NRRI 89-8

LETTER REPORT

of

POINT-TO-POINT MARGINAL COST MODEL FEASIBILITY STUDY

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November 1988

This report was prepared by The National Regulatory Research Institute (NRRI) with funding provided by participating member commissions of the National Association of Regulatory Utility Commissioners (NARUC).

PART 1

INTRODUCTION

Since the early part of this century, the telephone industry in the United States and most other countries has been characterized by a monopoly market structure in the provision of customer premises equipment, local network services, and long-distance services. There was an underlying belief that the cost structure was one of decreasing average costs and that social welfare would be maximized with a regulated monopoly structure. However, recent technological advances in microelectronics, such as digital switching, microwave transmission, and remote control systems, combined with increasingly diverse customer needs, have led to a reconsideration of the merit of the monopoly structure for all segments of the industry. The one view is that economies of scale are no longer substantial in telecommunications and, therefore, competitive entry is not inconsistent with cost efficiency. For one overview of the evolution of the telecommunications industry, see Brock (1981).

The divestiture of the Bell System has opened the long-distance telecommunications market to competitive entry. Competition is now also reaching local systems, and the need for local exchange companies to compete with local bypass systems, which provide local telecommunication services (e.g., via microwave, mobile telephones, etc.) without the use of the established public network, is increasing the pressure to move away from traditional pricing practices, mostly based on the value-of-service concept, towards prices that are more closely tied to the real cost of providing local exchange service.

Economic theory shows that maximizing the social welfare function (defined as the sum of consumers' and producers' surplus) requires that prices be set equal to marginal costs, with $P_i = MC_i$, where P_i and MC_i are the price and marginal cost for telecommunication service i (e.g., access, local transport, intraLATA toll, interLATA toll, etc.). Second-best efficient pricing is necessary, however, when the firm operates under decreasing costs conditions and a profit constraint. Welfare maximization then requires that prices verify the condition $(P_i - MC_i)/P_i = k/E_i$, where E_i is the demand elasticity for service i, and k is the Ramsey number (Baumol and Bradford, 1970). Ramsey pricing suggests that the service with the greatest elasticity is priced closest to its long-run marginal cost.

Whatever the telephone company's constraints, efficient pricing requires knowledge of the marginal costs of the various services provided. However, there is little agreement as to a sound methodology for calculating these marginal costs. The literature review presented in part 3 suggests two general approaches: (1) econometric estimation of telephone cost functions, and (2) engineering cost analysis. The present study is to assess the feasibility of a third approach: the use of telecommunication network optimization models for estimating temporally and spatially disaggregated marginal costs.

The remainder of the report is organized as follows. Part 2 provides an overview of telephone exchange technology, including a clarification of the basic cost trade-off between transmission and switching, which is central to the proposed point-to-point optimization model. Part 3 consists of a literature review, covering econometric, engineering, and optimization approaches to telecommunication cost analysis. This review has led to the general formulation of the proposed point-to-point marginal cost model as well as to the delineation of the various data needed to test and implement that model. Part 4 describes a multi-directional search for a telephone company willing to provide the necessary data and to interact with the research team during the process of model implementation. This search turned out to be successful, with New England Telephone Company agreeing to provide the necessary data for its whole New Hampshire LATA. Part 5 provides an overview of New England Telephone-New Hampshire, as well as of the data that would be provided. Part 6 concludes this report with an overview of the various potential applications of the proposed model.

PART 2

BRIEF OVERVIEW OF TELEPHONE EXCHANGE NETWORK

A local exchange network consists of a set of nodes and links organized in a hierarchical fashion and connecting every subscriber's instrument or station equipment (telephone set, teletypewriter, computer terminal, etc.) located in the exchange territory so as to allow for any point-to-point communication, whether both points are located within the exchange territory, or whether one of them is located without, thus requiring interconnection with an interexchange carrier (IC).

A hypothetical local telephone network is presented in figure 1. Subscribers' stations are connected to local switching machines located in end offices (EOs), usually through a pair of wires, which are organized in a tree-like local network of feeder and distribution cables with a topology designed to achieve economies of scale. Several feeder routes may branch out of a given EO. This component of the network is called the local loop, which may extend over several miles. Approximately 90 percent of all loops are less than 20,000 feet in length. Feeder cables generally leave the EO in underground conduits that provide physical protection and also allow new cables to be easily added along a route without having to dig up the streets. The conduit systems are usually multiple-duct structures. Distribution cables branching out of the feeders are placed aerially on poles or are buried without the use of a conduit. The end office switch will route calls between subscribers attached to that same office (intra-office traffic) or will serve as an intermediate node for connecting two subscribers attached to two different offices within the same exchange territory (inter-office traffic) through inter-office transmission trunks. When such trunks directly link the two EOs, they are called high-usage trunk groups. Alternatively, the traffic between two EOs may be routed through a higher level switching node called a tandem, which serves essentially as a transhipment node, with no subscribers directly attached to it. Such a link is called a final trunk group. The role

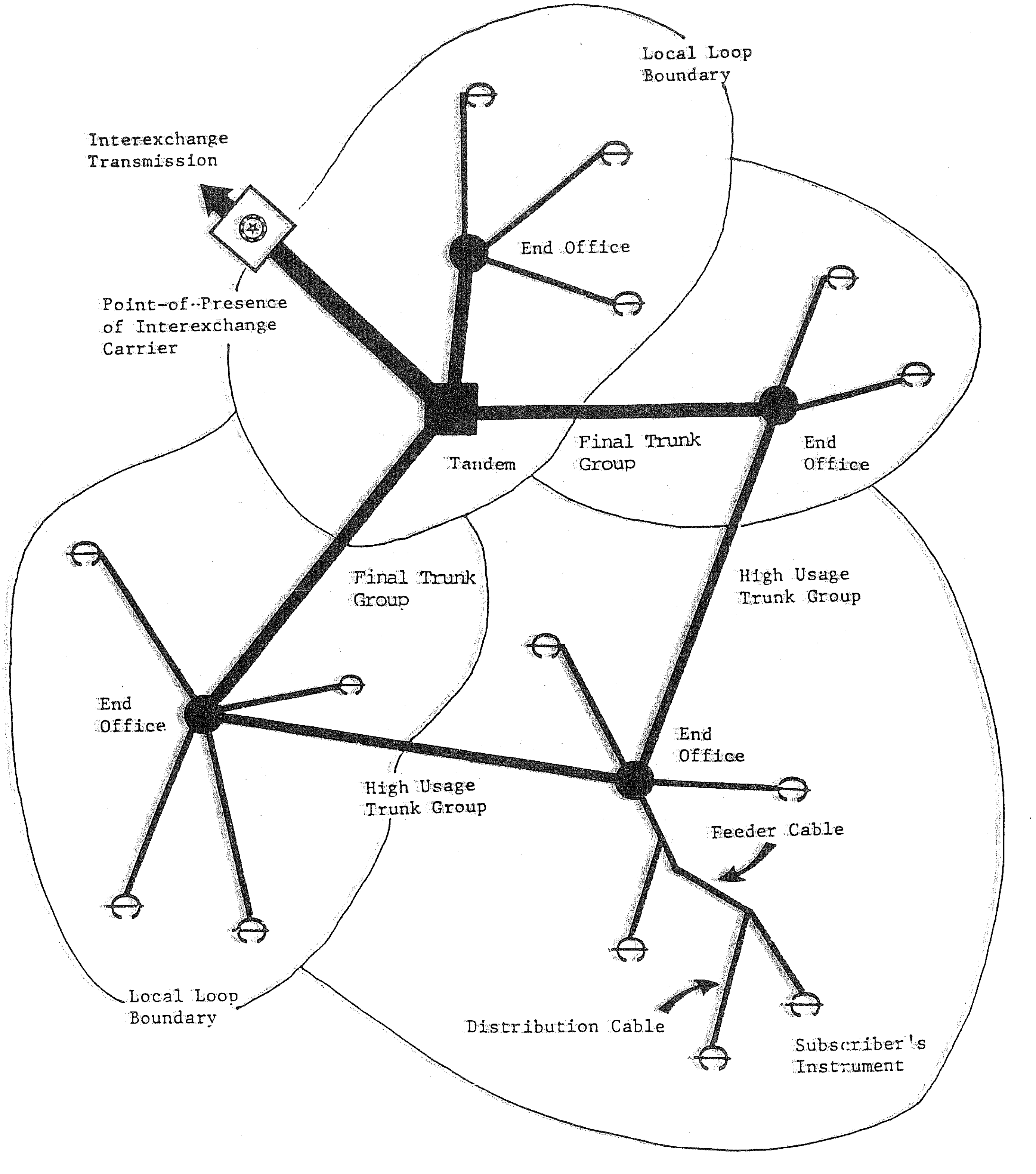

Fig. 2-1. Hypothetical local telephone network

of these tandems is to concentrate traffic, thus achieving economies of scale in transmission links. These scale economies have been recently enhanced by the introduction of multiplexing techniques. Tandems also usually provide the transmission connection with the interexchange carrier at its point of presence within the exchange boundary. Generally, any call can be routed over several alternative paths, which allows for better utilization of transmission and switching capacity in the presence of a time-variable and stochastic demand for calls.

In the past, transmission technology consisted exclusively of copper wires. However, the current trend is toward installing fiber optical cables, which, with multiplexing equipment, can achieve very high capacity levels, as well as microwave systems, topography permitting. Likewise, switching technology is evolving rapidly, and the step-by-step and crossbar electromechanical switches are being replaced in an accelerated fashion by computer-controlled electronic digital switches that are cheaper and much easier to expand.

The locations, numbers, and capacities of the various switches and transmission links depend upon the locations, numbers, and calling patterns of the subscribers, the available technologies, their costs and the cost and availability of land, and the need for redundancy in the network as a protection against disasters. Fundamentally, switching nodes exist because it would be obviously uneconomic (if possible at all in dense urban areas) to provide a line from each telephone to every other one. Within a given area, the larger the number of switching centers, the shorter the local loops and transmission trunks, and the higher the economies of scale achievable in transmission due to more concentrated traffic. However, while transmission costs decrease, switching costs increase. There is, therefore, a fundamental cost trade-off between switching and transmission. The network is designed to minimize the total switching and transmission investment and operating costs while enabling the establishment of any point-to-point call with a given grade of service (call blocking probability due to congestion and insufficient equipment) during typical peak busy hours.

PART 3

LITERATURE REVIEW ON TELEPHONE MARGINAL COST ANALYSIS

Three major streams of studies on the economics and planning of telephone exchange systems that bear some potential for the estimation of telephone services marginal costs can be distinguished. The first one consists of econometric approaches, making use of historical data for the statistical estimation of highly aggregated production and cost functions. The second one consists of engineering cost studies, which usually focus on the cost characteristics of the individual components of the telephone system. The third one consists of optimization models that produce least-cost designs of telecommunication networks. These various approaches and studies are discussed in detail in the following sections.

Econometric Approaches

In the early 1970s, there were several studies of telephone scale economies using the production function approach. Vinod (1972), using highly aggregated time-series data for the U.S. Bell System over the period 1947-1970, studied the relationship between net value added as output, and labor and net capital stock as inputs, with a nonhomogeneous production function. He estimated economies of scale to be around 1.2.[1] Dobell et al. (1972) performed a similar analysis with time-series data from Bell Canada (1952-1967), using a Cobb-Douglas production function. Their results suggest the presence of modest increasing returns to scale. However, since the mid 1970s, econometric studies of the structure of production have shifted from direct estimation of the production function to the estimation of the neoclassical

[1] The meaning of 1.2 is as follows: if all inputs (capital, labor, etc.) are increased by 1%, the total output increases by 1.2%.

cost function. Fuss and Waverman (1982) estimated a multiproduct cost function with aggregate time series data for Bell Canada (1952-1975) and the translog functional form. They considered three distinct outputs--local services, message toll services, and competitive services--and three inputs--materials, labor, and capital. They found that all three inputs can be substituted one for another and that marginal costs increase for local exchange service and decrease for toll and competitive services. However, they were not able to reject the hypothesis of overall constant returns to scale. Christensen et al. (1982) also estimated a translog and other related specifications, using time-series data for the whole United States Bell System for the period 1947-1979. While considering the same inputs as Fuss and Waverman, they combined all outputs into a Tornquist index of aggregate output instead of considering explicitly the multiproduct nature of the industry. They estimated economies of scale within the range of 1.4 to 1.8. Nadiri and Schankerman (1981), also investigating the cost structure of the Bell System, reported scale economies estimates in the range of 1.75 to 2.12. These results are clearly not consistent with the constant-returns-to-scale results of Fuss and Waverman. More recently, Evans and Heckman (1983), using Christensen's data, estimated translog and modified translog (via the Box-Cox transformation) functions while explicitly considering two outputs--local service and long distance service. They tested and rejected the hypothesis that there is an aggregate measure of output, implying that single output cost functions and related scale economies measures are not appropriate.

All the previously reviewed telephone cost studies deal with huge conglomerates (Bell System, Bell Canada) providing, in a technologically integrated fashion, both local and long-distance communication services. While the estimated cost functions can and have been used to derive estimates of marginal costs, they are of little use in assessing the cost structure of local exchange (intraLATA) carriers (LECs). The only study focusing on LECs is the econometric analysis of Chesapeake and Potomac (C&P) Telephone Company by Rohlfs (1983). Using time-series data for the period 1962-1983, he has estimated seven separate econometric equations: (a) four expense equations (maintenance and service connections, traffic, commercial and marketing, and general office), and (b) three capital investment equations (central offices, outside plant, other constructions). A large number of cost determinants were considered (number of access lines, inward movements, number of directory assistance calls, etc.). However, no clear theoretical rationale was provided for the functions selected, and the small sample further casts doubt on the validity of the analysis. Clearly, an extensive cross-section time-series data base on LECs appears to be needed to conduct the appropriate econometric analyses.

Engineering Approaches

Engineering cost studies focus on specific components of the telephone system and provide detailed cost estimates for various sizes/capacities of, for instance, specific switching machines or loops or transmission trunks. Most of these studies are performed by telephone companies internally or with the help of external consultants, and their results are generally not easily accessible. A typical example of such studies is the analysis of electronic analog switching costs by Mount-Campbell (1987), who generated pseudo cost data using a design engineering model developed by Ohio Bell for alternative EES switching configurations. The basic design parameters included the numbers of added access lines, DID trunks, intra-office busy-hour CCS, inter-office busy-hour CCS, and interexchange busy-hour CCS. The next step was to relate the capital and total costs of expansion to these cost determinants via regression analysis. Such cost functions can then be used to derive marginal costs. Another representative study is that conducted by Ben Johnson Associates, Inc. (1986) on behalf of the Office of Utility Consumer Counselor of the state of Indiana, with data obtained mostly from Indiana Bell Telephone Company. This study, focusing on local usage, determined the short-run and long-run marginal costs of customer drops, feeder/distribution lines, inter-office trunks, and central office switches. Finally, it is worth mentioning the engineering and policy analysis of fiber optic's introduction into the residential subscriber loop by Sirbu et al. (1987), who developed models of residential fiber optic networks for alternative designs such as switched star, where fibers lead directly from a central office to the subscriber, and active and passive double stars, where the feeder fibers emanate from the central office and terminate in a remote distribution unit which contains either active or passive equipment, distribution fibers providing the final link to the subscriber. Average costs per subscriber are then computed with these models under different scenarios of loop penetration and service provision (e.g., entertainment video). Marginal costs can then be derived from these analyses.

