A systems framework for the evaluation of capital expenditure proposals in the telecommunications industry

DEPARTMENT OF MECHANICAL ENGINEERING
THE UNIVERSITY OF ALBERTA

A SYSTEMS FRAMEWORK FOR THE EVALUATION OF CAPITAL EXPENDITURE PROPOSALS IN THE TELECOMMUNICATIONS CARRIER INDUSTRY

PREPARED
UNDER THE DIRECTION OF
DR. J. C. SPRAGUE
MECHANICAL ENGINEERING DEPARTMENT
UNIVERSITY OF ALBERTA
EDMONTON

March 30, 1977

DEPARTMENT OF
MECHANICAL ENGINEERING

THE UNIVERSITY OF ALBERTA
EDMONTON, ALBERTA, CANADA
T6G 2E1

QUAECUMQUE VERA

March 30, 1977

Mr. G. Henter
Department of Communications
300 Slater Street
Ottawa, Ontario
K1A 0C8

Dear Mr. Henter:

A systems framework for the evaluation of capital expenditure proposals in the telecommunications carrier industry has been outlined in this report. Major emphasis has been placed on methods of developing costs within exchange areas for budgeting and comparison purposes.

The exchange area (the area serviced from an individual switching centre) was selected as the basic module for developing all demand and cost data. Formats have been developed for forecasting demand requirements and developing budgeted costs within each exchange area.

Recommendations have been made regarding the functions of the carrier and the regulator in developing a total effective system to insure the development of just and reasonable rate structures on a continuing basis. The monitoring of costs is suggested through a central agency with feedback to both the carrier and the regulator to insure a continuous assessment of costs for comparison within and between carriers.

The basic framework suggested should be beneficial to all parties concerned and should require minimal change in any carriers existing budgeting system for implementation.

Yours truly,

J. C. Sprague

J. C. Sprague, Ph.D. P. Eng.
Professor
Mechanical Engineering
University of Alberta

ACKNOWLEDGEMENTS

Funds for the support of research assistants and graduate students involved in this project were supplied through a research grant from the Department of Communications.

All individuals involved in this project are very grateful to Edmonton Telephones. Without the willingness of many individuals within Edmonton Telephones to supply technical guidance and information on request, this project could not have been completed.

TABLE OF CONTENTS

I INTRODUCTION

1.1 Purpose

The purpose of the total system is to design the framework for a system for the evaluation of capital expenditure proposals in the telecommunications carrier industry in a manner that will insure the development of just and reasonable rate structures.

1.2 Scope and Methodology

The assurance of just and reasonable rate structures within each carrier on a continuing basis requires the development of a cost data base by carrier to accomplish the following functions:

1) budgeting;
2) the conversion of costs into corresponding rate structures;
3) monitoring of costs for comparative purposes within an individual company;
4) monitoring costs for comparison purposes between companies; and
5) the organization of cost data for optimization studies.

The intent of this study is to concentrate on a framework to accomplish the above objectives. The study will not attempt to develop any specific data bank cost information or computer programs. However, the units of measurement with respect to demand requirements and physical facilities will be assessed and suitable formats for collecting and utilizing the data requirements will be designed. In addition a method of evaluating all cash flows will be recommended.

In order to accomplish these objectives it is necessary to

1) develop realistic classifications for the physical facilities;
2) identify the various demands for services and develop a system that promotes conversion of these demands for services into physical facilities, budgets and related rate structures; and
3) develop a framework for a uniform costing system which includes data banks that can be used for budgeting, cost comparisons and optimization studies.

1.3 Background

This background information is intended to highlight some of the philosophy and thinking that evolved from the Transport Commission Cost Inquiry (1972-1974) and to stress the complexity of the problems that must be considered in developing "A Framework for a Capital Budgeting Model for the Telecommunications Industry."

There are many views presently expressed regarding the method of costing that should be used within the telecommunications carrier industry. For example:

A. Ontario - Proposes that book costs be distributed among the services on the basis of their respective use of the telephone system.

This approach does not consider demand elasticity or value of service considerations. According to the Snavely, King Tucker Report (consultants), it ignores valid rate making objectives such as:

1. 1) To stimulate consumption by means of preferential rates price-elastic markets in order to realize the benefits of declining costs resulting from improved system utilization,

economies of scale, and high density technologies.

