subsidy or support mechanism.

The entire question of what constitutes a rate that is "too high" is a difficult question, and one not directly related to the local rate. Nearly all customers use some mix of local service and toll services. This is especially true in rural areas, where calls to schools, local government and stores may be toll calls. In these circumstances, it is important to look at a customer's local calling area - the area s/he can call without incurring toll charges - in determining ability to pay. The geographical and demographical information is required to do such an analysis is different for all exchanges, and as such is beyond the scope of this paper.

Keeping in mind that ignoring toll costs will overestimate customer ability to pay, it is possible to look at the need to put ceilings on local rates. Rate ceilings, of course, mean that the LECs would need to recover the revenue shortfall somewhere else - namely through some form of intrastate universal service fund. If local rates were capped at $15.00 per month, including the FCC EUCLC, the independent LECs would need $45,750,000 annually in support funding.[14] If the ceiling were raised, the amount of funding would decrease. A rate ceiling of $25.00, including the FCC EUCLC, would require $14,050,000 annually; a ceiling of $35.000 only $650,000 per year.

Social service agencies (and home budget planners) recommend that clients not spend more than a certain percentage of their income on particular items - 25% on food, 50% on rent, etc. A similar technique can be used to estimate the average customer's ability to pay for local telephone service. The median household (pretax) income for Wisconsin counties ranges from $14,122 to $44,565. The statewide median is $29,442. If local rates were capped at 1% of median income, the rate ceilings would range from $11.76 to $37.14 per month. If capped at 1% of the statewide median, the local rate ceiling would be $16.67. At this level, the ICOs would need $40,165,000 annually. The ceiling could be raised, but requiring customers to pay more than 1% of gross income for local telephone service, exclusive of toll, could be a significant hardship for many people.

Obtaining the Required Funding: If local service rates are capped, the LECs will require funding to cover their shortfall. Since they will be unable to cover the shortfall internally, some type of subsidy mechanism will be required. This mechanism must be as broad based as possible, in order to minimize the disruption in the market, and must be administratively feasible. A number of methods exist. All have strengths and weaknesses.

The simplest mechanism is a surcharge on local rates for all companies. All LECs, including those receiving the fund, would add a surcharge to all local rates. If residential rates were capped at $25.00, the surcharge would be approximately $0.50 per line per month. If they were capped at 1% of median income, the surcharge would climb to $1.45 per month. Two advantages to this method are that the surcharge can be easily collected, and, since local rates

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14 This figure assumes that rates for GTE North and Wisconsin Bell do not exceed the ceilings. While Wisconsin Bell, with an average density of 222 customers per mile, is unlikely to need funding, GTE North has an average density of 20 customers per mile, very similar to the 18 customers per mile in ICO territory, and its rates may exceed the caps. GTE has roughly the same number of access lines as the ICOs, so if GTE needs intrastate USF funding, the funding levels could double. The figure also assumes that the ceiling applies only to residential rates.

have very low elasticity, the surcharge will not significantly distort demand for local service. On the other hand, local rate increases made to subsidize certain customers, especially those of other companies, are politically explosive. The Illinois Commission had to retract a much smaller universal service surcharge due to public outcry.

A second collection method is a surcharge on access rates. The advantages to this method are that it is politically palatable and that it can be easily collected, since it could be billed through the Carrier Access Billing System (CABS) and nonpayers could be threatened with disconnection. The main disadvantage is that the surcharge, if applied to the local switching rate, would be $.00426 with a local rate ceiling of $25.00, and $.01219 if capped at 1% of median income. As described above, total traffic sensitive rates will have to fall to approximately $.015 to limit pressure to deaverage toll. The surcharge would significantly increase that rate. In addition, a LEC toll provider would not pay the surcharge on calls between its own exchanges, giving it a competitive advantage. This last problem can be resolved by some form of direct assessment or by requiring imputation of access costs.

The third method of collecting the subsidy is to directly assess some group or carriers, either LECs, IXCs or others. Wisconsin collects a portion of its intrastate universal service fund from IXCs through a direct assessment based on the carrier's gross toll revenues, as reported to the Wisconsin Department of Revenue for tax purposes. The assessment could also be done based on MOU, split evenly between all companies, or based on any other reasonable allocator. Direct assessments usually have minimal market impact, but if the assessment is not related to ability to pay, it may force small competitors, and those with narrow profit margins, out of the market. Direct assessments can be difficult to collect from deregulated or partially deregulated firms. A direct assessment also provides firms with an incentive to continually redefine themselves in an attempt to avoid the surcharge. (For instance, resellers in Wisconsin have claimed to be exempt from PSC notification requirements because they are not resellers but "rebillers", "call aggregators", "independent marketing agents for AT&T", "call concentrators", etc.)

The FCC funds the federal portion of the life-line and link-up programs through a direct assessment to carriers based on the total number access lines presubscribed to that carrier. This method of assessment has some advantages: it can be billed through the CABS system, it is related to IXC earnings, and is more politically acceptable than billing local customers directly. The only real disadvantages are that intrastate CABS billing systems may not be already set up to bill the charge, and some supplemental method of allocation will be necessary where intraLATA presubscription is not allowed. Assessing carriers based on presubscribed lines also misses resellers doing business via virtual private network (VPN) services, since their customers are usually presubscribed to the carrier providing VPN services to the reseller, instead of being presubscribed to the reseller itself.

A second special type of direct assessment is a capacity plan. Under a capacity plan, carriers are assessed based on the capacity of their network, usually determined by the number of voice grade channels terminating on the network. Capacity plans have difficulty dealing with resellers, and in assessing capacity for dark fiber, leased fiber and special access circuits. Capacity plans can also allocate a disproportionate share of costs to small carriers, forcing them out of business. The Wisconsin Commission unsuccessfully experimented with a capacity plan several years ago. Capacity plans are in operation in other state, however, so the problems can be resolved.

Conclusions: Competitive entry will continue to put pressure on all the areas where rates are set to recover substantial subsidies. Unless a Commission acts to limit competition in a service, rates for that service will be driven to underlying direct costs, and shared and common costs will be shifted to the least competitive markets. Commissions have three basic alternatives in dealing with the impact of these changes on rural residential customers.

1: The "you chose to live there" approach. A Commission could allow competition to drive rates to their cost. Geographical rate averaging will end. Rural rates will rise. This will be economically efficient; many residential and business customers will make the economically efficient choice of not subscribing to telephone service. The quality of life for these residents - and the ability to compete for these businesses - will be hurt, but the pretty country scenery should make up for it.

If a Commission promotes competition without addressing universal service goals, or intends to handle universal service problems only after it has introduced competition, it is adopting this approach.

2: The "no competition - not now, not ever" approach. A Commission could conclude that competition needs to be locked out of a market in order to preserve subsidy flows. Some Commissions have taken such actions. The Tennessee Commission, for instance, declared the intraLATA market off limits to presubscribed competition, stating that "competition and value of service pricing are incompatible."[15] Tennessee had priced intraLATA toll services below cost, and greatly expanded EAS calling, to meet its policy objectives. It remains to be seen whether Tennessee can continue these policies, or whether they fall to competitive pressures.

Like a struggle to save a historical building or pristine wilderness, the fight to lock competition out of a market never ends. Potential competitors will see profits, and large customers will see cost savings, if the market is opened. These players can justify funding continual lobbying in hopes of their future earnings in an open market. Despite the continual pressure, the Commission must win every battle in the fight to keep the market closed. Once the market is opened, even slightly, most of the subsidies will disappear.

A second concern in limiting competition is that the closed market must be large enough to supply the needed subsidies. Locking competition out of the intraexchange market, for instance, won't allow a Commission to extract subsidies from interexchange toll and access, thereby requiring local customers to subsidize themselves. In addition, the closed market must be large enough to allow cross-subsidies without putting the subsidy provider at a competitive disadvantage. Protecting the intraexchange market from direct competition is of little value if the subsidies involved make it cost-effective for customers to use cellular or toll services to substitute for local service.

3. The "targeted subsidies" approach. The most realistic approach to the emergence of competition is accept that competition is going to limit the amount of subsidies collected and to use whatever subsidies are available as carefully as possible.

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[15] June 27, 1991 order in Dockets 89-11065, 89-11735 and 89-12677, Tennessee Public Service Commission

As competition grows, the traditional, broad-based subsidy programs - access rates, rate classifications, and averaged toll rates - will see increasing pressure. Commissions will have to choose whether, where and when they are willing to abandon them. They should work to phase down those subsidy programs they choose not to maintain, recognizing that they will not be able to keep all local rates uniformly low. Instead, Commissions will have to establish subsidies programs targeted at specific problem areas: life-line and link-up programs for low-income subscribers, and high-cost support limited to residential, and possibly small business, customers of truly high-cost companies.

To support these programs, the Commissions will have to carefully extract subsidies. Subsidies distort the market, but the distortion is directly proportional to the size of the subsidy collected. If handled carefully, Commissions can extract small subsidies from a number of sources - access rates, local rates, direct assessment, interconnections - without harming the market, provided the subsidy is collected from all competitors.

Commissions electing this approach should begin implementing it immediately. The emerging competition will mean big savings for most large toll users, but most rural residential customers will be losers. Their local service increases will be far greater than their toll savings. Beginning the transition now will not ease the harm to these customers, but it can reduce the rate shock.

MAPPING ANALYSES AT THE PUBLIC UTILITIES COMMISSION OF OHIO

BY

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Introduction: Telecommunications rate structures in Ohio have evolved for more than a century. The complexity and diversity of the telecommunications environment has been modified, adjusted and reformulated through the years. Presently, many volumes of tariffs and 738 paper exchange maps of varying clarity provide the official references for telecommunications service in the state. To better understand these geographical relationships, the Public Utilities Commission of Ohio (PUCO) has implemented a computer mapping project.

Background: Historically, Ohio's telecommunications companies have evolved from various service points. These have been consolidated into a statewide network. Over the past century, simple flat rates for limited service have evolved to include mileage surcharges, zone rates, banded rates, message rates and measured rates. Also, all kinds of new services have been added. In recent years, the PUCO has responded to requests for rate increases with geographic rate simplifications, first by eliminating mileage charges in favor of zone charges and then by consolidating and abolishing the rate zones.

Presently, Ohio has a wide range of flat rate structures. The simplest consists of uniform rates averaged throughout a company's extensive service territory. The most complicated include surcharges for every quarter mile that a customer is located outside the base rate area. Some companies have banded rates based on the number of access lines in the local calling area.

Local calling areas have evolved from a few people connected to a local switchboard to many people in multiple exchanges networked together. When the calling public has demanded larger and larger "tollfree" local calling areas, the PUCO has responded with a variety of rate structures including message toll service (MTS) discounts, measured rates and sometimes the desired flat rates. For banded companies, the granting of extended area service (EAS) often results in a rate increase for the exchanges involved. The affected customers then must be canvassed to ascertain that they will pay extra for the expanded calling area.

Understanding the diversity and complexity of the intricate network of rates, services and territories on file at the PUCO requires a common reference. Computerized maps provide one common reference. Computer technology makes it possible to analyze geographic distributions of rates and facilities. A computerized geographic information system (GIS) can show and calculate the size and nature of extended local calling areas. It can also calculate distances from any school to the nearest digital switch with fiberoptic connectivity if relevant data are available.

When exchange-specific cases come before the Commission, maps of pertinent exchanges help us to better understand the geographic significance of any actions that might be taken. Ideally, geographic references could depict the various rates charged by all carriers in specific geographic areas for possible comparisons of similar services. For example, local exchange maps could be compared with the system maps of alternative access providers and also with those of the wireline and non-wireline cellular utilities. Such geographical comparisons are possible with map data that have been put into a geographical information system.

System: A MicroVAX II computer uses ArcInfo software to digitize and analyze the data. As its name implies, ArcInfo attaches attribute data to points, lines and polygons of graphic data. When the points, lines and polygons have specific relationships to points, lines and polygons on the earth's surface, the resulting graphical data represents a map.

Input: At the PUCO, we have digitized the service area maps, including the rate zones, of all 738 exchanges in Ohio. From these digitized data, it is possible to print maps of all or part of Ohio to show company service territories as well as exchange, rate zone, area code and LATA boundaries.

Computerized geographic data are especially useful when a variety of map coverages are available for comparison. For that reason, when we digitized the local exchange maps, we also digitized Ohio road and rail lines and road/rail crossing locations, locations of hospitals, court houses, colleges and public schools, and school district boundaries. County and township boundaries had already been digitized when electric service areas were input several years ago. Eventually we hope to have coverages representing all utilities that we regulate together with other infrastructure that relates to the public's perception of utilities' service needs.

Output: Spatial analyses may be conducted by any staff that have access to a graphics terminal on the State of Ohio VAX network. The graphics can be displayed either on a 4125 Tektronix terminal or on a 4105 Tektronix terminal emulator. These devices are needed primarily for editing the map coverages. For example, companies have modified two exchange boundaries in the first half of 1992.

Alternatively, the digitized geographic data may be converted to files which can be displayed directly on a personal computer (PC) that is not connected to the network. The PC must have a graphics card and at least an EGA monitor; it should have a mouse and Windows Version 3.0 or 3.1. A PC MAPS program for displaying these data on a PC has been written and developed for the PUCO by one of the co-authors of this paper (TJB). The PC MAPS data may be examined and analyzed without affecting the integrity of the GIS data on the VAX.

Any access to the VAX network permits analyses of the data via map printouts or by calculating the areas in square miles served by any digitized portion of any utility. Various map coverages and combinations thereof can be printed out on a Postscript printer in black and white from any graphic or non-graphic terminal. For color maps, the data are processed into color separates files which can be used by a local print shop to print color maps, such as for the service areas of Ohio local exchange telephone utilities.

Analyses: From a regulatory point of view, it is possible to do geographic analyses based on numbers and allegations without ever looking at a map. However, spatial relationships in the form of a telecommunications map are much more understandable. A map provides a clearer picture than similar data given in tariffs, spreadsheets and other non-graphic forms. A digitally-created computer map is more representative of a service area than the schematic displays in many phone books.

The exchange map data have become quite useful for showing how requests for extended area service would affect a given exchange's extended local calling area. The commissioners are now able to visualize what they are voting on as they consider EAS cases. By combining a table of EAS data with the digitized map data, the computer can plot any of Ohio's 738 local calling areas in less than an hour.

The computer can calculate service areas for exchanges or for whole companies. Thus, the company data can be normalized not only per access line but also per square mile of service territory. The results might reflect why some companies have higher costs than others.

Examples of Mapping Analyses: Figure 1 shows the service areas for the four area codes in Ohio. Figure 2 provides similar information about the LATA boundaries. While these could be considered as "standard" maps, the computerized data permit them to be printed out in various nonstandard ways. For example, they may be included with rate zone maps of Ohio local exchange telephone companies as shown in Figure 3 or as part of local calling area maps like the one shown in Figure 4. Table 1 summarizes the types of exchange-specific rate structures which are associated with extended local calling areas in Ohio. The computerized exchange data can even be printed out as a sample tariff page. Figure 5 shows what one would look like for a one-exchange telephone company.

Table 2 lists the service areas, in square miles, for the local exchange telephone companies in Ohio, as calculated from the digital database. These numbers may then be combined with the access line data published by the Ohio Telephone Association to give the numbers of access lines per square mile. The companies may be better understood when one realizes that Cincinnati Bell's 572 access lines per square mile provides a much different operating environment than the 134 line-per-square-mile average for Ohio. Nearly all of the small companies and most of the "independent" large companies operate with fewer than 100 access lines per square mile. Some have as few as 11.

Figure 6 provides an example of the use of these maps to show requests for extended area service. Previously, the Commissioners had to rely on case files with calling data and testimony from local subscribers that sometimes resulted in EAS being granted between noncontiguous exchanges. Now the Commissioners can look at the map to see the geographical relationships among the requested exchanges. Figure 7 provides an example of how the map data can be combined with data from another source to show the portion of Ohio that allegedly has a particular type of service. Figure 7 is an approximate representation of portions of the state that have digital switch service. It is only approximate because the two databases do not exactly match.

Computerized county maps can show cellular service areas in Ohio, as in Figure 8, or Ohio 9-1-1 service, as in Figure 9. Figure 10 combines county data with exchange data to show which exchanges serve one Ohio county. Figure 11 shows the stylized service areas of one paging company. This map shows only the reported antenna sites in Ohio. Service provided by antennas in neighboring states is not shown. However, the 20-mile-radius circles defined by the FCC for pagers can be produced by ArcInfo without any need for digitizing data from hard copy.

Ancillary databases support other PUCO regulatory functions while providing coverages for comparison with the telecommunications data. The railroad lines in Ohio mapped in Figure 12 not only are regulated by the Transportation Department of the PUCO but also provide rights-of-way for many fiberoptic lines used for telecommunications. Similarly, maps showing the public schools and school districts in Ohio, as in Figure 13, are useful for analyzing distance learning projects. Figure 14 shows locations of hospitals in Ohio for their consideration in analyzing local calling areas or emergency response plans.

<u>Conclusions:</u> The complicated geographic relationships among Ohio utilities may now be analyzed with computerized maps. Exchange boundaries, rate zone boundaries, LATA boundaries and area code boundaries may be examined on a single map of all or a portion of the state as desired. New extended local calling area maps may be generated in less than an hour to reflect the current state of extended area service. By placing map coverages on top of one

another, exchange maps may be compared with maps of schools, hospitals, roads, railroads, various political jurisdictions and other utilities. Spatial analyses of rates and facilities are possible by combining appropriate ancillary databases with the geographic information system. Service area calculations permit analyses of access line densities and the potential for competitive carriers. Thus, the geographic aspects of the operating environment of each company can be better understood. Analyses of cases involving specific geographic locations can benefit from having an appropriate map to consider along with the numbers and allegations. Mapping analyses enhance the decision-making process at the PUCO.

Acknowledgments: This telephone mapping project was inspired by John Borrows, Director of the Utilities Department at PUCO. Information about public schools and school districts in Ohio was furnished by the Ohio Department of Education. Information about hospitals was furnished by the Ohio Department of Health, Office of Resources Development.

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* The views and opinions of the authors do not necessarily state or reflect the views, opinions, or policies of the PUCO, the NRRI, the NARUC or other NARUC member commissions. Some of the data are subject to change.

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Table 1. Categories of Optional Calling Plans Between Exchanges in Ohio.*

Service Name	Service Abbreviation	Monthly Fee	$/15 Min of Calls	Per-Call Fee	Per-Call Time Fee	Per-Call Mile Fee	Time of Day Restriction
Community Calling Service	CCS	X	X				X
Optional Off-Peak	OPOP	X	X				X
Econo-Call	ECONO	X		X			
Option B	OPT B	X		X			
Extended Local Calling	ELC			X	X	X	
Local Calling Plus	LCP			X	X	X	
Optional [Flat Rate]	OPT	X					
"EAS" [CBT]	EAS	X					
Optional Measured [1-Way]	OPT1M	X		X	X	X	

* Non-Optional Extended Area Service Has No Fee for Expanding the Toll-Free Local Calling Area.

Table 2. DISTRIBUTION OF LOCAL EXCHANGE TELEPHONE COMPANIES IN OHIO

COMPANY NAME	TOTAL NO. OF LINES	SERVICE AREA [SQ. MI.]	LINES PER SQ. MI.	NUMBER OF EXCHANGES	AVG. LINES PER EXCHANGE
The Ohio Bell Telephone Company	3,313,591	10,490	315.9	192	17,258.3
GTE North, Inc.	671,866	15,043	44.7	244	2,753.5
Cincinnati Bell Telephone Company	658,456	1,152	571.6	12	54,871.3
United Telephone Company of Ohio	472,116	8,710	54.2	164	2,878.8
The Western Reserve TelCo (ALLTEL)	138,401	1,740	79.5	41	3,375.6
ALLTEL Ohio, Inc. (Mid-Ohio + Elyria)	110,340	1,054	104.7	15	7,356.0
Century Telephone Enterprises	63,840	174	366.9	6	10,640.0
The Chillicothe Telephone Company	27,007	730	37.0	10	2,700.7
Champaign Telephone Company	9,578	161	59.5	2	4,789.0
Telephone Service Company	7,895	86	91.8	2	3,947.5
Conneaut Telephone Company	6,634	55	120.6	1	6,634.0
Orwell Telephone Company	5,155	255	20.2	9	572.8
Germantown Independent TelCo	3,438	46	74.7	1	3,438.0
Doylestown Telephone Company	3,111	18	172.8	1	3,111.0
Minford Telephone Company	2,288	112	20.4	1	2,288.0
Little Miami Communications	2,053	77	26.7	2	1,026.5
Continental Telephone Company	2,008	156	12.9	3	669.3
Sycamore Telephone Company	1,753	116	15.1	3	584.3
United Telephone Company of Indiana	1,529	65	23.5	1	1,529.0
Columbus Grove Telephone Company	1,510	45	33.6	1	1,510.0
Arthur Mutual Telephone Company	1,117	46	24.3	1	1,117.0
Ottoville Mutual Telephone Co.	1,109	57	19.5	2	554.5
Benton Ridge Telephone Company	1,061	92	11.5	3	353.7
Kalida Telephone Company, Inc.	1,048	41	25.6	1	1,048.0
Oakwood Telephone Co.	1,026	48	21.4	1	1,026.0
Ayersville Telephone Company	991	33	30.0	1	991.0
Sherwood Mutual Tel Assn, Inc.	990	60	16.5	1	990.0
New Knoxville Telephone Company	936	39	24.0	1	936.0
Nova Telephone Company	803	47	17.1	2	401.5
Glandorf Telephone Company, Inc.	740	26	28.5	1	740.0
Arcadia Telephone Company	712	46	15.5	1	712.0
Buckland Telephone Company	682	49	13.9	1	682.0
McClure Telephone Company	672	35	19.2	1	672.0
Vanlue Telephone Company	658	52	12.7	1	658.0
Wabash Mutual Telephone Company	655	59	11.1	1	655.0
Middle Point Home TelCo.	632	46	13.7	1	632.0
Fort Jennings Telephone Company	622	29	21.4	1	622.0
Ridgeville Telephone Company	580	33	17.6	1	580.0
Bascom Mutual Telephone Co, Inc	524	31	16.9	1	524.0
C,C&S Telco, Inc.	479	36	13.3	1	479.0
Farmers Mutual Telephone Company	398	27	14.7	1	398.0
Pattersonville Telephone Company	325	18	18.1	1	325.0
Vaughnsville Telephone Company	301	18	16.7	1	301.0
Joint Service Areas	?	5		NA	
Unclaimed Areas	0	3		NA	
	5,519,630	41,261	133.8	738	7,479.2

NUMBERS FOR LINES AND EXCHANGES COME FROM 1992 DIRECTORY OF MEMBERS, OTA
NUMBERS FOR SQUARE MILES OF AREA WERE CALCULATED FROM DIGITIZED EXCHANGE MAPS
NO INFORMATION IN THIS TABLE COMES FROM CONFIDENTIAL SOURCES!

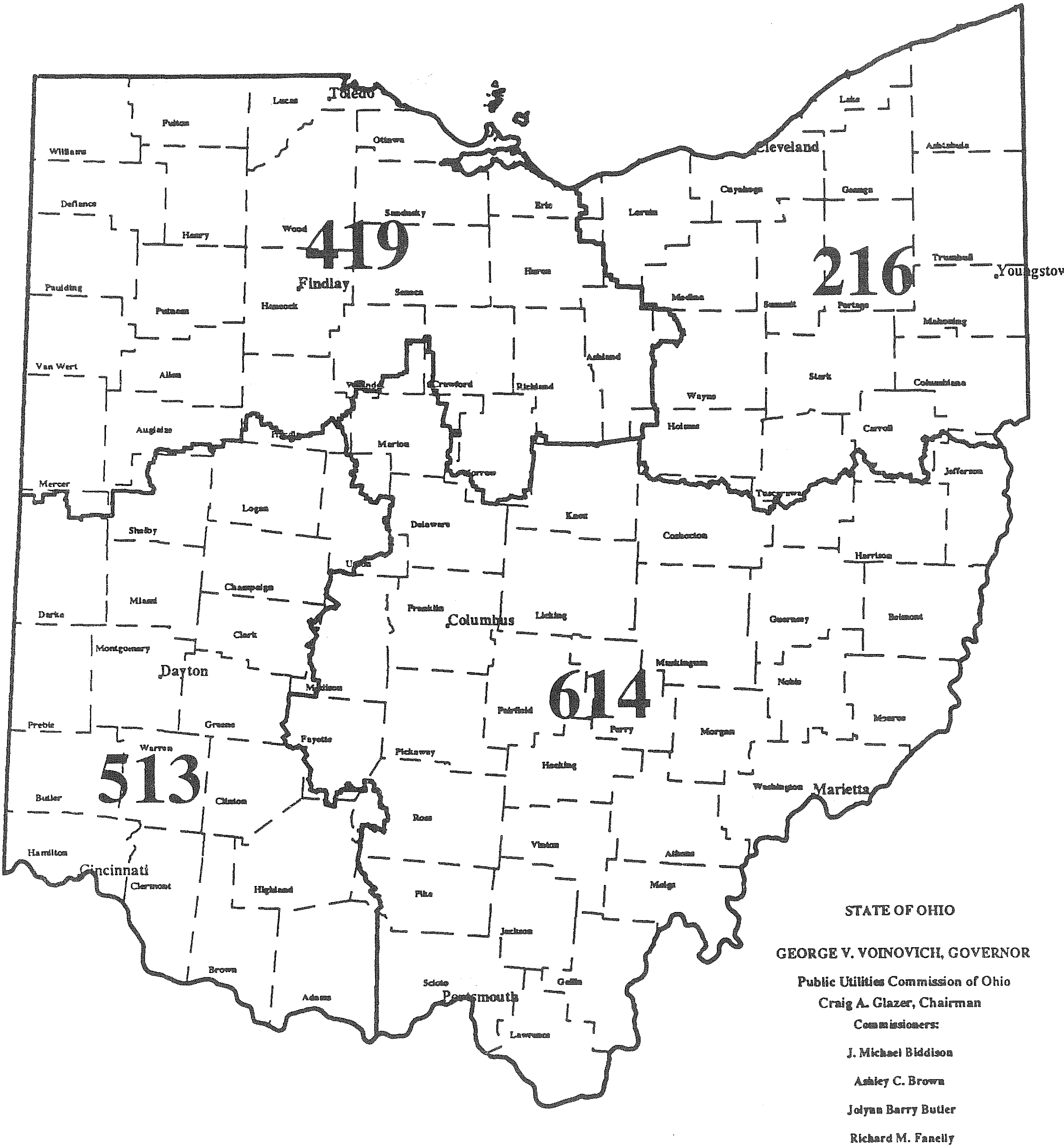

Figure 1. **SERVICE AREAS FOR THE FOUR AREA CODES IN OHIO**

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Figure 2. **SERVICE AREAS FOR THE LATAS IN OHIO**

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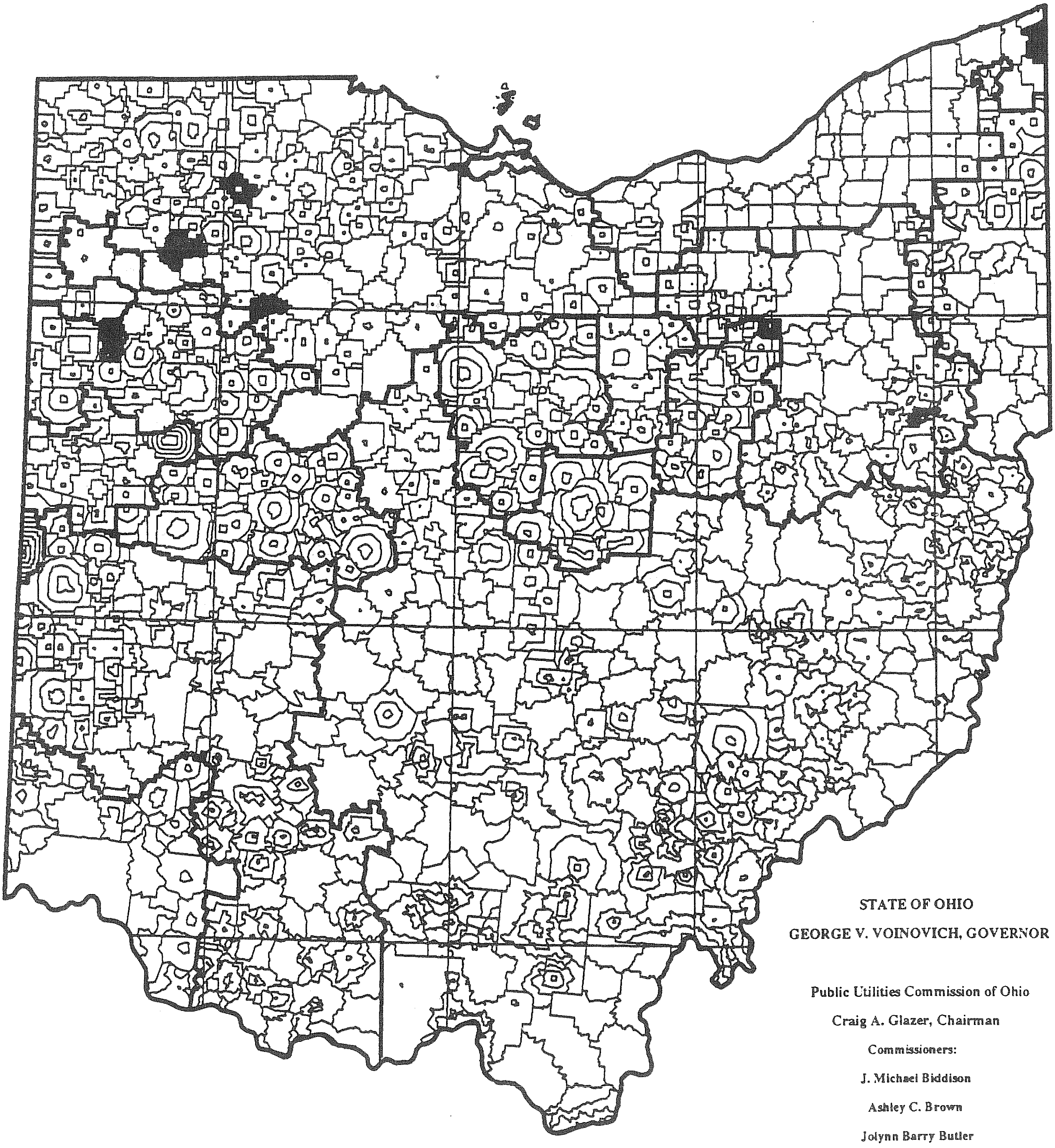

Figure 3.