While these engineering studies provide very useful information on specific parts of the telephone "puzzle," their major shortcoming is simply that they do not put this "puzzle" together while accounting for the cost trade-offs among components. Such an integration is, at least theoretically, achieved by the network optimization approaches.

Optimization Approaches

Optimization models for communication network design are generally cost-minimization models that account for the complex trade-offs between switching and transmission while accounting for the time-variable pattern of point-to-point calling within the network. These models determine simultaneously the optimal expansion and traffic routing. Some of these models are purely deterministic, while others treat traffic demand as a random variable. Illustrative of this stream of work are the studies by Kortanek, Lee and Polak (1981); Baybars, Kortanek, Lee and Polak (1983); Baybars and Kortanek (1984); Kortanek and Polak (1985); Campbell (1984); Rosenberg (1987); and Sen and Doverspike (1987). Various algorithms and heuristics are proposed to solve these models. One approach, which appears most promising for large networks involving thousands of variables and constraints, is the decomposition method for linear programming, which involves the resolution of a sequence of smaller linear programs in place of a very large one.

While all the above studies aim at designing optimal networks, that is, least-cost networks, none of these models is structured to yield marginal cost information. A peak-load pricing model involving network optimization, albeit in a simplified fashion, has been developed by Littlechild (1970) and produces the marginal costs of calls over three different routes (Chicago-Chicago, Chicago-Peoria, and Chicago-New York) during four periods of the day. The model is a nonlinear program that maximizes producers' plus consumers' surplus, subject to capacity constraints for each item of equipment at each time of day.

Finally, it is worth mentioning the model developed by Coopers and Lybrand (1986) for the calculation of the marginal cost of toll service at the intraLATA level. This is a simulation and not an optimization model. It takes as given the network expansion plan as well as the point-to-point traffic routings and simulates alternative increments of traffic. The major shortcoming of this approach is that both capacity expansion and routing are not endogenous to the model, and thus the marginal costs obtained are not representative of the true long-term marginal costs of point-to-point calling.

PART 4

SEARCH FOR A DATA-PROVIDER TELEPHONE COMPANY

The purpose of this chapter is to describe the efforts undertaken to find a telephone company willing to provide the data necessary to test/implement the point-to-point model.

Proposal Development

The review of the literature on optimization models for telecommunication network design and traffic routing has confirmed the soundness of using an optimization model for the determination of point-to-point marginal costs. A proposal was therefore developed for submittal to telephone companies and state regulatory commissions to elicit their interest and, ultimately, their support and cooperation. This proposal, set out in appendix A, contains a mathematical description of the proposed model as well as a description of the necessary data. A special additional section has been prepared in the case of Southwestern Bell, simply because several of the necessary data are potentially available at NRRI.

Search

Contacts have been established with three telephone companies and two state commissions. The related correspondences can be found in appendices B, C, D, E, and F.

Ameritech (appendix B)

Mr. Joseph L. Daleiden, Director of Corporate Planning and Capital Development at the Ameritech Service Corporation, was contacted and expressed an interest in the idea. However, after staff consultation, he declined further involvement in the project.

G.T.E. (appendix C)

Dr. George Cluff of the California PUC was initially contacted and he forwarded the proposal to Mr. Lawrence P. Cole, Pricing Analysis and Plans Manager at the GTE Service Corporation. Despite a strong initial interest in the model, Mr. Cole finally declined participation, primarily because of staff time commitment and the view that the model would not be useful in the current regulatory environment.

Southwestern Bell (appendix D)

Contact was established by William Pollard of NRRI with both the Texas PUC and Mr. Jon Loehman, Vice President, Rates and Revenues, Southwestern Bell of Texas. Mr. Loehman agreed in principle to participate in the study, provided that the research team would use only the data available in Texas and would not require additional data from the St. Louis headquarters of Southwestern Bell. Preliminary phone conversations indicated some interest in the potential selection of Austin, Texas for the application of the model, and sample representative data provided by Mr. William Deere, Southwestern Bell Telephone Co., are also presented in appendix D.

New York State Public Service Commission (appendix E)

Contact was initially established with Mr. Neil Swift, Director of the Communications Division, and further contacts were made with Mr. Dennis Taratus of the Communications Division and Mr. Joel P. Brainard, Office of Research.

The New York PSC had mandated (Opinion No. 87-11) that telephone companies plan and perform incremental cost studies of both access and toll. A working committee was established with the charge of developing the overall methodology. (See the November 19, 1987 Initial Report of the Working Committee, also in appendix E.) A review of that report's "Incremental Costs" section (pp. 4-7), suggests that a model such as the proposed NRRI model would have been suited for the studies mandated by the NYSPSC. This is at least partially confirmed by Mr. Joel Brainard in his April 15 letter. Unfortunately, efforts to elicit interest from one of the several independent telephone companies in New York State were unsuccessful.

New Hampshire Public Service Commission (appendix F)

Dr. Sarah Voll and Dr. Connie Colter, NHPUC, expressed a strong interest in seeing the model applied to the New Hampshire LATA of New England Telephone Company (NET). Extensive mail and telephone interactions, as well as a meeting between Dr. Guldmann and Dr. Colter in Columbus, led to a general meeting between Dr. Guldmann, staff of the NHPUC, and staff from NET, on July 13, 1988, in Concord, New Hampshire, at the NHPUC. Prior to this meeting, Dr. Guldmann received from Dr. Colter various background information on NET, including its 1987 Annual Report, Network Exchange Profile, Depreciation and Expansion Plans, and summaries of the ongoing cost and usage studies. This background information provided Dr. Guldmann an important opportunity to assess the value of the available information for the purpose of model implementation and increased the likelihood of a productive meeting.[2]

The meeting's participants are listed in table 1. The meeting started with a presentation by Dr. Guldmann with a particular focus on the usefulness of the approach for the computation of the marginal/incremental costs of both access and toll. Then an extensive discussion took place with regard to the data that would be needed (these are reviewed in part 5). About two weeks

[2] Participants in the July 13, 1988 meeting in Concord, New Hampshire were as follows:

New England Telephone Company
Kathy Veracco, Regulatory Liaison
Jack Donovan, Incremental Costs
John Egan, Incremental Costs
Bruce Larson, Engineering
Marvin Hanson, Embedded Costs
Charles Paone, Tariffs

New Hampshire PUC
Sarah Voll, Head of Economics
Connie Colter, Economics
Leslie Stachow, Economics
Merwin Sands, Economics
Mary Hain, Attorney

The National Regulatory Research Institute
Jean-Michel Guldmann, Principal Investigator

after the meeting, NET informed Dr. Guldmann and the NHPUC of its willingness to provide the necessary data. This commitment was further confirmed in a letter from Mr. John A. Eagan to Dr. Douglas N. Jones, Director, NRRI (dated August 15, 1988).

Because funding was not available from the NRRI, the study will continue using alternative sources of funding under the direction of Dr. Guldmann.

PART 5

NEW ENGLAND TELEPHONE COMPANY - NEW HAMPSHIRE

The purpose of this chapter is to provide an overview of NET-New Hampshire and to describe some of the data that would be provided for model testing and implementation.

Overview

The NET-NH network, outlined in figure 5-1, consists of 132 central offices; 7,125 miles of aerial wire; 16,994 miles of aerial cable; 1,168 miles of underground cable; 2,346 miles of buried cable; 33 miles of submarine cable; and 311 miles of fiber optic cable. Aerial wires and cables are supported by 204,439 poles, and underground cables are contained in 3,705 miles of underground conduit.[3] The central office switching machines are distributed as follows among the alternative technologies: 12 electronic-analog; 36 electronic-digital; 12 cross-bar; and 72 step-by-step. Each exchange is fully described in the exchange profile, including the precise location of the switch and its technology, the municipalities served, the number of exchange access lines, etc. A sample profile is presented in figure 5-1.

NET's network is undergoing rapid technological change, as illustrated in figure 5-3 for switching systems. By 1992, all cross-bar and step-by-step switches will have been phased out, hence the request by NET that the model be applied with the 1992 network, which will only include analog and digital EES. Likewise, the trunk network is evolving towards fiber optics, as illustrated in figure 5-4, and this planned evolution will also be fully accounted for in the model.

[3] 1987 Annual Report of NET to the NHPUC.

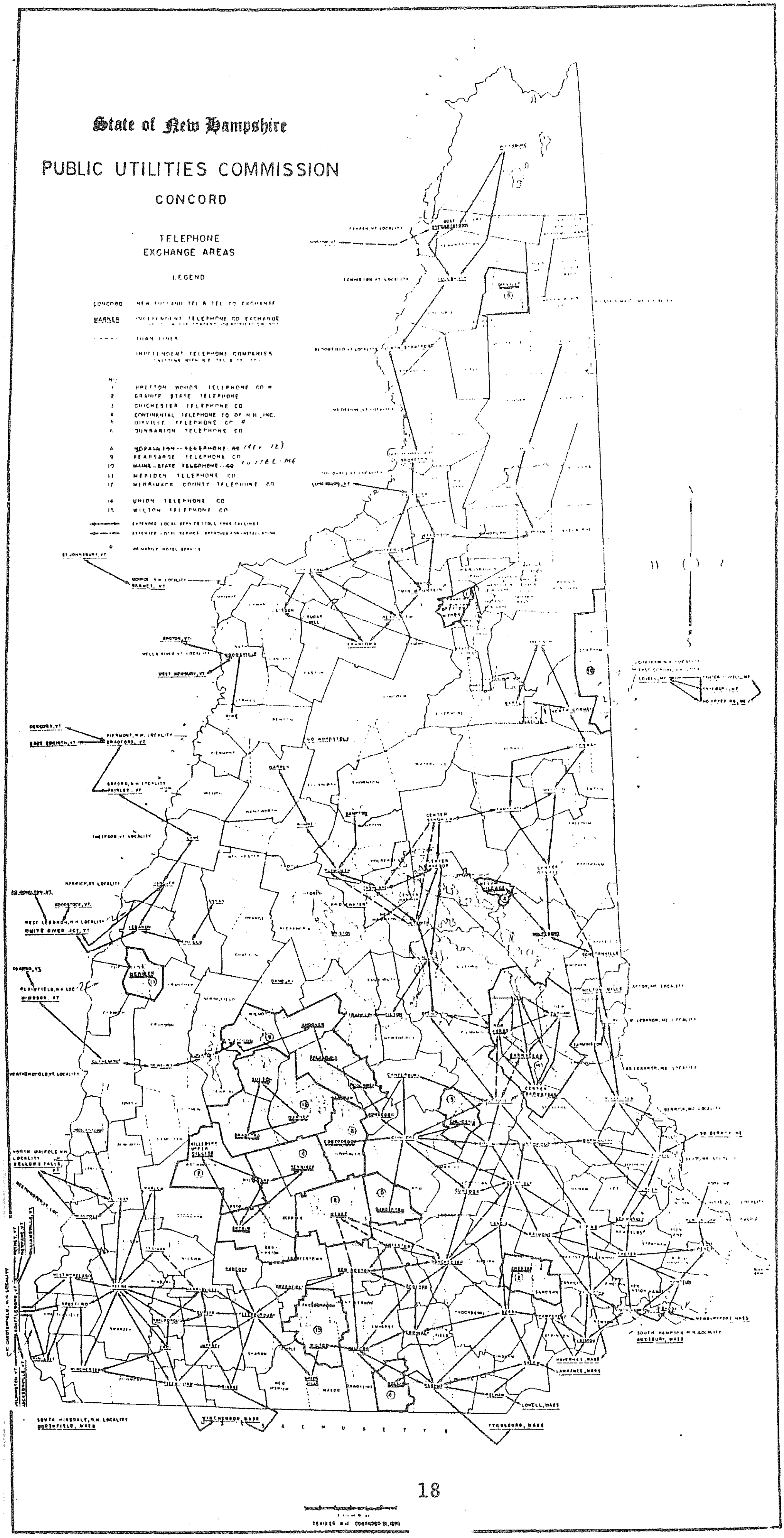

Fig. 5-1. NET and Independent Telephone Companies Exchange in New Hampshire

ACCOUNTING CTR: Manchester
BUS. SVC CTR: Portland, ME
RES. SVC CTR: Laconia
NPA: 603
CENTRAL OFFICE CODES: 744

RATE CTR COORD: Vert 4279 Horiz 1505

CENTRAL OFFICE BUILDING:

Location	Equip.	Svc. Date	Equip. Repl'd	No. Ident.
Spring St.	355-A			ANI

MUNICIPALITIES SERVED*

Active (Rate Group)		MCS CODE
Bridgewater	(13)	4004
Groton	(13)	4012
Hill	(13)	4015
Meredith	(14)	4023
New Hampton	(13)	4027
Plymouth	(13)	4033
Inactive		
Alexandria		4501
Bristol		4657
Hebron		4567

EXTENDED LOCAL SERVICE
Rate Group: 13 (See "Exchange Statistics")
Exchanges in LSA (Date Established:)
Laconia (9-81), Plymouth (9-81)

Other Adjacent Exchanges:
Canaan, Rumney, Ashland
Meredith, Tilton, Franklin, Danbury

OPTIONAL SERVICES (Date in Service)

Selective Calling Service	10-9-80
Circle Calling Service	1-1-82
Granite State Service	4-1-82
MS4E & LUMR	6-15-84

EXCHANGE STATISTICS: Main Tel. Exch. Lines

Date		Res.	Bus.	Total
6-30-87	ISSM	3201	442	3643

EXCHANGE MAP: NHPUC No. 75, Part A, Section 5 Sheet #9 EFFECTIVE DATE 6-16-79

DIRECTORY: #110, Laconia - Franklin - Plymouth Area

COIN SERVICE: Dial Post Pay

ADDITIONAL INFORMATION:
Local Exchange Service Mileage eliminated 6-16-79

*For Any Additional Exchange Serving These Municipalities See "Municipalities/Exchanges" External Affairs Dept. Form EP-1 Rates & Tariffs Division (Rev. 1-88)

Fig. 5-2. Exchange profile, Bristol

TECHNOLOGY LIFE CYCLE
SWITCHING SYSTEMS
(ACCESS LINES)