2) To extend the use of the telecommunications system to the broadest cross section of society through rate discrimination according to relative price elasticities.

3) To recognize different values of service to different classes of customers.

4) To recognize different abilities of customer groups to pay for service.

2. Secondly, Ontario's simplistic view of service costing ignores:

1) the prevalence of common costs which are shared among services in no fixed proportion and are largely insensitive to service mix of usage;

2) the prevalence of fungible facilities which are interchangeably assigned among services;

3) the effect of the timing of facility installation which causes different vintages of facilities to differ substantially as regards technology, capacity, and therefore cost; and

4) the presence of a common growth reserve in new facilities which are added in large capacity increments.

B. Bell Canada suggests continuation of the present system of controlling only the aggregate revenue generation from all services and, in effect, permitting the carriers to distribute their revenue requirement among services largely on a basis other than cost. Bell believes that if the aggregate revenue from the optional and the competitive services exceeds its aggregate incremental costs, then the "core" local and toll switched services would be protected from bearing any burden by reason of the other services.

Bell's approach would seem to contradict Section 321 of the Railway Act which prohibits unjust discrimination, undue preference, prejudice, advantage, or disadvantage.

C. Neither of these approaches is feasible according to the Snavely, King and Tucker Report (consultants re the Canadian Transport Commission cost inquiry). They suggest the calculation of service costs on two bases:

1. Average variable embedded costs reflect the book net investment and associated expenses which are reasonably related to and variable with the provision of each service. These costs, plus the residual of fixed, corporate common overhead and growth reserve costs would "close" with the accounts of the company. Except for obsolescent facility types which are assigned only to services offered when such facilities were put in place, these costs fully reflect the age and technology distribution of the facilities which are currently used by each service.

2. Average variable current costs represent the cost of facilities variable with each service at current price levels using technology which is currently being installed. Depreciation reserve is taken at the average for each plant class so as to neutralize the effect of differences in age among different plant elements. These costs are computed from the unit costs already prepared and employed by the carriers in estimating their current construction costs.

The embedded costs will identify components of the revenue requirements historically created by each service, while the current costs will compare the engineering and operational requirements of the respective services without the distortions created by the largely arbitrary and often irrelevant history of plant additions. By comparing these two cost measures, the Commission can observe whether costs for each service are increasing or decreasing, and whether its revenues cover its costs both historically and prospectively. The use of these dual measures of discrimination does not lead to the simplistic conclusions available from a single measure. Rather, it recognizes that the characteristics of the telecommunications system do not permit a refined computation of "the" cost of an individual service.

They also suggest that a simple allocation of costs according to usage will help neither the company nor the regulator in resolving the question of rates.

Rate Discrimination

Discrimination in an economic sense means the charging of rates to different services or classes of customers in a manner disproportionate to the distribution of cost.

The following factors suggest that some measure of rate discrimination is desirable; at least, these factors suggest that a thorough evaluation of all factors concerned is necessary before rate discrimination can be ruled out.

Factors:
1. System utilization - shifting peak demand through price discrimination.
2. Social factors.

3. Decreasing cost of service by:

   A) If rate discrimination can stimulate greater demand new circuits required will cost less than old ones and even those customers discriminated aginst will be no worse off than before. Or, in some cases, facilities installed initially are of such an increment that they have low utilization initially.

   B) Long run economies of scale.

   C) Technological development.

   D) Increased use of company services.

4. Relative value of service.

5. Ability to pay.

The question of rate structures raises many challenging and controversial issues that reach far beyond the scope of this report. However, some discussion is presented with respect to the criteria that should be used as a basis in developing just and reasonable rates.

II THE SYSTEM FRAMEWORK

2.1 Fundamental Structure

The design of the total closed loop system for evaluating investment decisions within the telecommunications carrier industry involves four major sub-systems. These are (1) demand, (2) physical facilities, (3) costs, and (4) rate structure. These four components, as shown schematically in Figure 2.1 must be integrated into a total system in order to develop an "optimal" rate structure (optimal with respect to both the carrier and the customer). These four major sub-systems must also consider the interaction between 1) the carrier, 2) the regulator and 3) the customer.