RATE ZONE AREAS OF OHIO LOCAL EXCHANGE TELEPHONE UTILITIES

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Figure 4. **AUSTINBURG**

EXCHANGE OF WESTERN RESERVE TELEPHONE COMPANY

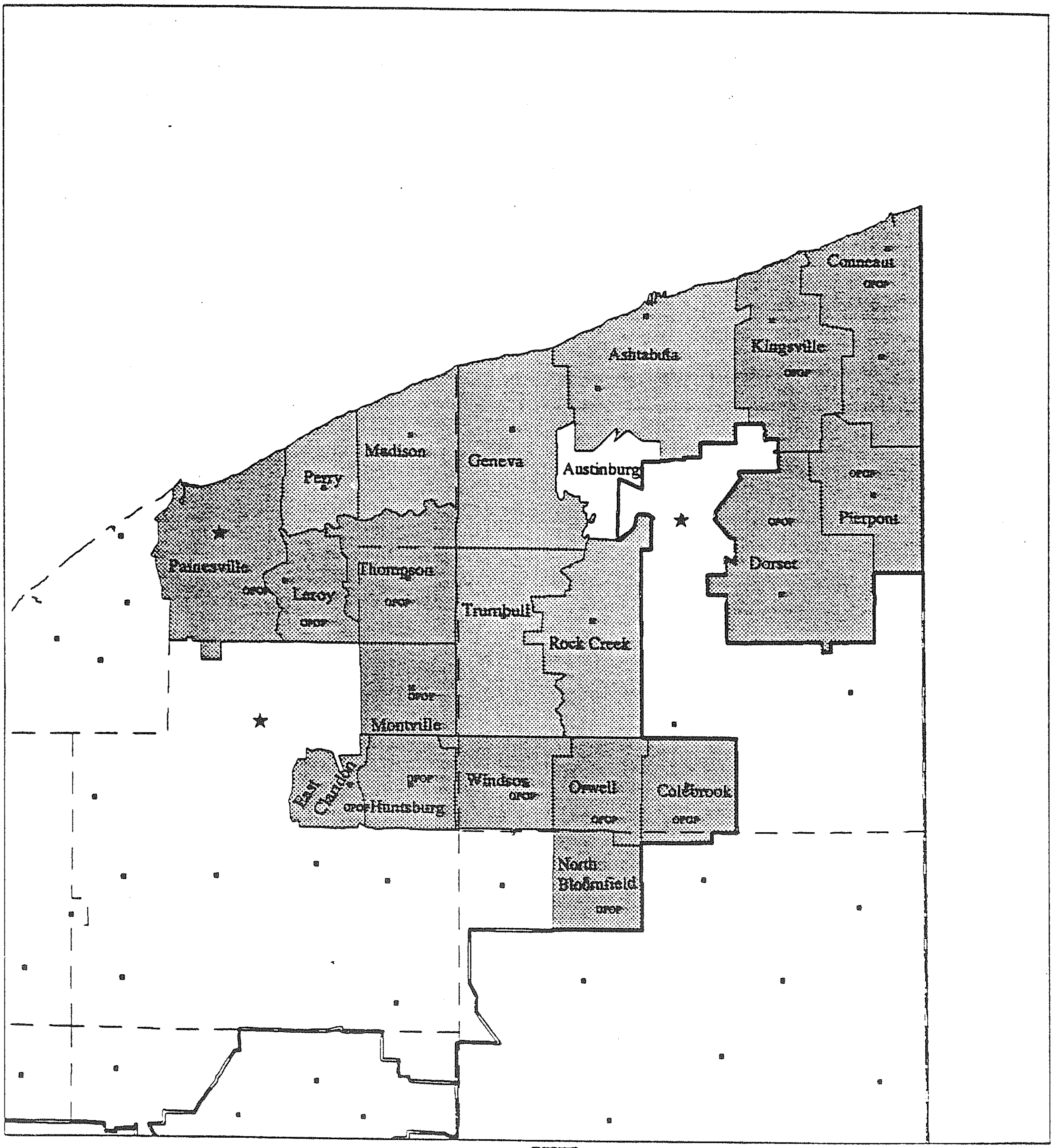
has non-optional extended area service with the ancillary exchanges shown on this map in light gray. Special OPTIONAL extended area service, with optional added fees lower than the usual message toll rates, MAY exist with the exchanges shown in dark gray (if any). A description of the optional service types is given in Table 1.

(LATA BOUNDARIES, IF ANY, APPEAR AS HEAVY LINES ══)

(DASHED LINES ARE COUNTY BOUNDARIES — — — — — —)

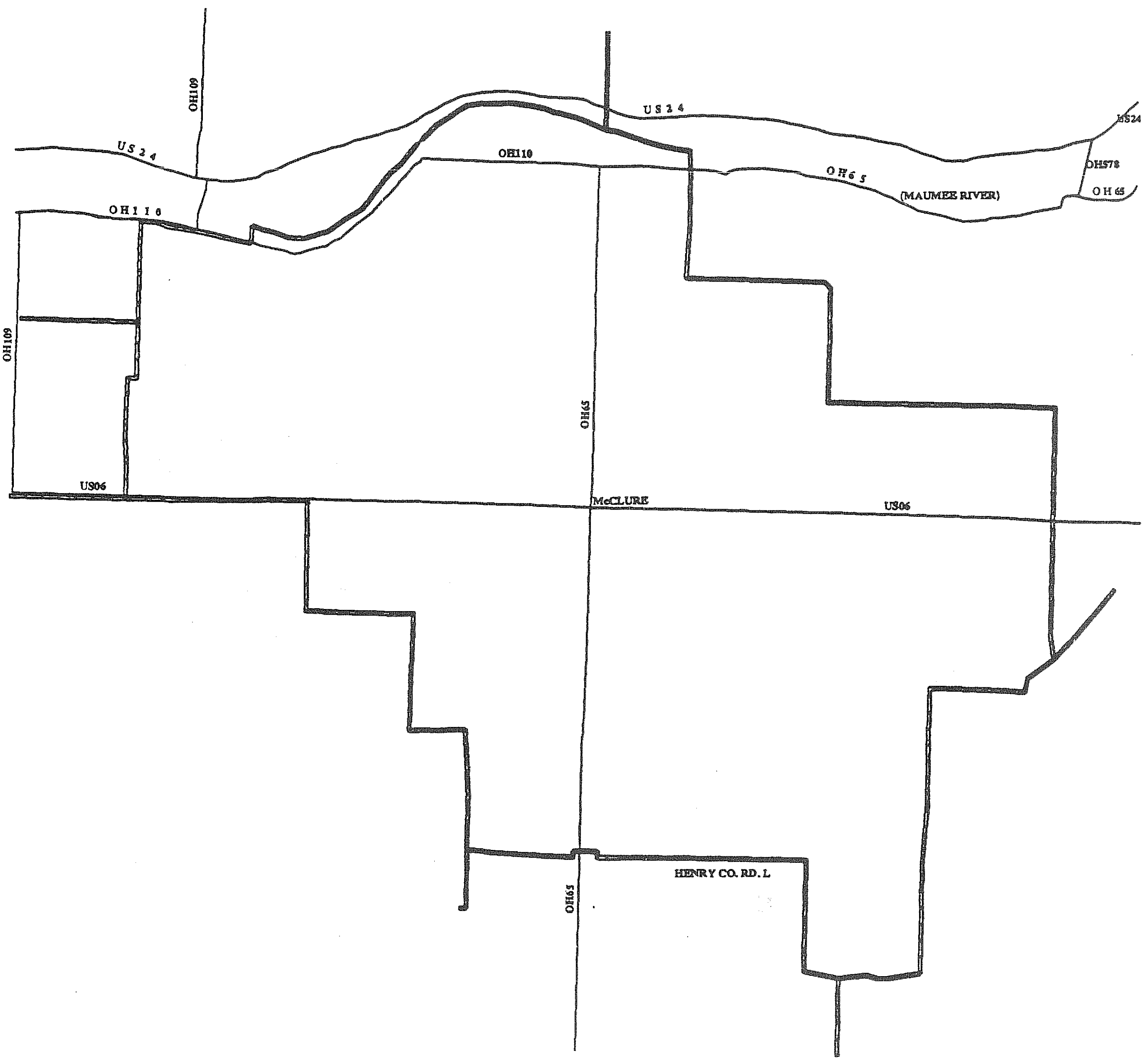
(SQUARES = LEC WIRE CENTERS; STARS = COUNTY SEATS)

SCALE: 1:500,000



P. U. C. O. NO. 5
LOCAL EXCHANGE TARIFF

McCLURE EXCHANGE AREA



ISSUED__________________________EFFECTIVE__________________
In accordance with Order No.____________________________
Issued by The Public Utilities Commission of Ohio____________________

By Hugo Miller, President, McClure, Ohio 43534

Figure 5. Sample tariff page showing one exchange map.

Figure 6. MOLINE

EXCHANGE OF UNITED TELEPHONE COMPANY

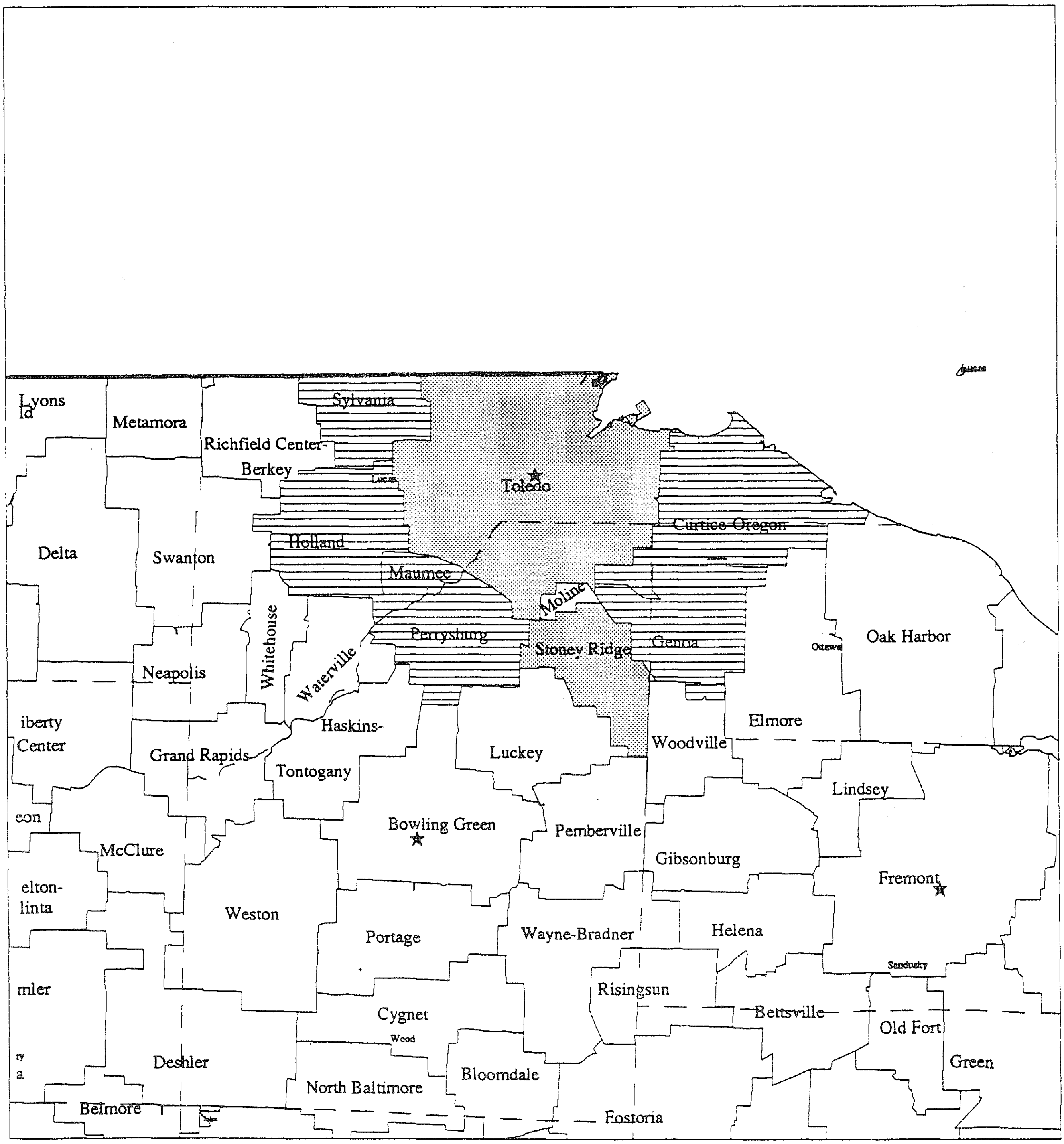
has non-optional extended area service with the ancillary exchanges shown on this map in light gray. Special OPTIONAL extended area service, with optional added fees lower than the usual message toll rates, MAY exist with the exchanges shown in dark gray (if any). The requested exchanges for EAS are shaded with horizontal lines.

(LATA BOUNDARIES, IF ANY, APPEAR AS HEAVY LINES ===)

(DASHED LINES ARE COUNTY BOUNDARIES --- --- --- --- ---)

(STARS = COUNTY SEATS)

SCALE: 1:500,000; PEX CASE = 92-1250



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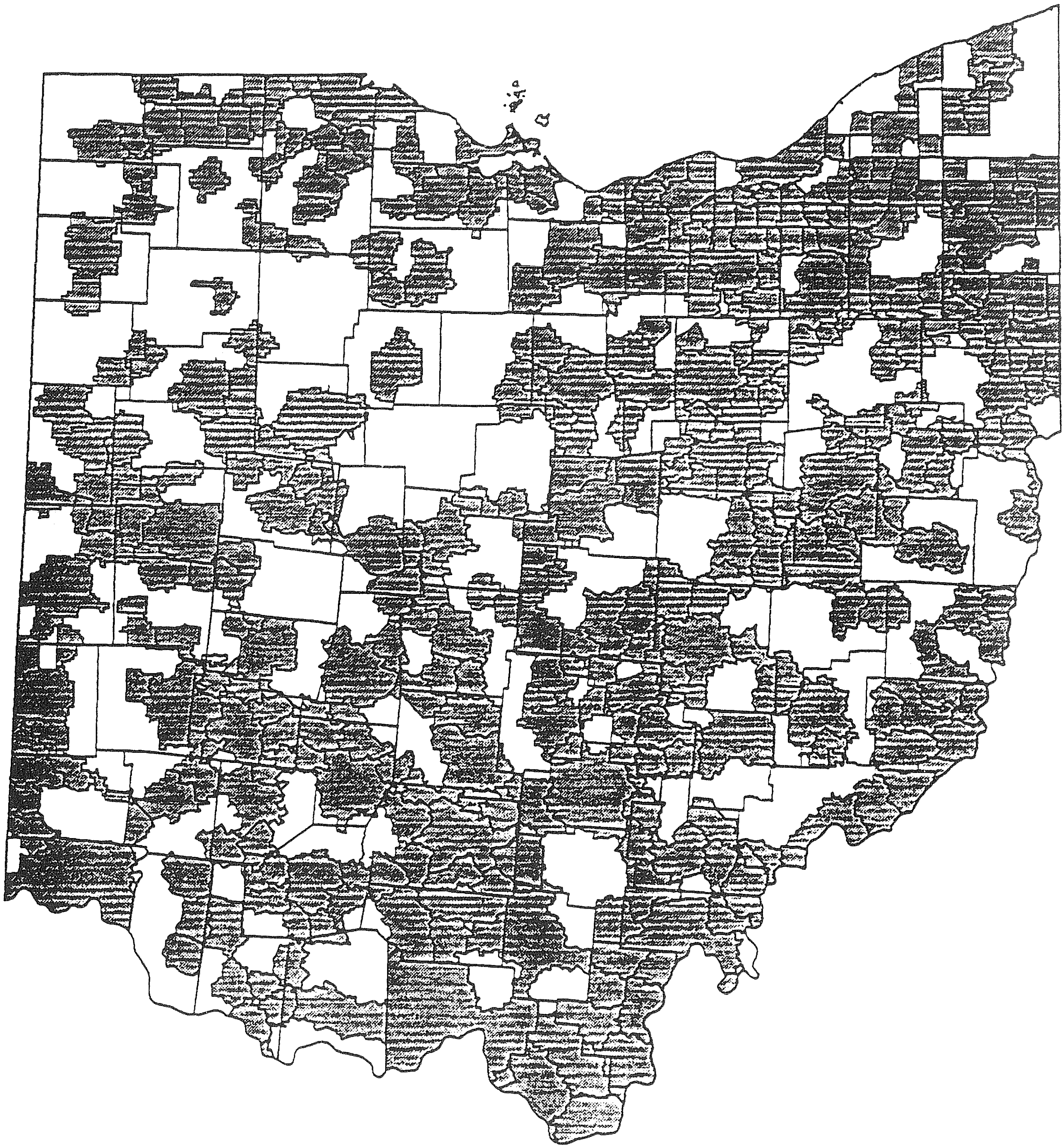


Figure 7. Sample representation of exchanges offering a particular type of service.

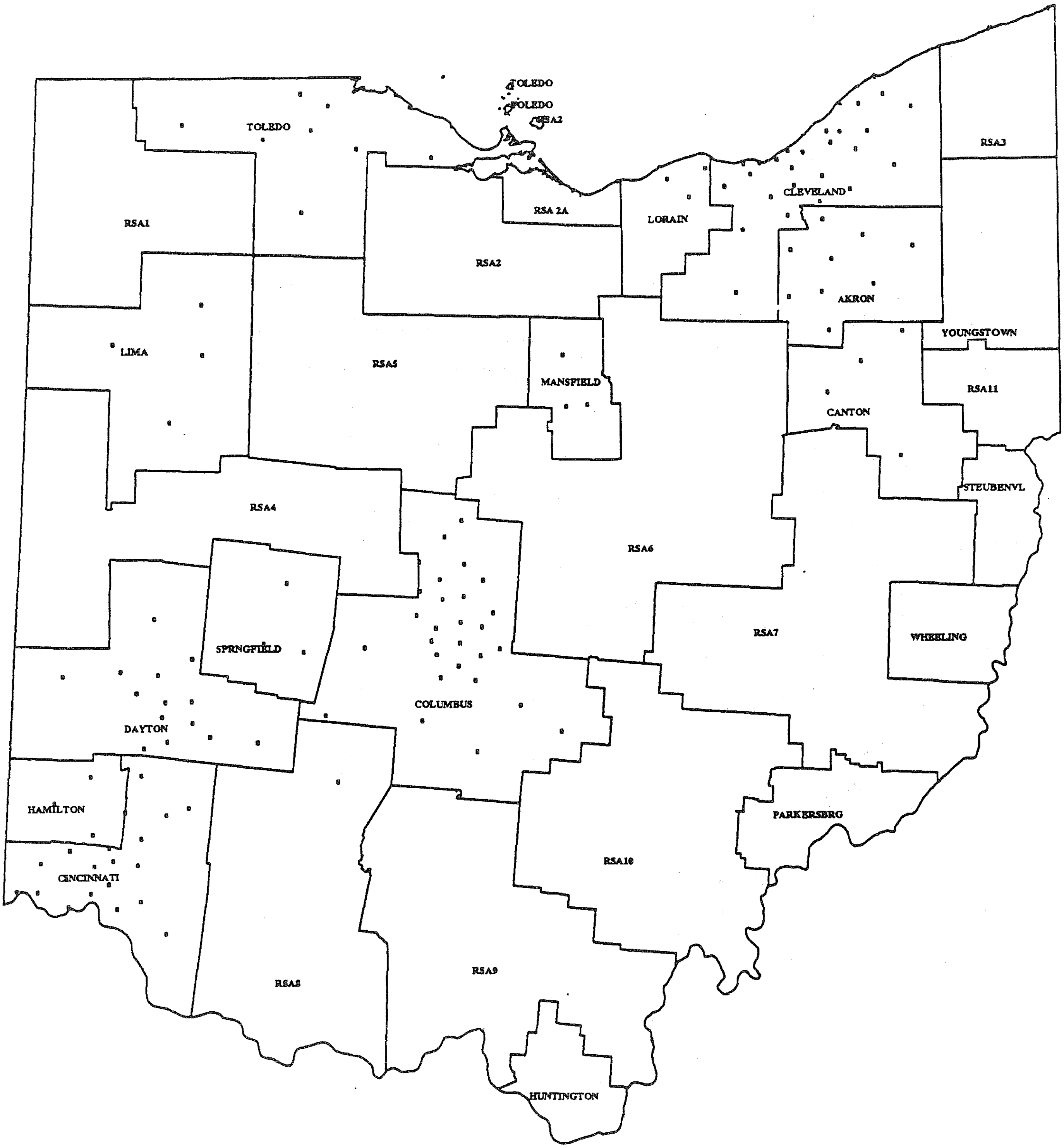
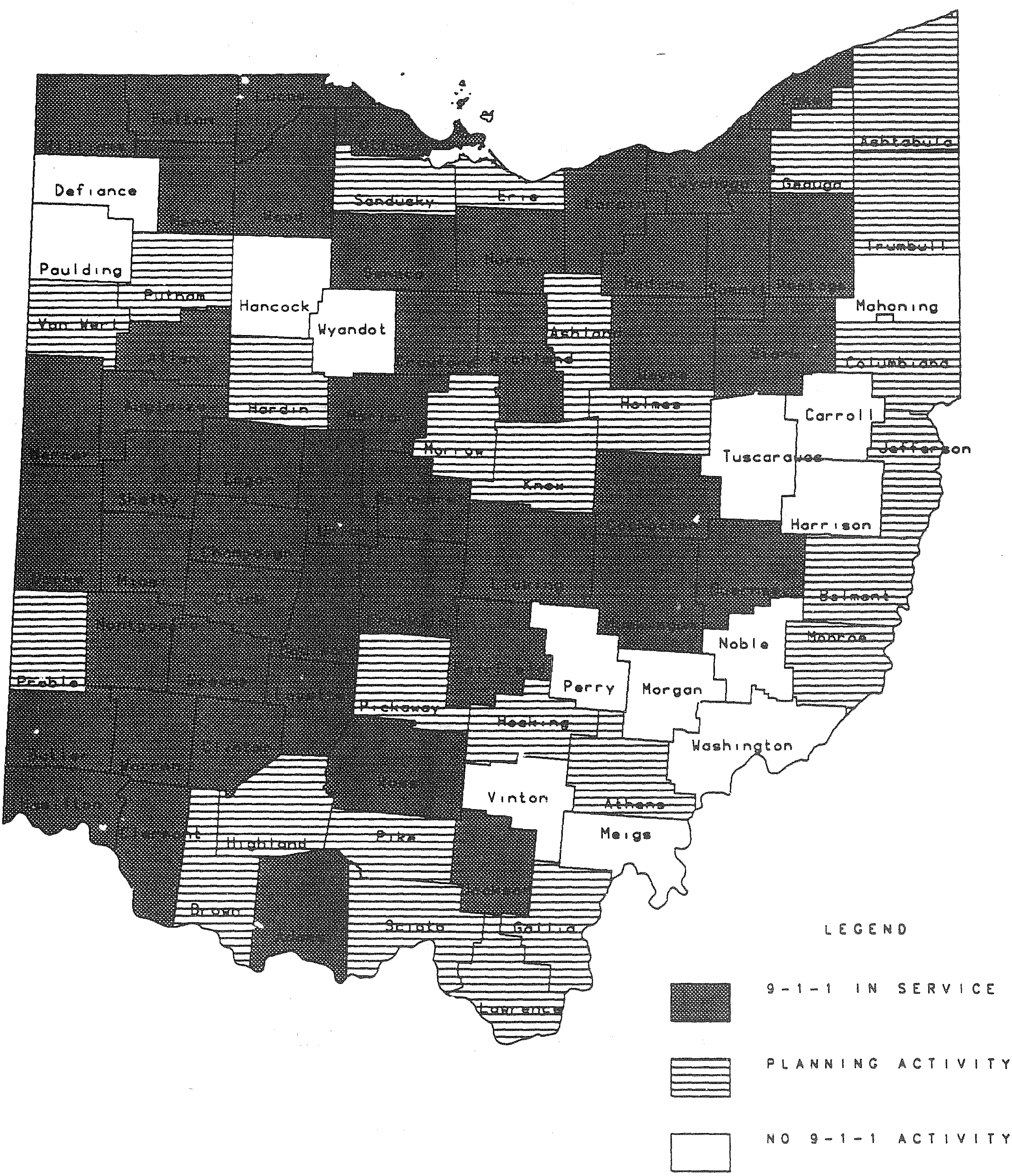