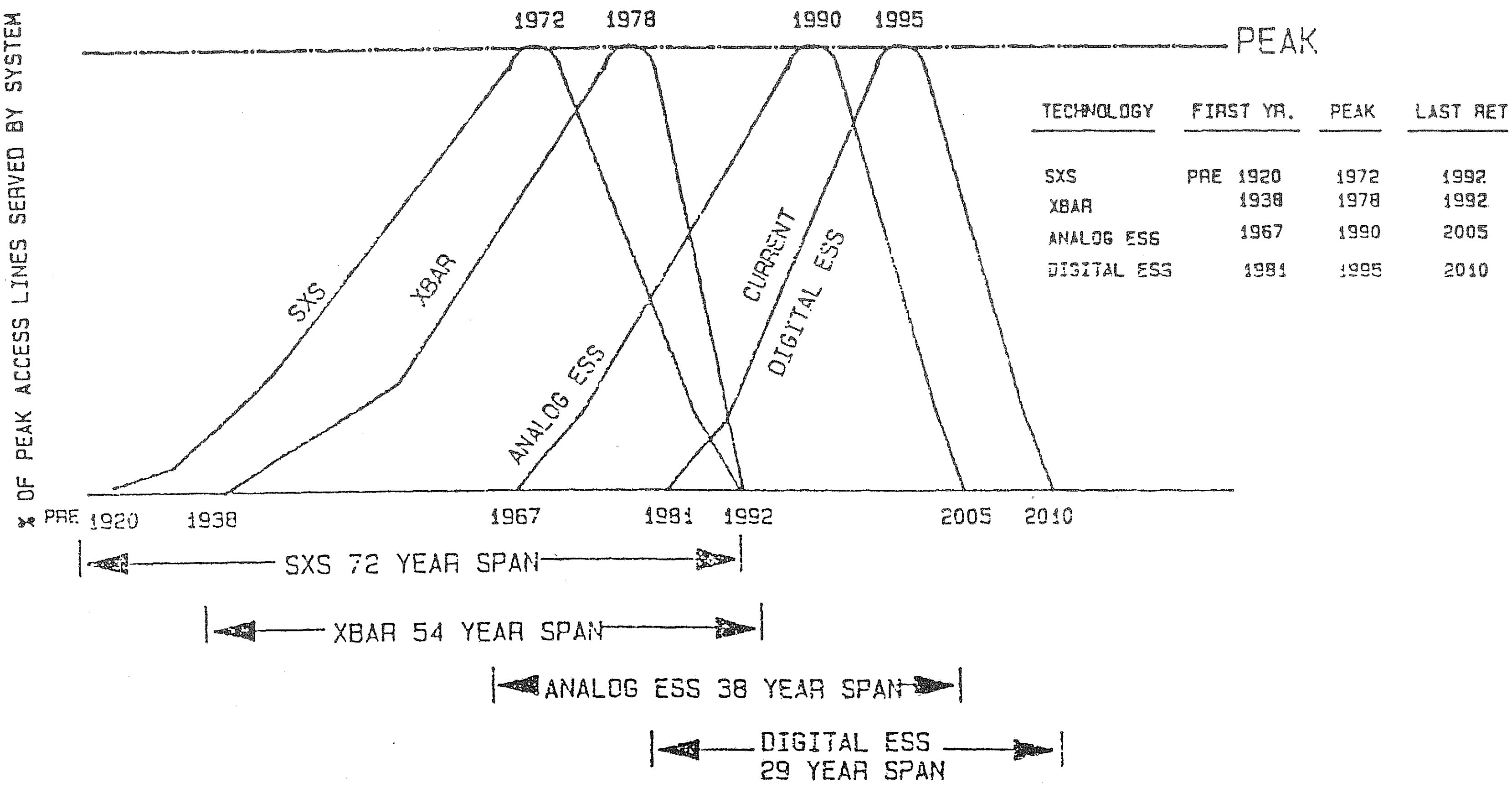

Fig. 5-3. NET planned switching changes

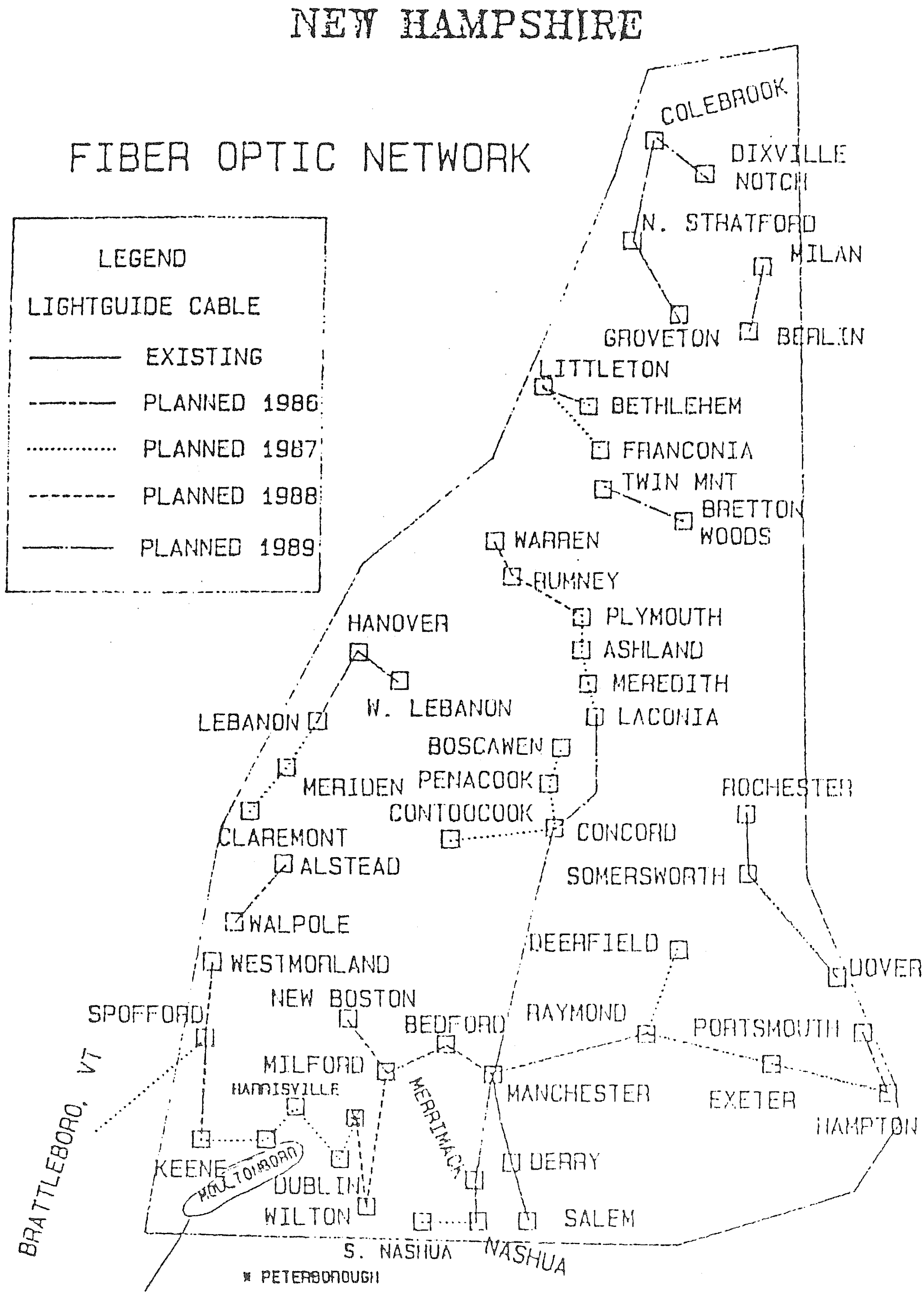

Fig. 5-4. Planned installation of fiber optic trunks - NRT-NH

Data Provision

The data to be provided by NET are outlined in table 5-3. Of particular interest are the traffic data that would be made available. NET and some independent telephone companies (ITCs) have been performing a usage study over twenty-three switches for several months. These data provide, for a sample of around 15,000 residential and business customers, the daily calling pattern, with indication of the called numbers. Processing these data would provide precious information about the origin-destination structure of local as well as toll calls. These data are described in table 5-4 (input call record format) and table 5-5 (sample sizes). This information will be complemented by billing tapes data that will cover all the 132 exchanges, but only for toll calling. The combination of the two data sources should provide a good estimate of the pattern of traffic over the NET network.

TABLE 5-3

APPLICATION OF THE POINT-TO-POINT MARGINAL
COST MODEL TO THE NEW HAMPSHIRE LATA*

A. Network Facilities (1992 Network)

Central Offices: locations (V&H coordinates), type (EO, tandem, remote), technology, numbers of access lines and inter-office trunks, busy hour capacity, network connections.

Local Loops: mileages, technology, numbers, and types of customers.

B. Traffic

Usage Study: NET and several independent telephone companies have recently gathered detailed daily usage profiles for a sample of twenty-three switches; these data provide the opportunity to build origin-destination matrices using the NPA-NNX of the calling and called parties, including local calls.

Automatic Message Accounting (AMA): The complete MTS and WATS toll traffic data are available on the AMA billing tapes and will be used to build the toll traffic matrix.

Peak Traffic Flows: These data are available for each switch and each inter-office link.

C. Cost Parameters

NET will provide estimates of the expansion and operation unit costs of its various facilities in New Hampshire using (a) estimates developed in the course of NET's Massachusetts Incremental Cost Study, and (b) engineering data and studies specific to NewEW Hampshire.

* Data to be Provided by New England Telephone Company

TABLE 5-4

NEW HAMPSHIRE USAGE STUDY
STUDY TAPE INPUT CALL RECORD FORMAT

Position	Field Description	Explanation
1-3	Calling NPA	Three-digit NPA of the calling number
4-6	Calling NNX	Three-digit NNX of the calling number
7-10	Calling line	Four-digit line number of the calling number
11-13	Calling NPA	Three-digit NPA of the called number
14-16	Called NNX	Three-digit NNX of the called number
17-20	Called line	Four-digit line number of the called number
21-22	Connect hour	A two-digit number representing the connect hour in the range 00-23
23-24	Connect minute	A two-digit number representing the connect minute in the range 00-59
25-27	Conversation minutes	A three-digit number in the range 000-999
28-29	Conversation seconds	A two-digit number in the range 00-59
30	Conversation tenths	A one-digit number in the range 0-9
31-36		Currently not used (blank)
37-42	Date	A six-digit number that represents the date of the call in the form YYMMDO, where YY = Year, MM = Month, DD = Day,
43-44	Rate indicator	A two-digit number in the range 00-22, where the digits represent the following: 00 = Non-rated attempt, 01 = 1 Message unit call, 02 = 2 MU call, 03 = 3 MU call, 04 = 4 MU call, 05 = 5 MU call, 06 = 6 MU call,

TABLE 5-4 (Cont'd)

NEW HAMPSHIRE USAGE STUDY
STUDY TAPE INPUT CALL RECORD FORMAT

Position	Field Description	Explanation
		07 = 7 MU call, 08 = 8 MU call, 09 = 9 MU call, 10 = 10 MU call, 11 - Flat rate call
		15 = OCP call 16 = Toll call
45	Attempt vs. message	1 = Attempt 2 = Message
45-47*	Office identifier	A two position alphabetic identifier, left justified, where the character represents a valid office under study.
48	Study indicator	1 = ESS study
49-50		Currently not used (blank)
51	Toll indicator	0 = Non-toll messages 1 = Toll
52-80		Currently not used (blank).

* Independent co. office identifiers

SL - Salisbury
AL - Alton
ND - New Durham
MV - Melvin Village
HE - Henniker
AN - Antrim
HI - Hillsboro

TABLE 5-5

NEW HAMPSHIRE USAGE STUDY
RESIDENCE AND BUSINESS SAMPLE SIZES

RATE GROUP	OFFICE	OFFICE TYPE	IFR	2FR	1MR	MS4E LOW	MS4E STD	1FB	1MB	PBX UNLIM	PBX MEAS	B4E
05	Greenfield	5ESS	60	0	0	0	0	0	0	0	0	0
07	Littleton	5ESS	120	60	60	0	0	60	0	12	0	0
08	Sunapee	5ESS	120	60	60	0	0	60	0	0	0	0
10	Newport	5ESS	120	60	60	60	0	60	0	12	0	60
11	Hanover	5ESS	120	60	60	0	0	60	0	24	0	60
12	Epping	5 RSM	120	60	60	0	0	0	0	12	0	60
12	Raymond	5ESS	120	60	60	0	0	60	0	0	0	60
12	W.Chesterfield	5ESS	60	0	0	0	0	0	0	0	0	0
12	West Lebanon	1AESS	60	60	60	0	0	60	0	12	0	60
13	Glendale	5ESS	120	60	60	0	0	0	60	12	0	0
13	Laconia	5ESS	120	60	120	0	0	120	120	24	24	0
13	Portsmouth	1AESS	120	60	60	120	120	120	0	24	0	120
14	Concord	1ESS	240	60	120	0	60	120	0	24	12	120
14	Dover	5ESS	120	60	120	60	60	120	0	24	12	60
14	Plaistow	5ESS	120	60	60	60	60	60	0	12	12	60
16	Atkinson	5 RSM	120	0	0	0	0	0	0	0	0	0
16	Hampstead	5 RSM	120	0	60	0	0	0	0	12	0	60
16	Goffstown	5ESS	120	60	0	0	0	60	0	0	0	60
17	Milford	5ESS	120	60	60	60	60	60	0	24	0	60
18	Candia	5 RSM	120	60	0	0	0	0	0	0	0	60
18	Manchester	1ESS	240	240	120	60	60	120	60	24	24	120
18	New Boston	5ESS	60	0	0	0	0	0	0	0	0	0
19	Nashua/Hudson	1AESS	240	120	120	60	60	120	0	24	12	120
20	Salem	1AESS	120	60	120	0	60	120	0	24	0	120
21	Derry	1AESS	240	60	120	60	60	120	0	24	0	60
Total			3,360	1,500	1,620	540	600	1,560	240	324	96	1,380

Grand Total: 11,220

NOTE: Totals represent the number of accounts rather than lines.

PART 6

CONCLUSIONS

The development of the proposed point-to-point marginal cost model is feasible on methodological, computational, and data requirement grounds. The use of decomposition methods and the availability of extremely powerful linear programming software make it feasible to treat a network of the size of NET-NH. The provision of all the necessary data by NET guarantees that the process of model development will not remain an academic exercise.

If developed, the model would, to the best of our knowledge, be the first non-proprietary point-to-point marginal cost model publicly available and could be used by state commissions in analyzing telecommunication regulatory issues and in formulating regulatory policy. For instance, the matrices of marginal costs (MC_{ijt}) for any origin i, destination j, and time t, to be produced by the model, could be used to clarify and solve the following issues in telecommunications policy.

Cost-Based Pricing

The knowledge of the true marginal costs MC_{ijt} could be used to design rates closer to those costs. This might reduce the occurrence of uneconomic bypass on specific routes. The MC_{ijt} could be used to develop flexible pricing and other marketing approaches to retain large business customers (in the same way they are designed to operate in the natural gas area). To fully assess such new pricing approaches, telephone service demand models could be used to determine equilibrium prices, and to assess the impacts of these prices on users' welfare and on the LEC's financial situation (i.e., satisfaction of the revenue requirement constraint).