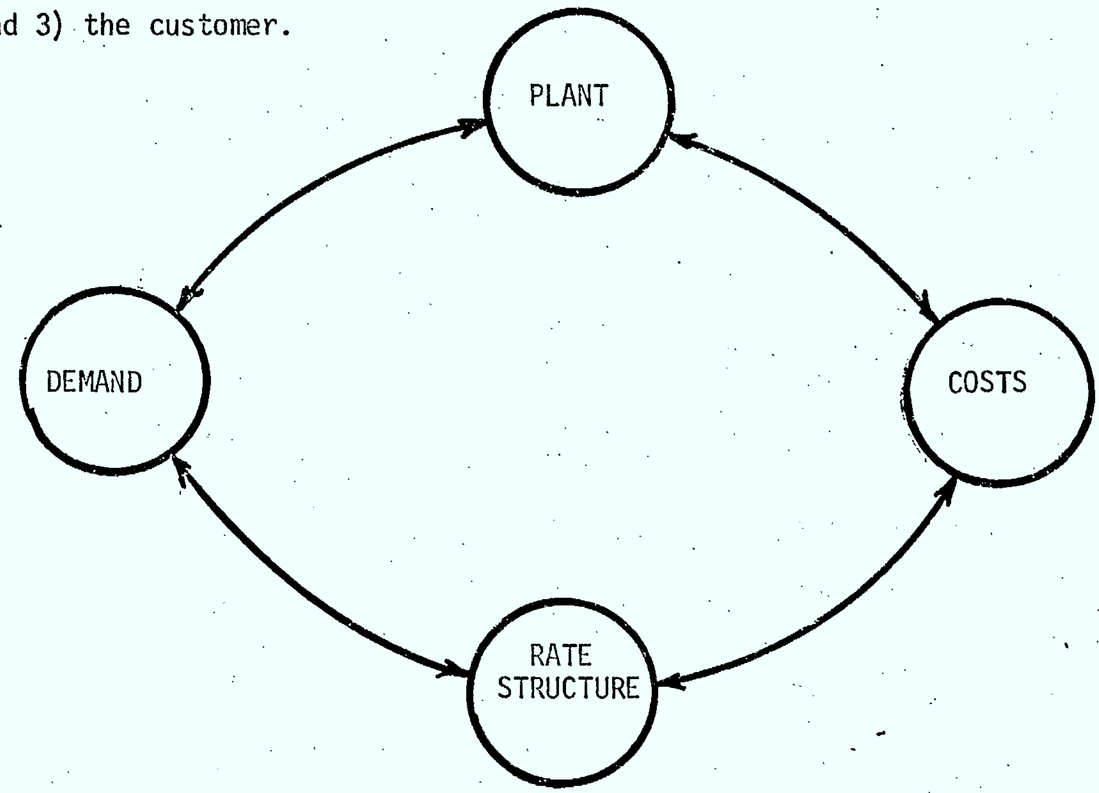

Figure 2.1 A Schematic of the Critical Factors Involved in the Design of the Total Functional System for Evaluating Investment Decisions in the Telecommunications Carrier Industry

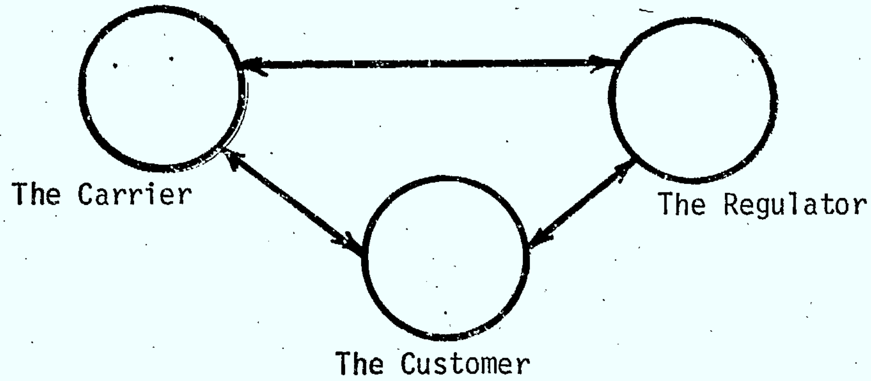

Figure 2.2 The Interacting System

The role of each dynamic body in Figure 2.2 in developing an economically viable system with respect to the four major sub-systems in Figure 2.1 has been a question in contention for many years. We may visualize the carrier on one side of the bargaining table representing the shareholder and the "regulator" on the other side of the bargaining table representing the customer by insuring that the rate structures of the carrier are "just and reasonable." The customer playing somewhat of a passive role with some interaction with both groups. The environment within which the carrier and the regulator operate can be considered a strong parallel to the company - union environment, basically one of confrontation rather than one of cooperation and coordination of effort to produce an end product that is mutually beneficial to all concerned.