Figure 8. **CELLULAR SERVICE AREAS IN OHIO**

Gene O. Johnson James E. Reinoehl Thomas J. Baird

Figure 9. OHIO 9-1-1 SERVICE

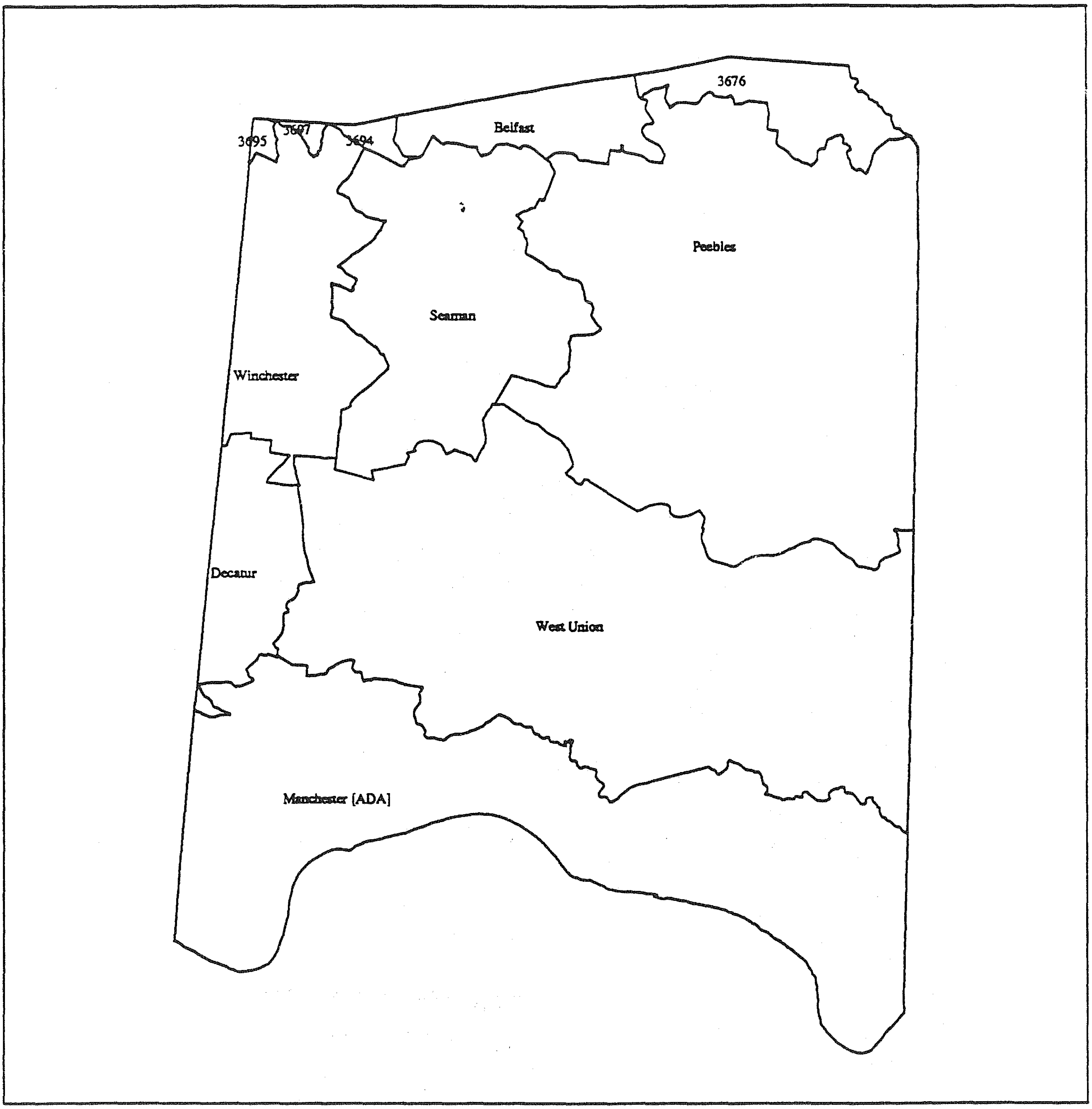
(July 1992)



jer

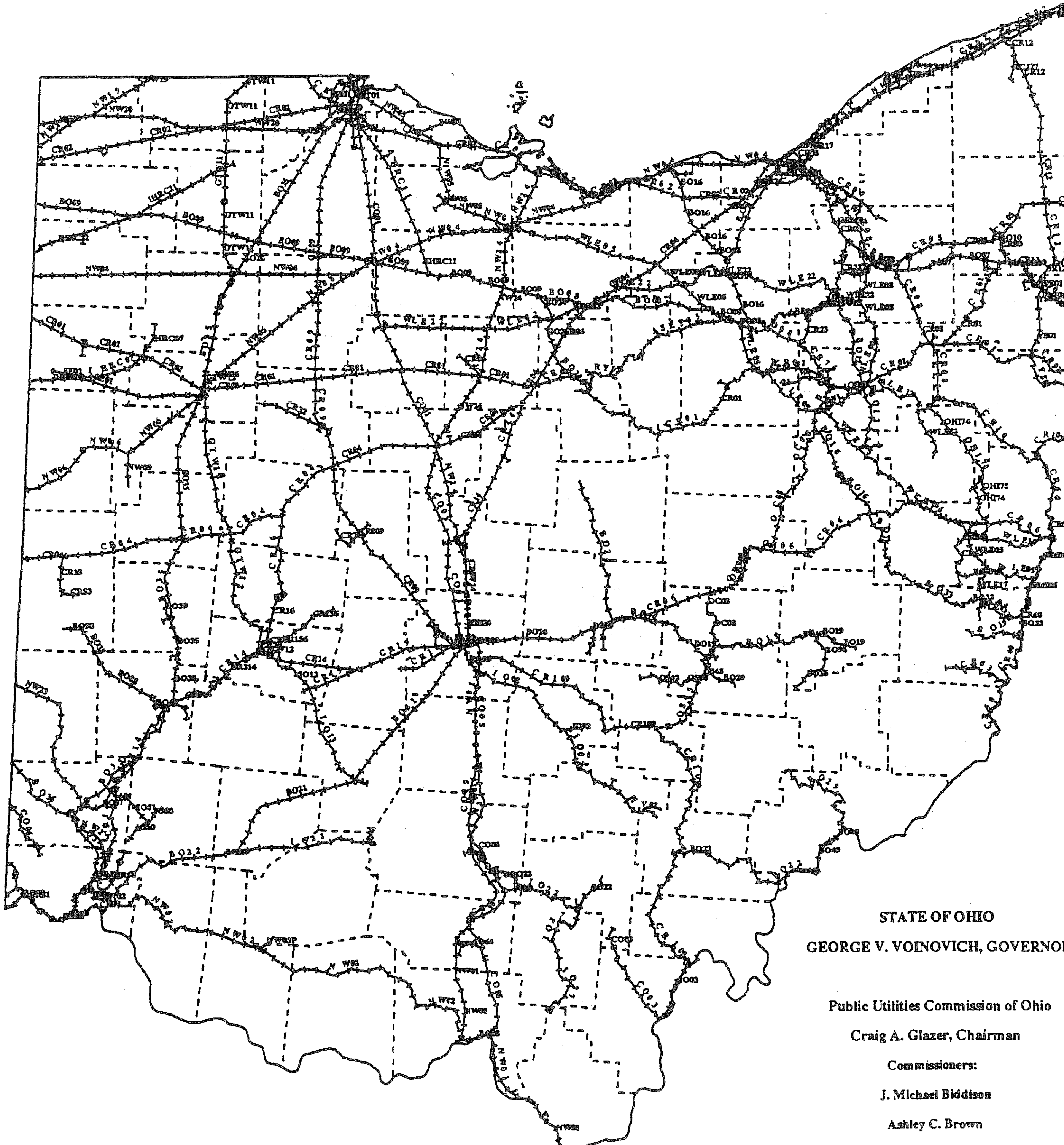
Figure 10.

Adams County Telephone Exchanges



3676 Sinking Spring
3694 Sugar Tree Ridge
3695 Mowrystown
3697 Sugar Tree Ridge

Figure 11. 40-mile-diameter service areas of one pager in Ohio



STATE OF OHIO

GEORGE V. VOINOVICH, GOVERNOR

Public Utilities Commission of Ohio

Craig A. Glazer, Chairman

Commissioners:

J. Michael Biddison

Ashley C. Brown

Jolynn Barry Butler

Richard M. Fanelly

Figure 12. **RAILROAD LINES IN OHIO**

Gene O. Johnson   James E. Reinoehl   Thomas J. Baird

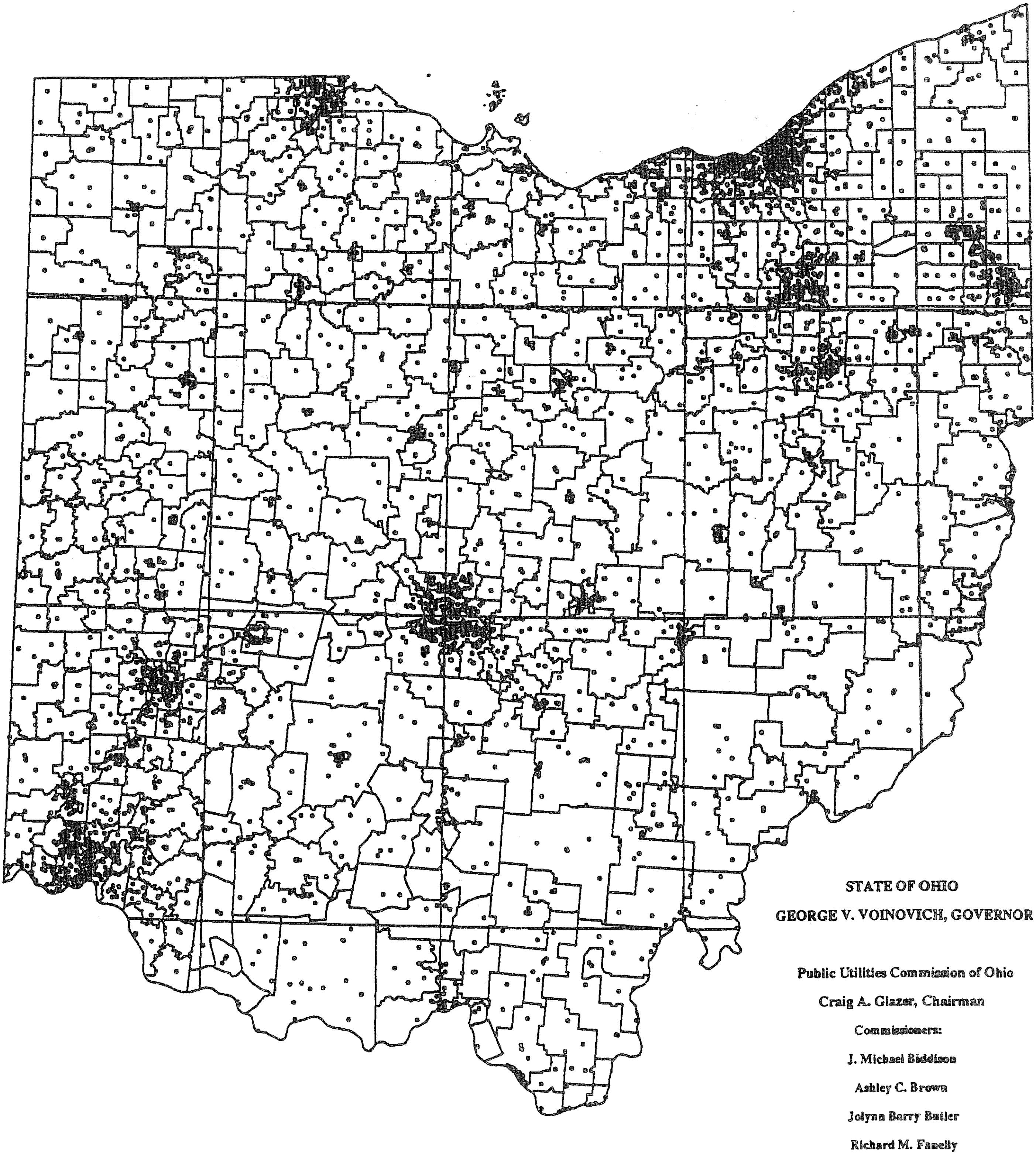


Figure 13. **PUBLIC SCHOOLS AND SCHOOL DISTRICTS IN OHIO**

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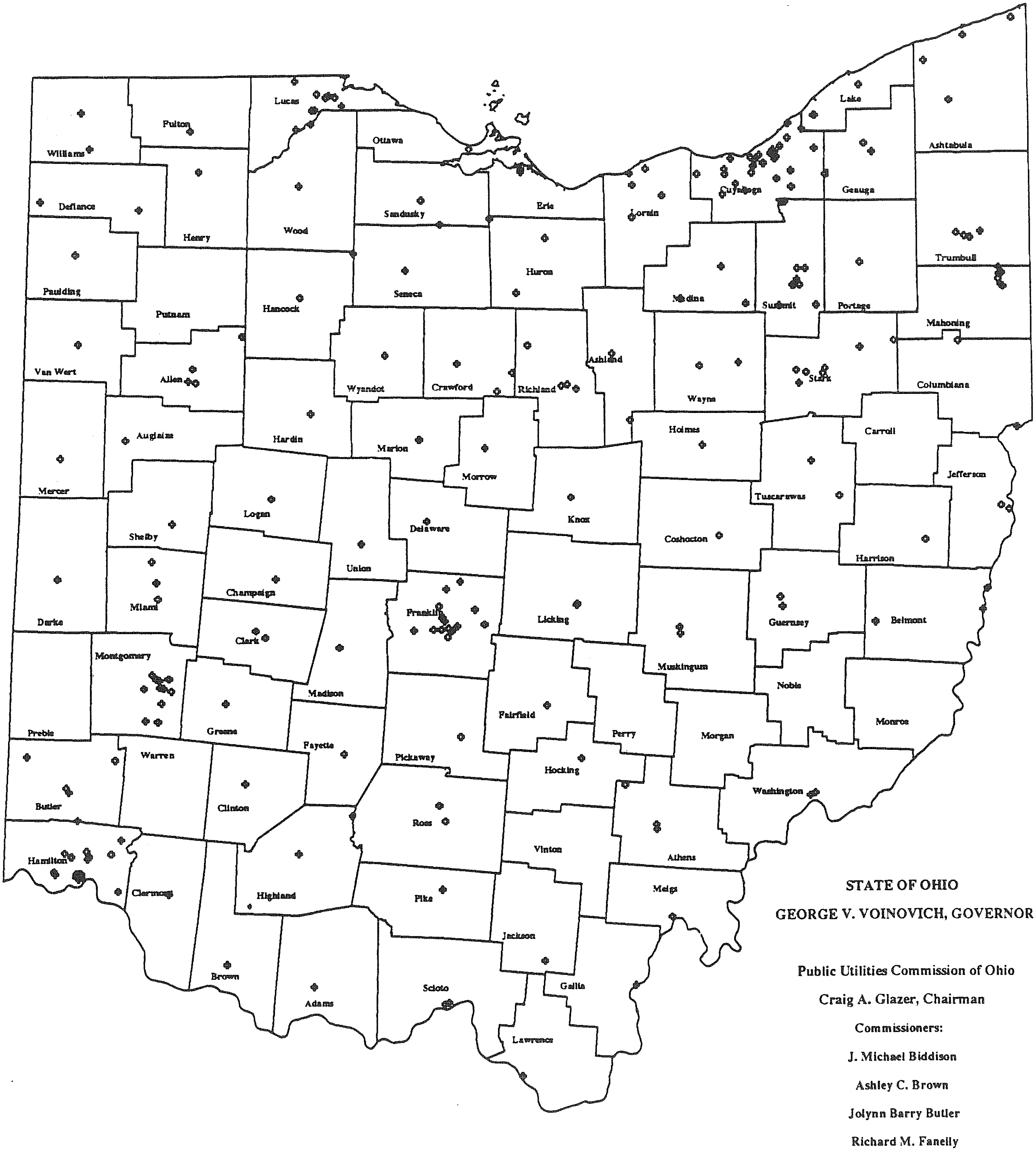

Figure 14. **LOCATIONS OF HOSPITALS IN OHIO**

Gene O. Johnson James E. Reinoehl Thomas J. Baird

Regulatory Geographic Information for The Public Utilities Commission of Ohio

by
Gene O. Johnson, P.E.G.
Phone (614) 466-9162
Computer Mapping Section

Public Utilities Commission of Ohio
180 E. Broad St. Columbus, Ohio 43266-0573

The **Computer Mapping Section** of the **Forecasting Division** has developed **regulatory-geographic data bases** of the various utilities in the State of Ohio. These data bases represent the authentic boundaries and locations of those **utilities** and their **infrastructure**. This regulatory data base and the technology to create, process, and display these utility functions enable the **Commission** to graphically **analyze, review, monitor, and critique the prudence** of numerous factors of **Ohio's utilities.**

The **Ohio Revised Code 4935** et. seq. requires the **Commission** to **monitor** factors and trends which significantly affect **energy** consumption, demand, conservation, cost, and needs throughout the State. The Commission is also to **maintain** an effective **program** for the collection, verification, and analysis of those **energy data** with internal validation procedures for the verification of the accuracy of the information received. In addition, the Commission is to prepare for several levels of **energy emergency** conditions if critical shortages or interruptions of the supply of electric power, natural gas, coal, or individual petroleum fuels occur to the citizens of Ohio. During such an emergency, the **equitable distribution of energy** to all geographic regions of the State shall be encouraged by the Commission.

The **Computer Mapping Section** is **dedicated** to fulfilling those requirements by actively creating three (3) functions of utility analysis. The section is developing (1) the Ohio Joint Utility Mapping Program, **OJUMP**, where all the regulated utilities in Ohio will be identified by an authentic graphic data base as well as the **Census**; (2) An Energy Geographic Information System, **AEGIS**, will be established where the regulated Ohio utilities will be graphically linked and compatible with the PUCO - OJUMP data bases for regulatory interaction, and (3) an **electronic and technical interchange** between the **Utilities and the Commission** for regulatory procedures.

By 1995 most of these function will be operational.

These **data bases** and **geographic displays** are significant in the understanding rate structure, regional regulations, and the results from alternative forms of regional regulation. Combined with the U.S. Census data on fuels and telephones, the utility impacts and regulatory functions are better understood by both the citizens and the regulators.

The **Ohio Joint Utility Mapping Program (OJUMP)** is a computer based geographic information system (GIS) designed to catalogue, process, plot, and display the **energy distribution networks of Ohio**. The system is based on the digital Cartesian location in Universal Transverse Mercator (UTM) coordinates of the regulated utility systems in Ohio in the ARC/INFO - GIS. The **certified service areas** and **energy line network** are included as polygon and polyline data bases in the OJUMP system. The polygons of the regulated service areas of electric and phone utilities display the geographic location and areal distribution of each regulated company for phone and electric service. The gas, electric, and phone line data include **origin, transmission, and distribution lines** of the regulated industries in Ohio as well as the **stations, plants, control and distribution points** within those systems.
The **data base** is created in **three phases**: (1) The location information of each utility line or area is **graphically transferred** from the utility's engineering plan sheets or maps to **U.S. Geological Survey 7.5 minute quadrangles** at a scale of 1:24,000. This universal reference base map is graphically delineated with the ground location of the energy lines, stations, areas, as well as the company or regulatory designation codes; (2) The information is **electronically digitized** into UTM coordinates for all the tangent segments of the energy systems and the perimeters of the polygon areas; (3) The digital data are **plotted** at a check scale and returned to the utility company for verification of content and accuracy. Corrections and additions are integrated at this time.

The final geographic data base is **used** in **forecast analysis and emergency preparedness**. From these data, efficiency of the line utilization can be evaluated, strategic planning, utility system support of computer forecast development can be projected as well as power wheeling, state energy transportation programs, and computer modeling of utility rate systems. This cooperative data gathering and usage effort has developed the Joint Utility Mapping Program at the Public Utilities Commission of Ohio.

The **OJUMP** system is utilized by the PUCO to support the public utility **regulatory activities** at the Commission. At present, the GIS data bases and hardcopy output have been used to analyze the rate structure of Ohio Electric Utilities as well as the geographic distribution of electric service. The PUCO map of the Service Areas of Ohio Electric Utilities was instrumental in refuting the testimony of one of Ohio's major gas companies in a recent rate increase case. The testimony stated that differential gas customer rates over Ohio were necessary to compete in the energy market with the electric companies. The gas rate areas were plotted over the electric service map. This geographic display demonstrated that not only electric company boundaries were bisected by the gas rate areas but the lowest priced electricity was in the highest gas rate area. The rate increase failed.

The use of the **OJUMP geographic information system** has given the PUCO an ability to display the relationship of the utilities and the services to the citizens of Ohio. The Commission can also analyze the relationships between the various abstract and vague aspects of its regulatory responsibilities by using GIS displays. With these GIS tools, **fair and equitable decisions** can be made for the protection and trust of the **citizens, industries, and aesthetics of Ohio.**

The **ARC/INFO GIS program** operating in a **MicroVAX II** with a Tektronix 4125 graphics terminal and 4958 digitizer is used to digitize, edit, compose, and print the various utility coverages of the State of Ohio. Approximately 240 square miles are digitized with each "tile" of four 7.5 minute quadrangles. Each one of these tiles has nine (9) control points for accuracy verification within the GIS program. The total error expressed as root mean square (RMS) for the 9 control points of each tile is usually 8 to 10 meters. The two man digitizing team has averaged 16.2 tiles per month for 11 coverages of Ohio. The complete digitization of 11 coverages for Ohio requires approximately 225 uninterrupted days of digitizing. The accuracy of the total state coverage in area was 41260.9 square miles or 99.9948 percent of the 41,263.03 square miles accepted by the Auditor of the State of Ohio.

1990 CENSUS FOR UTILITY REGULATION

The **United States Census for 1990** is now available. The Census is composed of two forms (1) **TIGER*** and (2) **statistical summaries** of the population. The TIGER files are the geographic locations of the census features i.e. blocks, block groups, tracts, places, townships, or counties. The statistical summaries are tables in the form spread sheet information attached to those geographic locations.

* **TIGER** = Topographic Integrated Geographic Encoding and Referencing.

The **Ohio Census for 1990** is on the Ohio Department of Development computer system at the Ohio Data Users Center and on CDROM disks. The Commission, through the Computer Mapping Section of the Forecasting Division, has access to the Ohio Data Network (ODN) and these data bases. All the Census data is **directly compatible** and **convertible into ARC/INFO** geographic information system at the Commission.

The **Computer Mapping Section** has begun the conversion of these data and the compilation of the TIGER geography for each census tract of Ohio. The subject content of the statistical tables are coded as follows for Population and Housing :

100 PERCENT COMPONENT OF 1990 CENSUS

STF 1

POPULATION TABLES by Spread Sheet Items

P1 Persons, P2 Families, P3 Households, P4 Urban and Rural, P5 Sex, P6 Race, P7 Race (geographic origin), P8 Persons of Hispanic Origin, P9 Hispanic Origin P10 Hispanic Origin by Race, P11 Age, P12 Race by Sex by Age, P13 Sex by Age, P14 Sex by Marital Status, P15 Household Type and Relationship, P16 Household Size and Household type, P17 Persons in Families, P17A Persons Per Family, P18 Age of Household Members by Household Type, P19 Race of Householder by Household Type, P20 Household Type, P21 Household Type and Relationship, P22 Relationship and Age, P23 Household Type and Relationship, P24 Age of Household Members by Household Size and Household Type, P25 Age of Household Members by Household Size and Household Type, P26 Household Type, P27 Household Type and Household Size, P28 Group Quarters, P29 Persons Substituted, P30 Imputation of Population Items, P31 Imputation of Relationship, P32 Imputation of Sex, P33 Imputation of Age, P34 Imputation of Race, P35 Imputation of Hispanic Origin, P36 Imputation of Marital Status.

HOUSING TABLES by Spread Sheet Items

H1 Housing Units, H2 Occupancy Status, H3 Tenure, H4 Urban or Rural, H5 Vacancy Status, H6 Boarded-Up Status, H7 Usual Home Elsewhere, H8 Race of Householder, H9 Tenure by Race of Householder, H10 Hispanic Origin of

Householder by Race of Householder, H11 Tenure by Race of Householder, H12 Tenure by Age of Householder, H13 Rooms, H14 Aggregate Rooms, H15 Aggregate Rooms by Tenure, H16 Aggregate Rooms by Vacancy Status, H17 Persons in Unit, H17A persons per Occupied Housing Unit, H18 Tenure by Persons in Unit, H18A Persons per Occupied Housing Unit by Tenure, H19 Aggregate Persons, H20 Aggregate Persons by Tenure, H21 Persons per Room, H22 Tenure by Persons per Room, H23 Value, H23A Lower Value Quartile, H23B Median Value, H23C Upper Value Quartile, H24 Aggregate Value, H25 Race of Householder, H26 Aggregate Value by Race of Householder, H27 Hispanic Origin of Householder, H28 Aggregate Value by Hispanic Origin of Householder, H29 Aggregate Value by Units in Structure, H30 Vacancy Status, H31 Aggregate Price Asked, H32 Contract Rent, H32A Lower Contract Rent Quartile, H32B Median Contract Rent, H32C Upper Contract Rent Quartile, H33 Aggregate Contract Rent, H34 Race of Householder, H35 Aggregate Contract Rent by Race of Householder, H36 Hispanic Origin of Householder, H37 Aggregate Contract Rent by Hispanic Origin of Householder, H38 Aggregate Rent Asked, H39 Age of Householder by Meals Included in Rent, H40 Vacancy Status by Duration of Vacancy, H41 Units in Structure, H42 Units in Structure, H43 Tenure by Units in Structure, H44 Tenure by Units in Structure, H45 Housing Units Substituted, H46 Imputation of Housing Items, H47 Imputation of Vacancy Status, H48 Imputation of Duration of Vacancy, H49 Imputation of Units in Structure, H50 Imputation of Rooms, H51 Imputation of Tenure, H52 Imputation of Value, H53 Imputation of Price Asked, H54 Imputation of Contract Rent, H55 Imputation of Meals Included in Rent.

These data are **presently available** from ODN and CDROM. All these spread sheet items are from the data collected on the U.S. Census short form filled out by 100 percent of the responding citizens. These data represent the **100 PERCENT COMPONENT** of the Census.

The 1990 Census also contained a **Census "Long Form"** sent to a **sample component** of the U.S. Population. In rural areas, every other person (50 percent) was sent the long form. In urban areas, one in six (16.6 percent) was sent the long form. The SAMPLE COMPONENT was as follows:

SAMPLE COMPONENT OF THE 1990 CENSUS (Long Form)

STF 3

POPULATION TABLES by Spread Sheet Item

P1 Persons, P2 Unwieghted Sample Count of Persons, P3 100 Percent Count of Persons, P3a Percent of Persons in

Sample, P4 Families, P5 Households, P6 Urban or Rural, P7 Sex, P8 Race, P9 Race - detailed, P10 Persons of Hispanic Origin, P11 Hispanic Origin, P12 Hispanic Origin by Race, P13 Age, P14 Race by Sex by Age, P15 Sex by Age, P16 Persons in Household, P17 Household Type and Relationship, P18 Household Type and Relationship P19 Household Type and Presence and Age of Children, P20 Race of Householder, P21 Household Type and Presence and Age of Children, P22 Family Type and Presence, P23 Family Type and Age of Children, P24 Household Type by Age of Householder, P25 Subfamily Type and Presence and Age of Children, P26 Subfamily Type and Relationship, P27 Sex by Marital Status, P28 Age by Language Spoken at Home and Ability to Speak English, P29 Household Language and Linguistic Isolation, P30 Age, Language Spoken At Home and Linguistic Isolation, P31 Language Spoken at Home, P32 Ancestry (percent), P33 Ancestry - first, P34 Ancestry - second, P35 Ancestry - pure, P36 Year of Entry, P37 Age by Citizenship, P38 Marital Status, P39 Aggregate Number of Children, P40 Group Quarters, P41 Group Quarters by Age, P42 Place of Birth, P43 Residence in 1985 - state and county, P44 Residence in 1985 - MSA/PMSA Level, P45 Place of Work - State and county, P46 Place of Work - place level, P47 Place of Work - MSA/PMSA, P48 Place of Work - minor civil division, P49 Means of Transportation,

P50 Travel Time to Work, P51 Aggregate Travel Time to Work, P52 Time Leaving Home to Go to Work, P53 Private Vehicle Occupancy, P54 School Enrollment and Type of School, P55 Race by School Enrollment and Type of School, P56 School Enrollment and Type of School, P57 Educational Attainment, P58 Race by Educational Attainment, P59 Educational Attainment, P60 Educational Attainment, P61 School Enrollment, Educational Attainment and Employment Status, P62 Race by School Enrollement, P63 School Enrollment, Educational Attainment, and Employment Status, P64 Sex by Age, by Veteran Status, P65 Period of Military Service, P66 Sex by Age by Work Disability Status and Employment Status, P67 Sex by Age by Mobility Limitation Status by Employment Status, P68 Sex by Age by Work Disability Status by Mobility and Self-Care Limitation Status, P69 Sex by Age by Mobility and Self Care Limitation Status, P70 Sex by Employment Status, P71 Race by Sex by Employment Status, P72 Sex by Employment Status, P73 Presence and Age of Children and Employment Status, P74 Presence and Age of Children by Employment Status of Parents, P75 Sex by Work Status in 1989, P76 Sex by Work Status in 1989 - Usual Hours Worked Per Week in 1989 and Weeks Worked in 1989, P77 Industry, P78 Occupation, P79 Class of Worker, P80 Household Income in 1989, P80a Median Household Income in 1989, P81 Aggregate Household Income in 1989, P82 Race of Householder by Household

Income in 1989, P82 Household Income in 1989 - Hispanic, P84 Aggregate Household Income in 1989 by race of householder, P85 Aggregate Household Income in 1989, P86 Age of Householder by Income, P87 Race of Householder by Age by Income, P88 Age of Householder by Income, P89 Earnings in 1989, P90 Wage of Salary Income in 1989, P91 Nonfarm Self-Employment Income in 1989, P92 Farm Self-Employment Income in 1989, P93 Interest, Dividend, or Net Rental Income in 1989, P94 Social Security Income in 1989, P95 Public Assistance Income in 1989, P96 Retirement Income in 1989, P97 Other Type of Income in 1989, P98 Aggregate Wage or Salary Income in 1989, P99 Aggregate Nonfarm Self-Employment Income in 1989,

P100 Aggregate Farm Self-Employment Income in 1989, P101 Aggegate Interest, Dividend, or Net Rental Income in 1989, P102 Aggregate Social Security Income in 1989, P103 Aggregate Public Assistance Income in 1989, P104 Aggregate Retirement Income in 1989, P105 Aggregate Other Type of Income in 1989, P106 Aggregate Persons in Household by Public Assistance Income in 1989 by Age, P107 Family Income in 1989, P107a Median Family Income in 1989, P108 Aggregate Family Income in 1989, P109 Aggreate Family Income in 1989 by Family Type and Presence and Age of Children, P110 Nonfamily Household Income in 1989, P110a Median Nonfamily Household Income in 1989, P111 Aggregate Nonfamily Household Income in 1989, P112 Workers in Family in 1989, P113 Aggregate Family Income in 1989 by Workers in Family in 1989, P114 Aggregate Income in 1989 by Group Quarters, P114a Per Capita Income in 1989, P114b Per Capita Income in 1989 by Group Quarters, P115 Aggregate Income in 1989 by Race, P115a Per Capita Income in 1989 by Race, P116 Aggregate Income in 1989, P116a Per Capita Income in 1989, P117 Poverty Status in 1989 by Age, P118 Poverty Status in 1989 by Sex by Age, P119 Poverty Status in 1989 by Race and by Age, P120 Poverty Status in 1989 by Age, P121 Ratio of Income in 1989 to Poverty Level, P122 Poverty Status in 1989 by Age by Household Type and Relationship, P123 Poverty Status in 1989 by Family Type and Presence and Age of Children, P124 Poverty Status in 1989 by Race, P125 Poverty Status in 1989 by Family Type and Presence and Age of Children, P126 Poverty Status in 1989 by Family Type and Age, P127 Poverty Status in 1989 by Age of Householder Type, P128 Imputation of Population Items, P129 Imputation of Relationship, P130 Imputation by Sex, P131 Imputation by Age, P132 Imputation by Race, P133 Imputation by Martial Status, P134 Imputation of Hispanic Origin, P135 Imputation of Group, P136 Imputation of Place of Birth, P137 Imputation of Citizenship, P138 Imputation of Year of Entry, P139 Imputation of School Enrollement, P140 Imputation of Educational Attainment, P141 Imputation of Educational Attainment, P142 Imputation of Ancestry, P143 Imputation of Mobility Status, P144 Imputation of Residence in 1985, P145 Imputation of Language Status, P146 Imputation of Language Spoken At Home, P147 Imputation of Ability to Speak English, P148 Imputation of Veteran Status, P149 Imputation of Period of Military Service,

P150 Imputation of Work Disability Status, P151 Imputation of Mobility Limitation Status, P152 Imputation of Self-Care Limitation Status, P153 Imputation of Children Ever Born, P154 Imputation of Place of Work, P155 Imputation of Means of Transportation to Work, P156 Imputation of Private Vehicle Occupancy, P157 Imputation of Time Leaving Home to Go to Work, P158 Imputation of Travel Time to Work, P159 Imputation of Employment Status, P160 Imputation of Work Status in 1989, P161 Imputation of Usual Hours Worked Per Week in 1989, P162 Imputation of Weeks Worked in 1989, P163 Imputation of Industry, P164 Imputation of Occupation, P165 Imputation of Class of Worker, P166 Imputation of Income in 1989, P167 Imputation of Household Income in 1989, P168 Imputation of Family Income in 1989, P169 Imputation of Nonfamily Household Income in 1989, P170 Imputation of Poverty Status in 1989.