Access Charges Evaluation

Suppose that i is a point-of-presence of an interexchange carrier. Then MC_{ijt} represent the marginal cost of access to the local office j at time t. Possibly, some averaging of the MC_{ijt} over all the offices of the LEC might be used to compute a company-wide access charge.

Analysis of Extended Area Service (EAS)

The knowledge of the MC_{ijt} together with the knowledge of telephone flow patterns would be helpful to assess the impact of EAS conversions (for instance, the extent of customer cross-subsidizations), and to determine the optimal size and boundaries of EAS.

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APPENDIX A

PROPOSAL TO TELEPHONE COMPANIES AND STATE REGULATORY COMMISSIONS

COMPUTING POINT-TO-POINT MARGINAL COSTS FOR LOCAL TELEPHONE SERVICE: MODEL FORMULATION AND DATA REQUIREMENTS

by

Jean-Michel Guldmann

March 28, 1988

TABLE OF CONTENTS

1. Introduction

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

The divestiture of the Bell System has opened the long-distance telecommunications market to fully competitive entry and has led to new pricing arrangements, in particular the access charges for connecting customers to toll carriers. Access costs, representing part of the costs of the local facilities used to originate and terminate toll calls, can vary greatly among the local exchange companies, but historically they have been averaged on a nationwide basis for interstate toll calls and on a statewide basis for intrastate toll calls. Much debate has therefore taken place recently about the proper level of these new access charges, mainly to avoid the cross-subsidization of light toll users by heavy ones, thereby giving an incentive to the latter to bypass the network, with the resulting permanent loss of customers to the telephone company. The need for local exchange companies to compete with local bypass systems, which provide local telecommunication services (e.g., via microwave, fiber optics cables, etc.) without the use of the established switched network plant, has also increased the pressure to move away from traditional pricing practices, mostly based on the value-of-service concept, towards prices that are more closely tied to the marginal cost of providing local exchange service.

The above changes raise several important policy issues: What is the share of local exchange costs related to toll calls, and how to estimate it? Are local exchange systems still natural monopolies, that ought to be protected from competition through regulation? If competition in the local exchange is feasible, how should the transition to a competitive environment be managed, while retaining the generally universal access to basic telephone services? How should marginal costs of service be calculated and how should rates be determined to achieve maximum efficiency subject to social goals (e.g., universal access to basic telephone services)?

The answers to the above public policy issues require a thorough understanding of the cost structure of local telephone systems and the ability to estimate the marginal costs of various services both over time and over space. However, what is currently missing is a commonly accepted method to calculate such marginal costs. Some of the existing approaches are of a proprietary nature (e.g., the Levelized Incremental Unit Cost (LIUC) Model of Southwestern Bell Company, as outlined in Pollard et al. [1985]), or use econometric equations estimated with limited time-series data of a highly aggregate nature (e.g., Fuss and Waverman [1982] for Bell Canada, Christensen et al. [1982] for the Bell System, and Rohlfs [1983] for the Chesapeake and Potomac Telephone Company).

The thrust of the proposed project is to develop a detailed network representation of a prototypical local telephone system and to design a least-cost telephone network planning model that would account for the trade-offs between switching and transmission costs and that would yield the marginal costs of service for any route and service in the system. A major feature of the process of developing the telephone network planning model will be to take advantage of the structural similarities between telephone and transportation networks, with road links being equivalent to trunk groups, road link junctions to tandems, travel zone centroids to class 5 central offices, and origin-destination car trips to point-to-point calls. Thus, the research will take advantage of the important advances that have taken place in recent years in the field of transportation planning, particularly in the area of network design models and computational algorithms, as summarized in Magnanti and Wong (1984) and Friesz (1985). The research will also build upon research related to the specific design of communications networks, as illustrated by the studies of Baybars and Kortanek (1984) and Rosenberg (1987), as well as upon earlier research by Littlechild (1970) and Littlechild and Rousseau (1975), using simplified network configurations and focusing on pricing issues.

2. Model Formulation

Consider a telephone network as illustrated in figure 1, made of nodes (existing and planned central offices linked to subscribers loops, tandems and points-of-presence connecting with interexchange carriers) and trunk groups of varying sizes, both existing and planned, linking all these nodes. Consider any two nodes i and j in this network, and define by F_{ijt} the traffic flow (at some time in the future) between them at time-of-day t. The matrix F_{ijt} fully describes the traffic pattern on this network. Alternative assumptions with regard to the respective growth rates of usage and numbers of access lines will be considered, and their cost implications will be accounted for in the model. The basic question this proposed research is to answer is: What is the long-term marginal cost related to a unit increment (e.g., minute of use) in traffic flow F_{ijt} whatever the nodes i and j, and the time t?

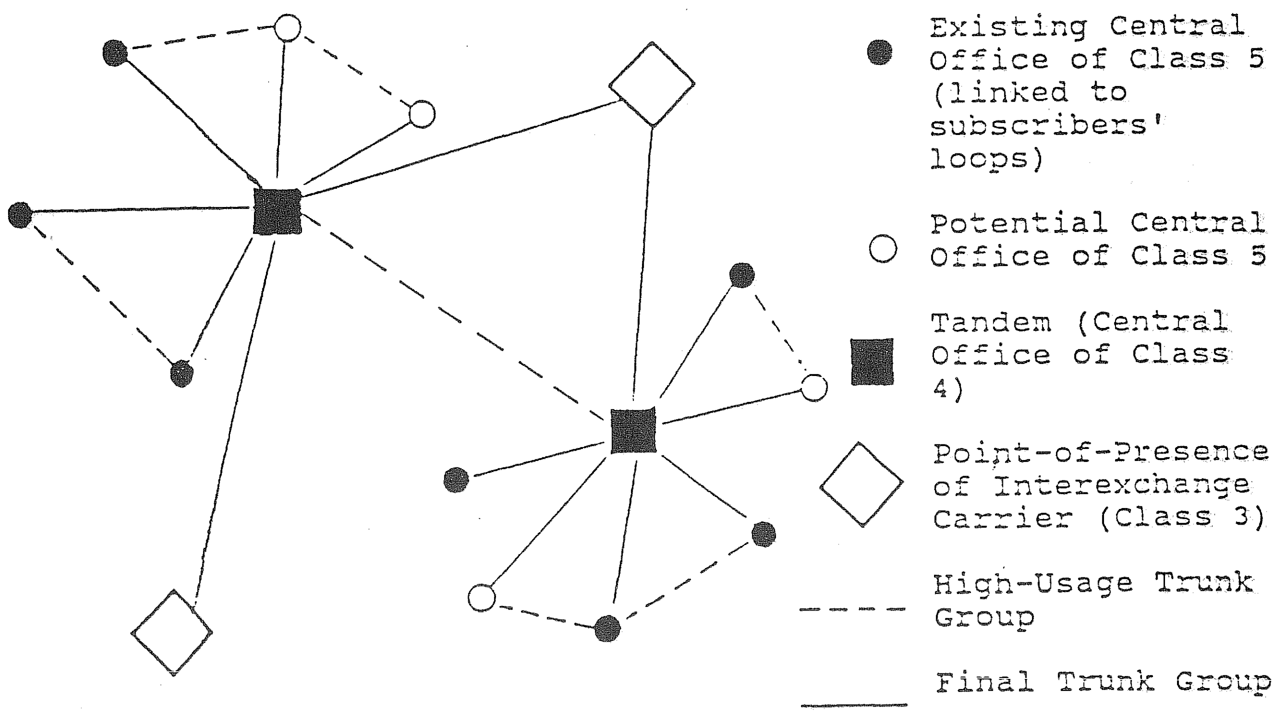

Figure 1. Hypothetical telephone network

The telephone voice traffic flow is fully defined by the origin-destination (O-D) time-linked matrices $[F_{ijt}]$, which are assumed given as output of a separate forecasting process using spatially disaggregated demographic and economic projections for the area served by the local exchange company (LEC), as well a projections of changes in telephone usage habits. Node i is the traffic-originating node and node j is the traffic-terminating one. A system planning model will be developed, that will determine the least-cost system accommodating the given traffic flows. The cost function to be minimized will include both operating and maintenance (O&M) costs and capacity expansion capital costs. The decision variables will include: (1) which of the existing central offices (COs) and trunk groups to expand, and by how much; (2) which of the potential new COs and trunk groups to develop, and with what capacity; and (3) the average traffic flow on each trunk group and through each CO at various times of day t.

Basically, the model is a transportation planning model which accounts for the trade-offs between switching and transmission costs. In order to keep the model formulation presented in this note relatively simple, issues related to the design of local loops have not been formally included in it. However, such issues as the choice between CO replacement with another technology, or use of a remote/host, or use of pair gain equipment, can and will be incorporated into the model. Let us define the following parameters:

F_{ijt} = traffic flow from node i to node j during period (e.g., hour) t

X^0_{kl} = existing capacity of the trunk group linking offices k and l

Y^0_k = existing capacity of central office k (number of exchange circuits)

We set X^0_{kl} and Y^0_k equal to zero for potential trunks and COs, which may be added to the network, and define the following 0-1 parameters determining which of the above trunks do exist or can be built: δ_{kl} = 1 if a trunk group does link nodes k and l or can be feasible in the future, = 0 if not. (Note that, by definition of the network, all the nodes are existing or potential central offices, including tandems.)

The decision variables are defined as follows:

ΔX_{kl} = capacity expansion of trunk group k-l (δ_{kl}=1);

ΔY_k = capacity expansion of CO k;

Z^{ij}_{klt} = traffic flow during period t on trunk group k-l which is part of the O-D flow F_{ijt}.

The constraints of the problem can be expressed as follows:

$$(1) \quad \sum_{\substack{\text{all } l/\\ \delta_{il}=1}} Z^{ij}_{ilt} = F_{ijt} \qquad \forall(i,j,t) \ :$$

the traffic flow during period t, F_{ijt}, originating at i and terminating at j is distributed over the several trunk links originating at i;

$$(2) \quad \sum_{\substack{\text{all } k/\\ \delta_{kj}=1}} Z^{ij}_{kjt} - \sum_{\substack{\text{all } l/\\ \delta_{il}=1}} Z^{ij}_{ilt} = 0 \qquad \forall(i,j,t) \ :$$

the traffic flow F_{ijt} terminating at j is equal to the traffic flow F_{ijt} originating at i;

$$(3) \quad \sum_i \sum_j Z^{ij}_{klt} \le X^0_{kl} + \Delta X_{kl} \qquad \forall \ (k,l,t) \ :$$

the sum, during any period t, of all the traffic flows over trunk link k-l must be less than or equal to trunk link k-l capacity;

$$(4) \quad \sum_i \sum_j \sum_k Z^{ij}_{klt} - \sum_i \sum_j \sum_k Z^{ij}_{lkt} = \sum_i F_{ilt} - \sum_j F_{ljt} \qquad \forall(l,t) \ :$$

this telephone flow conservation constraint for CO l simply indicates that the net balance between all the flows entering and leaving CO l at any time t (left-hand side of the equation) must be equal to the net balance of the route flows terminating at and originating from CO l at the same time t; the latter would be equal to zero in the case of a <u>tandem</u> (no local loops attached), which can be viewed as a pure transhipment node;

$$(5) \quad \sum_i \sum_j \sum_k Z^{ij}_{klt} + F_{llt} \le Y^0_l + \Delta Y_l \qquad \forall(l,t) \ :$$

the interoffice and intraoffice (F_{llt}) traffic flow through CO l at any time t must be accommodated by the capacity of that office.

Let C^K_{kl} be the cost of adding capacity to trunk link k-l for one unit of additional traffic, C_k^K be the same cost for expanding CO k, C_{kl}^{OM} the O&M unit cost of trunk link k-l operation, and C_k^{OM} the O&M unit cost for CO k operations. The total cost for telephone network expansion and operations is then:

$$(6) \quad CT = \sum_{k,l} C^K_{kl} \Delta X_{kl} + \sum_k C^K_k \Delta Y_k + \sum_t \sum_{i,j} \sum_{k,l} C^{OM}_{kl} Z^{ij}_{klt} + \sum_t \sum_i \sum_j \sum_k \sum_l C^{OM}_l [Z^{ij}_{klt} + F_{llt}]$$

The planning problem is, for given parameters (F_{ijt}, X^O_{kl}, Y^O_k), to determine the values of the decision variables (ΔX_{kl}, ΔY_k and Z^{ij}_{klt}) that minimize the total cost CT subject to constraints (1) through (5). The above model is a linear program, that can be solved by standard methods. One very important by-product is the marginal cost MC_{ijt} associated with an increment in O-D flows F_{ijt}. Indeed, if V_{ijt} is the dual value associated to constraint (1), we have:

$$(7) \quad V_{ijt} = \frac{\partial CT}{\partial F_{ijt}} = MC_{ijt}$$

Note that the marginal cost of the intraoffice traffic F_{iit} is simply MC_{iit}. The above model may have to be rendered more complex for several reasons. For instance, cost functions may have to be nonlinear. While the current overwhelming trend is toward digital switches, other CO technologies (e.g., electronic, crossbar, step-by-step) may have to be considered, involving discrete choices and thus integer variables. Similar technological choices would apply to transmission (coaxial cables, fiber optics, microwave).

The nonlinear functions implied by economies of scale in transmission links and COs could be transformed into linear functions by introducing additional integer variables. Exclusion-type of constraints may have to be set to deal with the choices of new COs and other local loop design issues (e.g., remote/host). For instance, a given area may be served by either one large CO or (for instance) three smaller COs. The first case would involve less CO costs (economies of scale and land costs), but more access line costs, and the second case the opposite. Only one of the two configurations can be selected, and integer variables can be used to that effect. In addition to voice transmission, both data and video services as well as private line services might be considered in the model. Finally, service reliability, expressed in terms of call blocking probability, should also be considered in the model. See, for instance, Kortanek et al. (1981). Obviously, all the above factors may increase the size of the model to such a point where exact solution methods may not be used, and heuristic methodologies will then have to be considered (e.g., decomposition-coordination methods that have been successfully used in the case of water supply/treatment systems). Creating clusters of closely located office, which would be treated as super-nodes, might be one approach to reduce the size of the model. However, the feasibility of global optimization will be thoroughly assessed in the course of the research. Whatever the final solution method used, a natural output of the model will be the matrices of the marginal costs $[MC_{ijt}]$.

3. General Data Requirements

We propose to test the usefulness of the model by applying it to an actual telephone network, which might cover a complete LATA or be only a part of a LATA, such as a metropolitan telephone network. This network should be relatively small to minimize data gathering costs. A maximum number of 50 end offices appears to be a reasonable limit. Once the network is selected, four categories of data will have to be assembled. These are described in the following sections.

3.1 Central offices

Basic data requirements include:

(a) A map showing the locations of all the end offices and tandems

(b) The switching technology used in each office: digital, electronic, cross bar, etc.