The first major step in diminishing this environment of confrontation is the development of a total system that insures uniformity with respect to the measurement of the cost of services and uniformity with respect to the method of converting these costs into a rate structure for each service. The objective should be to design a system for the carrier to optimize, to the maximum degree possible, the four major sub-systems of demand, physical facilities, costs, and rate structure. The monitoring function of the regulator, should be complementary to the system. The uniform measurement criteria necessary for the regulatory body to perform its function should also be very useful to the carrier in measuring its performance. Systems of performance measurement such as total factor productivity measurement (TFP) are already in use by several carriers throughout North America [3]. The framework for the performance measurement system recommended herein strives for simplicity while accomplishing the major objective of accurately measuring performance.

Within a partially monopolistic industry such as the telecommunications industry there is justification for special protection of the consumer by a regulatory body. The purpose of this body may be stated as follows: "To regulate telecommunications carrier companies in a manner that will insure desirable telecommunications service levels within just and reasonable rate structures."

Every company has a major obligation to its investors to provide a reasonable return on their investment. In fulfilling this obligation, and the many other objectives of any organization, it is necessary for the company to remain economically viable. Within a free enterprise system it is not possible, in the long run, to maintain economic viability, and thus survive, without providing competitive service levels within just and reasonable rate structures. Should the basic purpose or function of companies in a regulated industry be any different than companies operating in non-regulated industries? Assuming, the answer is no then one can, for all practical purposes, say that the prime function of the regulator is the same as the prime function of the carrier.

Our purpose should then be one of designing a feasible system that best utilizes the total cooperative resources of the carrier and the regulatory body "to supply telecommunication services at just and reasonable rates." Clarification of the role of each participating body and the freedom of movement within this role should be of prime concern. The carriers should have adequate freedom of movement to accomplish their function. The regulators should perform a monitoring process in a simple but effective manner.

2.2 The Role of the Carrier

The carrier should develop total costs and incremental costs for each classification of plant within each integral system (e.g. city or rural area) using agreed on standard procedures for measuring and reporting these costs that are uniform throughout the entire Canadian system.

These costs are converted into individual rate structures for each service using utilization of facilities within each integral system as the initial base criteria. The specific prime measure being some base cost in terms of planning units and planning lines. A suggested approach is a comparison of facility utilization by each type of subscriber to the facility utilization of a residential subscriber. However full consideration should be given to such factors as cross subsidization, value of service and the degree of necessity associated with the service.

The carrier should supply complete, but concise, information with respect to total costs, incremental costs and rate structures to the central agency for processing and comparison with data from other carriers. This data, in turn, should be distributed to all carriers and regulating bodies for their respective uses.

Important considerations within this system are:

1) uniformity of measurement of all costs;
2) uniformity in the development of all rates; and
3) the information supplied to the central agency should be a data summary readily generated and of use to the carrier.

2.3 The Role of the Central Agency

The role of the central agency should be one of correlating all cost data and the corresponding rates from each carrier in a predetermined format agreed on by carriers and regulatory bodies. This data should then be returned to each individual carrier and regulatory body. The purpose of this data can be many fold such as: operating results

1) Each carrier can make useful comparisons of their costs in each major cost area with other carriers' costs. This can be accomplished through the use of realistic indices for each area which would be updated on a continuous basis by the central agency.
2) Rate comparisons can be made in a similar manner to cost comparisons.
3) The need for rate adjustments should be obvious to both the carrier and the regulator. These adjustments should not require lengthy hearings to warrant their implementation.