HOUSING TABLES by Spread Sheet Item

H1 Housing Units, H2 Unweighted Sample Count of Housing Units, H3 100-Percent Count of Housing Units, H3a Percent of Housing Units in Sample, H4 Occupancy Status, H5 Urban and Rural, H6 Condominium Status by Vacancy Status, H7 Condominium Status by Tenure and Mortgage Status, H8 Tenure, H9 Race of Householder, H10 Tenure by Race of Householder, H11 Hispanic Origin of Householder by Race of Householder, H12 Tenure by Race of Householder, H13 Tenure by Age of Householder, H14 Tenure by Race of Householder, H15 Tenure, H16 Rooms, H17 Aggregate Rooms, H18 Tenure by Persons in Unit, H19 Aggregate Persons by Tenure, H20 Units in Structure, H21 Units in Structure- Vacant, H22 Tenure by Units in Structure, H23 Source of Water, H24 Sewage Disposal, H25 Year Structure Built, H25a Median Year Structure Built, H26 Year Structure Built, H27 Tenure by Year Structure Built, H28 Year Household Moved Into Unit, H29 Tenure by Year Householder Moved into Unit, H30 House Heating Fuel, H31 Bedrooms, H32 Bedrooms - vacant, H33 Tenure by Bedrooms, H34 Bedrooms by Gross Rent, H35 Tenure by Telephone in Housing Unit, H36 Age of Householder by Telephone in Housing Unit, H37 Tenure by Vehicles Available, H38 Aggregate Vehicles, H39 Race of Householder by Vehicles Available, H40 Vehicles Available, H41 Age of Householder by Vehicles Available, H42 Kitchen Facilities, H43 Gross Rent, H43a Median

Gross Rent, H44 Aggregate Gross Rent, H45 Race of Householder by Gross Rent, H46 Hispanic Origin by Gross Rent, H47 Meals Included in Rent, H48 Aggregate Gross Rent by Meals Included in Rent, H49 Inclusion of Utilities in Rent,

H50 Household Income in 1989 by Gross Rent as a Percentage of Household Income in 1989, H50a Median Gross Rent As a Percentage of Household Income in 1989, H51 Age of Householder by Gross Rent as a Percentage of Household Income in 1989, H52 Mortgage Status and Selected Monthly Owner Costs, H52a Median Selected Monthly Owner Costs and Mortgage Status, H53 Aggregate Selected Monthly Owner Costs by Mortgage Status, H54 Race of Householder by Mortgage Status and Selected Monthly Owner Costs, H55 Mortgage Status and Selected Monthly Owner Costs, H56 Aggregate Selected Monthly Owner Costs by Mortgage Status, H57 Aggregate Selected Monthly Owner Costs by Mortgage Status, H58 Mortgage Status by Selected Monthly Owner Costs as a Percentage of Household Income in 1989, H58a Median Selected Monthly Ower Costs as a Percentage of Household Income in 1989 by Mortgage Status, H59 Household Income in 1989 by Selected Monthly Owner Costs as a Percentage of Household Income in 1989, H60 Age of Householder by Selected Monthly Costs as a Percentage of Household Income in 1989, H61 Value, H61a Median Value, H62 Aggregate Value by Mortgage Status, H63 Aggregate Household Income in 1989 by Tenure and Mortgage Status, H64 Plumbing Facilities, H65 Plumbing Facilities - vacant, H66 Race of Householder by Plumbing Facilities, H67 Plumbing Facilities - Hispanic, H68 Age of Householder by Plumbing Facilities, H69 Tenure by Plumbing Facilities by Persons per Room, H70 Plumbing Facilities by Units in Structure, H71 Plumbing Facilities by Persons per Room by Year Structure Built, H72 Imputation of Housing Items, H73 Imputation of Condominium Status, H74 Imputation of Plumbing Facilities, H75 Imputation of Source of Water, H76 Imputation of Sewage Disposal, H77 Imputation of Year Structure Built, H78 Imputation of Year Householder Moved into Unit, H79 Imputation of House Heating Fuel, H80 Imputation of Kitchen Facilities, H81 Imputation of Bedrooms, H82 Imputation of Telephone in Housing Unit, H83 Imputation of Vehicles, H84 Imputation of Mortgage Status, H85 Imputation of Tenure, H86 Imputation of Vacancy Status, H87 Imputation of Rooms, H88 Imputation of Units in Structure, H89 Imputation of Value, H90 Imputation of Meals Included in Rent, H91 Imputation of Gross Rent, H92 Imputation of Mortgage Status.

These data compose the Table 1 and the Table 3 spread sheet data headers for the 1990 Census data for Ohio.

FORCASTING ANALYSIS OF CENSUS DATA

For the **1990 Census**, the U.S. Census Bureau made available digital map data, the TIGER files, along with the numerical results of the census. A CD-ROM containing all the Tiger files for Ohio was borrowed from the Center for Mapping at OSU. This data was used to **extract** a complete coverage of Ohio using **census tracts and block numbering** areas. This coverage makes possible the application of **polygon overlay analysis** to utility service areas in Ohio.

The 8 maps attached show the **electric service area boundaries** superimposed on the **1990 census tracts**. ARC/INFO's polygon overlay facilities were used to calculate combined service area/census tract polygons. Statistics for the census tracts were combined to produce **summary statistics** for the service areas. A similar analysis was performed for the **Ohio telephone utilities.**

Forecasting Division, expressed interest in the calculation of **service area populations**. This section uses a model developed by John Scarry in the early 1980's to calculate service area populations from county data. For the analysis, the first three variables on the short form were used- persons, families, and households. Results for total persons are compared with results from the Scarry model.

In the analysis, **populations** for all census tracts lying completely within the service area are simply **added up**. If a census tract is **split** by a service area boundary, the population is **weighted** by the area ratio.

The first attached table shows **population figures by electric utility and county**. The number of persons is also shown as a fraction of the total county population, since these are the coefficients used in the Forecasting model. These numbers are then summed over counties to get figures for the service areas. The population distribution **differs** significantly from the **Scarry model**.

The data have been **verified** by **summing** population figures over company. This gives a set of county populations which can be compared with known values. This procedure caught a number of errors, which were corrected. The final **error** is less than **one percent** for each of the 88 counties in Ohio.

This analysis was repeated for the telephone service areas, and the resulting spreadsheet is attached.

Most of the work done in this **calculation is saved** on the computer and will not need to be repeated to calculate **other census statistics.**

AEGIS - An Energy Geographic Information System

The Public Utilities Commission of Ohio (PUCO) has made available to the various utilities of the state a **personal computer** (PC) based **geographic information system**. This program is called PCMAPS and has been developed in the Forecasting Division of the PUCO for the **AEGIS Program. PCMAPS** is now available for testing by the various Ohio utilities interested in geographic information systems applications.

The **PCMAPS** program is offered at no charge to the Ohio utilities for **Beta Testing** of the program. Each interested utility will use the program to test the program functions, displays, and output in a production environment. Problems and suggestions for improvements under this Beta testing will be relayed to the PUCO Forecasting Division for modification of the program.

PCMAPS is an MS-DOS system running under **Microsoft(R) Windows(TM)** graphical environment - version 2 or 3. The personal computer should have a hard disk drive with more than 5 megabytes of storage and a color video display with enhanced graphics adapter (EGA) capability or better. **Printers** for hard copy output can be **dot matrix or laser** for paper map production from this geographic information system (GIS).

The **data bases** in this GIS presently include two levels of data resolution for graphics display. The **high resolution** data bases include the County/Township, Telephone Service Areas, and Electric Service Areas of Ohio derived from the 787 USGS quadrangle maps at 1:24,000 scale. These data bases have a precision of one centimeter and a ground accuracy of 10 meters.

Other data bases in PCMAPS include (1) the electric transmission lines and substations, (2) the gas transmission lines and stations, (3) state, federal, and interstate highways, and (4) rivers, lakes, and water ways. These data bases have **less resolution** and lower ground accuracy.

Documentation of the PCMAPS program in the form of a users manual will be included with each program package.

PCMAPS and these data bases are offered to the **Ohio utilities** as an **introduction to AEGIS** as well as a test of the program. Future goals for the development of this system include electronic exchange of regulatory information and graphic display of utility functions and relationships.

Utility managers and professionals interested in providing the PUCO with a Beta Testing site for PCMAPS can contact the Forecasting Division or the Ohio Power Siting Board for a copy of the program and users manual.

CONCLUSIONS

These **data bases** and geographic displays are significant in the understanding of geographically based regulatory features. It serves as a check to utility based statistics as well as a **dynamic tool** for monotoring population shifts and rate impact. Combined with the U.S. Census data on fuels and telephones, the utility impacts and **requlatory functions** are **better understood** by both the citizens and the regulators.

DISCLAIMER

The contents of this text reflect the views of the author, who is responsible for the facts and accuracy of the data presented. The contents do not necessarily reflect the official views or policies of the Public Utilities Commission of Ohio. This text does not constitute a standard, specification, or regulation.
Gene O. Johnson, Research Administrator.

THE PHONE MAP - 1992

by
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The **736 local telephone exchanges** in Ohio have been composed as an ARC/INFO electronic data base from the **map files** and **tariff records** at the **Public Utilities Commission of Ohio**. This **state-wide** data base **coverage** includes the exchange boundaries, the internal rate areas by exchange, the wire centers, the affiliated telephone company, and the name of the exchange. The area code, the local access transport area (LATA), and cellular service areas were also composed as coverages of the **telecommunications systems of Ohio**. These coverages were transcribed into PostScript(R) graphics language to produce a **1:500,000 scale color map** of the exchanges, rate areas, and phone companies with legend as well as four (4) 1:2,000,000 scale color maps of Ohio telecommunications systems.

The **Ohio Revised Code 4905.13** as amplified by Ohio Administrative Code 4901:1-3-03 established the zones of operation or service areas of **Ohio telephone** exchanges. The telephone companies agreed to the **boundaries** of these **exchanges by mutual consent**. Each exchange was defined by a 1:24,000 scale map (one inch equals 2000 ft.) and signed copies were supplied to the Commission for reference. The OAC stipulates the boundary will follow natural features or highways. In the case of highways, the boundary will be 150 feet off the centerline of the road to include all those subscribers on both sides of the road in one phone exchange.

The **telephone exchange/rate area boundaries** were **converted** from the 2000 foot per inch map image **to electronic data base** by digitizing the boundary lines (arcs) into UTM cartesian coordinates and joining with the edge of the composite quadrangles. A circle of 0.075 inches was used on the digitizing cross hairs of the "puck" for the 150 foot offset for the highway boundary to create true ground coordinates of the regulated boundary.

The **wire centers** or switch locations were derived from the vertical and horizontal (V&H) coordinates supplied by the utilities. Overlaps and voids in service were noted as certain boundaries of the exchange maps did not agree or had a registered overlap with their neighbor.

The **primary objective** of the Phone Map project was the development of an **electronic data base** to **display** an authentic representation of the local exchange **telephone utilities** of Ohio for regulatory analysis. However, a hard copy display for public use was an added option to the electronic data base.

The primary hard copy **map** was selected at a **scale of 1:500,000** - a standard wall size map of the **State of Ohio**. This map displays the local area **telephone exchanges** and differential **rate areas** that were color coded for each of the **44 telephone companies of Ohio**. Additional maps at a Scale of 1:2,000,000 were generated to display the Area Codes, the LATAs, and ancillary exchanges as well as the Cellular Service Areas of Ohio.

DIGITIZING MAPS TO DATA

The **ARC/INFO GIS** program operating in a **MicroVAX II** with a **Tektronix 4125 graphics terminal and 4958 digitizer** is used to digitize, edit, compose, and print the various utility coverages of the State of Ohio. Approximately **240 square miles** are digitized with each **"tile"** of four 7.5 minute quadrangles. Each one of these tiles has nine (9) control points for accuracy verification within the GIS program. The total error expressed as root mean square (RMS) for the 9 control points of each tile is usually 8 to 10 meters.

Eleven coverages were dititized during the **Phone Map Project**. These were (1) Phone Exchange Boundaries, (2) Phone Rate Boundaries, (3) School District Boundaries, (4) Public Schools, (5) Universities, (6) Interstate, Federal and State Highways, (7) Railroads, (8) Public Railroad Crossings, (9) County Court Houses, (10) Hospitals, (11) Phone Wire Centers.

The two man digitizing team has averaged **16.2 tiles per month for 11 coverages of Ohio.** The complete digitization of 11 coverages for Ohio requires approximately **225 uninterrupted days** of digitizing. The **accuracy** of the total state coverage in area was 41260.9 square miles or **99.9948 percent** of the 41,263.03 square miles accepted by the Auditor of the State of Ohio.

Tiles of **four 7.5 minute quadrangle maps** were positioned on the digitizing surface. This 15 minute block of data was digitize in one set up using this technique. Time required for the set up of this four quad block is five (5) minutes. Each corner and edge is matched as an overlay to the neighbor.

Preparing these maps for digitizing typically takes about **45 minutes** to transcribe the exchange and rate boundaries as well as additional data onto the formatted

7.5 minute quadrangles.

Entering point labels is proportional to the number of point included in the complexity of the topology. A technique was developed to **pre-enter the labels** in an INFO files which speeds up the actual digitizing process and assists in determining the identifier points in each 15 minute (4 - 7.5 minute) quadrangle set up. Labels for lines and polygons are entered in similar INFO files on a VT100 terminal as that topology is being digitized on the Tektronix terminal. These labels are attached using the **JOINITEM command** of ARC/INFO to the appropriate points, lines, and polygons at the time of digitizing.

The actual digitizing process in ARC/INFO begins by creating a **coverage** called **STDUTM** and inputting the appropriate UTM numbers for the **nine control points**. This is the STDUTM.TIC file. This process takes 6 to 7 minutes. During the next 5 minutes, a coverage called **SDTDIG** is created in ARC/INFO and coordinated with the digitizer to match the physical locations of the nine corners with their corresponding **TIC-IDs**. The coverage STDDIG is transformed from machine coordinates to the UTM coordinates of the **SDTUTM**. A second set of TIC-IDs matches the corner location with the UTM numbers that were previously entered in the STDUTM.TIC file. The digitizer commonly matches the TIC locations with an **Root Mean Square error of between 8 to 12 meters** in UTM coordinates: Best match achieved has been an individual error of x=0.066 and y=-0.291 meters.

The **SDTUTM coverage** is then **replicated** to five working coverages: **Cover A** is created for entering point data; **Cover B**, for line data; **Cover C**, for school district boundary polygons; and **Cover D**, for phone rate zone polygons. A fifth coverage was generated for providing a standard perimeter of the two polygon coverages and for future digitizing projects. These preliminary efforts required 20 minutes per set up. By creating the **"standard" coverages**, subsequent digitizing efforts will require only about 5 minutes to begin.

The **point data** were digitized on **Cover A** in the order that their labels were pre-entered in the INFO file. That file is displayed in the VT100 screen for reference. Digitizing times varied depending on density of points. Urban areas required as much as an hour. Rural areas as little as a few minutes. The average time per set up was approximately 18 minutes for digitizing the point area.

The **line data** were digitized on **Cover B** and consisted of roads and railroads. Their labels were entered into an INFO file on the VT100 terminal simultaneously as the line were being digitized. This line data coverage required 20 minutes digitizing time with data entry.

The **polygon coverages** were digitized on **Covers C and D**. A border line, perimeter of the set up, was digitized with points at each corner and every 2.5 minute (longitude and latitude) break. Points were also established at each of the polygon contact points with the set up border. This served as a controlled tie point for the digitized arc during the next stage. The polygon border line setup required approximately 8 minutes including the computer replication of the coverage for Covers C and D.

Cover C was the **school district boundaries**. Time to digitize and label this coverage required 10 to 15 minutes. These boundaries were usually less complex and more geographically tied to simple boundaries.

Cover D was the **phone exchange and rate boundaries**. Time to digitize and label this coverage required 30 to 40 minutes per set up. The rate zone areas subdivided the exchange polygons and the labels were coded to facilitate the merging of these features. Cover D was the complex exchange rate areas that merged to form **Cover E - the exchange area**. This process was designed at the set up format but was performed on the 64 quadrangle "Block" of merged phone rate area quadrangles. This facilitated the edit and the computer time for dissolving the rate zone boundaries to exchange boundaries.

Editing the raw digitized data was a necessary process. The **"BUILDING"** of a four quadrangle set up required approximately 20 minutes for the polygon coverages (Covers C and D). Excess features in the digital data base are called **"dangles"** in the computer graphics jargon. These dangles were manually removed by computer editing/operator interface to clean and refine the digitized polygon coverage. When all dangles were cleaned from the coverage, the ARC/INFO building process was invoked.

Building the points, line, and polygon coverages as well as joining the appropriate labels was the **last step** in the **digitizing process**. The graphic files were joined with the label files. Covers A were joined with the .PAT files (Point Attribute Table). Covers B were joined with the .AAT files (Arc Attribute Table). The Covers C and D were joined with the .PAT (Polygon Attribute Table). These steps were performed while maps were being prepared for the next set up or while workers were at lunch. The times for building and joining four coverages of a set up averaged 16 to 30 minutes. The time spread was a function of the ARC/INFO subdirectory load. This was recognized during the process, and individual "BLOCK" subdirectories were developed for each one degree by one degree area consisting of 16 set ups of four (4) 7.5 minute quadrangles.

After the **four coverages were built**, an **edit** was performed by plotting the output on a laser printer. The data was still fresh in the operators mind and resources and the corrections were easily facilitated. This required five minutes per set up. It also served as a moment to admire one's work.

The **total time spent** actually digitizing one set up ranged from 2 to 4 hours. The average was close to 3 hours. Thus a 2 person team would need approximately 4 months to digitize the entire **43,263.03 square miles** of Ohio per coverage. A full time programmer was also needed to code, process and edit the files in the mainframe computer. In addition a part time effort is needed to prepare the maps and research the various sources of the geographic data. **10 person months,** uninterrupted, are needed to digitize the entire state of Ohio. Multiple coverages can increase productivity per digitizing session.

In a **professional office environment**, the distractions, interruptions, and unexpected **delays** while digitizing process in being performed increased the total time for development of a state wide coverage. Disruptions added one hour per set up. Visitors, phone calls, meetings, office events are all part of the technical production environment.

PRINTING THE PHONE MAP

The **ARC/INFO data base** for the PUCO coverage entitled "Service Areas of Ohio Local Exchange Telephone Utilities" was generated into **four (4) Postscript(R)** for **CMYK process printing.** The black file (K) occupied 3.5 megabytes and displayed the outline as follows: (1) phone service areas in 0.007 inch lines, (2) phone rate areas as 0.002 lines, (3) rate zones A,B,& C etc. in gray tones of 10, 20, and 30 percent. The Cyan, Magenta, and Yellow files occupied 0.5 megabytes were defined in the percentage gray tone for each of the 44 Ohio Telephone Companies from the Pantone(R) Process Color Imaging Guide.

Custom patterns were designed in ARC/INFO and converted to Postscript(R) to **graphically differentiate** special-associated **phone companies**. The degree angles for optimum process printing were set in Postscript(R) as C = 15, M = 75, Y = 0, and K = 45. An additional coverage of the county/township lines was developed for an overprint in Watkins Y R6 K4 medium brown for geopolitical reference. Each coverage was registered by four ARC/INFO symbols located outside the Ohio boundary.

The **final map** was designed to be approximately 36 inches by 48 inches and include a legend of the **44 telephone companies in Ohio**. However, no large format electronic photo-type setters were available to produce printing-plate negatives of that size. A reverse image photo enlargement technology was developed to create the necessary transparencies for process color printing.

The data bases were transferred to the **Linotronic 300** in 1.44 Mb 3.5 inch diskettes via a MS-DOS personal computer. The files were composed and executed to **display** the highest resolution of the original files with a weed tolerance of 1/400 of an inch. This weed tolerance permitted the maximum photo resolution of 1/300th of an inch in the Linotronic with a 25 percent higher graphics control per pixel. The image was transmitted as a scale to fit command for the 11 X 17 inch Fugi HENE (helium/neon laser) film. The high resolution setting for the Linotronic 300 of 2590 pixels per inch was used to expose the film. An emulsion down - positive transparency of each of the **color separates** was exposed in the Linotronic 300.

The **positive transparencies** of the color separates were photo enlarged to create the **printing plate negatives** for process color printing. The printer utilized the ARC/INFO registration marks to establish the printing registration marks in the cropping area beyond the neat map.

1400 copies will be **printed** of this 44 color map displaying Ohio Telephone Utilities and the 736 local exchange telephone areas with rate zones.

2000 copies of the 1:2,000,000 scale map (8.5 X 11 inches) were published.

CONCLUSIONS

The **Phone Map** was developed using **geographic information system technology** to transcribe the regulatory data into a electronic digital data base. The effort to create the initial data base was extensive although accurate to 99.9948 percent. This **complete data base** of the local telephone exchanges' service areas, the individual rate areas, the wire centers as well as the ancillary coverages will be **used numerous times** in the future for precise regulatory analysis of the telecommunication utilities of Ohio. Each additional use will only require a **brief processing** to analyze, display, and resolve regulatory proceedures at the Commission. The "hard copy" paper Phone Map is an artifact of the time it was printed. The **electronic data base** will be **dynamic** with time for each Ruling and Order by the Public Utilities Commission of Ohio.

Disclaimer

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The Virtual Computer: A New Paradigm for Educational Computing

by

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INTRODUCTION

At a recent seminar with a group of North Carolina secondary school math and science teachers, we presented the following for their consideration:

> What if we were able to provide every student and teacher, whether at home or at school, continuous access to a system of modern, networked personal computers for the duration of their educational experience from kindergarten to college at a reasonable cost?
>
> This system would:
>
> - Provide access to state-of-the-art, personal computers from all vendors.
> - Run all current and future personal computer software.
> - Support full multimedia computing: text, graphics, sound, video.
> - Provide graduates fully trained on the actual computers used in business.
> - Allow sharing of specialized, expensive computers among schools.
> - Provide complete teacher control of student access and software availability.
> - Be immune to software piracy.
> - Deliver distance learning to housebound students.

The question we posed to them was: "If we could create such a system, would it be worth doing?" Not surprisingly, the consensus of the group was that such a system would be desirable and could truly enhance the effectiveness of math and science teaching, as well as benefit many other aspects of primary and secondary education.

This article will show that by coupling the current telephone network with several new technologies which were not available even one year ago, we could build such a system. This system, termed virtual personal computing, could become a new paradigm for educational computing. This could be the most cost-effective way to provide state-of-the-art, networked, personal computing to every student and teacher in the country as the key to meeting our national education goals as articulated in the nation's America 2000 vision [1].

BACKGROUND

As we look forward to a world in which economic competition in a global marketplace is rapidly replacing large-scale military confrontation, it is apparent that the ability of a country to master advanced technologies and systems will be the key factor in determining its global competitiveness. Of the technologies to be mastered, the computer is paramount since it is the critical component in designing, manufacturing, controlling, organizing, and monitoring the most complex systems

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1 America 2000: An Education Strategy, U.S. Department of Education, Washington, DC, 1991, p. 35.

mankind has created. These systems encompass automated manufacturing, telecommunications, air transportation, environmental monitoring, and national defense.

The computer in industrialized society will fulfill at least three roles. The first will be as a critical component of complex systems. The second will be as a tool for the creation, dissemination, and management of the enormous quantity of information that is a part of an advanced industrialized society. To succeed in these two roles, society must master both the application and the technology of the computer. This will require that most individuals in society be capable of effectively using computers in the workplace, that some individuals become experts in developing new applications, and that a few individuals completely master the technology and guide its evolution.

The third role of the computer will be as a device to assist in the education of the populace in an economy aspiring to world leadership. Beyond its obvious role in educational administration, the computer can be a powerful tool to facilitate learning and motivate students. In a recent article, Apple Computer Fellow Alan Kay, based on his experience in the experimental, computerized Open School in Los Angeles, described the benefits of having networked computing technology accessible to teachers and students . These benefits included the ability of the computer to *become* any and all existing media, to show information from different perspectives, to deliver simulations that can portray and test conflicting theories, and to become a universal library granting access to information and computational resources wherever they exist in the network [1]. Merely granting computer access to teachers and students will not unlock these benefits or save a poorly designed curriculum. From the same article, "computers in the open school are not rescuing the school from a weak curriculum, any more than putting a piano in every classroom would rescue a flawed music program...But once the teachers and children are enfranchised as explorers, computers, like pianos, can serve as powerful amplifiers, extending the reach and depth of the learners."

By far the most promising benefit of networked computers for education lies in extending the network to include access to computing from the homes of teachers and students. This would address head-on one of the most difficult roadblocks to educational improvement - the fact that students in the United States spend some 91% of their first eighteen years outside of school [2]. Non-classroom access to a significant learning tool would be especially important in the case of disadvantaged students, where the home environment has neither the facilities nor the nurturing environment needed for student motivation. For such students, access to a personal computer in the home away from the censure of their peers could provide a powerful alternative to entertainment television or the street.