(c) The potential maximum number of simultaneous calls through each office (i.e., communications paths)

(d) The number of access lines, by customer class (residential, business)

Data (c) provides a measure of the office's existing capacity (the parameter Y_k^o), while data (d) may be used to estimate calling patterns if actual calling data are not available.

3.2 Transmission links

For each transmission link between either two end offices or an end office and a tandem or two tandems, the following data are necessary:

(a) link mileage and technology (copper wire, fiber optics, microwave)

(b) mileage or aerial and underground cable

(c) number of trunks (channels)

Data (c) provides a measure of the link's existing capacity (the parameter X_{kl}^o), while data (a) and (b) are necessary to assess the costs of capacity expansion.

3.3 Traffic pattern

A basic data input to the model is the traffic flow F_{ijt} (measured in CCS) between any two end offices i and j at any time of day t, for some future year. Such flow forecasts may have been prepared by the LEC, and their use in the model would constitute an "ideal" situation. Alternatively, several contrasted forecasts could be prepared by the research team, based on existing flows, if available, and on the expected economic and urban development of the area served by the network.

3.4 Costs

The unit expansion and operation costs of both the end offices and the transmission trunks are the basic parameters of the cost function that the model attempts to minimize. In view of the uncertainties surrounding various estimates of these costs, it is proposed to conduct sensitivity analyses of the model over ranges of values for these costs. These ranges will be established using estimates provided by past research conducted at NRRI and elsewhere, as well as estimates that might be provided by the LEC.

4. The Case of Southwestern Bell Company

Southwestern Bell Company (SBC) has provided NRRI data on calling patterns for a project currently conducted by W. Pollard. These data are considered of a proprietary nature by SBC, and their use is restricted by a legal agreement between SBC and NRRI. Discussions with W. Pollard with regard to the characteristics of these data suggest that they might constitute part of the data base necessary to implement the model. The data available and the additional data that would have to be gathered are discussed below.

4.1 Service area

We propose to select a metropolitan area and its surrounding rural areas for testing the model. San Antonio or Austin might be good candidates.

4.2 Central offices

Subscriber line counts by customer class are available for all the 563 offices of SBC. There are 14 customer classes. The technology and number of communication paths for each office are known.

The additional data needed for the subset of offices selected would be the exact location of the office (e.g., UTM coordinates)

4.3. Transmission links

The total number of trunks (channels) originating from and terminating at each office is available, and so are the tandems' homing patterns (indicating which offices are linked to each tandem). The additional data needed would be:

- the number of trunks between each interlinked pair of offices (only the totals originating from/terminating at any given office are available), and the corresponding mileage

- the transmission technology, and its aerial/underground mix.

4.4 Traffic patterns

Originating and terminating 24-hour traffic profiles (conversation time in seconds and number of calling attempts), by customer class and by way of telephoning (intra-office, inter-office local, intrastate intraLATA toll, intrastate interLATA toll, interstate interLATA toll), for 34 offices (a subset of the 563 offices), are available for a period of 3 consecutive months. Using the data of this sample, one could develop typical calling profiles by subscriber line, and apply these profiles to generate originating/terminating traffic at the selected offices. Growth factors might be applied to these flows, under alternative hypotheses, and forecasts of point-to-point flows might be developed based on this information. Such forecasts could be reasonably used in testing the model. Alternatively, SBC might provide its own forecasts of point-to-point traffic, if available. However, this "ideal" situation is not a prerequisite for realistically applying the model.

4.5 Data confidentiality

The NRRI research team in charge of this project would naturally comply with any requirement by SBC and AT&T Communications of the Southwest to protect the confidential nature of the data that might be made available.

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APPENDIX B

CORRESPONDENCE WITH AMERITECH

February 23, 1988

Dr. Joseph L. Daleiden, Director
Corporate Planning & Capital Development
Ameritech
30 South Wacker Drive, Floor 37
Chicago, IL 60606

Dear Dr. Daleiden:

Pursuant to our telephone conversation, I enclose the project plan for "A Feasibility Study of a Point-to-Point Marginal Cost Model for Local Telephone Service."

I would be most interested to have the opportunity to discuss with you and/or your colleagues current network planning practices and evolving new methodologies, as well as assessing data availability, should one of the Ameritech companies be interested in a test development of such a model.

I look forward to hearing from you.

Sincerely,

Jean-Michel Guldmann
Professor

JMG:ld

Enclosure

AMERITECH

JOSEPH L. DALEIDEN
Director
Corporate Planning

30 South Wacker Drive, Floor 37
Chicago, Illinois 60606
312/750-5474

March 1, 1988

Dear Professor Guldmann,

I have received your proposal for a feasibility study for a point-to-point marginal cost model for local telephone service. I found your model to be of interest, however I'm not certain what work of a similar nature might be currently underway in this vast bureaucracy. I know of two past attempts to develop extensive network models, but both collapsed under the weight of their own complexity.

Since there may be another effort of which I am unaware, I will circulate your proposal to our Regulatory and Network Planners at Ameritech Services. I also want to see what is going on at BELLCORE. After this review, I'll get back in touch with you.

Best Regards,

Joe Daleiden

AMERITECH

JOSEPH L. DALEIDEN
Director
Corporate Planning

30 South Wacker Drive Floor 37
Chicago, Illinois 60606
312/750-5474

March 18, 1988

Professor J. M. Guldmann
Department of City and
Regional Planning
The Ohio State University
289 Brown Hall
190 W. 17th Ave.
Columbus, Ohio 43210-1320

Dear Professor Guldmann,

I have circulated your study proposal to my counterparts and various research groups, both here and at BELLCORE. At present, there is no activity being undertaken in this area. I am told that the primary value seen in such an approach is to provide evidence of bypass potential. However, in the past, the FCC has not been receptive to the use of theoretical models to prove our case in this regard. In short, while several people thought that an effort such as you propose would be of interest from a theoretical perspective, they did not see a practical application that would warrant the expense inherent in estimating the parameters for such a model.

I appreciate your interest in developing a marginal cost model and regret that I cannot stimulate a similar interest at Ameritech. If you would like to discuss your proposal further, don't hesitate to call.

Sincerely,

Joseph Daleiden

APPENDIX C

CORRESPONDENCE WITH G.T.E.

THE OHIO STATE UNIVERSITY

Department of City
and Regional Planning

289 Brown Hall
190 West 17th Avenue
Columbus, OH 43210-1320

Phone 614-292-6046

February 23, 1988

Dr. George Cluff
Division of Strategic Planning
California Public Utilities Commission
505 Van Ness Avenue
San Francisco, CA 94102

Dear Dr. Cluff:

Pursuant to our telephone conversation this morning, I enclose a copy of the project plan. I look forward to hearing from you.

Cordially,

Jean-Michel Guldmann
Professor

Enclosure

THE OHIO STATE UNIVERSITY

1080 Carmack Road
Columbus, Ohio 43210-1002

614 292-9404

March 31, 1988

Mr. Lawrence Cole
GTE Service Corporation
ONE Stamford Forum
Stamford, CT 06904

Dear Mr. Cole:

I have been informed by Dr. George Cluff of the California PUC that GTE Service Corporation had expressed an interest in our proposal to develop a point-to-point marginal cost model for local telephone service. I enclose a note describing the proposed approach as well as the data needed to test this model. We are looking for a company that might be willing to provide these data as well as interact with us in the process of model development, so as to make sure that the final product will be a useful one.

I very much hope that GTE will be interested in this endeavor, and I certainly would be willing to come to your place to further discuss this project, if this could prove helpful.

I look forward to hearing from you. I may be contacted at (614)292-6046 or (614)292-9404. Thank you very much in advance.

Sincerely,

Jean-Michel Guldmann
Senior Faculty Associate

Enclosure

JMG:jkm

THE OHIO STATE UNIVERSITY

Department of City
and Regional Planning

289 Brown Hall
190 West 17th Avenue
Columbus, OH 43210-1320

Phone 614-292-6046

April 29, 1988

Mr. Lawrence Cole
GTE Service Corporation
ONE Stamford Forum
Stamford, CT 06904

Dear Mr. Cole:

Pursuant to our telephone conversation, I enclose a recent resume as well as some reprints of past research in the gas, electricity, and telephone utility areas. Please, let me know if you need any other information.

I very much hope that GTE will decide to cooperate on this project and I look forward to hearing from you.

Sincerely,

Jean-Michel Guldmann
Professor

Enc.

GTE Service Corporation
One Stamford Forum
Stamford, CT 06904
203 965-2000

June 20, 1988

Dr. Jean-Michel Guldmann
Senior Faculty Associate
The National Regulatory Research Institute
1080 Carmack Road
Columbus, Ohio 43210-1002

Dear Dr. Guldmann:

Having discussed your proposal for a study of point-to-point marginal cost of local exchange service with both a member of the technical staff at GTE Laboratories and with my management here, I regretfully conclude that we must decline the opportunity to cooperate in the undertaking. The reasons are as follows.

First, in the existing regulatory environment, there is almost no use we can make of point-to-point marginal cost estimates in the foreseeable future; that is, we are compelled to file highly averaged rates.

Second, the data needed for the study would require a very substantial commitment of staff time and other resources on our part at a time when the Telephone Operations component of GTE is in the throes of a significant organizational change.

Third, there are apparently some specification problems with the model itself, as indicated by the enclosed excerpts from the review provided by one of our researchers who had considerable experience in transportation modeling before switching over to telecommunications. And, while the model specifications are surely correctable, the other problems remain.

We appreciate having had the chance to consider your proposal and wish you good luck in finding a company willing to participate.

Yours truly,

Lawrence P. Cole

Lawrence P. Cole
Pricing Analysis & Plans Manager

LPC:amb/2684H

Enclosure

Excerpts from Private Communications to L. Cole

"There are several problems with the proposal. The first is that it assumes away the most difficult part of the problem (lumpy investment). A significant part of the costs leading to the variation in marginal costs among traffic paths would be those related to capacity; it is assumed at the outset that the marginal costs of capacity of transmission links and of central offices are known. It seems to me that determining these marginal costs is the heart of the problem. Point-to-point marginal costs as defined in this study would be extremely sensitive to network configuration and traffic patterns. In any time period, expansion costs will only be included in those point-to-point costs for which the path is at capacity. Slightly different assumptions about growth patterns or or network expansion would yield significantly different assumptions about growth patterns or or network expansion would yield significantly different cost patterns. It is difficult to imagine how such "cost" information would be useful. This problem would be avoided if only point-to-point variable (O&M) marginal costs for a fixed traffic pattern and fixed network configuration were required. In this case, the cost matrix would be quite stable, but of less interest."

"There are also several technical problems with the proposal. Some related to the fact that no specific framework is proposed for the optimization. In the discussion of some of the possible complications, approaches are suggested, but these approaches would result in an extremely difficult problem to solve. It is admitted in the proposal that some ad hoc method might be required. To be fair, it is reasonable that a solution approach not be decided on until the formulation is complete, and the formulation will depend on the form an availability of the data. However, knowledge of an experience with solution methods is necessary to guide the formulation. Another problem is that the formulation, the easiest part of the problem is incorrect. The flow conservation constraints are not sufficient to guarantee feasible traffic flows. In particular, constraint (4) should be

$$\sum_k Z^{ij}_{klt} - \sum_k Z^{ij}_{lkt} = 0 \quad \text{for all } l \neq i, j; \text{ and for all } i, j, t$$

In summary, I believe that GTE's participation in this study would require more resources than the results would warrant. If analysis of point-to-point marginal costs is important, in house expertise could be used more efficiently.

APPENDIX D

CORRESPONDENCE RELATED TO SOUTHWESTERN BELL, TEXAS, AND SAMPLE DATA

T · H · E
OHIO
STATE
UNIVERSITY

1080 Carmack Road
Columbus, Ohio 43210-1002

614/292-9404

April 1, 1988

Phillip Diehl
Director, Telephone Division
Public Utility Commission of Texas
7800 Shoal Creek Boulevard Suite 400N
Austin, Texas 78757

Dear Phil:

Enclosed is a copy of the proposal for the marginal cost study that we have discussed on the telephone previously. Dr. Guldmann is a Professor in the Department of City and Regional Planning at The Ohio State University and a Senior Faculty Associate of The National Regulatory Research Institute. The model in the proposal is laid out in a highly technical fashion in order to specify the data requirements and their uses. Beginning on page 9 of the proposal are the specific additional data required from Southwestern Bell to perform the proposed study. I will briefly discuss the proposed approach and data.

Dr. Guldmann has decided to limit the focus of the study to one or two local exchange areas in Texas that have a tractable but interesting network. Austin or San Antonio are mentioned in the proposal. The additional data would focus solely on the local exchange chosen and other switches (tandems, remotes, and switches) directly linked to switches in the local exchange, but not in the local calling scope. The data needed to supplement the already rich data I have at the NRRI are:

1. The exact location of each central office (switch) in the local exchange area.

2. The number of trunks (circuits) originating from and terminating to each switch and the length (miles or feet) of each interconnection.

3. The transmission technology for each interconnection between switches (i.e. underground cable, buried cable, aerial cable, microwave, or fiber). This includes the mix of transmission technologies or cable types and the length of each where there is a mix to achieve the interconnection.

4. For the local exchange area(s) chosen, forecasted growth of usage and subscriber lines by existing switch and geographical area would be desirable, though not necessary.

Southwestern Bell in conversations (not about this proposal) has indicated that item one and the first part of item two would be relatively simple for the entire state. Consequently, providing the data for a couple of local exchanges will be very easy and not time consuming. As for the mileage of each interconnection, I do not know though estimates could be use. The real question involves the mix of technologies and cable types and the corresponding distances of each. Ideally we would like these. The demand forecasts are not a prerequisite, but very desirable. Hopefully, this would not be bargained away.

What I would like you and the Texas commission to do is request or require Southwestern Bell of Tesas to provide these additional data to the NRRI under the current protective agreement and extend the expiration date of the agreement until June of 1991. Establishing contact with Southwestern Bell's planning department persionel to answer specific questions would also be helpful.

I think this project begins to address Dr. Charns concerns and suggestions although we are not using goal programming. This project appears to have great promise of contributing significantly to the art of marginal costing in telephone. I hope you and the Texas commission decide to help the NRRI. I will be back in my office the week of April 18. I will give you a call.

Sincerely,

William Pollard

The National Regulatory Research Institute

THE OHIO STATE UNIVERSITY

1080 Carmack Road
Columbus, Ohio 43210-1002

614/292-9404

June 17, 1988

Jon Loehman
Vice President, Rates and Revenues
Southwestern Bell of Texas
1616 Guadalupe
Austin, Texas 78701

Dear Jon:

Enclosed is a copy of the proposal for the marginal cost study that we have discussed on the telephone previously. Dr. Guldmann is a Professor in the Department of City and Regional Planning at The Ohio State University and a Senior Faculty Associate of The National Regulatory Research Institute. The model in the proposal is laid out in a highly technical fashion in order to specify the data requirements and their uses. Beginning on page 9 of the proposal are the specific additional data required from Southwestern Bell to perform the proposed study. I will briefly discuss the proposed approach and data.