2.4 The Role of the Regulator

Within the system suggested the regulatory body can play a very active role. The true costs of each service within each carrier can be effectively monitored on a continuing basis. Areas of high and low productivity should be obvious to both the carrier and the regulatory body. Strong incentives through rate structure bonuses in high productivity areas and rate structure penalties in low productivity areas can insure that both the consumer and the carrier are receiving fair value for their respective dollars of investment.

Under this system the regulatory body can and should make periodic detailed audit checks of the carriers' records pertaining to specific areas of operation. These checks should initiate positive recommendations for improving productivity.

III THE PHYSICAL FACILITIES

The telecommunications facilities consists of a physical network that allows verbal and ~~written~~ communication between users of the system.

In view of our previous discussions regarding methods of allocating costs to services, telecommunications plant should be classified under two major headings.

1) Support facilities (service and administration)
   - A) land,
   - B) buildings,
   - C) Office furniture and equipment, and
2) Operating facilities
   - A) subscriber terminal equipment,
   - B) outside plant, and
   - C) central office.

The support facilities include all physical facilities necessary to perform the administrative and service functions such as accounting, corporate planning, research and development and engineering. Support equipment (e.g. vehicles and tools) required as part of the direct functions performed by plant personnel will be allocated directly to each class of plant.

The terminal equipment represents the equipment utilized by the subscriber at point A to communicate with the subscriber at point B. The network facilities (outside plant, station connection and central office equipment) represent the telecommunications equipment necessary to transport the message from point A to point B. For ease of costing and developing rate structures, the following classifications as outlined in Figure 3.1 are recommended.

Classification of Plant

A) 1) terminal equipment,

B) 2) subscriber loops,

3) local switching,

4) exchange trunking - between exchanges,

5) toll connecting trunks to local exchange,

6) toll switching, and

7) toll trunking - ~~intercity point to point trunks~~

The importance of measuring the interaction between these subsystems with some degree of accuracy in order to develop a near optimal telecommunications system cannot be over emphasized. For example, the gross local additions per telephone are approximately $1300.00 (this cost can be expected to vary somewhat depending on location). In addition, a nominal saving of one percent in capital costs, based on the present rate of telecommunications capital investment in Canada, represents in the order of $20,000,000, or for a city of 500,000 people an annual saving of at least $400,000 can be expected. A one percent saving in capital budgeting costs with no loss in service level is a conservative estimate of the possibilities open to each individual carrier.

The optimization of the total Canadian communications system, including all local and toll networks, as an individual entity does not appear to be practical within the realm of existing computer technology. However, fortunately a high degree of optimization within the total system is possible by considering each city or rural community as an integral system with the toll connecting facilities being the tie node with other integral communication systems throughout Canada and the world. The major emphasis in this report will be to design a capital <u>budgeting framework</u> for a typical Canadian city, an integral system within the total Canadian telecommunications network. This basic framework should be applicable to any other city or rural community using the exchange area as the key functional component. The toll facilities represent the tie node between centres and the impact of changes within any city or rural community can be measured through the toll connecting network. Figure 3.1 is intended to schematically show a segment of the total Canadian telecommunications network.

3.1 The Method of Optimization Within an Integral System

The exchange area is considered the critical building block within an individual system (an exchange area is the area serviced by an individual switching centre). Therefore, all information with respect to the design of a near optimal network such as forecasting data and equipment requirements will be generated by exchange area. The interaction between other individual exchange areas within the system (e.g. city) and the impact of each exchange area on the toll system must be carefully monitored and converted into capital and operating budget requirements. Figure 3.2 is a schematic representation of the exchange area as a building block.

3.2 Budgeting

A five year planning horizon is suggested for budgeting purposes. The procedure recommended in developing a five year rolling budget for each class of plant is discussed in Section VI. A more specific and