If students had home access to personal computers integrated into the curriculum and linked to the schools' library resources, they would be able to extend their classroom exposure by repeating lessons missed in class, retrying simulation-based "lab experiments", and preparing homework using the computer for library access, word processing, drawing, music study, and computation. The fact that each student had access to the same computer facility and library materials would be a major step forward in equalizing the home learning environment for all students. The home time available to students during each week of the school year could easily equal the time spent in the classroom. During the summer vacation, the same computer facility would be available for educational gaming, electronic mail, summer projects, and adult literacy or other training programs.

In the state of Indiana, a project called the Buddy System was started in 1987 to provide elementary school students with home computers and modems to be used for homework, electronic mail and database access. With funding provided from both private and public sources,

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1 Kay, A. Computers, Networks, and Education, *Scientific American,* September 1991.

2 America 2000: An Education Strategy, U.S. Department of Education, Washington, DC, 1991, p. 10.

the project has a goal of ultimately providing a computer for every student's home in Indiana for grades four through 12. In an assessment of the system, 95% of educators said that "students using the system demonstrate more self-reliance, higher self-esteem, and greater pride in their work" [1].

An educational infrastructure in which every student and teacher has access to state-of -the-art, networked computing from kindergarten to college would have several benefits beyond the enhancement of learning, motivation and self-esteem. Since the computer would be used in all aspects of the educational process, graduates would enter the workforce with 12 or more years of intensive application experience, much of it on the same computers and software used in business, with the obvious benefits to their employers. Some students would have gone beyond the application of the computer in day-to-day work, to the development of new applications and application software. Others, their interest stimulated in the computer itself, would become the computer scientists responsible for advancing computing technology to the next plateau. As for the teachers, they would have the opportunity to develop new computer-based teaching aids that could then be sold back into the system for use by others, creating an opportunity for excellent teachers to receive additional compensation for their efforts.

An important aspect of a universally available educational computer would be the potential to uncover the best computing talent the country has to offer, as students take the computer to the limits of its capabilities in applications and programming. Through the same process of natural selection which has been so effective in generating the tens of thousands of programs for today's personal computer users, programs would be developed by both students and teachers that would be fed back into the system to enhance the education of the next generation of student. Teachers, who had been through the system as students, would pass on their inherited experience to the next generation of students, thus providing positive feedback that would continually improve the system.

If the goal of developing a computer-based educational infrastructure for all students is valid as the key to reaching our national educational goals, the next steps are to achieve consensus on its requirements, determine the most cost effective means of deployment, and test its validity in the field. The remainder of this article will postulate what the requirements of this infrastructure should be, and will introduce a new paradigm for educational computing that could be field-tested as early as 1993.

EDUCATIONAL COMPUTING INFRASTRUCTURE REQUIREMENTS

Establishment of some level of consensus on the requirements for a new educational computing infrastructure is the essential first step in choosing the appropriate system design. One view of these requirements is outlined below, together with the rationale for each requirement.

1. **Provide teacher and student access at home or in school to a range of modern computers from multiple vendors that would include the major personal computers used in the workplace.**

   If students are to leave school competent in the use of the computers and software used in the workplace, they should use the same computers and software during their schooling. Today, there is a tendency for industry to donate obsolete computers to schools thus ensuring obsolete computing knowledge on the part of students. Many of these computers are condemned to running only old, unsupported software.

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1 Eng, P. (Ed) The Password is H-O-O-S-I-E-R, *Business Week,* July 29, 1991.

As outlined earlier, providing computing access from both home and school is possibly the most significant benefit of a new educational computing infrastructure in that it motivates students and extends the hours of student exposure to a learning environment.

The multivendor requirement recognizes the multivendor reality of the workplace, stimulates competition between vendors to constantly improve their offerings, and allows teachers to select the best platform to use for specific topics. Although most of the computers used in the workplace and schools are personal computers, there are occasions when access to networked supercomputers or specialized workstations might be appropriate.

2. **Deliver personal computing capable of supporting all current and future personal computer software with full multimedia capability, including the retrieval of stored video.**

The amount and variety of software available for modern personal ccmputers is enormous. This software is constantly being improved by the hundreds of individuals and companies involved in its creation. It is important that, over time, the investment in the infrastructure not be negated by new software that is incompatible with the existing installed base of computers.

The multimedia capability, which implies the manipulation and display of video stills, sound, and full-motion video, is important because of the increasing use of this capability in stimulating learning, and its expected role in the future workplace [1]. Retrieving video is important both for access to educational information, and for viewing recorded lectures that a student might have missed.

Audio storage and manipulation would be invaluable for language and music study. In language study, students could record language exercises, attach them to their written homework and submit them as a multimedia document to the teacher for correction.

3. **Allow sharing of specialized or costly computers and software among schools.**

For some learning situations, such as computer-aided design, data visualization, 3-D graphics, and modelling, expensive computers or software are often required. Rather than denying access to these facilities for students working in these areas, it would be preferable to share the facilities across many schools to achieve an acceptable level of utilization.

4. **Provide teacher control over the set of applications available to students**

Without some way for teachers to control the domain of software available to students, problems arising from software misuse or incompatibility could plague the system. Access to games with little redeeming educational value could prove too tempting for students trying to complete their assignments. Hopefully, this control would not extend to the point where motivated students would be barred from progressing beyond the class level on their own initiative. Access to specialized applications would have to be controlled to ensure availability for those students needing these applications in their course work.

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1 With the Apple Macintosh and the IBM-compatible computers, the capability to store, manipulate and process video is provided by plug-in circuit cards from a variety of manufacturers. In the case of the Commodore Amiga, much of this capability is built-in.

5. Be immune to software piracy

Software piracy is a significant problem in personal computing, since it denies software developers legitimate revenues which could lead to the elimination of high-value software for education. A fair return on investment is essential if software developers are to continually improve their products.

6. Deliver distance learning to housebound students

Due to illness, physical disabilities, or inclement weather, some students would benefit from being able to participate in classes via one-way video teleconferencing using the computer facility at home as the teleconferencing interface. The same facility could be used for teacher / parent conferences between the school and home.

7. Use a communication link that co-exists transparently with the telephone in the home and operates on the same loop

Since a second telephone loop cannot be guaranteed in the homes of all students, it is important that student computer access use the same loop as the home's main-line phone service. Use of the loop for computer access should have no effect on the use of the telephone so that computer sessions spanning several hours could take place.

8. Minimize the need for students to back up their data, manage their own application library, or use floppy disks

One of the nightmares of personal computer users is the loss of many hours of labor due to computer malfunction or finger trouble. This would be especially troublesome where computers are used for the preparation of assignments and study material. It would be highly desirable that the system automatically back up data and provide an "undo" or recovery path.

The management of libraries of applications would be a real problem if students had to carry them between home and school on floppy disks and had to perform their own system upgrades. If upgrades were the responsibility of individual students, it would not take long for compatibility problems to arise.

Rather than depending on floppy disks for exchanging data, it would be preferable to have centralized, secure files accessible to all users from both school and home.

9. Provide networking within and between schools at all levels

One of the benefits of a computer-based educational infrastructure is that all users can be linked in networks spanning individual schools, in networks linking schools at different levels, or in other states or countries, and in networks linking schools and industry. Within a school, networking would be used for electronic mail, distribution and collection of homework, parent-to-teacher communication, access to library material, and collaboration among students.

Between schools, networking could be used for shared library or computer access, to allow advanced high school students to link to universities facilities, or for distant learning where one specialist could teach simultaneously in several schools via teleconferencing. Links between industry would be valuable at the high school or university level for students working on joint projects with industry.

With global networking the possibility exists for computer mediated links between students in different countries. As language translation technology improves in the future, the possibility will exist for students to communicate with foreign students via computer translated electronic mail thereby enhancing student global awareness.

10. Minimize the investment exposed to theft or damage

A practical reality of deploying costly computer facilities in the home is the potential for theft or damage, especially with computers incorporating hard disk storage. If the requirement to provide access to modern, multimedia computers is upheld, an alternative must be found to placing costly multimedia computers in the home, where they would be exposed to theft or damage.

11. Cost-effectiveness

Even without the current state budget crises, any investment in improving education must be as cost-effective as possible. Providing computer access for all students at home will not be cheap no matter how it is done. The system design should strive for high utilization of the expensive system components through sharing, and minimization of the re-investment brought on by the rapid obsolescence of computing technology.

Because of the reduced expenditure for industry in providing on-the-job computer training, some form of industry subsidy in creating and sustaining the infrastructure could be appropriate. The Buddy System in Indiana, funded jointly by business, foundations and government agencies is an example of such an approach [1].

The next section will outline the concept of virtual personal computing which could potentially satisfy all of the above requirements. The key technology needed for its implementation is Bellcore's recently proposed Asymmetric Digital Subscriber Line (ADSL) [2,3]. The proposed capability of ADSL is to deliver a data bit stream of 1.5 Mbit/s *toward* the home and a 16 kbps transmission path *from* the home on the existing telephone line along with regular phone service.

THE VIRTUAL PERSONAL COMPUTER

The basic concept of a virtual personal computer or virtual PC is to place the human interface of a personal computer near the user, and use a communication link to connect this interface to a distant personal computer processing unit. In general, this human interface consists of the display, keyboard, microphone, loudspeaker, and mouse or other tracking device. The essential difference between this approach and conventional multi-access computing or time-sharing is that here the user is connected to personal computer that is dedicated to the user for the duration of his or her session. Ideally, the functionality and performance of a virtual personal computer should be identical to that of a real personal computer connected to a local area network.

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1 Eng, P. (Ed) The Password is H-O-O-S-I-E-R, *Business Week,* July 29, 1991.

2 Bellcore, Request for Information: Asymmetrical Digital Subscriber Line (ADSL) Systems That Support Simplex High-bit-rate Access and POTS in the Copper Loop Plant, RFI 91-04, June 1991.

3 Anderson, M. VCR Quality Video at 1.5 Mbps , *Proceedings of the National Communications Forum,* October 1990.

In the home application of the virtual PC, the computer video and audio would be delivered downstream *from* a personal computer *to* the user using the 1.5 Mbps downstream path of ADSL, and the keyboard or microphone input would be delivered upstream *from* the user *to* the computer on the 16 kbps upstream path of ADSL. The regular phone service to the home would be unaffected.

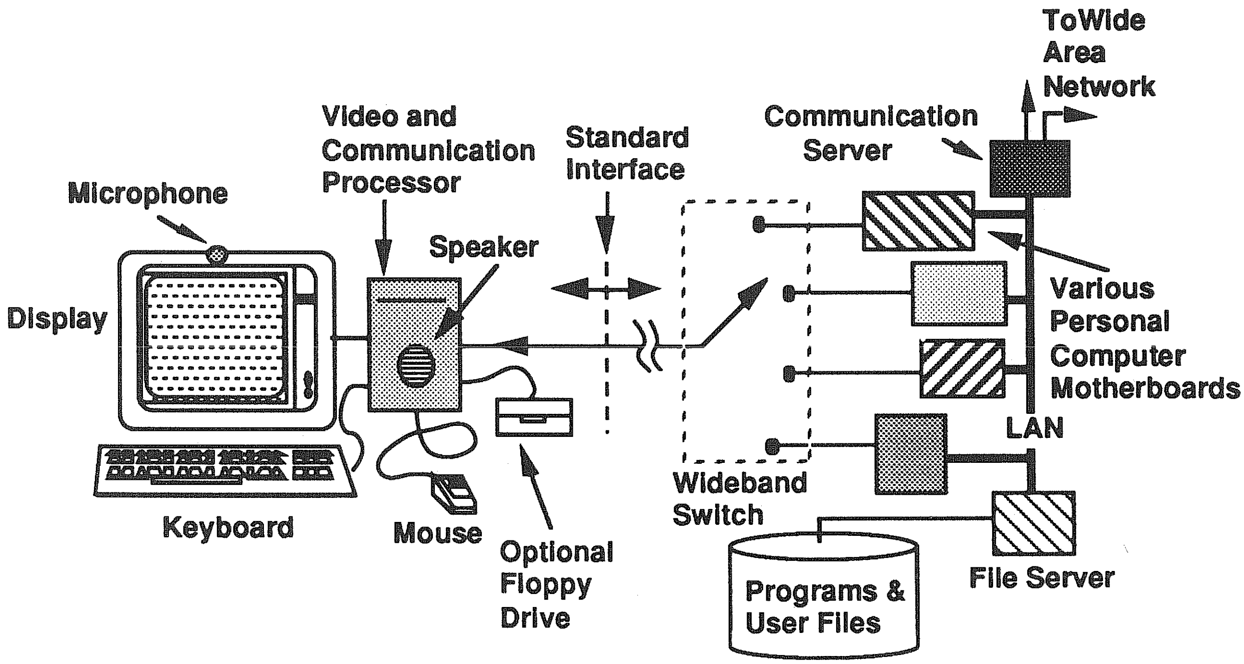

***Figure 1*: Virtual Personal Computer Concept**

The virtual PC concept is shown diagrammatically in figure 1. To use a virtual PC, the user would "dial" through a wideband (1.5 Mbps) switch and be connected to the actual motherboard of a personal computer via a video compression interface. These motherboards, each equipped with random access memory (RAM), would rack-mounted and linked to a common power supply and high-speed local area network (LAN). All application and user files would be stored on large file-servers ranging from RAM-based storage for application programs and operating system software, through conventional large hard disks, to optical storage devices for library and multimedia material. Communication servers and bridges would connect the virtual PC LAN to other rack-mounted systems or to other networks. The interface between the video compression device on the motherboard and the human interface in the home would be based on a standard, vendor-independent interface that would include decoding for compressed, real-time computer display data, decoding for stored video access (MPEG), and real-time video decoding for distant learning or teleconferencing (Px64) [1].

Figure 2 illustrates two schools in a district accessing virtual computing provided by a centralized shared facilities center. This center is, in turn, connected to similar centers in other districts. The personal computer motherboards are shared between schools, and between users at home, through the switching function of the wideband switch.

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1 Magel, M. JPEG, MPEG, and Px64: Setting the Pace for Multimedia, *AV Video*, March 1991, p. 134.

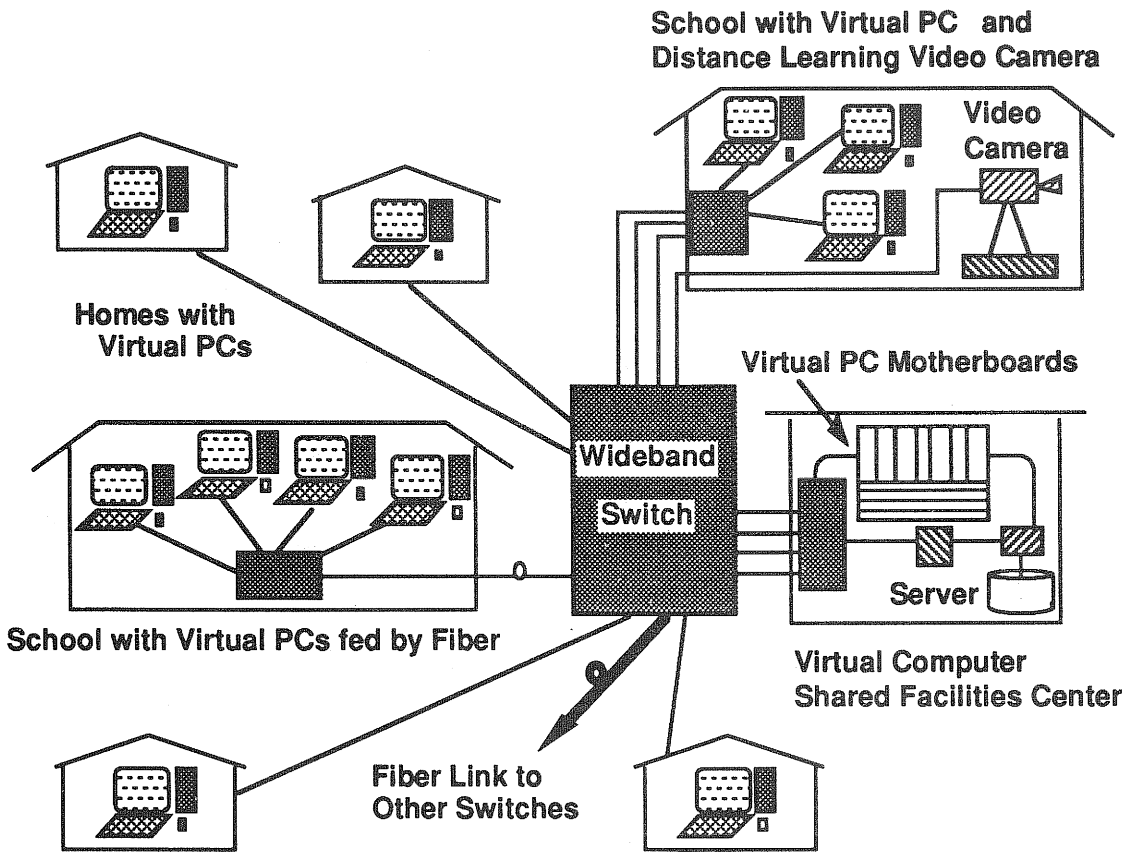

Figure 2: School District Network

The virtual PC, in principle, matches each of our requirements stated above. Since the video decoding and keyboard / mouse interface would be based on a newly defined standard, it would be possible to connect to any vendor's computer provided they implemented the standard interface. These computers could range from modest personal computers used in school today, to high-performance workstations or even super computers. In one evening at home, a student might execute a physics simulation on a virtual NeXT computer, switch to a virtual IBM PC for a spreadsheet and graphing application, and finish up with a virtual Apple Macintosh for a page layout assignment. During that same evening, each of these computers could be shared across several students, thus achieving a higher utilization of the school system's computing resources than could be achieved with dedicated computers located in each school.

Since only the display information is transmitted to the user, the virtual PC should be able to deliver any multimedia application available today or developed in the future. The single PC motherboard that is connected to a user during a session is also connected to the file server and to the other motherboards by a high-speed, parallel LAN. With this design, file transfer performance could easily eclipse that of a conventional serial LAN.

Access to files and computers on the virtual PC LAN could be controlled by teachers so that students had access only to the software and applications appropriate to their curriculum. Since users receive only the display information when applications are running, there would be no possibility of software piracy and very little opportunity for the introduction of viruses. A system administrator would maintain the application libraries and provide for secure backup of the users' data. Floppy disks would not be required, since each user would have their own file space on the system. If needed, floppy disks could be accommodated by providing a disk drive port on the virtual PC interface.

A strength of the virtual PC is that very high speed networking is possible between users within the same cluster, since the LAN connecting the rack mounted motherboards could be implemented as a fast, highly parallel bus extending across the few feet separating the motherboards and the file servers. LAN bridges and gateways would interconnect the cluster LANs to achieve regional and wide-area networks.

Since only the human interface and video processor appear in the home, the theft and damage exposure would be small relative to a complete PC. A virtual PC could be designed to work only in a specific system to reduce its salability if stolen.

Finally, the virtual PC approach has the potential to be less costly than buying complete multimedia computers and modems for the home. This is true because of the opportunity for sharing the costly and rapidly evolving part of the computer, the potential for higher component utilization, and the reduction of redundant storage devices and software. Furthermore, since the human interface would be manufactured in large volume and have an installed life of at least ten years, its contribution to the overall system cost would be minimal.

THE THEORETICAL BASIS OF THE VIRTUAL PERSONAL COMPUTER

The virtual PC is based on a sound theoretical basis that will only strengthen as computer capability evolves. The data transfer rate to a color monitor on a personal computer is, at first glance, very large. A color monitor with a resolution of 640 x 480 pixels (picture elements) per frame, eight bits per pixel and 65 frames per second is receiving data at a raw data rate of more than 150 Mbps. However, this data represents static or moving images to the user, and contains an enormous degree of redundancy. Were this redundancy not present, the display would be meaningless to the brain. It is the presence of this redundancy that permits significant video compression to be done to reduce the data rate between the computer display generator and the computer monitor.

This compression can take place over both space and time. Compression as specified by the recently implemented JPEG standard could be performed independently on each video frame [1]. From frame to frame, additional compression would be possible due to the small difference between each frame of a moving image that the brain interprets as motion. The exploitation of inter-frame compression is the basis for the recent MPEG standard for the compression of stored NTSC video and audio to a rate less than 1.5 Mbps [2].

For the virtual PC to be acceptable, artifacts and delays invariably introduced by the computer video compression would have to fall below a minimum level. A comprehensive study of this subject would be required before taking the virtual PC beyond the concept stage.

The virtual PC concept is sound in principle because the rate at which visual information can be transferred to a human is bounded by the limitations of the brain. For a typical color display, as described above, there is little to be gained by dramatically improving the resolution, color depth,or frame rate since the display performance is already near the limit beyond which a human could perceive no improvement. In the cost-sensitive school application, such display

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1 Leonard, M. IC Executes Still-Picture Compression Algorithm, *Electronic Design*, May 23, 1991, p. 49.

2 Leonard, M. Color Image Compression Finally Heads for Maturity, *Electronic Design*, May 23, 1991, p. 55.

performance would more than adequate. Since human physiology is not likely to change in the foreseeable future, we can be confident in installing a standard display interface in the home that would not become obsolete with advancing computing technology.

In contrast, the rate at which information can be delivered to a computer from a storage device or across a network is by no means approaching such a fundamental upper bound. As computer processing capability evolves, this rate can be expected to continually increase. For example, in a recent article, Nicolas Negroponte of the MIT Media Lab describes a scenario where one hour of time compressed video could be delivered in five seconds at one gigabit per second over a fiber optic link [1] ! As a general principle, it will make more and more sense over time to put the computing element of a personal computer close to its source of data, and to use the network to deliver the computer's compressed video to the user. This is potentially the next paradigm of personal computing.

Note that the virtual PC is not a return to the time sharing of the late sixties, but it does take advantage of the considerable benefits in centralizing storage and in having the processors and data sources in close proximity. In each virtual PC session, a user is connected to a single motherboard which is not normally shared with any other users (although such sharing would make sense for some applications). Even the contention for processors is not inherent in the concept, since the system could be engineered to have one motherboard dedicated to each user in the system.

SUMMARY and CONCLUSION

A new educational infrastructure, based on access to state-of-the-art, networked computers in our schools, and in the homes of all teachers and students, could be the key to reaching our national educational goals. This infrastructure could be built most effectively by adopting a new paradigm for educational computing - the virtual PC. With the virtual PC we can create a hybrid between conventional time sharing and personal computing that preserves the advantages of both paradigms while avoiding their drawbacks. The critical new technology needed to achieve this is ADSL - a technology which could exploit the underutilized telephone loop to deliver both phone service and virtual computing to the home.

The video processing and ADSL technologies critical to the virtual PC were not technically viable even one year ago. The cost of high speed digital processing at the chip level, which is the basis of both of these technologies, is destined to decline steadily over time. At the same time, the emergence of cell relay switching technology coupled with fiber optics would enable virtual PC deployment to begin on a nationwide basis by the middle of the decade [2].

Because the theoretical basis of the virtual PC is linked to the fundamental limits of human perception and to the relentless advance of computing technology, its rationale can only strengthen over time. As the ability of computers to absorb information at ever-higher rates continues to grow, the case for placing computers near their sources of data and extending the human interface across a network to the user becomes compelling, at least in the cost-sensitive environment of educational computing.

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1 Negroponte, N. Products and Services for Computer Networks, *Scientific American*, September 1991.

2 McQuillan, J. Cell Relay Switching, *Data Communications*, September 1991, p. 58.

GLOSSARY

ADSL - Asymmetric Digital Subscriber Line - Bellcore proposal for 1.5 million bits per second asymmetric transmission of data to the user together with ordinary phone service on a single copper telephone line.

Bellcore - Central service organization, established after the divestiture of AT&T, that provides centralized technical and management services on behalf of the Regional Bell Operating Companies and others.

JPEG - Joint Photographic Experts Group - International Standards Organization study group responsible for developing a new standard for encoding and decoding **still**-video color images.

LAN - Local Area Network - a network interconnecting personal computers or workstations within a building.

MPEG - Moving Picture Experts Group - International Standards Organization study group responsible for developing a new standard for encoding and decoding **stored** full motion video sequences.

NTSC - National Television Systems Committee - Term is used to refer to technical standard for color television in North America.

Px64 - International telecommunication standard for real time video encoding and decoding using multiples of 64,000 bits per second bandwidth up to 24 x 64,000 bits per second in North America.

Motherboard- The main circuit board of a personal computer containing main memory, microprocessor and other associated components.

3. REGULATORY SAFEGUARDS IN TELECOMMUNICATIONS

Chairperson: Ben Omorogbe

Minnesota Public Utilities Commission

A FINANCIAL ANALYSIS OF THE BELL TELEPHONE REGIONAL HOLDING COMPANIES

BY

Dr. D. M. Burney*

District of Columbia Public Service Commission

I. INTRODUCTION

On December 29, 1989 the Federal Communications Commission (FCC) initiated a formal proceeding to represcribe the authorized rate of return for the interstate services of the Local Exchange Carriers (LECs). 1/ In the testimony filed by the seven Bell Regional Holding Companies (RHCs), among others, two dominant themes emerged. 2/ First, the RHCs had become less risky than the LEC's since divestiture due to the portfolio effect of diversification into non-regulated lines of business. This caused the investor required rate of return on common equity to be higher for the LECs than for the RHCs. Second, the LECs needed significant amounts of new investment to protect their competitiveness. This increased the risks of investment in RHCs and LECs to potential investors, thus requiring a higher ROE to induce such investments.

The submissions filed in response to the RHCs argued that these themes were undocumented assertions lacking in both analytical support and evidence. 3/ The FCC ultimately issued a rate of

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* Dr. Burney acknowledges helpful comments from Dr. Felicia Fauntleroy and Dr. Robert Loube and the support of the District of Columbia Public Service Commission. Mr. Larry Coates provided valuable data assistance. However, the analysis and opinions expressed herein are solely those of the author.

1/ In the matter of Represcribing the Authorized Rate of Return for Interstate Services of Local Exchange Carriers, CC Docket No. 89-624, Order, DA 90-5 (released January 5, 1990) ("Jan.5 Order").

2/ Initial Rate of Return Submissions, CC Docket No. 89-624, (February 16, 1990)

3/ Responsive Submissions, CC Docket No. 89-624, (March 27, 1990).

return order rejecting most of the RHC's positions. Nevertheless, the issues themselves remained unresolved, and became subject to further debate.

This study examines the RHC's claim that the diversification efforts of the RHCs made them less risky than their respective LECs. To the contrary, this study found that the diversification efforts of the RHCs were thinly capitalized, a characteristic closely associated with high risk. Moreover, it was the financial cross-subsidization from the LECs to the RHCs that allowed the RHCs to give the appearance that they were less, not more, risky than their respective LECs.

The non-regulated activities of the RHCs were highly unprofitable. The net income or earnings of the LECs was being used to support the highly unsuccessful diversification activities of the RHCs. In every instance the RHCs collected more in dollar amount from the LECs than they paid out in dividend payments to RHC shareholders. Finally, Net LEC investment expenditures have been flat in nominal dollars since divestiture. These findings support the claim that the RHCs have been made more risky, not less, by post-divestiture diversification activities.

This study is divided into six sections. Section I is introductory; Section II analyzes the capitalization of the non-regulated diversification activities of the RHCs; Section III analyzes the profitability of the RHCs non-regulated or diversified activities; Section IV analyzes the dividend payout ratios of the LECs and the RHCs, Section V examines the relative investment expenditures and depreciation expenses of the LECs; And, Section VI presents the conclusions of the study.

The data used to conduct the analysis were taken from the 10-K Reports filed with the Securities and Exchange Commission (SEC) by the RHCs and the LECs for the years 1985 through 1991.

II. THE EFFECTS OF DIVERSIFICATION ON CAPITALIZATION

In this Section the capital structures of the RHCs are considered both with and without their respective LECs. This provides a proxy measure of the diversification efforts of the RHCs. Further, it demonstrates that the RHCs have relied upon the capitalizations of the LECs to support the creditworthiness of their non-LEC activities, e.g., financial cross-subsidization of the RHCs non-regulated activities by the capital structures of the LECs.

The common equity ratio is the percent of the shareholders claims to the total claims against the company, that is, the claims of both shareholders and debtors. A higher common equity ratio is matched by a lower debt ratio in the capitalization structure, and vice versa. Debt carries legal or contractual obligations not generally born by debt. All other factors equal, the higher the percent of debt in the capital structure, the greater the financial risk of the company, and vice vera.

The common equity ratios for the RHCs, including annual means, were computed for the years 1985 through 1991. The common equity ratios for the RHCs demonstrated a stable pattern, peaking at near 60 percent in 1986, and declining to 52 percent in 1991. This masks a different pattern of capitalization for the separate parts of the capital structure.