Dr. Guldmann has decided to limit the focus of the study to one or two local exchange areas in Texas that have a tractable but interesting network. Austin or San Antonio are mentioned in the proposal. The additional data would focus solely on the local exchange chosen and other switches (tandems, remotes, and switches) directly linked to switches in the local exchange, but not in the local calling scope. The data needed to supplement the already rich data set I have at the NRRI are:

1. The exact location of each central office (switch) in the local exchange area.

2. The number of trunks (circuits) originating from and terminating to each switch and the length (miles or feet) of each interconnection.

3. The transmission technology for each interconnection between switches (i.e. underground cable, buried cable, aerial cable, microwave, or fiber). This includes the mix of transmission technologies or cable types and the length of each where there is a mix to achieve the interconnection.

4. For the local exchange area(s) chosen, forecasted growth of usage and subscriber lines by existing switch and geographical area would be desirable, though not necessary.

If feasible and readily available, busy-hour information for each switch and interconnection that is used for planning purposes would be useful in validating the estimated flows derived from using the sample data the NRRI already has. I know we didn't discuss these data on the telephone, but the issue was raised in a subsequent conversation with Dr. Guldman.

I look forward to hearing from you regarding this project. I will call before I come to Austin next time and we can play a round of golf.

Sincerely,

William Pollard

Southwestern Bell
Telephone

One Bell Plaza
Dallas, Texas 75202

July 22, 1988

Jean-Michel Guldmann
227 Sinsbury N. Drive
Worthington, Ohio 43085

Dear Mr. Guldmann:

Attached you will find a sample of the type of information that we can provide for you on Southwestern Bell offices in Austin, Texas.

Please call me on Monday, July 25, 1988 to discuss this data. I can be reached at 214-464-8111.

William C. Deere

Attachments

TRUNKING - INCOMING AND OUTGOING

FROM OFFICE:
AUSTIN BEECAVES

	TRUNKING						FACILITIES			
	INCOMING			OUTGOING						
	QTY	TYPE	CCS	QTY	TYPE	CCS	MILES	TECHNOLOGY	CABLE CAPACITY	EQUIP. CAP.
AUSTIN FAIRFAX	24	(2 WAY) PH	767				9.2	139 MB F.O.	UNLIMITED	6048
							5.8	139 MB F.O.	"	10080
							10.0	565 MB F.O.	"	48384
							3.0	565 MB F.O.	"	153216
							7.0	TID	250	6000
AUSTIN HICKORY				13	PH	229	9.2	139 MB F.O.	UNLIMITED	6048
							5.8	139 MB F.O.	"	10080
							10.0	565 MB F.O.	"	48384
							3.0	565 MB F.O.	"	153216
							3.3	TIC	200	4800
AUSTIN HOMESTEAD CGO				13	PH	229	9.2	139 MB F.O.	UNLIMITED	6048
							5.8	139 MB F.O.	"	10080
							10.0	565 MB F.O.	"	48384
							3.0	565 MB F.O.	"	153216
							4.1	TI	407	9768
AUSTIN TENNYSON				6	PH	102	9.2	139 MB F.O.	UNLIMITED	6048
							5.8	139 MB F.O.	"	10080
							10.0	565 MB F.O.	"	48384
							3.0	565 MB F.O.	"	153216
							3.9	565 MB F.O.	"	96768
							5.2	565 MB F.O.	"	96768
AUSTIN GREENWOOD-TANDEM	121	(2 WAY) AF	2715				9.2	139 MB F.O.	UNLIMITED	6048
							5.8	139 MB F.O.	"	10080
							10.0	565 MB F.O.	"	48384
							3.0	565 MB F.O.	"	153216

OFFICE	TYPE SWITCH	FUNCTION (END OFFICE OR TANDEM)	COORDINATES V	COORDINATES H	MAXIMUM # OF SIMULTANEOUS CALLS	ACCESS LINES RESIDENCE	ACCESS LINES BUSINESS
AUSTIN BEECAVES	DMS10	END OFFICE	9011	4035	THIS INFORMATION WILL BE SUPPLIED AT A LATER TIME	1633	535
AUSTIN BEE CREEK	RSC	END OFFICE	9010	4059		1283	138
AUSTIN CEDAR VALLEY	5XB	END OFFICE	9026	4025		4266	749
AUSTIN CREEDMOOR	RSC	END OFFICE	9034	3976		1402	241
AUSTIN EVERGREEN	DMS100	END OFFICE	9007	3984		6013	3270
AUSTIN FAIRFAX	DMS100	END OFFICE	9006	4012		8090	5511
AUSTIN FIRESIDE	5ESS	END OFFICE	8984	4011		16465	8782
AUSTIN GARFIELD		END OFFICE	9013	3963		1584	229
AUSTIN GREENWOOD CGO	1AESS	END OFFICE	9004	3997		10049	13301
AUSTIN GREENWOOD CGI	1AESS	END OFFICE	9004	3997		12809	17655
AUSTIN HICKORY	1AESS	END OFFICE	9012	3997		42376	14040
AUSTIN HOMESTEAD CGO	1AESS	END OFFICE	8993	3999		30007	18938
AUSTIN HOMESTEAD DSO	5ESS	END OFFICE	8993	3999		1408	604
AUSTIN JOLLYVILLE	1AESS	END OFFICE	8973	4026		19456	5220
AUSTIN LAKE TRAVIS	SXS	END OFFICE	8979	4054		2692	496
AUSTIN LAKEWAY	RSC	END OFFICE	9002	4046		2353	301
AUSTIN LEANDER	5ESS	END OFFICE	8949	4042		3704	561
AUSTIN MANCHACA	DMS100	END OFFICE	9035	3999		11510	1383
AUSTIN MANOR	5ESS	END OFFICE	8977	3970		1265	421
AUSTIN MARSHALL FORD	SXS	END OFFICE	8990	4033		1809	340
AUSTIN PFLUGERVILLE	5ESS	END OFFICE	8962	3990		7314	1516
AUSTIN ROUND ROCK	1ESS	END OFFICE	8952	4004		13918	4136
AUSTIN TENNYSON	1AESS	END OFFICE	8978	3996		25877	10274
AUSTIN TWINBROOK	5XB	END OFFICE	9017	4009		4005	1279
AUSTIN WALNUT	5ESS	END OFFICE	8994	3987		11337	2392
AUSTIN WEBBERVILLE		END OFFICE	8996	3963		643	84

APPENDIX E

CORRESPONDENCE WITH NEW YORK STATE PUBLIC SERVICE COMMISSION
and
INITIAL REPORT OF THE WORKING COMMITTEE

THE OHIO STATE UNIVERSITY

Department of City
and Regional Planning

289 Brown Hall
190 West 17th Avenue
Columbus, OH 43210-1320

Phone 614-292-6046

February 24, 1988

Mr. Neil A. Swift, Director
Communications Division
State of New York Department of Public Service
Three Empire State Plaza
Albany, NY 12223

Dear Mr. Swift:

Pursuant to our telephone conversation this morning, I enclose a copy of the NRRI project plan for "A Feasibility Study of a Point-to-Point Marginal Cost Model for Local Telephone Service."

I very much hope that you and your staff will be interested in further discussing with us both the methodology and application of this approach, and possibly helping us identify a company that might be interested in a test application of the model.

I will contact you in a few weeks to get your reactions.

Thank you very much for your attention to this matter.

Sincerely,

Jean-Michel Guldmann
Professor of City and Regional Planning
Senior Faculty Associate
The National Regulatory Research Institute

JMG:ld

The National Regulatory Research Institute

THE OHIO STATE UNIVERSITY

1080 Carmack Road
Columbus, Ohio 43210-1002

614/292-9404

April 5, 1988

Mr. Dennis Taratus
Chairman, Working Committee
Communications Division
New York Public Service Commission
3 Empire State Plaza
Albany, New York 12203

Dear Mr. Taratus:

Pursuant to our telephone conversation, I enclose the note on the proposed point-to-point marginal cost model. As you can see, this is a linear program based on a detailed network representation of a telephone system (a whole company or part thereof). The model is presented in general form, but several extensions are mentioned in the note.

The purpose of this model is to calculate the long-term marginal (i.e., incremental) costs of usage between any two points in the network and by time of day. The knowledge of these costs can be used to assess the incremental costs of any intraLATA toll route, and thus the potential of bypass along such routes, possibly justifying alternative pricing approaches. These costs can also be aggregated to compute the marginal access costs of an interexchange carrier. The model could also be used to aid in the selection of alternative local loop designs (e.g., remote/host). It therefore seems to me that such a model could be very useful to your Commission in its efforts to develop both a general philosophy and, more importantly, tools for the computation of incremental toll and access costs.

While the general modeling framework has been developed, the mathematical structure of the model must be fine tuned, and its usefulness must be demonstrated through an application to an actual telephone system. The type of data we would need is indicated in the third section of the note. We are looking for a telephone company to provide such data for some or all of its

Established by the National Association of Regulatory Utility Commissioners at The Ohio State University in 1976

territory. We fully understand concerns related to the proprietary nature of such data, and we would certainly be willing to sign an agreement protecting these data (NRRI has signed such an agreement with another company for another research project). We believe that your Committee might help us identifying a company willing to provide these data.

I look forward to hearing from you. I may be contacted at (614)292-6406 or (614)292-9404. Thank you very much in advance.

Sincerely,

Jean-Michele Guldmann
Professor and Senior
Faculty Associate

Enclosure

JMG:jkm

STATE OF NEW YORK DEPARTMENT OF PUBLIC SERVICE

THREE EMPIRE STATE PLAZA, ALBANY, NY 12223

PUBLIC SERVICE COMMISSION

PETER A. BRADFORD
Chairman

HAROLD A. JERRY, JR.
GAIL GARFIELD SCHWARTZ
ELI M. NOAM
JAMES T. McFARLAND
EDWARD M. KRESKY
HENRY G. WILLIAMS

ROBERT A. SIMPSON
Acting Counsel

JOHN J. KELLIHER
Secretary

April 15, 1988

Professor Jean-Michele Guldmann
National Regulatory Research Institute
Ohio State University
1080 Carmack Road
Columbus, Ohio 43210-1002

Dear Professor Guldmann:

Dennis Taratus and I have reviewed your letter of April 5, 1988. Apparently, Dennis did not explain clearly enough what you needed to provide. I believe what you need to do is to pretend that you are a salesman for a few minutes and ask yourself what it is you want to sell to the telephone companies in New York State in exchange for being paid in the form of being supplied data and other information.

I believe you will find that most of the telephone companies are very concerned with solving problems and answering questions that they know they have to deal with in the near term. They are not going to be terribly receptive to an academic study. You need to explain to them why your project will help them solve some important problem that they know they have to resolve. Let me give you some ideas. You could tell them that you are going to develop a model and this model will allow them to determine the incremental costs of both access and toll. They need those estimates in the next year in order to comply with a Commission Order (enclosed). Right now, they have no model to compute such costs. They are considering hiring outside consultants who either have a model or who could develop one. You need to tell the companies how you can save them time and money compared to their other options. You should also consider the following. What kind of time schedule would you be willing to agree to in terms of completing the model and providing results? Will your model run on a PC or will it require a main frame? Will you set the model up on the independent's computer system? For example, if you set it up on the Rochester Telephone's computer, will it stay there? Will people have to use the computer facilities at Ohio State? Will the computer model and associated analysis be fully documented? What happens if they need help with the model or bugs are found later? Who would they go to to get the model straightened out? How much would it cost?

I realize that some of this information is in your proposal, but to sell the companies I think you need to pull it together in a description apart from a discussion of the mathematical model.

I do not want to sound too pessimistic. From what I can tell, your model is pretty much what the independent companies should be looking for. I personally would like to see your model applied to companies in New York State. However, I do not think that the telephone companies are going to want to commit large amounts of staff time helping you develop a largely theoretical model that is going to be located in Ohio when what they need is something that they can easily use to answer cost estimation questions both in this proceeding and any following phases. You need to think of yourself as a salesman in terms of what specific goods and services you are going to be providing the telephone companies that choose to cooperate with you. If you could take a few moments to write me or Dennis another letter in which you lay out some specifics along the lines I have suggested above, then Dennis or I would use that to see if the group would like to have you come and make a presentation. From that, if there were a favorable response, I would expect that you and one or more independents would work together on the project. You should probably also know that New York Telephone has already committed to a particular model effort and they are unlikely to wish to become very involved. Also, except for Rochester Telephone, the independents have very simple networks. You should decide whether or not a telephone company with only two or three exchanges would provide you with enough variety to be worth modelling or whether you would require six, nine, or more exchanges before the company would be of interest to you.

There is a much less attractive alternative to what I have suggested above. You could wait until later in the toll and access proceeding and hope to get some of the data the companies will have compiled by then. This runs the risk of being ignored by the companies since they will not see much reason to help you with your data and analytical needs. That is why I think it would be worth your effort now to try to "sell" the companies on the value of helping you at this time.

Sincerely,

JOEL P. BRAINARD
Policy Analyst
Office of Research

Enclosure

cc: Robert Entlinger, New York Telephone

The National Regulatory Research Institute

THE OHIO STATE UNIVERSITY

1080 Carmack Road
Columbus, Ohio 43210-1002

614/292-9404

June 8, 1988

M. Joel P. Brainard
Policy Analyst
Office of Research
State of New York Department
of Public Service
Three Empire State Plaza
Albany, NY 12223

Dear Mr. Brainard:

As you suggested, I would like to provide additional information and clarification with regard to the proposed development of a point-to-point marginal cost model for telephone companies, that would be undertaken by the National Regulatory Research Institute (NRRI), and for which we request the cooperation of a telephone company in providing the necessary data in the testing phase.

1. The proposed model relies on a complete network representation of a telephone company (or part thereoff), and aims at answering the following types of questions: (a) What is, for any given level of demand, the marginal/incremental cost of any toll route? (b) What is, for any given level of demand, the marginal/incremental cost of access from any point of presence of an interexchange carrier to any end use office? These highly disaggregated costs can then be aggregated to any required level.

It seems to me that the proposed model, the complete mathematical description of which has already been made available to you, fits very well with the incremental costs study goals outlined in the Working Committee report on statewide cost studies for toll and access service (pages 4-7, Nov. 30, 1987), and thus should help the many independent telephone companies in the state of New York get estimates of their incremental costs of both access and toll, which they will need in order to comply with the Commission's Order of June 11, 1987.

2. The resulting product of this research will be completely in the public domain. The model, its software, and a user's manual will be available to

anyone requesting them, at the costs of a magnetic tape (or set of diskettes) and of printing the final report and user's manual. I am sure that you will agree with me that such an option is economically more attractive than having to pay large sums to a consultant for running a "black box" model, the structure of which is, for obvious commercial reasons, carefully concealed from potential users.