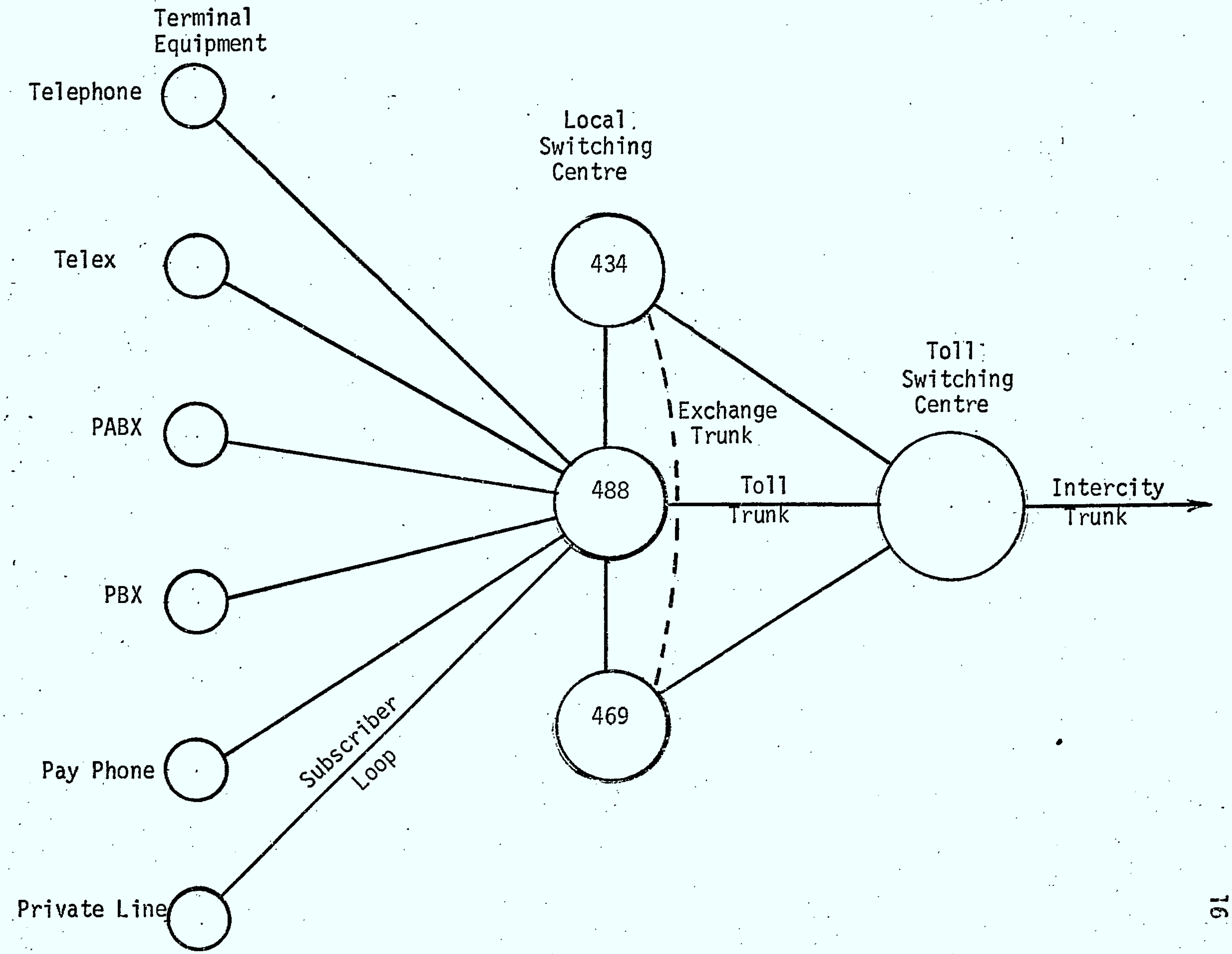

Figure 3.1 Physical Plant Facilities Within the Telecommunications Network

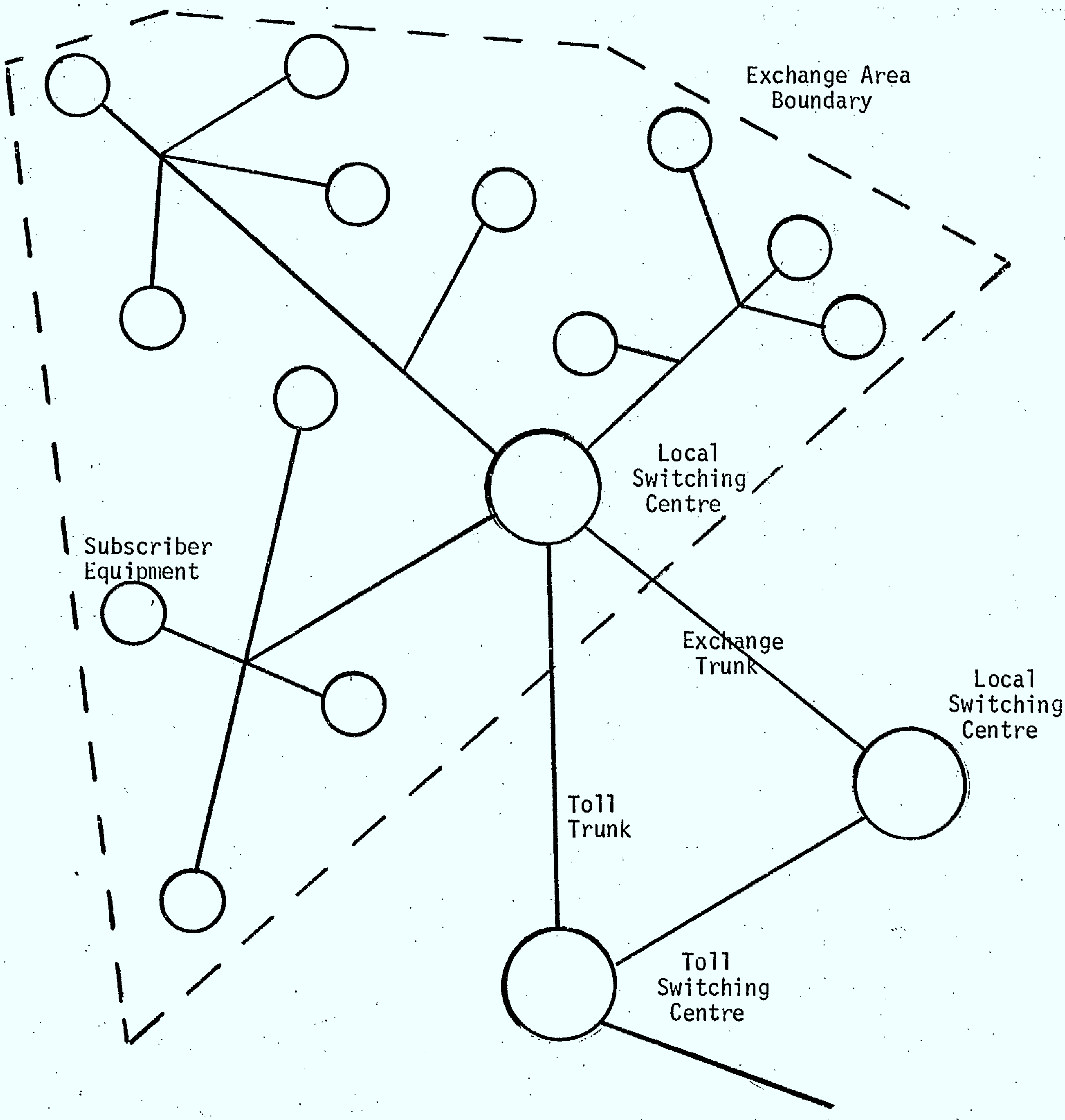

Figure 3.2 The Exchange Area As a Building Block

comprehensive framework will be presented in the sections to follow.

3.3 Forecasting Service Demand

Demand is forecast in terms of station terminal equipment requirements by exchange area. This forecast requires input from marketing and service engineering and represents the actual terminal equipment in existence and expected over the next five year period.

3.4 Subscriber Loops

The forecast in terms of terminal equipment is not sufficient information for outside plant engineering to complete their budget requirements regarding subscriber loops. The terminal equipment forecast must be supplemented by an area breakdown within the exchange area. The terminal equipment information should be developed on a basis that allows determination of present demand requirements and spare capacity within each feeder cable. Additions to the cable network within the exchange area can then be determined and a subscriber loop budget forecast recommended.