The debt and equity for the individual LECs are removed from their respective Holding Company debt and equity. This residual is the capital associated with the non-regulated or diversified activities of the RHCs. In nominal terms, the non-LEC common equity of the RHCs plateaued in about 1987 and has remained flat, amounting to about $7 billion at the end of 1991. This was matched by a debt level of about $19 billion at the end of 1991. The mean common equity ratio for the RHCs diversified or non-regulated activities declined from a high of over 82 percent in 1987 to a low of about 26 percent in 1991.

The non-regulated common equity ratios showed even greater variation for individual RHCs. For the years 1990 and 1991, three out of seven of the RHCs had non-LEC common equity ratios in the single digits. Bell Atlantic's non-LEC common equity, in particular, bottomed out below 5 percent in 1990 from a peak level above 65 percent in 1986. This is in contrast to Bell Atlantic's RHC common equity which declined from 59 percent in 1985 to 44 percent in 1991.

A common equity ratio in the 44 percent range, as in the Bell Atlantic case, might be consider normal by industry standards for any of the three primary regulated industries, e.g., electricity, telecommunications, and/or natural gas distribution. However, a decrease from above 65 percent to 44 percent signals a shift in the relative risk associated with the corresponding debt leverage. And, under normal circumstances, a company with a 5 percent common equity ratio and 95 percent debt, e.g. Bell Atlantic's non-Lec activities, would probably not be considered a "going-concern." It might reasonably be expected to be into varying stages of financial reorganization and/or bankruptcy. Such declining common equity ratios do not support the financial profile of low-risk diversification activities which would be required to reduce the overall risk of the RHCs.

The financial markets are generally unwilling to lend monies when thin capitalization exists. This means that the RHCs, in effect, leveraged against the LEC common equity component in order to support or justify the leveraging of the non-LEC activities. Such financial cross-subsidization of the non-LEC activities by the LECs has the further effect of reducing the creditworthiness of the LECs, although to a lesser degree. This, in turn, increases the financing costs for the LECs.

Several factors have either been associated with the changing capitalizations, or are expected to have more effects on the capitalizations. First, what has been called Restructuring has resulted in significant balance sheet equity reductions. This generally involves either the downsizing of the LEC or the losses/write off of non-regulated activities. In 1991 the RHC 10-K reports identified about $2 billion restructuring costs. Part, but not all of these costs were assigned to the LECs. The allocation of restructuring costs needs to be closely monitored by state regulators to be assured that restructuring costs associated with unprofitable non-LEC activities are not paid by regulated rate payers.

Second, every RHC has established a Leveraged Employee Stock Ownership Plan (LESOP). By December 31, 1989, the LESOPs accounted for about fifty percent of the increase in the non-LEC long term-debt. The LESOP's debt is serviced by Company contributions and the dividends paid to the trusts for the shares of Company common stock held by the trusts. The Company guarantee of the LESOP Trust debt requires that the Company reflect this on their balance sheets. Bell Atlantic records the debt guarantee as an increase in long-term debt and an increase in deferred compensation (a decrease in common equity). There are at least two areas of impact for state regulators. First, since the LESOPs cover the regulated LEC employees, the increased debt and decreased common equity adjustments at the RHC level should be passed back to the LECs for adjustments to the LEC capital structures. Second, the tax savings due to the LESOPs are LEC employee based and should be passed back to the ratepayers by the state regulators.

Third, at least one RHC, Bell Atlantic, has already adopted FASB Statement No. 106, which is mandatory by January, 1993. This requires the accrual of all postretirement benefits other than pensions. The cost is expected to be in the $2 billion to $3 billion range for most of the RHCs. These postretirement plans entail a variety of economic, financial and demographic variables, which might be expected to change over the tenure of the plan. The State Regulators need to pay particular attention to these Plans to be sure that excessive cost recovery does not occur.

Fourth, FASB Statement No. 109 changes the accounting for deferred tax items. While there is uncertainty regarding the impacts of this Rule, enforcement and subsequent policy related decisions will eventually determine the magnitude of the effects.

Fifth, FASB Statement No. 107 requires companies to disclose the fair value of all financial instruments. Such requirements to revalue equity interest will impact upon how the RHCs carry the LECs equity on their books. The common equity value of the LECs, as recorded on their books, has been virtually unchanged since divestiture. Any revaluation, for whatever reason, changes the capitalization relationships and impacts on rates of return through changed capital structures.

III. THE PROFITABILITY OF DIVERSIFICATION

Contrary to industry claims, the non-regulated activities of the RHCs have produced mixed results. The net income of the LECs was subtracted from the RHCs to determine the non-LEC net income of the RHCs. This residual net income as a percent of the non-LEC common equity was also used to compute the non-LEC return on equity (ROE).

The non-LEC RHC ROE for the period 1985 through 1991 was widely divergent for the industry as well as the individual companies. The mean ROE across the seven RHCs was negative in four out of seven years, including both 1990 and 1991. The mean RHC non-LEC ROE was -9.4% and -13.6% for the years 1990 and 1991, respectively. Only Bell South and Southwestern Bell showed positive returns in every year. However, these numbers showed wide fluctuations and were based on thin capitalizations.

IV. DIVIDEND PAYOUT RATIOS

The RHCs maintained a stable dividend payout ratio at the expense of the LECs. The RHCs demonstrated a stable but increasing pattern of dividend payments over the post-divestiture period. This ratio of dividends paid out to the shareholders, as a percent of net income, stabilized around 60 percent from 1985 to 1988, and increased to 75 percent in 1990. The 1991 statistic exceeded the 100 percent level because of some payouts in the face of writeoffs. The RHC dividend payout ratio serves more as a facade for the pattern of dividends collected by the RHCs from their respective LECs.

The dividend payout ratio was computed for each LEC for each year from 1985 through 1990. the mean ratio for the LECs averaged 89 percent over the post-divestiture period, peaking at 98 percent in 1989. It was not unusual for RHCs to remove more in a dividend payment from a LEC than the respective LEC earned in a particular year. This, in effect, constituted a downsizing of the LEC, a practice totally inconsistent with the alleged need for significant net investment to keep the LEC's competitive. For example, in both 1987 and 1988 Bell Atlantic removed in excess of 100 percent of C&P's net income in the form of dividend payments, 127 percent and 134 percent, respectively. Bell Atlantic removed 97 percent of C&P's net income in 1991, in spite of a loss passed back to C&P from Bell Atlantic of about $33 million. NYNEX removed 140 percent of N.Y. Telephones' net income in 1989. PACTEL removed 104 percent of Pacific Bells net income in 1999.

The dollar amount of dividend payments made by Bell Atlantic to Bell Atlantic shareholders was deducted from the total dividend collections of the RHCs from their respective LECs for each year 1985 through 1991. Without a single exception, the RHCs collected more in dividend payments from the LECs than they paid out in dividends to their shareholders. Such a cash drain from the LECs by the RHCs decreases the ability of the LECs to make investments. Instead, the excess collections from the LECs are going to fund the non-LEC activities and cover their respective losses. This suggests that the RHCs have become more risky, not less risky, because of post-divestiture diversification and non-regulated activities.

V. DEPRECIATION AND INVESTMENT SPENDING

This Section compares the annual capital investment expenditures of the LECs with their annual depreciation expenses. The capital investment expenditures have been adjusted for gains and/or losses associated with salvage, removal and disposition for the respective year in which they were made. The depreciation expenses are at book value or nominal amounts. No adjustment has been made for the time value of money related to the underlying costs of the plant and/or equipment being expensed as depreciation. Again, the data was analyzed for each RHC by individual LEC.

The annual depreciation expenses as a percent of total annual investment expenditures were computed. They tend to hover about 80 percent. However, in some years, the ratio was above 100 percent for some participants.

While this 80 percent depreciation to investment (D/I) ratio may appear to present a strong positive growth scenario, it does not, in fact, do so. The depreciation expenses are based on historical book value, while net capital expenditures are in real or current terms. Because of this discrepancy of real and historical dollars, anything above 80 percent might be considered a posture of net-disinvestment or downsizing of the company.

Bell Atlantic's 80 percent D/I ratio suggests that Bell Atlantic is basically in a maintenance posture with respect to the LECs. However, on an individual LEC basis, the situation is different. For two of Bell Atlantic's LECs, namely, C&P of D.C. and C&P of W. Va., significant amounts of downsizing, or net disinvestment actually occurred in the years 1987 and 1989. This is typified by D/I ratios reaching as high as 120.17 percent.

VI. CONCLUSIONS

Three conclusions can be drawn from the above analyses. First, diversification has resulted in significantly increasing the riskiness of the regional holding companies to their shareholders and prospective investors. This increased risk is associated with what appears to be speculative and relatively unprofitable non-local exchange carrier investments. Second, the regional holding companies have actively downsized or disinvested in their local exchange carriers to support their speculative and relatively unprofitable non- local exchange carrier investments. Finally, the regional holding companies have been less than open and forthright in their failure to pass the financial impacts of the LESOP's back to their respective local exchange carriers. For this reason, state regulators need to pay particular attention to the cost recovery associated with FASB Statement No.s 106, 107 and 109 as well as the volume of restructuring charges being written off.

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In June 1990, the District of Columbia Public Service Commission prepared a study on the issue of why separate subsidiaries are necessary for competitive services offered by telecommunications companies which also provide noncompetitive services. The study was entitled, "For Whom Do The Bells Toll? The case for separate subsidiaries." This paper will highlight the findings of the D.C. Commission study on separate subsidiaries. Prior to discussing the findings, the paper will review the genesis of the study.

During the late 1980's the regional bell operating companies intensely lobbied Congress regarding the need for legislative relief from business restrictions imposed in the Modified Final Judgment (MFJ) that concluded the U.S. Department of Justice's antitrust suit against AT&T in 1984. Under the MFJ, the Regional Bell Operating Companies (RBOCS) were prohibited from (1) manufacturing telephone equipment, (2) providing information services, and (3) providing long distance service. If Congress had allowed the RBOCS to provide information services, the question arises as to what safeguards are necessary for monopoly ratepayers (and other competitors) because of the advantages the RBOCS have from the joint provision of monopoly and competitive services using the same integrated network. The study addressed the problem of how to develop realistic and adequate safeguards. Since Judge Greene under the direction of the Appeals Court has alllowed the

RBOCS into the information markets, it is time to revisit the issues addressed in the study. The D.C. Commission study addresses these concerns from a state regulatory perspective.

The study of separate subsidiaries has two major conclusions, each of which I will elaborate on further. They are:

1. There is a need for structural safeguards such as separate subsidiaries because of the increasing trend toward diversification by the RBOCS since divestiture and the economics of production of telephone services;
2. Separate subsidiaries have a number of advantages in minimizing cross-subsidization; and if separate subsidiaries are imposed, there are a number of necessary additional conditions which also must be met.

I will now discuss each of these issues in turn.

In the last few years, the RBOCS have sought regulatory changes on both the federal and state levels. One of their principal arguments is that rate of return regulation stymies growth. As the D.C. Commission study makes even visually clear, this argument is without merit. Since divestiture, with both the waiver process and rate of return regulation in place, there has been a dramatic explosion in the number of nonregulated subsidiaries of the RBOCS. For example, the Bell Atlantic Company grew from 17 nonregulated subsidiaries right after the break-up, to over 90 by year end 1989. These nonregulated subsidiaries provide services in a wide variety of markets and they reflect a corporate strategy towards increased diversification away from the traditional core telephone business.

Additional empirical evidence is reflected in the tripling, on average, of the growth of the RBOCS capital expenditures on nontelecommunications activities and the accompanying decline in the share of those expenditures on traditional telephone operations. RBOC's revenues from nontelecommunications services have also risen over 50 percent since divestiture.

These trends mean there is an even greater opportunity for and thus risk of cross-subsidization from monopoly ratepayers to the nonregulated services. It also means greater oversight responsibility for state regulators who are charged with protecting the ratepayers and the company interests in the traditional telephone lines of business. The risk of anticompetitive practices is also heightened, given the vast number of nonregulated markets in which the RBOCS now appear to be operating.

The integrated nature of the network makes cross-subsidization difficult to detect and monitor. Currently, the FCC requires the use of fully distributed costing (FDC) methods to allocate costs between regulated and nonregulated services and to divide the revenue requirement between the interstate and intrastate jurisdictions. The FDC methods, however, are not an adequate safeguard for protecting against cross-subsidization for several reasons.

While I have made it clear that we prefer separate subsidiaries to accounting/allocation rules, I want to stress that separate subsidiaries by themselves are insufficient for the tasks at hand. To clarify this point, I shall now describe the advantages of subsidiaries and note that each advantage must be associated with additional safeguards.

<u>Separate subsidiaries make it easier to detect any cross-subsidization which might occur through procurement practices.</u>

A major benefit of the division of regulated and deregulated businesses into the separate subsidiaries structure is that it exposes the relationships among the components of the holding company. If a deregulated subsidiary produces a good or service that the regulated subsidiary purchases, the opportunity for cross-subsidization exists. By requiring the regulated subsidiary to purchase products from a deregulated subsidiary, the holding company can subsidize its deregulated subsidiary and increase its overall profits.

The associated safeguard is the right to establish rules governing affiliate transactions. Such rules are needed because unsupervised holding companies will develop rules and procedures that favor in-house buying to the detriment of competition. Examples of such rules include the requirement for competitive bidding on any large purchase or a limit of 50 percent of any equipment type purchased from affiliate vendors. The purpose of these rules is not only to reduce the cost for the ratepayers, but also through the creation of a level playing field, support the market mechanism.

Separate subsidiaries facilitate the monitoring of intracorporate transactions and eliminate the need to develop accounting rules which prohibit the transfer of costs to ratepayers. Using accounting rules to separate costs between regulated and deregulated activities necessitates the development of rules and the auditing of applications of the rules. Any proposed set of rules governing a particular activity always appears reasonable. However, all rules must be based on certain assumptions. For example, should usage be measured at the peak or on a 24 hour a day basis. The choice of measurement standard will shift costs among the services that use the same equipment.

Once the rules have been established, it is necessary to audit the companies to ensure that the rules are being applied properly. However, the General Accounting Office, of the federal government, in its report, Telephone Communications: Controlling Cross-Subsidy Between Regulated and Competitive Services, sharply criticized the FCC for its failure to control cross-subsidization through the use of its cost allocation methods. The report stated: "the level of oversight the FCC is prepared to provide will not, in the GAO's opinion, provide telephone ratepayers or competitors positive assurance that FCC rules and procedures are properly controlling cross-subsidy." Moreover, Judge Greene, in his reconsideration of the MFJ judgment restrictions, also raised questions regarding the ability of the FCC to control and monitor abuses in light of its reduced resources. He noted that "in 1980, the FCC had an authorized ceiling of 2,103 employees; this had fallen by 1987 to 1,855 employees and the Commission was apparently short by 120 employees of even that lower ceiling."

The associated safeguard is the right of the FCC and state commissions to review affiliate interest transactions including not only the purchase agreements and contracts prior to execution, but also the books and records of affiliates. This authority is needed even in the regulatory environment of separate subsidiaries because separate subsidiaries do not reduce the incentive of the partially regulated firm to increase its profits through cost shifting. Separate subsidiaries only provide a bright line that can be seen if the regulator has the right to look.

Access to the books and records of affiliates is virtually impossible today without affiliate interest legislation. The New York Public Service Commission and the FCC have used their legislative authority to investigate affiliate transactions to audit the relationship among NYNEX's regulated and unregulated subsidiaries. NYNEX had established the Materials Enterprises Company (MECO) for the purpose of reducing the costs of purchasing goods and services for its regulated companies. However, instead of lowering the costs, MECO raised the costs. For example, MECO accepted a $574,000 bid to remove switches and charged New York Telephone $832,000 for the removal without providing any of the service. MECO purchased circuit boards for NYNEX. These boards could have been purchased for approximately $60, but MECO charged the operating companies $79 plus handling.

In addition, the general counsel of the New York Public Service Commission investigated the Commission's problems in regulating the relationship between NYNEX and New York Telephone. In its report, the general counsel made several recommendations with regard to affiliate interest transactions. First, there is a need to enhance the affiliate interest legislation so that the Commission and its staff can obtain more detailed information. Second, the report noted that there should be an additional regulatory proceeding with respect to New York Telephone Company because of the need to investigate the more complicated intracorporate transactions. Third, the report calls for an audit of New York Telephone's internal audit procedures and the need to protect whistleblowers. Fourth, and perhaps most provocative, the report recommends changing the corporate structure of New York Telephone and NYNEX in order to prevent future problems with affiliate interest transactions. Among the possible corporate structures that should be evaluated, the report recommended, the complete divestiture of New York Telephone Company from NYNEX.

<u>Separate Subsidiaries Protect The Monopoly Ratepayers From Losses Associated With The Risk Of Failures.</u>

Utility companies diversify into competitive businesses in order to obtain higher profits. However, the markets where higher profits can be earned feature higher levels of risk. The suppliers of debt and equity funds to the holding company will require a higher return in order to be compensated for accepting the higher risk. These higher levels of return will be required from activities the holding company is engaged in unless the risk associated with one activity can be separated from the risk associated with the other.

The separate subsidiary structure is the vehicle that can separate the risk of the utility from the risk of the competitive services. In order to fulfill this responsibility, the separate subsidiary vehicle must be augmented by a safeguard requirement that each subsidiary maintain a separate capital structure, that is, each subsidiary must raise its own funds in capital markets. These funds consist of both debt and equity.

Two reasons favor a separate capital structure: (1) to ensure that the utility's rates are not affected by the diversification and (2) to protect the investment of the utility from the failures of other subsidiaries of the holding company.

If the holding company were allowed to consolidate its capital structure, it could take advantage of the good credit of the utility to finance risky ventures. The effect of this action would be to raise the cost of debt to the utility and lower the cost of debt to the other subsidiary. The higher cost of debt would increase the rates to telephone customers.

When diversification leads to failure, the effect on the utility can be catastrophic. The example of Arizona Public Service and its parent holding company, Pinnacle West Capital Corporation, clearly demonstrates this problem. Pinnacle West purchased Merabank, which needed an immediate cash infusion of $507 million due to sustained real estate losses. Because of these problems, Pinnacle West's stock was given the lowest possible safety rating by Value Line, and Arizona Public Service's access to the capital markets was seriously impaired.

In conclusion, the study stated that the trends toward competition and increased diversification in the telecommunications industry contribute to an even greater need for the LECS to use structural separations such as separate subsidiaries to minimize cross-subsidization between regulated and unregulated services. Moreover, the separate subsidiary requirement, in conjunction with regulatory agencies' right to access the books and records of affiliates and the other safeguards I have mentioned, can facilitate competition and thereby increase the availability of services to customers at lower prices. Anything less, and I emphasize "anything" will clearly <u>not</u> be in the public interest, and therefore, is clearly unacceptable.

4. COSTING FOR RATEMAKING IN TELECOMMUNICATIONS

Chairperson: William Pollard

National Regulatory Research Institute

Telecommunications Category Costing in Canada: Accomplishments and Emerging Issues[1]

by

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<u>Introduction</u>: In recent months, the category costing approach being employed by a growing number of Canada's telephone carriers has been described as "most sophisticated form of accounting separation in the world" by industry representatives[2]. But, a recent <u>Globe and Mail</u> editorial implicitly described the approach as one designed to address what are "essentially theological questions - or what is the next thing to theology, accounting[3]".

This paper will not attempt to expound on these somewhat provocative if not paradoxical views. Rather, it will employ prudent and demure - some might venture to say dull - language more in keeping with the demeanour expected of regulatory officials. The story starts some twenty years ago.

At that time, Canadian regulators first identified the need for revenue and cost information for broad categories of telecommunication services being provided on a monopoly versus competitive basis. The required information was first filed with the Canadian Radio-television and Telecommunications Commission (CRTC) in 1987. Since then audited revenue/cost results (Phase III results), produced in accordance with documented procedures (Phase III Manuals), have been filed annually by Canada's two largest telephone companies, as well as one of the smaller operating companies. The regulatory requirement for Phase III results is now being extended to other major Canadian carriers. Table 1 lists the federally regulated carriers by total operating revenues and sets out the current status of Phase III initiatives for each. In addition, Tables 2, 3, 4 and 5 represent the actual 1990 audited Phase III results filed by Bell Canada on 30 September 1991. These Tables are included as basic reference material for what follows in this paper.

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1 This paper was prepared for presentation at the Eighth NARUC Biennial Regulatory Information Conference. Views expressed are those of the author and do not necessarily represent positions of the CRTC. This document is not to be cited without the author's permission.

2 This description was used by both A. Elek, witness for Unitel during the proceeding to consider its application to enter the Canadian long distance voice market, and Stentor Telecom Policy Inc. (i.e. alliance of the largest incumbent Canadian telephone companies) in a March 1992 public statement on proposed telecommunication legislation.

3 Globe and Mail (20 July 1992) editorial commenting on the decision to allow open competition in the Canadian long distance voice market.

Table 1
Canadian Federally-Regulated Carriers: Status of Phase III

CARRIER[4]	OPERATING REVENUES, 1990 ($MILLIONS)	STATUS
Bell Canada (Bell)	7,655	Annual audited results since 1987
British Columbia Telephone Company Limited (B.C. Tel)	1,852	Annual audited results since 1987
AGT Limited (AGT)	1,121	Guidelines for Manual expected in Fall, 1992
Maritime Telegraph and Telephone Limited (MT&T)	438	Manuals and initial results to be filed September 1993
Unitel Communications Inc. (Unitel)	362	Exempted in Decision 87-12, September 1987
The New Brunswick Telephone Company Limited (N.B. Tel)	324	Guidelines for Manual expected in Fall 1992
Newfoundland Telephone (Nfld. Tel)	257	Guidelines for Manual expected in Fall 1992
Teleglobe Canada (Teleglobe)	226	No requirement at this time
Northwestel Inc. (NWT)	84	Annual audited results since 1990
Island Tel	51	Implementation to be reviewed in Fall, 1993

Source: Annual Reports of Carriers and Author's Construct

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4 As a result of a Supreme Court Decision in August, 1989, CRTC's regulatory jurisdiction includes all the major Canadian telecommunications carriers except for Manitoba Telephone System and SaskTel. Legislation now before Parliament, if passed would bring these two carriers under CRTC's jurisdiction. Two municipal systems operating in Edmonton, Alberta and Prince Rupert, British Columbia and 47 independent systems operating in Ontario and Quebec are regulated by either municipal or provincial bodies rather than the CRTC.

TABLE 1
BELL CANADA: 1990 PHASE III RESULTS
AVERAGE NET INVESTMENT BASE
($Millions)

	ACCESS	MONOPOLY LOCAL	MONOPOLY TOLL	COMP. NETWORK	COMP. TERMINAL MULTILINE & DATA	COMP. TERMINAL OTHER	OTHER	COMMON	INVEST. IN SUBS. & AFF.	PLANT UNDER CONSTR.	TOTAL
1. Telephone Plant	10998.5	3602.2	3063.8	2132.7	624.5	378.7	189.0	182.2			21171.7
2. Accumulated Depreciation	3408.9	1426.3	1081.2	797.4	347.6	216.2	69.9	62.2			7409.7
3. NET PLANT INVESTMENT (Line 1 - Line 2)	7589.7	2176.0	1982.6	1335.3	276.9	162.5	119.2	119.9			13762.1
4. Deduct: Deferred Income Taxes	1012.4	293.0	265.6	178.9	237.5	21.9	16.0	15.9			2041.3
5. SUB-TOTAL (Line 3 - Line 4)	6577.2	1882.9	1717.0	1156.4	39.5	140.6	103.1	104.0			11720.8
6. Plant Under Construction										479.4	479.4
7. Material & Supplies	36.0	7.2	10.3	11.2	9.6	8.1	0.2				82.7
8. Invest. In Subs. & Aff.							90.0		58.9		148.9
9. Working Capital	(561.4)	32.7	149.3	(36.4)	237.4	12.5	22.5	(19.5)			(162.9)
10. Long Term Receivables					270.9						270.9
11. Other Deferred Charges - Net	34.2	9.8	8.9	6.0	(43.1)	0.7	0.5	(5.0)			12.0
12. SUB-TOTAL (Lines 6 to 11)	(491.2)	49.7	168.5	(19.2)	474.7	21.3	113.2	(24.5)	58.9	479.4	830.9
13. NET INVESTMENT BASE, PRIOR TO ADJUSTMENTS (Line 5 + Line 12)	6086.0	1932.6	1885.5	1137.3	514.2	161.9	216.3	79.6	58.9	479.4	12551.7
14. Regulatory Adjustment	10.5	3.0	2.8	1.9	0.4	0.2	0.2	0.2	68.6		87.6
15. Averaging Adjustment	66.0	21.0	20.4	12.3	5.6	1.8	2.3	0.9	0.6	5.2	136.1
16. AVERAGE NET INVESTMENT BASE (Lines 13 to 15)	6162.5	1956.6	1908.7	1151.4	520.2	163.9	218.8	80.6	128.1	484.6	12775.4

Totals May Not Balance Due to Roundings.

TABLE 2
BELL CANADA: 1990 PHASE III RESULTS
CALCULATION OF REVENUE SURPLUS/SHORTFALL
($Millions)

	ACCESS	MONOPOLY LOCAL	MONOPOLY TOLL	COMP. NETWORK	COMP. TERMINAL MULTILINE & DATA	COMP. TERMINAL OTHER	OTHER	COMMON	INVEST. IN SUBS. & AFF.	PLANT UNDER CONSTR.	TOTAL
1. OPERATING REVENUES	251.0	2070.5	3130.7	685.2	612.6	262.9	315.3				7320.1
2. OPERATING EXPENSES (A) *	2194.5	888.7	820.2	505.4	492.1	184.5	44.6	268.5			5390.5
3. NET OPERATING REVENUE (LOSS) (Line 1 - Line 2)	(1943.5)	1181.7	2310.5	179.8	120.5	78.4	270.6	(268.5)			1929.6
4. OTHER INCOME (B) *	2.6	0.8	0.8	0.5	0.2	0.1	10.4		60.7	38.3	114.4
5. OTHER EXPENSES (C) *	8.1	2.6	2.5	1.5	0.7	0.2	0.3	0.1			15.9
6. NET INCOME (LOSS) BEFORE FIN. EXPENSES, TAXES AND REG. ADJ. (Lines 3 + 4 - 5)	(1949.0)	1180.0	2308.9	178.8	120.0	78.2	280.8	(268.5)	60.7	38.3	2028.1
7. FINANCIAL EXPENSES (D) *	710.1	225.5	219.9	132.7	59.9	18.9	25.2	9.3	17.5	55.8	1474.9
8. INCOME TAXES	287.3	91.5	90.1	53.8	20.4	7.7	10.7	3.7			565.3
9. REGULATORY ADJUSTMENT									12.1		12.1
10. SUB-TOTAL (Lines 6 - 7 - 8 + 9)	(2946.4)	863.1	1998.8	(7.7)	39.7	51.6	244.8	(281.5)	55.2	(17.6)	0.0
11. OTS ADJUSTMENT (E) *	(51.2)	(29.0)	(33.3)	93.4	51.9	(8.4)	(2.6)	(20.8)			0.0
12. REVENUE SURPLUS (SHORTFALL) (Line 10 + Line 11)	(2997.6)	834.1	1965.5	85.6	91.6	43.2	242.3	(302.3)	55.2	(17.6)	0.0

* Tables 3 and 4 For Details
Totals May Not Balance Due to Roundings

TABLE 3
BELL CANADA: 1990 PHASE III RESULTS
OPERATING EXPENSES AND OTHER INCOME
($Millions)

	ACCESS	MONOPOLY LOCAL	MONOPOLY TOLL	COMP. NETWORK	COMP. TERMINAL MULTILINE & DATA	COMP. TERMINAL OTHER	OTHER	COMMON	INVEST. IN SUBS. & AFF.	PLANT UNDER CONSTR.	TOTAL
(A) OPERATING EXPENSES											
1. Depreciation	582.7	301.2	220.6	159.1	78.5	46.8	8.2	12.2			1409.1
2. Maintenance	641.9	158.9	113.3	65.8	108.7	56.3	3.6	2.3			1150.6
3. Operator Services	2.9	75.1	95.0	1.0	2.0		0.1				176.1
4. Customer Provisioning	237.6	106.5	108.0	82.9	216.5	53.8	23.4	29.1			857.8
5. Facilities Provisioning	284.0	91.1	117.2	102.8	40.0	10.4	(1.1)	33.5			677.9
6. General Administration	132.7	42.6	65.4	28.7	21.0	8.4	1.8	150.8			451.6
7. Pensions & Benefits	54.8	18.2	17.4	10.5	10.2	3.4	0.8	27.3			142.6
8. Operating Taxes	258.0	95.0	83.3	54.6	15.1	5.6	7.8	13.5			532.9
9. TOTAL (Lines 1 to 8)	2194.5	888.7	820.2	505.4	492.1	184.5	44.6	268.5			5398.5
(B) OTHER INCOME											
1. Dividend Income									60.7		60.7
2. Interest Earned	2.4	0.8	0.8	0.5	0.2	0.1	10.4				15.1
3. Allowance for Funds Used During Construction										38.3	38.3
4. Misc. Income - Net	0.2	0.1	0.1								0.3
5. TOTAL (Lines 1 to 4)	2.6	0.8	0.8	0.5	0.2	0.1	10.4		60.7	38.3	114.4

Totals May Not Balance Due to Roundings

TABLE 4
BELL CANADA: 1990 PHASE III RESULTS
OTHER EXPENSES, FINANCIAL EXPENSES AND OTS ADJUSTMENT
($Millions)

	ACCESS	MONOPOLY LOCAL	MONOPOLY TOLL	COMP. NETWORK	COMP. TERMINAL MULTILINE & DATA	COMP. TERMINAL OTHER	OTHER	COMMON	INVEST. IN SUBS. & AFF.	PLANT UNDER CONSTR.	TOTAL
(C) OTHER EXPENSES											
1. Other Interest Expenses	4.8	1.5	1.5	0.9	0.4	0.1	0.2	0.1			9.4
2. Amort. of LTD Expenses	1.7	0.5	0.5	0.3	0.1		0.1				3.3
3. Amort. of Unrealized Loss on FX-LTD	1.6	0.5	0.5	0.3	0.1		0.1				3.2
4. TOTAL (Lines 1 to 3)	8.1	2.6	2.5	1.5	0.7	0.2	0.3	0.1			15.9
(D) FINANCIAL EXPENSES											
1. Interest on Long-Term Debt	244.1	77.5	75.6	45.6	20.6	6.5	8.7	3.2	1.6	19.2	502.6
2. Net Income	466.0	148.0	144.3	87.1	39.3	12.4	16.5	6.1	15.9	36.6	972.3
3. TOTAL (Line 1 + Line 2)	710.1	225.5	219.9	132.7	59.9	18.9	25.2	9.3	17.5	55.8	1474.9
(E) OTS ADJUSTMENT											
1. OTS Provided	138.7	28.5	22.7	127.2	82.4	1.7					401.2
2. OTS Consumed	189.9	57.5	56.0	33.9	30.5	10.1	2.6	20.8			401.2
3. NET ADJUSTMENT (Line 1 - Line 2)	(51.2)	(29.0)	(33.3)	93.4	51.9	(8.4)	(2.6)	(20.8)			0.0

Totals May Not Balance Due to Roundings

Phase III History and Conceptual Framework: Phase III is the third and final phase of a proceeding known as the Cost Inquiry. It had its origins in the late 1960's and was initially driven by the concern that carriers which operate in both monopoly and competitive markets could price their competitive services below cost to the detriment of both monopoly subscribers and their competitors[5].