We plan to initially implement the model on a mainframe computer, which is likely to be the only feasible option for large networks. However, a PC version for small networks is certainly feasible in a second stage (or in the first stage if the NRRI Board of Directors agrees to fund such work), and I know that this would be useful to many of the small companies that operate in your state. In both cases telephone companies will thus have the option of having their own staff use the model on their own computer facilities, and complete documentation will be available to that effect. For companies that do not have their own computer, arrangements can be made, if so desired, to use Ohio State computer via remote access. Would additional help be needed, NRRI can provide it within the framework of its technical assistance activities. Also, if the demand is high, it is conceivable that user training workshops could be organized.

3. In the preceding sections, I have told you what we would do, at no charge, to help telephone companies compute their various incremental costs. What do we request in return? Well, simply that one (or possibly more) company cooperate with us in the process of model development and testing, by providing the needed data pertaining to its system. While not setting an upper bound, I think that the very small companies (2-3 exchanges) would not be appropriate for the testing phase, and that a minimum size would be 6-8 exchanges. Companies such as Alltel New York, Rochester Telephone, and many of the divisions of Continental New York, could be very appropriate for this project. Finally, I would like to emphasize that we fully understand concerns related to the possibly proprietary nature of some of the necessary data, and that we would certainly be willing to sign an agreement protecting these data with the cooperating company.

As you can see, this is a practical, operational project, and not a theoretical endeavor. I hope that the above comments will elicit enough interest to persuade a company to cooperate with us. If this appears possible, I would be glad to come to Albany to further discuss this matter with you and all interested parties.

Sincerely,

Jean-Michel Guldmann
Professor and NRRI
Senior Faculty Associate

INITIAL REPORT OF THE WORKING COMMITTEE
November 19, 1987

* * *

The Commission's Order of June 11, 1987 in Case 28425 (Opinion No. 87-11) mandated the following:

> New York Telephone Company, Rochester Telephone Corporation, Continental Telephone Company of New York, Inc., ALLTEL New York, Inc., a representative of the other independent telephone companies in New York State, and any such other independent telephone company wishing to participate on its own rather than through a representative are ordered to consult with each other and with the Commission's Staff and to <u>submit for the Commission's approval, within 120 days of the date of this opinion and Order, and agree upon design and plan for a set of uniform incremental, separated, and direct cost studies</u> [of inter- and intra-LATA access, and inter- and intra-LATA toll service (Order, p.116)] suitable for the purposes described in the foregoing opinion. The design and plan shall address and identify, at a minimum, (1) a timetable for completion of the studies, (2) study parameters, and (3) methods of data development. Staff shall report to the Commission promptly on any developments suggesting an inability to reach agreement by the foregoing deadline. (Order, Clause 2, emphasis added)

Implementation of the Commission's order began with an organizational meeting of all interested parties on June 30, 1987. Representatives of Staff, New York Telephone Company, Rochester Telephone Corporation, Continental Telephone Company, ALLTEL New York, Inc., AT&T Communications of New York, Inc., MCI Telecommunications, the Consumer Protection Board, the New York State Telephone Association and representatives of a large number of smaller independent telephone companies in the State were in attendance. It was determined that satisfaction of the Commission's order would require the establishment of a working committee, which would be charged with developing the overall methodology and a timetable for study completion within the 120 day period ending October 9, 1987 required by the Commission's Order. An advisory committee, whose membership would be open to all parties in Case 28425 and all members of the working committee, was also suggested with the role of reviewing the recommendations of the working committee and providing necessary input to the working committee as required.

In this regard, the working committee met on July 17, July 23, July 29 and August 13, 1987. A number of issues related to the implementation and development of the required cost studies were discussed by the members of the working committee and to the extent possible, resolved. The purpose of this report is to summarize that process, to provide details concerning a design and plan for the required cost study effort, and to serve as the report to the Commission, in compliance with the Commission's Order in Case 28425.

STUDY PARAMETERS

The Commission's order will require the development of uniform, consistently applied cost study methodologies for inter- and intra-LATA carrier access, and intra-LATA toll services* by the major local exchange carriers--New York Telephone Company, Continental Telephone Corporation, Rochester Telephone Corporation, and ALLTEL New York Inc.--and representative studies for the remaining 37 independent

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*The Commission's order also suggested studies for the provision of inter-LATA toll services. The exchange carriers of the State do not presently provide such services directly, but indirectly through the provision of inter-LATA carrier access. It will not, therefore, be necessary to perform inter-LATA toll studies by the exchange carriers at this time. Furthermore, we anticipate a need for intra-LATA toll studies to be performed only by those carriers most likely to become "designated" carriers, i.e. New York Telephone Company and Rochester Telephone Corporation (Order, p.88).

A number of independent telephone companies provide toll service on an intra-company basis, or between companies other than New York Telephone and Rochester. It should be noted that we do not by these proposals suggest any resolution to the issue of independent intra-company toll, or to independent-to-independent toll traffic not directly involving one of the designated carriers. Rather, we anticipate this matter should await final Commission action to implement a designated carrier plan. Since such traffic constitutes only a small fraction of the total intra-LATA toll market, little appreciable information loss will occur by not requiring intra-LATA toll cost studies from those companies.

telephone companies in the state. The studies will be designed to provide information concerning the costs on an incremental, embedded and separated basis.* Given that the exchange company's network exists to provide many services simultaneously--toll, access, local, busy/no answer, directory assistance, operator, 911, etc. -- to the extent such facilities exist they will be included in each of the studies to be performed. It will then be the intent of this process to estimate and segregate those costs specific to the service, toll or access, being analyzed. A discussion of each cost concept and the generally agreed upon criteria for the development of such studies follows.

INCREMENTAL COSTS

The incremental costs associated with the provision of access and toll services will be developed based upon estimation of the average total incremental cost that would be incurred to handle a

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*Cost studies, especially those for intra-LATA toll, will be designed to provide disaggregated output. Consistent with the Commission's Order (page 94-106), it will be necessary to study intra-LATA toll transport separately from intra-LATA toll switching in order to address the Commission's concerns that "the access costs (from) providing intraLATA toll service ... remain unknown" and the determination of these costs will be a goal of this process (p.106). The precise level of disaggregation is a matter still to be resolved by the committee.

In addition, New York Telephone Company agrees to prepare its incremental cost studies of intra-LATA toll services inclusive of all inter-regional calls in the New York Metro LATA, since a portion of those calls constituted intra-LATA toll under the Commission's Order at the time it was issued. The company will also prepare embedded cost studies for the same interregional calls using appropriate allocation procedures. Finally, an attempt will be made to produce such costs on a separated basis, if practicable.

given level of demand at predetermined points in time. Every effort will be expended to develop cost estimates using sound economic principles and pertinent information concerning the actual traffic loads for those local exchange carriers' networks that are studied, and utilization of forward-looking engineering criteria based upon the most efficient technologies available.

Study Outputs

Incremental cost study parameters will be defined to provide the following outputs:

1) The average incremental cost disaggregated by tariffed unit.

2) Incremental cost by time of day

3) Incremental cost by length of haul or geographic region.

4) Reasonable efforts will be expended to develop studies flexible enough to allow for additional disaggregation of incremental cost by, for example, class of customer or geographic area.

Study Methodology

The essential ingredient to developing a firm's incremental cost is the ability to measure the change in costs between a baseline condition and a future condition. This will entail the collection of various existing and future data concerning central offices, network routing, and traffic volumes for a specific point in time. The traffic volume for the service studied will then be stimulated by some increment and a new total traffic volume determined.

Next, a forward-looking study will be carried out utilizing the most efficient technology available as reflected by appropriate network expansion plans to determine the disaggregated central office and network investment that would be needed to serve that total demand.

A set of engineering algorithms consistent with the network plan will then be applied in order to redesign a theoretical network configuration to handle the traffic demand so imposed. Estimates of investment and expenditure required to handle that demand will be separately developed based on network experience using appropriate expansion plans.

Implementation Process

The development of a consistent procedure for estimating incremental costs will require the development of an incremental cost manual. This manual will specify in general and specific terms how such studies are to be performed and all relevant criteria for their implementation. It will be the intent of the working committee to develop a cost manual detailed enough in concept* to allow any party to employ either its own in-house capability to perform the study, or

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*But yet sufficiently general enough to permit parties to utilize their individual systems and data sources (e.g. accounting systems, engineering records, etc.) where reasonable.

to acquire the services of an outside consultant. It is our estimate that a manual for the development of incremental costs can be developed by July, 1988.

Size of the Increment

The Commission's Order states that:

> Incremental analysis determines the change in costs and investments associated with a change in demand for access and toll services (Order, page 115).

It does not instruct us as to the level of demand change necessary to elicit a proper estimate of incremental cost. Much of the initial discussion of the Committee centered on prior incremental cost analyses performed by New York Telephone where relatively small increments in demand (e.g. a 1%, 5%, 10%, etc. increase) have been used to derive cost estimates. However, certain parties, notably MCI and Sprint, have taken the position that very large increments in demand are necessary to properly calculate incremental costs. The obvious compromise is to perform the incremental studies in both manners; however, the costs, time frames, and relevance of this solution have not yet been fully explored.

Since it was not specifically considered at prior Committee sessions by the full group, the matter of the size of the increment will be the subject of future discussions. Resolution of this matter is, therefore, deferred, and a complete report on the outcome will be the subject of a future report to the Commission.

EMBEDDED COSTS

The embedded costs related to the provision of toll and access services differ significantly from the incremental costs. Briefly, embedded costs represent the actual expenses and investments associated with the provision of a given service. The costs are assigned to a specific service in the most cost causative manner (i.e., direct assignment where possible and/or allocations based on usage).

Study Parameters

The output of the embedded cost study will simply be the total revenue requirement for toll and access services.

Study Methodology

The essential element of an embedded cost study is the requirement that that cost study ultimately close to the corporate books. Therefore, it is necessary to review the overall investments and expenses of the study firm for a specific historical period, and to utilize a "top down" approach to disaggregate investments and expenses so that they may be directly assigned or allocated to the service which is studied. An embedded study would be based upon actual historical costs as opposed to the forward looking estimates derived from an incremental analysis. Initially, the investments of the study firm will be analyzed and those investments specifically associated with the provision of the studied services will be directly assigned to each service. The concept of direct assignment is fundamental to an embedded analysis. For those investments related to shared facilities (e.g., central office investment), it will be necessary to develop allocation procedures in order to assign the proportion of that shared equipment related to the provision of the studied service. The development of such assignment techniques will be a significant portion of the cost study effort in this area.

Expense allocations will be performed in a similar matter. Expenses will be reviewed in order to determine those which can be directly assigned to toll or access service. In addition, a rule of thumb will be employed that capital-related expenses (such as depreciation) should follow investments. This means that for all investments directly assigned or allocated to the provision of a studied service, capital related expenses will be assigned proportionately to the investment assigned and allocated.

The development of the assignment and allocation process requires a review of the study firms operation for the development of appropriate assignment and allocation techniques. A study firm's review and collection of data from detailed company records concerning usage (e.g. busy hours, etc.) and continuing property records, among others, is essential, in order for the study to be successfully performed.

Implementation Process

Embedded cost studies will require the development of an embedded cost study manual in order to assure consistent application of these principles between study firms. It is the goal of the working committee to develop such a manual in concert with the proposed incremental cost manual by July, 1988.

SEPARATIONS

Separated costs represent the actual investments and expenses associated with the provision of service as allocated to the inter- and intrastate jurisdictions utilizing the FCC/NARUC Separations Manual. This study methodology is currently utilized in allocating costs for the purpose of determining toll and access charge settlements. Presently, the allocation of costs between the interstate and intrastate jurisdictions is made based upon that Manual. The resultant intrastate costs are further allocated between intrastate toll (which currently includes carrier access) and other services based upon a modified version of that Manual specific to the State.

Study Parameters

The output of the separated cost study will be the separated costs for the provision of interLATA access, intraLATA access and intraLATA toll.

Study Methodology

Since most companies currently perform separations studies, a general study methodology for a separated cost study is already in place.

Similar to the embedded cost studies, an essential element of the separated studies is the requirement that all parts add up to the total on the corporate books. Therefore, a "top down" approach to allocating investment and expenses to the various services is required. The separated study will be based upon actual historical total costs. Once the total intrastate element has been identified via the normal separations procedures, the separated cost components of the various intrastate toll and access services will be determined based upon appropriate procedures to be developed by the working committee.

Implementation Process

A revised Separations Manual for settlement purposes will be in effect January 1, 1988. Slight modifications to that Manual will have to be made to reflect the specific requirements of these studies, (e.g., the development of procedures to separate intra-LATA toll from intra-LATA access, disaggregate costs upon a LATA-specific basis). Major modifications will be required to the Manual for separations-like assignments to interregional calling in the New York Metro LATA*. It is the goal of the working committee to modify the Manual by July, 1988.

DATA DEVELOPMENT

The development of the data necessary to perform these studies will require considerable time, effort and expense to obtain. Briefly, traffic studies will be required in order to determine the network load and to provide input to the assignment/allocation processes described above. In addition, it should be noted that the uniform system of accounts which determines the structure of telephone corporation's books and accounting records is scheduled to be modified effective January 1, 1988. Similarly, Part 67 separations rules will also be replaced by Part 36 effective at that point in time. The working committee has determined that, to be relevant to future periods, it is imperative that the cost studies be performed using the new system of accounts and separations rules. In this regard, it is proposed that data appropriate for the development of the aforementioned studies be assembled during the year ending December 31, 1988. New York Telephone Company has been asked to define the type of traffic data necessary to perform the incremental studies.

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*It should be noted that New York Telephone believes this change may prove to be a project of substantial difficulty and expense.

The working committee will meet on a regular basis from this point forward in order to assure the proper data collection routines are in place as of January 1, 1988 for the firms which will be studied.

OTHER CONSIDERATIONS

The working committee has further determined that implementation of the Commission's decision can best be accomplished without the necessity of requiring that each of the 41 local exchange carriers presently operating in the state actually perform each of the study efforts. It has been suggested that aside from those firms required by the Commission order to actually perform the studies -- New York Telephone Company, Continental Telephone Corporation, Rochester Telephone Corporation, ALLTEL New York, Inc. -- that the remaining 37 independent telephone companies arrange to perform the studies on the basis of proxies. In this regard, the independent telephone companies in the state have been grouped in terms of their relative size, based on the number of access lines they provide. It should be noted that for the separation costs studies, all companies that currently perform separations studies for settlement purposes will be required to perform studies. Those nine companies that do not now perform separations studies, i.e. average schedule companies, will select proxy companies from among themselves to perform the separated cost studies. As shown below, Pattersonville, Ontario and Deposit have tentatively volunteered to perform the separations studies. It must be emphasized that use of proxies will be purely optional. All companies retain the right to perform studies on their own if they so choose.

At a meeting held on August 25, 1987, representatives of the various companies identified preliminarily four proxy firms in each of the groupings shown below. These firms have tentatively volunteered to actually perform the studies required, subject, for example, to determination of whether the data requirements still to be identified can be satisfied. Resolution of this matter still requires additional time. The three groupings determined by the working committee and the associated firms are shown below:

PROPOSED COMPANY GROUPINGS

Below 2,000 Access Lines	2,000 - 5,000 Access Lines	Above 5,000 Access Lines
Nicholville	Middleburgh Township	Highland
Cassadaga*	Champlain	Taconic
Hancock	Township*	Ogden
Citizens	Margaretville	Sylvan Lake
Fishers Island*	Oneida	Dunkirk & Fredonia
Crown Point	Addison Home	Seneca-Gorham
Oriskany Falls*	Port Byron	State*
	Newport	Trumansburg*
	Vernon	Ausable Valley

PRELIMINARILY SELECTED STUDY FIRMS

Clymer	Berkshire	Chautauqua & Erie
Edwards	Chazy & Westport	Empire Telephone
Germantown	Delhi	Warwick Valley
Pattersonville*	Ontario*	Deposit*

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*Average Schedule companies who do not currently perform separated cost studies.

Briefly, the proxy firms will perform the cost studies and keep cost records of the additional expenses associated with compliance with the Commission order. The independent telephone companies have formed a committee to address the issue of sharing the costs of completing the studies and the report of that group is attached (Appendix 1). The working committee believes that this process will provide for compliance with the spirit of the Commission's order that uniform statewide cost studies be performed, while at the same time avoiding the necessity that each and every firm in the state actually perform the study efforts. In the working committee's view, the expertise necessary to perform these studies is not universally available, and the use of proxies should provide the breadth of information the Commission requested, with a minimum impact on ratepayers overall.

TIMETABLE

Compliance with the Commission's order requires the development of a timetable for completion of the studies. The working committee has resolved to attempt to complete the final studies by the end of the second quarter of 1989. The proposed timetable follows:

Order issued June, 1987

Organizational Meeting	June, 1987	Completed
Design and Plan Development	September, 1987	Completed
Data Development Initiation	January, 1988	Pending
Incremental, Embedded, Separated Cost Manuals Prepared	July, 1988	Pending
Initial Studies Due	June, 1989	Pending

It should be noted that some parties believe this is an ambitious schedule. Acknowledging that this is a complex and time consuming task, it may become difficult to achieve these goals precisely. While every reasonable effort will be made to meet this timetable, additional time may be required and this schedule should be viewed flexibly.

CONCLUSION

The above report represents the initial recommendations of the working committee charged to develop uniform incremental, embedded and separated cost study parameters, timetables and methods of data development for the provision of toll and access service for the exchange carriers operating in the State of New York. The recommendations contained herein set forth the basic principles by which study efforts will be performed. The working committee has determined that the implementation of the specific detailed cost analyses will require the development of cost study manuals and will strive to have these manuals in place and available by July, 1988. The working committee also recommends that continuous regular meetings be held on a semi-monthly basis through July 1988 in order to prepare the manuals so required.

Respectfully submitted

DENNIS F. TARATUS

ANGELO F. RELLA

CO-CHAIRMEN, WORKING COMMITTEE

APPENDIX F

CORRESPONDENCE WITH THE
NEW HAMPSHIRE PUBLIC SERVICE COMMISSION

THE OHIO STATE UNIVERSITY

1080 Carmack Road
Columbus, Ohio 43210-1002

614 292-9404

April 1, 1988

Ms. Sara Voll
New Hampshire Commission
8 Old Suncook Road
Concord, New Hampshire 03301

Dear Ms. Voll:

I have been informed that the New Hampshire Commission has expressed an interest in our proposal to develop a point-to-point marginal cost model for local telephone service. I enclose a note describing the proposed approach as well as the data needed to test this model. We are looking for a company that might be willing to provide these data as well as interact with us in the process of model development. We would also look forward to interacting with the corresponding state regulatory commission, so as to make sure that the final product will be a useful one.

I look forward to hearing from you. I may be contacted at (614)292-6046 or (614)292-9494. Thank you very much in advance.

Sincerely,

Jean-Michel Guldmann
Senior Faculty Associate

Enclosure

JMG:jkm

RECEIVED
MAY 9 1988
N.H. PUBLIC UTILITIES COMMISSION

Phillip M. Huston, Jr.
Attorney

New England Telephone
A NYNEX Company
185 Franklin Street, Room 1403
Boston, Massachusetts 02107
Phone (617) 743-5781

May 6, 1988

Mary C. M. Hain, Esq.
Staff Attorney
Public Utilities Commission
8 Old Suncook Road
Concord, New Hampshire 03301-5185

Re: NRRI proposal to develop marginal cost study

Dear Mary:

We've reviewed the NRRI material you sent in your letter of April 12 ("Computing Point-to-Point Marginal Costs for Local Telephone Service: Model Formulation and Data Requirements" -- March 28, 1988). There seems to be some question whether New Hampshire presents the type of study network NRRI is looking for:

> We propose to test the usefulness of the model by applying it to an actual telephone network, which might cover a complete LATA or be only a part of a LATA, such as a metropolitan telephone network. This network should be relatively small to minimize data gathering costs. A maximum number of 50 end offices appears to be a reasonable limit. (page 7)

NET's New Hampshire network has some 130 end offices. Within that total there is no discrete subset susceptible of study (such as a metropolitan network) that would serve as a microcosm.

We are not in a position at this time to evaluate the totality of the work effort required by the proposal (assuming, of course, that NRRI itself finds the proposal to be feasible). We will need a much better understanding of the specific data and resource requirements that this proposal would impose.

Sincerely,

Phil

Phillip M. Huston, Jr.
Attorney

cc: Dr. Sarah Voll

STATE OF NEW HAMPSHIRE

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Vincent J. Iacopino
COMMISSIONERS
Bruce B. Ellsworth
Linda G. Bisson

EXECUTIVE DIRECTOR
AND SECRETARY
Wynn E. Arnold
Tel. (603) 271-2431

PUBLIC UTILITIES COMMISSION
8 Old Suncook Road
Concord, N.H. 03301-5185

May 10, 1988

Dr. Jean-Michel Guldman
NRRI
1080 Carmack Road
Columbus, OH 43210

Dear Dr. Guldman:

Enclosed is a copy of the initial reply we have received from New England Telephone regarding its participation in the testing of the NRRI marginal cost model.

Could you respond to the initial point in the letter, i.e., that NET's New Hampshire network at 130 end offices and no discrete subset susceptible of study, is not the type of study network NRRI is looking for? Further, do you have, or could we provide you with, sufficient information to evaluate whether a NH-NET subset could be delineated that would serve your purposes?

I would like to have something in writing from you before getting back to NET.

Yours truly,

Sarah P Voll

Dr. Sarah P. Voll
Chief Economist

SPV/ael

Enclosure

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PUBLIC UTILITIES COMMISSION
8 Old Suncook Road
Concord, N.H. 03301-5185

May 26, 1988

Dr. Jean-Michel Guldman
National Regulatory Research Institute
1080 Carmack Road
Columbus, Ohio 43210

Dear Dr. Guldman:

Enclosed is a map showing the exchanges in New Hampshire. I have colored in the Independents, leaving NET in white.

I have consulted with Dr. Connie Colter, my rate analyst, and Edgar Stubbs of the Engineering Department. Their consensus is that NET does not have any aggregation that is larger than a central office, of which there are 118, and smaller than the entire state. They also think that for our purposes a study that looked at the entire state would be most usable, if it is possible to do.

Could you write me a letter that would evaluate the feasibility of including the entire state or of identifying a smaller sub-set? Further, could you include some description of the level of effort NET would need to provide? I do not think they have a clear understanding of what their involvement would entail from pp. 7-8 of your study proposal. Once I have something in writing from you, perhaps we can set up a meeting with you, staff and NET.

Dr. Colter will be at the NRRI cost study conference June 6-10. If you have any questions you could probably plan to discuss them at some greater length there, rather than over the phone.

Sincerely,

Sarah P. Voll

Dr. Sarah P. Voll
Chief Economist

SPV/ael
Enclosure

THE OHIO STATE UNIVERSITY

1080 Carmack Road
Columbus, Ohio 43210-1002

614/292-9404

June 8, 1988

Dr. Sarah P. Voll
Chief Economist
State of New Hampshire
Public Utilities Commission
8 Old Suncook Road
Concord, NH 03301-5185

Dear Dr. Voll:

Thank you very much for your letters of May 10 and 26, and for the map showing the exchanges in New Hampshire.

Based on the information you sent me, my knowledge of the geography of New Hampshire, and further discussions I had yesterday with Dr. Connie Colter, whom I had the pleasure to meet at the NRRI Workshop, it is my assessment that it is completely feasible to use the whole NET's New Hampshire network (130 end offices) for the test application of the proposed point-to-point marginal cost model, including the connections of NET with the independent telephone companies, which would each be represented by either one or several nodes, depending upon the contiguity/disjointness of their service territories. I have outlined to Dr. Colter a clustering/decomposition approach for the numerical resolution of the model, that should enable us to deal relatively easily with a system of NET's size. I personally find this application very attractive, as New Hampshire combines rapidly urbanizing areas and low-density rural zones, with the obvious implication of significant variations in the cost of telephone service across the state.

With regard to the data we would need for this application, I am sure that NET has many of them in ready form (e.g., network description). I also read with interest in Docket No. DR 85-182 that NET and some of the Independents have collected usage data over six months to facilitate various cost of service studies under way or completed.' I am sure that these data will be helpful in our proposed project. In any case, I definitely feel that we should set up a meeting with your staff and NET to fully discuss these issues, and I believe that an early date would certainly be mutually beneficial. (I will be out of the country in August).

Established by the National Association of Regulatory Utility Commissioners at The Ohio State University in 1976

Finally, as I told you over the phone, I would like to emphasize that we fully understand concerns related to the possibly proprietary nature of some of the necessary data, and that we would certainly be willing to sign an agreement with NET protecting these data. (NRRI has signed such an agreement with another telephone company for another project).

I look forward to hearing from you.

Sincerely,

Jean-Michel Guldmann
Professor and NRRI Senior
Faculty Associate

STATE OF NEW HAMPSHIRE

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8 Old Suncook Road
Concord, N.H. 03301-5185

June 16, 1988

Kathy Veracco
Manager
New England Telephone
4 Park Street, Room 300
Concord, NH 03301

Dear Kathy:

NET's concerns as to the use of the Point-to-Point Marginal Cost study have been discussed with Jean-Michel Guldmann, Senior Faculty Associate at NRRI. These concerns were first, whether the Company would need to provide data for only a discrete subset rather than the total universe of end offices, and second, that the Company needs more information to assess the work that would be required by the study.

Mr. Guldmann has replied in a very positive manner, indicating that he would consider using the total number of end offices a challenge. (Please see attachment). He would like to discuss with the Company its existing engineering and usage data that might be used and work together to assess what else might be necessary. We would like to set up a meeting with the Company, Mr. Guldmann and Staff to explore whether a preliminary commitment to the pilot project is possible. We suggest that you propose one or two feasible dates between July 5th and through July 14, 1988.

We understand that this requires considerable coordination of all parties but believe the effort would well be worth it. NRRI is currently holding the funds for the study and Mr. Guldmann needs as timely a response as is possible.

If prior to the actual meeting Mr. Guldmann might check with your technical experts to explore preliminary aspects such as types of data available, the actual meeting might be used far more efficiently than otherwise. Could you please suggest the names and provide telephone numbers of such staff who would be knowledgeable in these areas?

Sincerely,

Connie Colter, Ph.D.
Utility Rate Analyst

CC/ael

Attachment

cc: Bob Duggan
Jean-Michel Guldmann
Mary Hain
Merwin Sands
Ed Schmidt
Les Stachow
Ed Stubbs
Gene Sullivan
Sarah Voll

STATE OF NEW HAMPSHIRE

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June 21, 1988

Mr. Jean-Michel Guldmann
Dept. of City & Regional Planning
Ohio State University
190 West 17th Avenue
Columbus, Ohio 43210

Dear Jean-Michel:

Please find enclosed some of the background information you had requested in our meeting of June 10, 1988 and subsequent discussions. Included are:

1) NET's 1987 Annual Report;

2) NET's Network Exchange Profile (a more abbreviated version is also available on request for the independents); and

3) NET's Depreciation and Expansion Plans

   a) depreciation information on switches,
   b) Fall 1987 Capital Plan View; and

4) Docket No. 85-182 information

   a) orders,
   b) negotiations/summary,
   c) position paper and other negotiations between the independents, NET and Staff, and
   d) Merrimack County Telephone's usage study (which should approximate that of NET).

Unfortunately I can not yet provide to you more information on NET's usage data as it will not be available until June 24th or so. However, Kathy Veracco sees no problem with you contacting Company technical experts for additional information. Marv Hanson, who developed the Company's cost data, may be reached at (617) 737-4151.

As we have already discussed, Bruce Larson is very knowledgeable on the engineering side. His number is (603) 645-2187.

I shall let you know as soon as possible when we may meet to discuss the study.

Sincerely,

Connie Colter, Ph.D.
Utility Rate Analyst

CC/ael

Attachment

New England Telephone
A NYNEX Company
265 Franklin Street
Boston, Massachusetts 02110

August 15, 1988

Dr. Douglas N. Jones
Director - The National Regulatory Research Institute
Ohio State University
1080 Carmack Road
Columbus, Ohio 43210-1002

The purpose of this letter is to inform you that New England Telephone (NET) is willing to provide New Hampshire specific input data to Dr. Jean-Michael Guldmann for use in his proposed point-to-point marginal cost model.

At a meeting held in Concord, New Hampshire on July 13th, Dr. Guldmann presented an overview of his model and its associated data requirements to representatives of both NET and the NH PUC staff. At that meeting four concerns regarding NET's involvement were discussed. First, Dr. Guldmann stated that he would be willing to rely on input data from NET that is readily available as he understands that NET does not have the resources to conduct time-intensive special studies. Second, Dr. Guldmann indicated that he would be willing to model a 1992 projected view of the New Hampshire network. (This eliminates the need for NET to develop capacity expansion cost for electromechanical central office technologies; moreover, a 1992 view is representative of NET's forward looking costs.) Third, Dr. Guldmann stated that NET would not incur a financial obligation beyond the expense associated with providing the input data. Fourth, Dr. Guldmann stated that given the competitively sensitive nature of the input data he understood the need for him to enter into a protective agreement with NET. The specifics of the protective agreement can be mutually agreed upon at a later date.

As final product output, Dr. Guldmann stated he would provide NET with a report that will address: the methodology, the assumptions, the usefulness of the study, the final results and other related output. Also, he will provide NET with a tape containing the algorithms and data that were used to produce the results.

I look forward to working with Dr. Guldmann. If you have any questions, please call me on (617) 737-4191.

John A. Eagan

Director - Incremental Costs (Acting)

cc: ✓Jean Michael Guldmann
Connie Colter
Sarah Voll