Phase I of the Inquiry addressed threshold accounting and financial issues such as the criteria for capitalization versus expensing plant expenditures[6]. Phase II established a methodology designed to estimate the streams of revenues and costs associated with a specific course of action such as the introduction of a new telecommunications service as a means of assessing the economic viability of that action (i.e. net present value analysis)[7]. Then, late in 1981, the CRTC turned its attention to the design of the Phase III methodology to be used to identify revenues and costs for a set of prescribed broad categories of existing services. In the next six years, Phase III moved through four stages, the confirmation of a conceptual framework for category costing, the specification of classification and assignment guidelines to make that framework operational, the actual preparation of the Phase III Manuals and production of revenue/cost results and the final regulatory approval of the Manuals and specification of audit, update and review processes to maintain the integrity of the annual results.

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5 The Canadian Transport Commission (CTC), predecessor to the CRTC, in a September, 1969 rate case decision stated: "It would be in the public interest for the Commission to investigate the feasibility of carrying out cost and revenue separations between regulated and unregulated services, and the method and procedures appropriate for determining such separations". Then in announcing its decision to conduct a cost inquiry, the CTC stated: "The basic reason for the inquiry is that the Commission wishes to be apprised of the most efficient methods or techniques of accounting and costing that might feasibly be uniformly applied by telecommunications carriers under its jurisdiction. The committee would then be in a better position to determine whether or not tolls, filed with it as tariffs of the carriers, meet with the provisions of Section 321 of The Railway Act."

6 Inquiry into Telecommunications Carriers' Costing and Accounting Procedures - Phase I: Accounting and Financial Matters, Telecom Decision CRTC 78-1, 13 January 1978 and Revisions to Certain Directives in Telecom Decision CRTC 78-1, Telecom Decision 79-9, 8 May 1979.

7 Inquiry into Telecommunications Carriers' Costing and Accounting Procedures - Phase II: Information Requirements for New Service Tariff Filings, Telecom Decision 79-16, 28 August 1979. Bell's Phase II methodology is described in Procedures Manual for Economic Studies of New Services, July 1986.

The Phase III conceptual framework was confirmed in Decision 85-10[8]. The Commission's requirement for a methodology to assign revenues and costs among prescribed broad categories of services based on the principle of cost causation was the primary feature of the framework. Two other key features were the selection and definition of the broad categories and the requirement that there be closure with the standard company-wide financial statements submitted in general rate proceedings or as otherwise required by the Commission.

Seven broad categories of service were prescribed, Access, Monopoly Local (ML), Monopoly Toll (MT), Competitive Network (CN), Competitive Terminal (CT), Other and Common[9]. The Access and Common categories hold particular conceptual interest. The Common category comprises those overhead and administration costs not causally related to the output levels of the other categories. Creation of this category avoided the used of an inherently arbitrary allocation rule to fully distribute the identified costs. The appropriate recovery of these costs becomes a matter of regulatory judgement in the context of general revenue requirement proceedings.

The Access category comprises those costs associated with the loop and other non-traffic sensitive facilities required to connect subscribers to carrier's networks. Creation of this category was based on the conclusion that a carrier's investment in these facilities is not caused by how subscribers choose to use network facilities but rather by the subscribers' requirement to initiate or receive voice or data transmissions. While creation of this category did not resolve how its large revenue shortfall should be recovered, the category's existence visibly illustrated that access costs are not causally linked to either local or toll services, but rather to the subscribers who want to be able to either initiate or receive calls. Creation of the Access category kept the distinction between the functions of costing and cost recovery intact.

Another central issue was whether embedded or current costs or a combination of both provided the best basis for regulatory costing purposes. It became clear in the Phase III proceeding that financial reconciliation of

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8 The Phase III conceptual framework was initially spelled out in Report of the Inquiry Officer with respect to the Inquiry into Telecommunications Carriers' Costing and Accounting Procedures: Phase III - Costing of Existing Services, 30 April 1984 and then confirmed by the CRTC, with some modifications, in Inquiry into Telecommunication Carriers' Costing and Accounting Procedures: Phase III - Costing of Existing Services, Telecom Decision CRTC 85-10, 25 June 1985.

9 Subsequently, the Competitive Terminal category was divided into Competitive Terminal - Multiline and Data [CT(MD)] and Competitive Terminal - Other [CT(O)]. Then, in Order and Guidelines for the Filing of Phase III Manuals by Bell Canada and British Columbia Telephone Company, Telecom Order 86-516, 28 August 1986 a detailed description of the eight categories was prepared (see Attachment A to this paper).

the category revenue and cost information with the conventional balance sheet and income statement submitted in general rate proceedings was essential. In the earlier Phase II proceeding, the Commission had considered what costing approach should be used to evaluate new or significantly changed service offerings. Essentially, that approach identifies all the anticipated cash inflows and outflows associated with a project and using a selected cost of capital as the discount rate converts these cash flows to present values. If the difference between the present worth of the cash inflows exceeds that of the cash outflows (i.e. a positive net present value), then, the project may be judged economically viable. In other words, the Commission saw value in having two costing approaches, one which evaluates the actual performance of broad categories of service measured through an assignment of revenues and costs as recorded in the company's accounting (i.e. embedded) records and another which evaluated the anticipated performance of a new individual service offering through an analysis of the economic (i.e. current) value of its cash flows.

In a nutshell, Phase III calls for the assignment of the company's revenues and costs among prescribed broad categories based on the principle of cost causation with the result the summation of the categories' revenues and costs reconcile with the company-wide financial statements.

<u>Implementation of the Conceptual Framework</u>: The next challenge was to convert the Phase III conceptual framework into a workable category costing approach. Staff meetings were held with both Bell and B.C. Tel culminating in the Commission's publication of a Guideline (Order 86-516) to be followed in the preparation of each carrier's Phase III Manual. The Guideline specified the assignment procedures relating to each company's revenues, plant investment and expenses. These procedures were to be documented in a Manual[10] in sufficient detail to permit a standard audit validation of the Phase III results.

A detailed classification of each company's tariffed services into the Phase III categories drives the assignment of revenues. To further facilitate these assignments, Bell Canada has revised the structure of its operating revenue accounts to match with the Phase III categories. Each company's telephone plant investment is assigned using, with certain adaptations, the study processes adopted in the mid-1970's by the member companies of Telecom Canada (now Stentor Canadian Network Management[11]) for revenue settlement

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[10] Bell's Phase III Manual contains approximately 2000 pages of documentation.

[11] These recent organizational changes were described in <u>Telecommunication in Canada: An Overview of the Carriage Industry</u> as follows: "Telecom Canada, now called Stentor Canadian Network Management, as of January 29, 1992, will continue to manage and monitor the telephone companies' interprovincial networks and their North American interconnections. The organization also administers the division of revenues from national services. On the same day, the telephone companies announced the creation of two jointly

purposes. These adapted study processes use direct assignment to the Phase III categories where possible (e.g. station apparatus) but large portions of the plant (i.e. switching and transmission facilities) must be classified into functional groupings and then assigned.

Assignment of those plant functions which are jointly used for local, toll or competitive services employ appropriate busy period usage measurements. The assignment of plant provides the base for the assignment of all plant-related expenses (i.e. maintenance, depreciation and operating taxes) as well as financial expenses and income taxes. The remaining operating expenses are comprised, in large measure, of the salaries of telephone company staff performing functions not related to the provisioning and maintenance of the telephone plant. Assignment of these salary dollars, account by account, requires an analysis of the employees' work activities in relationship to the Phase III categories and the selection of a measurable aspect of these activities (e.g. study of service orders) which can be causally linked to those categories.

Once the expense accounts for the main activities have been assigned, there is a basis for the assignment of associated activities (e.g. training expenses) and the loading of other general support expenses (e.g. personnel and medical activities). As noted earlier, the Phase III approach provided for those expenses arising from activities with no reasonable causal link to a particular category by creating the Common category.

The Commission's Phase III guidelines were issued in August, 1986 (Order 86-516). One year later Bell and B.C. Tel submitted, for approval, their respective Phase III Manuals. Decision 88-7[12] accepted the Manuals for regulatory purposes and established three processes aimed at ensuring, on an ongoing basis, the relevance and integrity of the Manual's procedures and the credibility of the Phase III results submitted each year.

To ensure the credibility of the results, the Commission directed each carrier to engage its external auditor to carry out an annual Phase III audit with provision for a Commission auditing consultant to review and report each year with respect to both the audit plan and the auditor's working papers.

To maintain the relevance of the Manuals, an annual updating process was established providing for notification by the carriers of all proposed changes

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held companies, Stentor Resource Centre Inc. and Stentor Telecom Policy Inc. The Stentor Resource Centre will consolidate the telephone companies' research and development, and national and international marketing activities and will start business on January 1, 1993. Stentor Telecom Policy Inc., which officially began operation on February 3, 1992, will act as a government relations advisory arm for the telephone companies.

[12] Bell Canada and British Columbia Telephone Company - Phase III Manuals: Compliance with CRTC Telecom Public Notice 1986-54 and Telecom Order CRTC 86-516, Telecom Decision CRTC 88-7, 6 July 1988.

with supporting reasons (e.g. the ongoing changes in accounting procedures and the introduction of new services) and the issuance of public notices by the Commission to seek comments on any major changes in the Manual's procedures. Finally, Decision 88-7 established a staff review process to allow for the periodic examination of particular studies and procedures to identify possible refinements and improvements.

If there is agreement between the company and Commission staff a proposed modification of Phase III assignment procedures is submitted for approval through the established updating process. If there is no agreement, particularly with respect to a Commission staff proposal, then a public proceeding can be initiated and the Commission will make its determination on the basis of the written submissions received from interested parties.

Regulatory Use of Results: Once Phase III results were available, reported revenue shortfalls in competitive categories drew attention. Identification of such shortfalls was indicative of cross-subsidization from monopoly categories. Of course, the need for a method to identify such cross-subsidies had been the primary catalyst for the Cost Inquiry. In a couple of cases the Commission directed a carrier to take corrective rate action but there was concern that exclusive and continuous use of that remedy could have the effect of aggravating rather than correcting a revenue shortfall.

Subsequently, in Decision 89-12[13] the Commission articulated a general approach to address cross-subsidization concerns. The approach has three essential features. First, it was recognised that Phase II prospective economic studies are subject to uncertainty and, although services within a category will be at various points in their respective life cycles[14], a reported revenue shortfall in a Phase III competitive category is an indication that the actual performance of some services is markedly below predicted performance and that appropriate corrective action needs to be taken.

Secondly, the Commission noted that its legal authority permitted corrective rate action only on a prospective basis. Consequently, the Commission modified the filing requirements for Phase III results with a provision that carriers file annually, in September, audited results for the prior calendar year and then, in December, forecast results for both the current and upcoming year.

Thirdly, the Commission directed that, if a carrier's forecast Phase III results projected a competitive category shortfall, then a supporting analysis of the causes and possible remedies (i.e. rate increases, cost reductions,

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13 Bell Canada and British Columbia Telephone Company - Phase III Matters and Related Issues, Telecom Decision CRTC 89-12, 15 September 1989

14 Recently introduced services may not be immediately profitable in contrast to the more mature services.

abandonment of specific services) was to be submitted for the Commission's consideration.

In addition to detection of cross-subsidization, Phase III results are available to monitor the outcome of initiatives taken to move the general structure of telecommunication rates towards the underlying cost structures[15]. In fact, in Decision 85-19[16] the Commission, while not persuaded that full rebalancing was either necessary or desirable, indicated that economic and societal benefits would result from a reduction in the carriers MTS/WATS rates. As a result, the Commission adopted the principle that, for Bell and B.C. Tel, the existing total contribution from MTS/WATS rates (i.e. the revenue surplus in the Phase III Monopoly Toll category) should, at a minimum, not be permitted to increase. Indeed, in subsequent years MTS/WATS rates have been reduced substantially[17] although a number of factors in addition to the Commission's principle in Decision 85-19 were prompting these rate reductions. Regardless of the contributing factors, one may observe the broad effects of these initiatives in the Phase III results. The relative contribution towards the recovery of the very large Access category shortfall from the Monopoly Local versus Toll revenue surpluses can be used to identify the aggregate effect of rate rebalancing initiatives. Observation of Bell and B.C. Tel Phase III results over the 1987 - 1992 period suggests the beginnings of a decline in the relative contribution from the Monopoly Toll category.

Another use of Phase III results is displayed in Decision 92-12[18], which opened the Canadian MTS/WATS market to competition. Entrants are obligated to make a contribution payment. This payment can be viewed as an amount to replace that portion of the MTS/WATS surplus lost to entrants by the incumbent carriers or as the new entrant's proportionate contribution towards the recovery of the access-related costs. In this case, Phase III results provide the benchmark information to calculate the entrants' contribution obligations. Subject to several adjustments, Decision 92-12 defined the target contribution as the Access category revenue shortfall excluding all contribution payments resulting from Decision 92-12 and net of all revenue surpluses from all other Phase III categories except Monopoly Toll. In direct

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15 This trend towards cost-based rates particularly with respect to the provision of ordinary long-distance and local telephone services has been termed "rate rebalancing" in the Canadian regulatory context.

16 Interexchange Competition and Related Issues, Telecom Decision CRTC 85-19, 29 August 1985.

17 Bell reported in 1991 that since 1987 the average per cent decrease in rates for calls form Bell territory to the rest of Canada had been 51% and for calls within Bell territory the decrease had been 28%.

18 Competition in the Provision of Public Long Distance Voice Telephone Services and Related Resale and Sharing Issues, Telecom Decision CRTC 92-12, 12 June 1992

proportion to any shift towards cost-based pricing, including the possibility of explicit access-related tariffs, this target contribution amount will be diminished. Meanwhile, the annual filing of Phase III results will provide the benchmark data for the computation of the entrants' contribution payments as well as the means to monitor how this benchmark is being effected by market and pricing initiatives.

Finally, in Decision 86-5[19] the Commission concluded that once audited Phase III results were available it could consider applications to eliminate tariff filing requirements for PBX key systems and data terminal equipment identified in the Phase III CT(MD) category. It was noted that, in this instance, competitive markets could be relied on and, to protect the monopoly subscribers of conventional telephone service, the CT(MD) category would be expected to recover its total causal costs as well as make a contribution towards the recovery of the Common category costs. Audited Phase III results became available in late 1988 but in October of that year, the Federal Court of Appeal[20] ruled that existing legislation did not permit the Commission to remove a regulated carrier's obligation to file tariffs. Legislation is now pending which, among other matters would empower the Commission to forebear from tariff regulation as envisaged in Decision 86-5. Phase III results will provide the prerequisite information for these anticipated detariffing applications.

Corporate Use of Results: Regulated company officials indicated, during the formation of the Phase III conceptual framework, that revenue/cost information by broad categories was not required for corporate purposes. That view appears to have changed. For instance, without regulatory prompting, Bell aligned its operating revenue accounts with the Phase III categories in 1988 and introduced a revised expense account structure in 1991 to facilitate the matching of revenues and costs and the development of contribution margins. Likewise, MT&T had begun to develop its Profit Centre Reporting System before the Commission assumed jurisdiction over the company. Full implementation of MT&T's system designed to identify "the bottom line contribution of defined product/service groupings through the separation of accounting costs and revenues"[21] was targeted for December 1991. In a similar fashion, NB Tel independent of any regulatory initiatives, has developed its Management Information and Costing system in recognition that "strategic management of

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19 Participation of Bell Canada and British Columbia Telephone Company in the Multiline and Data Terminal Equipment Market Telecom Decision CRTC 86-5, 20 March 1986

20 Telecommunications Workers' Union v. CRTC and CNCP Telecommunications [1989] 2 F.C. 280

21 Quotation used with permission from an internal company presentation provided to the author during initial Phase III discussions with MT&T staff.

services requires good financial information and most current accounting/reporting processes were not service oriented"[22].

Moreover, there are reports that Bell and B.C. Tel have created management positions responsible for the financial performance of specific Phase III categories. MT&T reported that its reporting system had already helped managers to better target their operational and market initiatives and benefits had been realized through asset and inventory reductions, more focused product lines, improved cost control and improved billing and collections. Indeed, this growing corporate demand for supplementary accounting information that links revenues and costs with business segments has been discussed in recent academic and trade literature[23]. While the categories or segments required for regulatory versus corporate purposes may differ, the need for disaggregated activity-based accounting information is now being driven by more than regulatory cross-subsidization concerns. Acknowledgement of this common ground between regulatory agencies and regulated companies has the potential both to provide better focus and to foster better performance in both regulatory and corporate environments.

<u>Emerging Issues</u>: Two specific issues related to Phase III results are now under active consideration. The first relates to a planned subdivision of the existing Phase III Access category and the second relates to an examination of the costs incurred in the companies' own use of its telecommunications facilities for administrative purposes.

As far back as Decision 85-10, it had been noted that the large revenue shortfall in the Access category would, under existing tariff arrangements, be recovered through contributions from the other Phase III categories. However, it was stated, at that time, that access costs might, in the future, be recovered, in whole or in part, by a separate set of tariffs designed for that purpose. Subsequently, Decision 88-7 concluded that there was a need to proceed with a disaggregation of the Phase III Access category costs into appropriate subcategories. Terms of reference for this subdivision of the Access category were announced in Decision 90-20[24] with provision for staff discussions both to reconcile the Commission's requirements for access cost information with the practical capabilities of the carriers' data bases and information systems and to develop implementation schedules. These

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[22] Quotation used with permission from an internal company presentation provided to the author during initial Phase III discussions with NB Tel staff.

[23] See H. Thomas Johnson and Robert S. Kaplan, <u>Relevance Lost: The Rise and Fall of Management Accounting</u>, Boston: Harvard Business School Press, 1987, and a recent collection of articles in a Harvard Business Review paperback No. 90028 entitled <u>Getting Numbers You Can Trust - The New Accounting</u>.

[24] <u>Bell Canada and British Columbia Telephone Company - Terms of Reference for Access Studies</u>, Telecom Decision CRTC 90-20, 7 September 1990

discussions were summarized and issued by staff as the Access Study Guidelines[25] in August 1991 with subsequent approval by the Commission in April 1992 (Telecom Order CRTC 92-529).

By March 1993, Bell and B.C. Tel are each to submit a draft Access Study Manual capable of subdividing the plant investment, revenues and expenses associated with the existing Access category into five subcategories. The three primary subcategories are defined as follows:

(i) Residential Access shall include all carrier provided facilities and equipment defined as Access and required to provide residential subscribers with access to the public switched telephone network.

(ii) Business Access shall include all carrier provided facilities and equipment defined as Access and required to provide business subscribers with access to the public switched telephone network.

(iii) Other Access shall include carrier provided facilities and equipment defined as Access and required to provide dedicated access that is not connected to a telephone company central office; or access to other than public switched telephone network services that is connected to a telephone company central office.

Discussions indicated the possibility of a small component of cost which can be causally linked to the Access category taken as a whole but not to any one of the three primary subcategories (e.g. certain research and development expenses). Therefore, provision was made for an Access-Common subcategory. There was also discussion of the appropriate treatment of those charges intended to compensate for the contribution towards the recovery of Access category costs which would have made by the incumbent carrier's revenues but which are displaced by facility-based competitor's or reseller's services. It was concluded that these contribution revenues should be disassociated from the recurring revenues for those access facilities actually furnished to competitors and resellers. Further, it was observed that these revenues are available for recovery of the combined costs associated with the Residential and Business Access subcategories, but there is no causal basis to subdivide the contribution revenues between these subcategories. Therefore, provision was made for an Access-Contribution subcategory.

The implementation schedule accepted by the Commission anticipates that the Access Study Manual will be approved by September, 1993 but Bell and B.C. Tel have been directed to file by November, 1993 an initial set of unaudited results for the five subcategories using the draft assignment procedures.

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[25] CRTC Staff Detailed Access Study Guideline Resulting from the Detailed Definition Process Pursuant to Telecom Decision CRTC 90-20, 22 August 1991

These subdivided Access results will be available to focus and inform the ongoing policy debate as to how best to recover access-related costs. This debate will sharpen to the extent that market circumstances move telecommunications rates, particularly for conventional telephone services, towards cost thereby diminishing the revenue surpluses now being used to recover Access category costs.

The second emerging issue relates to the costs incurred by regulated carriers as a result of Official Telephone Service (OTS). Telecommunication services are used by the carriers for both the routine administration of their business affairs and the monitoring, surveillance and test activities to maintain the operational integrity of the networks. OTS is that portion of the telecommunications services used by a carrier in its administration activities but not its network management activities.

Bell and B.C. Tel introduced a net adjustment for OTS services into the initial 1986 Phase III results. The net adjustment takes into account, for example, that the company's employees may make extensive use of facilities associated with the MT category but that use may be in a certain case sales advice for the initial installation of service (i.e. an Access category activity) and in another case design information for a large private line data network (i.e. a CN Category activity). As a result, the OTS adjustment nets the cost value of the official services used in a category's administrative support against the cost value of the official services supplied by that category.

The original guidelines had not provided for any explicit recognition of OTS in the calculation of Phase III results. Later, in Decision 88-7, the Commission concluded that it was appropriate to define a Phase III procedure for the treatment of OTS but found the proposed calculation procedures in part unacceptable. Subsequently, in Decision 89-12 revised calculation methods were approved.

A formal application by Unitel in late 1990 identified a number of concerns with OTS and requested that an oral hearing be held. Decision 91-18[26] concluded that, rather than an oral hearing, an on-site review of the companies' provisioning and use of OTS was a more appropriate way of addressing Unitel's concerns.

The objectives of the OTS Review, set out in Decision 91-18, were to obtain and assess information relating to criteria used to distinguish between the facilities and equipment used for the administration of the carriers' business affairs and those used for monitoring, surveillance testing and other operational purposes; specific inclusions which comprise OTS; and, procedures used to request, approve and implement OTS. Decision 91-18 indicated that the primary purpose of this process was to provide the Commission with sufficient

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[26] Unitel Communications Inc. v. Bell Canada and British Columbia Telephone Company - Official Telephone Service and Phase III Competitive Network Category Results, Telecom Decision CRTC 91-18, 28 November 1991

information to make meaningful determinations concerning the level of costs incurred for OTS and the degree to which the incurring of those costs is contributing to the overall operating efficiency of the companies.

Decision 91-18 indicated an intention to issue a report in mid-1992 at which time appropriate action, including the possibility of a public proceeding, would be considered. Release of the report is expected in September, 1992.

OTS represents a corporate expense which has always existed, but which did not warrant explicit identification. That changed with the initial production of Phase III results. There are indications that the effort to identify this corporate expense in an explicit fashion has sharpened management's awareness of this rather significant expense factor in the operation of a modern telecommunications carrier.

Conclusion: The identification of a carrier's revenues and costs by broad categories is not costless. The Canadian experience to date, however, suggests that the benefits resulting from the use of Phase III information in both regulatory and corporate circumstances outweigh the costs of costing.

1. <u>Access (A)</u>

The facilities associated with the Access category and their associated costs are composed of three separate components: the subscriber premises equipment, the loop, and the serving central office equipment.

a) Subscriber Premises Equipment

Costs related to the equipment and connections provided on a monopoly basis pursuant to <u>Attachment of Subscriber-Provided Terminal Equipment</u>, Telecom Decision CRTC 82-14, 23 November 1982, are to be included in the Access category. In some cases, costs associated with terminal equipment used to provide the subscriber with access to a service which can only be provided by the carrier are to be included in the Access category. A specific example of the above equipment is the PBX line card required for a centralized emergency reporting system.

All other subscriber premises equipment and connection costs are to be included in either the Competitive Network or the Competitive Terminal categories. Unless otherwise specified with supporting reasons by the carriers, the boundary between the Access and Competitive Terminal categories is the demarcation point on the customer's premises.

b) Loop

The loop component includes all costs associated with: (i) the provision by the company, for any purpose, of an interconnecting facility between a customer's premises and the nearest serving central office, and (ii) the termination and protection of the interconnecting facility at both the customer's premises and the serving central office.

These interconnecting facilities normally will consist of outside plant but will also include related equipment required to derive the interconnecting capability, e.g. subscriber line carrier systems, and line concentrator equipment. The interconnection may also be provided by a radio system, in which case the loop component includes all costs associated with the radio base station equipment and interconnecting facilities to the serving central office.

c) Serving Central Office Equipment

The costs associated with all non-traffic sensitive central office switching equipment components required to provide customer access to the public switched telephone network are to be included in the Access category.

The costs associated with central office located equipment components required specifically to derive the loop facility, such as subscriber line carriers and line concentrators, are to be included in the Access category while those associated with the service specific equipment such as the circuit conditioning and signalling equipment are to be included as appropriate in the Monopoly Local, Monopoly Toll or Competitive Network category.

2. <u>Monopoly Local (ML)</u>

The Monopoly Local service category is to include the costs related to the provision, operation and maintenance of those local switching equipment and interoffice transmission facilities required to establish and maintain communication services within the local calling area that generally are not provided by another supplier.

3. <u>Monopoly Toll (MT)</u>

The Monopoly Toll service category is to include the costs related to the provision, operation and maintenance of the switching equipment and transmission facilities required to establish and maintain communication services between local calling areas that generally are not provided by another supplier.

4. <u>Competitive Network (CN)</u>

The Competitive Network category is to include the costs related to the provision, operation and maintenance of those facilities required to establish and maintain communication services that are, or can be provided by another supplier, with the exception of the facilities included in the Access category.

The costs associated with terminal equipment which is specific to competitive network service and is company provided as an integral part of the service, are to be included in this category.

5. <u>Competitive Terminal - Multiline and Data [CT(MD)]</u>

As specified in Decision 86-5, the costs and revenues associated with the Competitive Terminal category are to be subdivided into two distinct service categories, Competitive Terminal - Multiline and Data, and Competitive Terminal - Other. The CT(MD) category will include the costs associated with key telephone systems, PBX systems and all telephone sets behind key and PBX systems including those behind Centrex systems subject to the final determination regarding the classification of proprietary sets and consoles. A detailed discussion of Centrex services including this matter, follows in subsection C. The costs associated with all data terminal equipment at the customers' premises not integral to the operation of the channel provided by the carrier is also to be included in the CT(MD) category. This category also includes the costs associated with inside wiring on the customer side of the service demarcation point associated with the multiline and data terminals. The costs associated with terminal equipment which may be located on a customer's premises but is provided by the company as an integral part of a network service shall be included as appropriate in the Competitive Network, Monopoly Toll or Monopoly Local categories.

6. Competitive Terminal - Other (CT-O)

The costs associated with terminal equipment other than that which is identified above is to be included in the Competitive Terminal - Other category. This will consist primarily of the costs associated with single-line telephone sets.

7. Other (O)

The Other service category is to include the causal costs associated with activities and services which, in general, do not relate directly to the provision of telecommunication services and are not included in the other service categories. Examples of inclusions in this category are:

- Building space rented to others.
- Subscription charges for tariffs.
- Arrangements for cable-television lessees.
- Billing service arrangements for CNCP.
- Communications seminars.
- Data processing for BCE.

8. Common (C)

The common category is to include costs which cannot be causally related to a particular service category and which, with the support of empirical evidence, are shown to be fixed.

Source: Telecom Order CRTC 86-516, 28 August 1986, pp. 9-13.

MARGINAL COSTS AND INVESTMENT UNDER UNCERTAIN DEMAND CONDITIONS[1]

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New telecommunications technologies such as digital switches and fiber optics allow telephone companies to provide a wide range of new services. However, the provision of these new technologies complicates the regulation of telephony, especially the pricing of services. When a local telephone company provides both basic services and new competitive services, there are incentives for cross-subsidies and predatory pricing[2]. The telephone company may set prices below costs for the new services and try to recover these costs from ratepayers in regulated basic services.

An inevitable question in addressing such issues is the calculation of the marginal cost of services. For some regulated telecommunications companies, long run marginal (incremental) costs (LRIC)[3] are used as a basis for efficient pricing as well as for examining cross subsidies and predatory pricing. Since most services in the telecommunications network require lumpy and recursive investment, the relevant cost for pricing services has often been the long run marginal cost which allows adjustment of all input factors.

In this paper I present a model for deriving long run marginal costs for services requiring lumpy investments. Although the model is developed for investment in digital switches, the analysis can be extended to other lumpy investment such as airports, bridges, highways, and other infrastructure.

Most telephone companies use the capacity cost method as a surrogate for long run marginal cost. The capacity cost method is simple in principle. The marginal unit for the capacity cost is the marginal equipment or the capacity of the marginal equipment.

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[1] The views expressed in the paper do not necessarily reflect those of the Commission or other Commission Staff.

[2] See Faulhaber (1975) on cross subsidies issue.

[3] We use the terms long run incremental cost (LRIC) and long run marginal cost interchangeably.

The capacity cost of service is the ratio of the outlay on the marginal equipment divided by its capacity; capacity is the maximum unit of service the equipment can provide.

Advocates of the capacity cost method argue that the marginal cost analysis does not apply to telephony because of the complexity of the communications network, and that the capacity cost concept is a good approximation for long run marginal cost. Also, some authors claim that capacity cost is exactly equal to the long run marginal cost under reasonable economic assumptions[4]. Thus, it is worth clarifying the linkage between capacity cost and long run marginal cost.

In essence, capacity cost assumes that services are homogeneous and that demand is perfectly predictable. Thus, the usefulness of the capacity cost concept is limited when services differ in their demand variability or uncertainty. The demand for new services is more uncertain and volatile than the demand for the basic services. Consequently, investment decisions under demand uncertainty would be different from the more certain cases. This observation is relevant for pricing services because long run marginal costs and investment decisions are jointly determined.

Consider a telephone company that provides services on a going concern basis. It faces recursive and lumpy investments because most services in the telecommunications industry require lumpy investments: the large investment of switched network is an example. Then, the relevant cost is the forward looking opportunity cost or the long run marginal cost.

We show that LRIC of a service depends on the demand uncertainty. Usually, the demand for the basic services is stable, while the demand for new competitive services is expected to be uncertain. We show that under this condition, it is more costly to meet the demand for new service than to serve the basic service, plain old telephone service (POTS). Consequently, LRIC of new or competitive services should be higher than that of basic services[5].

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[4] For instance, see Foster and Bowman (1989). Footnote 6 has a summary of their argument.

[5] As Stigler (1939) pointed out, plant may be planned to provide flexibility of output even if this involves higher costs. For instance, consider the inventory management of a grocery store. Since demand for groceries fluctuates during the week and the seasons, store managers keep inventories. Store managers pay when goods are delivered to the store, and the interest cost is incurred until the good is sold. This interest cost is part of the price consumers pay. Thus, goods with fluctuating demand will incur higher interest costs and price markups than those of goods with predictable demand.

In Section I, Boiteux's peak-load pricing is discussed which introduces the capacity cost method. Section II develops a model for recursive investments for a community where the demand for services grows over time. By allowing all possible adjustments in input factors (plant facilities and operating costs), LRIC reflects the firm's intertemporal decisions. The model introduces the demand uncertainty and the firm's investment decision explicitly. Consequently, investment schedules and long run marginal costs are jointly determined.

Section III derives the long run incremental cost (LRIC) for a reasonable investment strategy under uncertain demand. Conditions are examined under which the capacity cost is a good approximation for LRIC. These conditions indicate that capacity cost can be a poor surrogate for the long run marginal cost (LRIC) for investments that require high fixed costs and face demand uncertainty. Section IV provides concluding remarks.

I. Capacity Costs

This section discusses the capacity cost concept by Marcel Boiteux and others. The main idea is summarized in Boiteux (1960). We start with an example that will show the deceptive simplicity of the "capacity cost." Suppose one unit of equipment (say a digital switch) costs one million dollars and can serve a maximum of 10,000 units of services (say access lines). For simplicity, operating costs are ignored at this level of analysis. The capacity cost of access line service is simply \$100 per service: \$1,000,000÷10,000 = \$100.

This may be a reasonable way of computing the unit cost of service when demand remains constant. However, if demand grows over time, ultimately equipment must be added to meet the growth. If the equipment comes only in large capacity units, then investment will be lumpy and recurring. This is a realistic assumption for investment in modern digital switches, highways and other infrastructure. Unlike in the static case, unused capacity may exist for some of the time, but the capacity cost cannot tell the difference: the capacity cost is still \$100 because the outlay and capacity of the equipment have not changed. The question is then, what is the cost of serving additional demand when there is unused capacity?

The answer will depend on how the additional demand is viewed. One response to this question has been that the marginal cost is zero, and the additional service should be free (assuming zero operating costs). This would be the case if the additional demand is temporary and the duration of the additional service is short

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enough that the placement schedule of investment remains undisturbed. But if the additional demand is permanent, the placement schedule will be affected, and the demand would cause additional costs to the firm. The long run marginal costs under this condition of demand are presented in Section II.

Boiteux maintains that marginal costs differ according to whether they are planned to produce the extra unit "once-only" or to permanently raise by one unit the "flow" of output. His example of "extra passenger" is instructive. A train is about to leave, and there is one empty seat. A passenger arrives. The cost of carrying this extra passenger is zero (again assuming zero operation cost). But the same argument is valid for all the empty seats that there may be in the train. Then, the optimum rate as is understood by the marginal theory is zero.

To correct the argument of "extra passenger," Boiteux treats the railway car, not the seat, as the marginal unit, while implicitly assuming that an optimum size of investment is chosen. Thus follows Boiteux's conclusion that the service must be priced at marginal development cost or the capacity cost.

II. Model for Recursive Lumpy Investment

A dynamic model for lumpy investment is formulated in this section, and the long run marginal costs are derived under uncertainty in the following Section III. In developing models for pricing public utilities, Turvey (1969) emphasized that both cost and output have time dimensions, and that both may be subject to uncertainty. Thus, for a cost analysis to be useful in decision-making, it has to be dynamic (intertemporal) rather than static.

Turvey assumes that all equipment is fully utilized. This may be a reasonable assumption in many cases, but would be inappropriate for investment in telecommunications infrastructure which we wish to analyze, because demand for service is growing over time, and new equipment has to be added to meet the growing demand. If the available capacity unit is large relative to the service unit, then the investment is lumpy and new capacity is underutilized. Future demand will be met by recursive investment. Given a long-term forecast for demand, a cost minimizing capacity expansion path is generated, and the total cost, the present value of the whole future costs, can be calculated.

Long run marginal cost (LRIC) is calculated by considering two scenarios. Consider an alternative path of demand growth, and calculate the total cost of alternative capacity expansion. The difference between the two costs is the incremental cost in meeting new demand path.

To be more formal, consider two scenarios: the "baseline" service is growing over time (scenario 0), and the "alternative" (scenario 1) is a higher level of service growing at the same rate as the baseline (see Figure 1). We assume that the demand for services grows at a rate g (units of service per period). Then, the demand at time t is

(1) $$D_t = D_0 + gt$$

where, for convenience, we assume the initial demand D_0 is zero. To meet the steady growth of demand, there corresponds a schedule of investment separated by regular time intervals, which we call the "placement interval" (see Figure 1). (Note that we described the demand without any consideration of price change. This can be justified by the principle of stable ratemaking.)

Now the supply side is described. Let "I" denote the outlay on the equipment; the capacity of the equipment is Q units of services. For convenience, assume the equipment lasts forever, without depreciating. This assumption does not affect the result. We also assume that there is no technological change.

Then, the "placement interval" N is given by

$$N = Q \div g$$

and the time schedule of adding equipment is

$$t_0 = 0,\ t_1 = N,\ t_2 = 2N,\ \ldots$$

The total cost (TC) of the baseline scenario is the present value of investment outlays, given the discount rate r,

$$TC(0) = \sum_{i=0}^{\infty} I \div (1+r)^{iN} = I * \{1 + 1 \div [(1+r)^N - 1]\}.$$

Suppose there is a new arrival of demand, which causes a permanent demand increment by m units for each period. For convenience, the incremental demand as a fraction f of the capacity is

$$m = fQ,\ 0 < f < 1.$$

The demand flow of the alternative schedule is

$$D'_t = fQ + gt.$$

The alternative scenario requires placement intervals move forward by fN periods (see Figure 1),

(2) $$0,\ t_1 = N-fN,\ t_2 = 2N-fN,\ \ldots$$

The total cost of the alternative investment schedule is

$$TC(1) = I*\{1 + 1\div(1+r)^{N-fN} + 1\div(1+r)^{2N-fN} + \ldots.\}$$
$$= I*\{1 + (1+r)^{fN} \div[(1+r)^{N} - 1]\}.$$

Then the incremental cost (IC) is the difference between the two total costs, the present values of the two investment schedules:

(3) $$IC = TC(1) - TC(0)$$
$$= I*[(1+ r)^{fN} - 1]\div[(1+r)^{N} - 1].$$

The present values usually apply to cash flows expressed in nominal dollar terms. For non-monetary quantities, time discounting is a dubious practice unless the price is fixed over time. Assuming stable ratemaking, service price remains a constant. This assumption justifies present values of demand, though the assumption is not part of the marginal cost theory.

Based on this qualification, the present value of the demand increment is

(4) $$dD = fQ*\{1 + 1\div(1+r) + 1\div(1+r)^2 + \ldots\} = (fQ)(1+r)/r.$$

III. <u>LONG RUN INCREMENTAL COST</u>

The long run incremental cost (LRIC) is simply equation (3) divided by equation (4),

(5) $$LRIC = IC \div dD = \frac{rI \quad \{(1+r)^{fN}-1\}}{(1+r)fQ\{(1+r)^{N}-1\}} \quad .$$

In computing LRIC it was assumed that new demand arrives at the time of new investment (at time 0). However, new demand may arrive any moment while new equipment will have unused capacity. In this case, the LRIC of services may change over the life of the equipment. When the equipment is first installed, capacity is relatively abundant and the shadow price of capacity is low; whereas, as the unused capacity is filled, the shadow price is higher[6]. LRIC is higher right before, than right after the installation of the equipment.

Thus, it is desirable to express LRIC as a function of the arrival

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[6] Note that the shadow price is not zero even if there is excess capacity. In a static model the shadow price is zero if there is excess capacity.

time and size of new demand. Equation (5) provides the incremental cost right after the installation, and this is denoted by LRIC(0) if necessary to avoid confusion.

Suppose a new demand (in the same amount fQ) arrives at time t and stays for good. The present value of the new demand will be

$$dD_t' = (1+r)^{-t}dD_t$$

$$= (1+r)^{-t}fQ(1+r)/r$$

where dD_t comes from equation (4). If a new demand of size fQ arrives while there is available capacity, the new demand will be met by existing capacity. This is the case if the arrival time t is in the interval $0 \leq t \leq N\text{-}fN$. The investment plan is according to equation (2), and the LRIC is the incremental cost in equation (3) divided by the incremental demand dD_t' above,

$$\text{(6)} \quad LRIC(t) = IC \div dD_t'$$

$$= (1+r)^t LRIC(0) \quad \text{for } 0 < t < N\text{-}fN.$$

The long run marginal cost in equation (6) is greater than the LRIC in equation (5) because of the accumulated interest cost until t when new demand arrives.

It should be noted that formula (6) holds for new demand arriving between time periods 0 and N-fN, when there is sufficient capacity to serve new demand. What if new demand arrives when there is not sufficient capacity (i.e., the available capacity is less than fQ)?

If the company knows the exact timing of new demand, or if new demand can be served by an immediate addition of new capacity, an optimal strategy would be to install new equipment immediately upon new demand[7]. This assumption is not realistic, however, because

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[7]. This is the assumption made by Foster and Bowman (1989). Under this assumption Foster and Bowman show that LRIC is equal to capacity cost. It is not difficult to provide an intuitive explanation. In Foster and Bowman, new demand is met either by the existing capacity or by an immediate addition. In either case, new demand does not incur interest costs that is the opportunity cost of any additional capacity above status quo. Consequently, LRIC is exactly equal to the capacity cost.

The investment plan of Foster and Bowman scenario depends on the arrival time. If the new demand arrives within the time interval $0 < t < N\text{-}fN$, then the investment plan is the same as equation (2) in Section (II), adding new capacity in infrastructure like a digital switch requires adequate lead time and uncertain demand requires capacity installed in advance.

To analyze investment plans under uncertain demand, we assume random arrivals of new demand. Under such conditions it is well known in management science that the firm maintains inventories or spare capacity to meet demand fluctuations[8]. Stigler (1939) also observes that plant may be planned to provide flexibility of output even if this causes additional costs.

The appropriate investment strategy under demand uncertainty is to install a new capacity (equipment) when the remaining capacity is fQ, the size of additional demand, whether or not new demand has actually arrived. This strategy reflects the firm's "going concern" nature and optimizing behavior under uncertainty as well.

(A.1) $\quad 0,\ N-fN,\ 2N-fN,\ \ldots$

If the new demand arrives after N-fN, then the remaining capacity is not sufficient to meet the new demand; the size of new demand is fQ. In this case, Foster and Bowman assumes that new equipment will be installed immediately. Suppose new demand arrives at t after time N-fN. Then, the investment schedule will have to change accordingly,

(A.2) $\quad 0,\ t,\ 2N - fN,\ 3N - fN,\ \ldots$

Following the same procedure used in the paper, the total cost and the incremental cost for Foster-Bowman case can be obtained. Then calculate the ALRIC by integrating over the interval (0, N0) and obtain the Foster-Bowman result

(A.5) $$\text{ALRIC} = \frac{rI}{(1+r)Q}\ .$$

[8] See Scarf (1960) and Yoon (1985) for application of (s, S) inventory models in economics. Consider a retailer who faces economies of scale in making orders. The (s, S) policy is characterized by two critical numbers, the low case s and the upper case S. If the inventory is above the level s, no orders are made; when inventory falls below s, then orders are made to bring the inventory level up to S. This feature of (s, S) models is useful in analyzing recursive lumpy investment. An investment in equipment involves a fixed cost and the variable cost that depend on the capacity. The (s, S) optimal policy suggests an optimal size S for the equipment and a deployment decision of installing a new capacity if the remaining capacity is s. This model provides a tractable method of calculating LRIC under uncertain demand conditions more general than the case treated in this paper.

If the firm notices there is insufficient capacity to meet possible new arrival, to avoid the cost of adding capacity on short notice or losing customers (or failing to serve customers in case of going concern), the firm installs new capacity in expectation of the need.

For new demand arriving during the period N-fN and N, LRIC can be obtained by comparing the two total costs. The placement schedule is exactly the same as that for the "alternative" case in equation (2), and the same formula (4) applies for demand (see figure 2).

Assuming that the arrival of new demand is uniformly distributed over the N periods, the time average of long run incremental cost (ALRIC) can be calculated. The ALRIC can be considered as a relevant cost for stable rate making:

$$(7) \qquad ALRIC = \frac{1}{N}\int_0^N LRIC(t)\, dt$$

$$= \frac{rI*[(1+r)^{fN}-1]*[(1+r)^N-1]}{N*\ln(1+r)\ \ (1+r)*fQ*[(1+r)^N-1]}$$

$$= \frac{rI}{(1+r)*Q}\ \frac{[(1+r)^{fN} - 1]}{fN*\ln(1+r)}\ .$$

We note that ALRIC is a product of annualized capacity cost, rI/(1+r)Q, and the correction factor. For an infinitely small demand increment, ALRIC becomes the annualized capacity cost. By taking the limit as the fraction f goes to zero, we obtain

$$(8) \qquad \lim_{f\to 0} ALRIC = [rI\div(1+r)]\div Q$$

$$= \text{Annualized cost of investment} \div \text{capacity}$$

$$= \text{Annual capacity cost,}$$

where rI÷(1+r) is the annualized cost of the investment. The implication of the result in (8) is that the cost of serving a small demand increment is approximately the capacity cost.

IV. Critique of the Capacity Cost Method

A common practice in telecommunications costing has been the

capacity cost method. The standard argument in support of the capacity cost method has been that capacity cost is a good surrogate for long run incremental cost (LRIC) because it is theoretically sound and administratively simple. Perhaps this would be the case if capacity could be added in small size.
We note that technological conditions in telecommunications determines not only the kinds of new services to be provided, but also the market structure and the adequacy of economic cost concepts.

In Section III it was shown that LRIC is not equal to capacity cost unless demand is known with certainty. New competitive services are expected to face uncertain demand conditions than are plain old telephone service (POTS). The uncertain demand condition is expressed by the random arrival and the size of new demand, which reflects the variation of demand over the trend.

Conditions under which capacity cost is a good surrogate for LRIC can be obtained by examining equation (7), which expresses ALRIC as a product of capacity cost and the correction factor. The conditions demonstrate limitations of the capacity cost concept as costing method for investment in infrastructure. The capacity cost method will be a reliable device for calculating LRIC only under the following limited conditions:

(1) the placement period (N) is short;
(2) the size of demand increment (f) is negligible;
(3) there is no technological change.

Condition (1) implies that the capacity of equipment is small relative to the demand growth. Investment in durable infrastructure usually fails to meet this condition. Condition (2) indicates that the demand is stable and predictable, which would be the case for plain old telephone services (POTS), but not for new competitive services. Condition (3) matters, but is not discussed here.

Since the long run marginal cost from equation (7) is a product of capacity cost and the correction factor, the discrepancy between marginal cost and capacity cost can be measured by the quantity (correction factor - 1). This quantity tells the accuracy of capacity cost as a surrogate for long run marginal cost.

The accuracy or the error margin of capacity cost is reported in Table 1. Therein, capacity Q is unity (1), and the discount rate is 10% ($r = 0.1$). The growth rate in the baseline is denoted by g, and the replacement interval is $N = Q/g$. The table shows that the error margin increases with the summary statistic fN. The term fN can be rewritten as $fN = fQ/g$: the size of the demand variation relative to the rate (g) of general demand growth. This is not surprising because fN is a measure of demand uncertainty in the model, which can be interpreted as the portion of demand that is not captured by the trend.

V. Conclusion

The paper has developed a model for recursive and lumpy investment in infrastructure, and derived the long run marginal cost (ALRIC) of service under uncertain demand. The linkage to capacity cost is also obtained by expressing ALRIC as a product of capacity cost and the correction factor.

Two kinds of uncertainty are considered in this paper. The size of new demand arrival is a measure of demand uncertainty. Another kind of uncertainty is the timing of arrival. It is assumed the size of arrival is known, but the arrival time is random. Thus, a measure of uncertainty in this paper is the variability of the service away from the trend, which is the baseline.

Under conditions of demand uncertainty, which we believe are important aspects of new telecommunications services, the firm will use an investment strategy that adjusts to anticipated uncertainty. The firm would meet the demand as a going concern; or the firm may try to maximize expected profit by providing some flexibility in the form of inventories or excess capacity. In either case, the strategy is to add new capacity when the firm notices the remaining capacity is not sufficient to meet expected demand.

From the proposed model, the long run incremental cost of service is calculated. The main result is that capacity cost is a good surrogate for LRIC only for stable and predictable services. For a service with uncertain demand, capacity cost can be a poor substitute and needs adjusting. For instance, as is demonstrated in Table 1, if the equipment lasts 20 years (an approximate lifespan of a switch), and the demand fluctuation of a new service is expected to be 10% of the equipment's capacity, then the LRIC is about 11% higher than the capacity cost.

Table 1.a
Q = 1, r = 0.1, N = Q/g.

g \ f	0.05	0.1	0.2	0.4
5 % (N=20 yrs)	1 % (fN=1)	11 % (fN=2)	22 % (fN=4)	50% (fN=8)
10 % (N=10 yrs)	1 % (fN=0.5)	1 % (fN=1)	11 % (fN=2)	22 % (fN=4)
20 % (N=5 yrs)	1 % (fN=0.25)	1 % (fN=0.5)	1 % (fN=1)	11 % (fN=2)
50 % (N=2 yrs)	1 % (fN=0.1)	1 % (fN=0.2)	1 % (fN=0.4)	1 % (fN=0.8)

Table 1.b

fN	Correction
0.1	1 %
0.2	1 %
0.4	1 %
0.8	1 %
1	1 %
2	11 %
4	22 %
8	50 %

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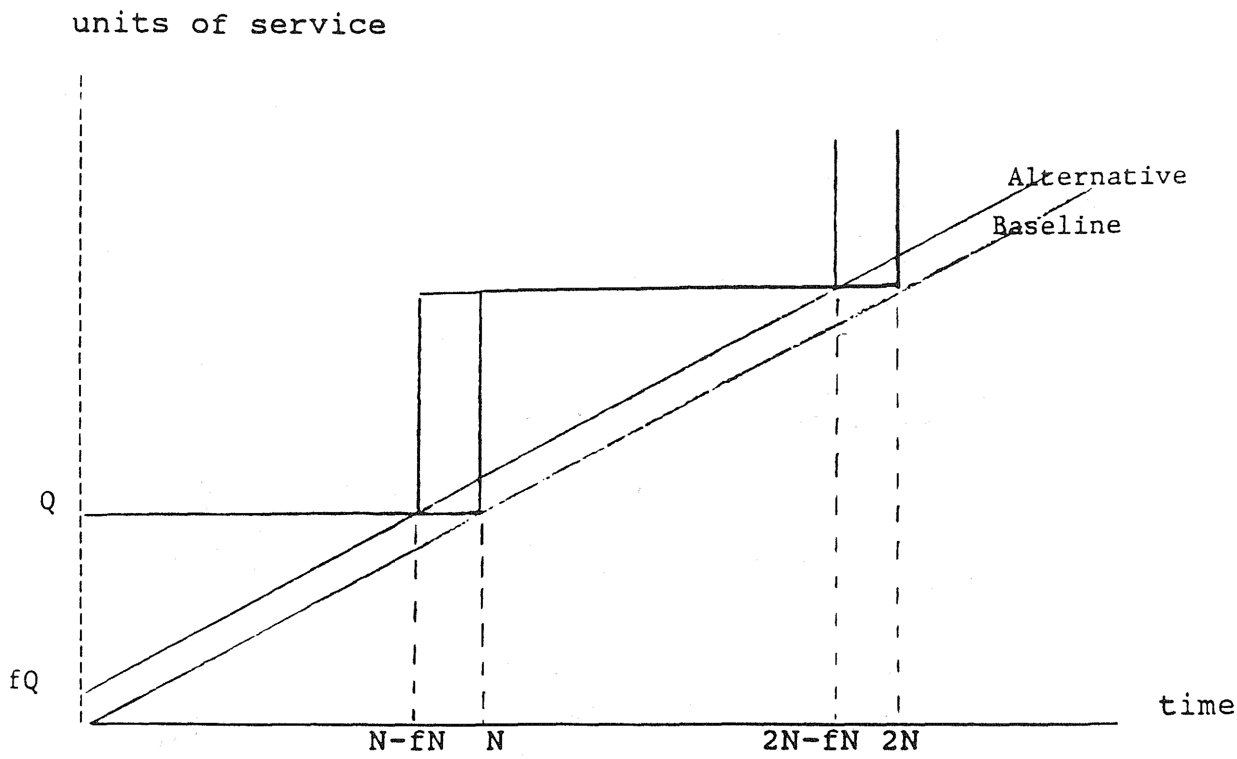
Figure 1



Note. N is the placement interval.

Figure 2 The model in this paper

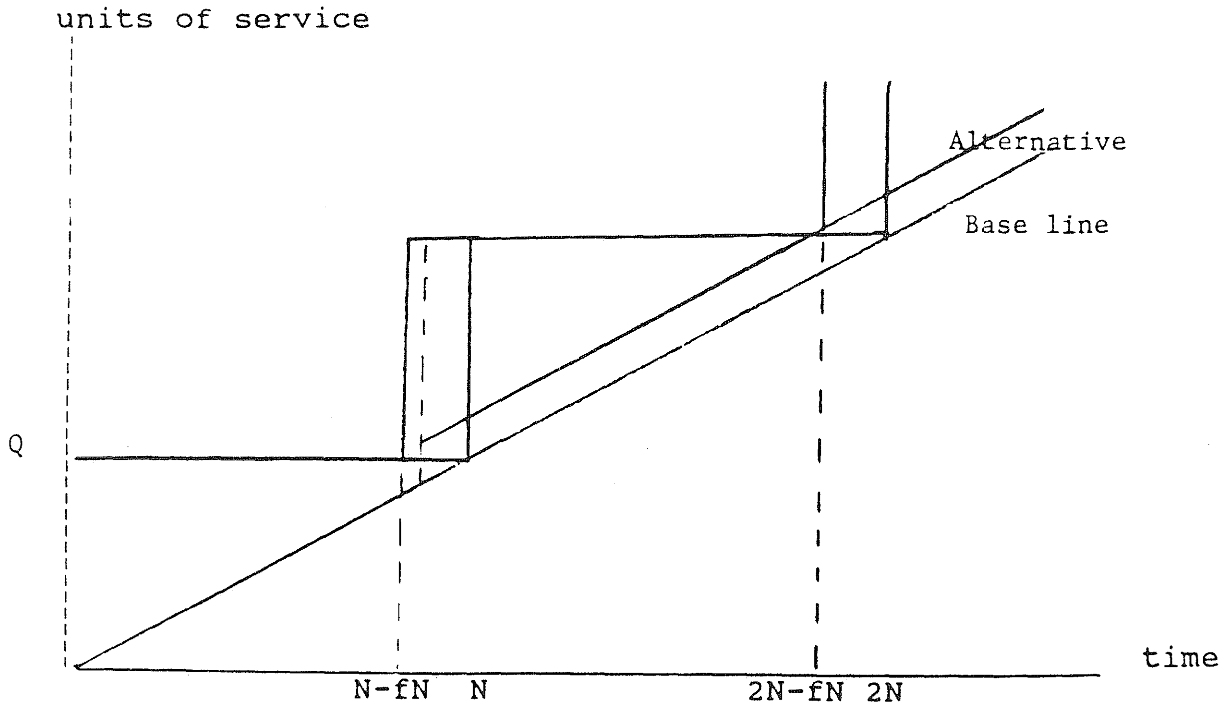


Figure 3. Foster and Bowman model