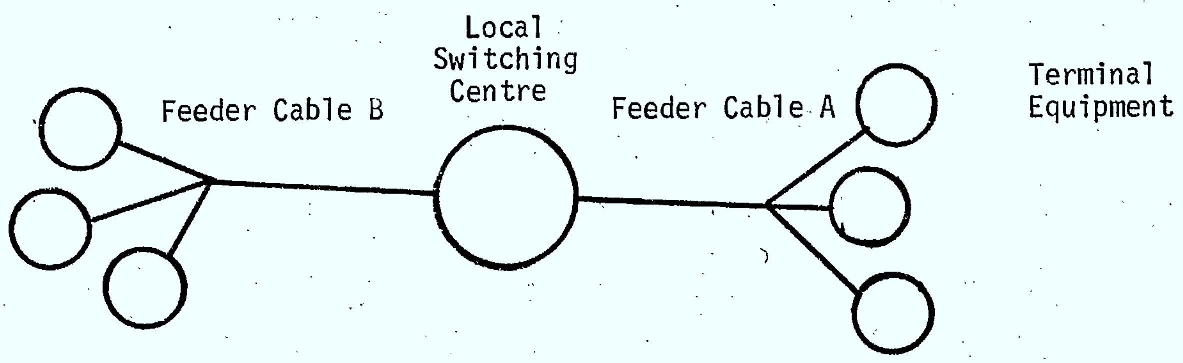

Figure 3.3 A Simplified Schematic of the Subscriber Network Cable Facilities

3.5 Local Switching

The terminal equipment demand forecast is converted into planning units by traffic engineering. [There are three basic planning units: 1) lines, 2) CCS and 3) call attempts (CA). These planning units can be converted to physical equipment requirements within each class of plant entering and leaving the switching centre].

level of service

The utilization of the switching centre is expressed in terms of physical lines within the subscriber loop plant, CCS requirements per terminal for all incoming and outgoing traffic, and call attempts per terminal for all incoming and outgoing traffic.

The forecasted demand is added to the present demand to determine the additional equipment requirements. Optimization studies are conducted within engineering on a continuing basis to determine the optimal time interval between equipment increments to meet demand and the optimal replacement timing of existing equipment with new technology. Each local switching centre is identified by the first three numbers of all telephone numbers associated with a specific switching centre.

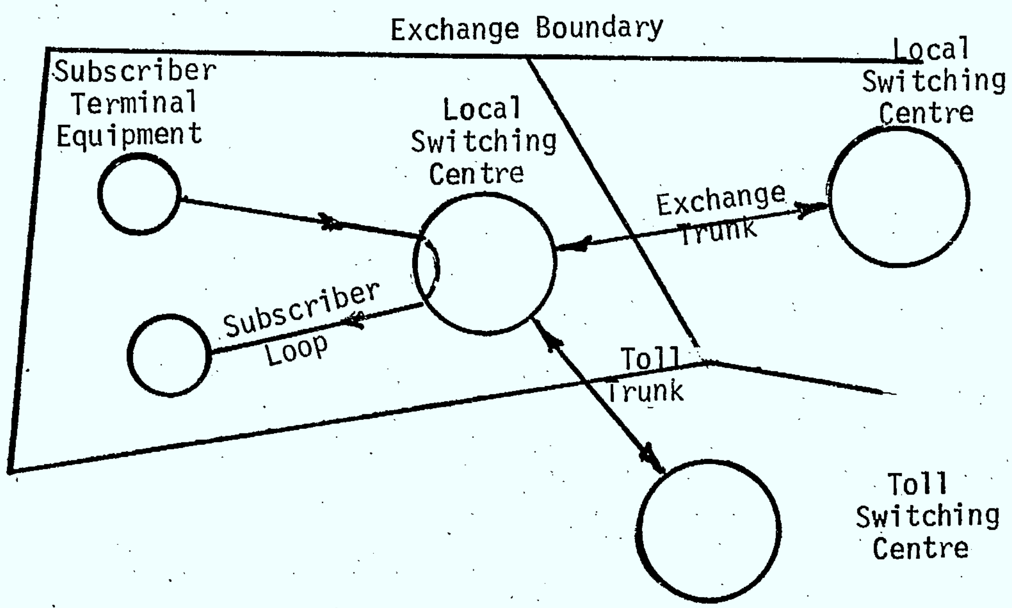

Figure 3.4 A Simplified Schematic of the Traffic Flow Into and Out of a Local Switching Centre

3.6 Exchange Trunking

The forecasted planning unit requirements with regard to the exchange trunking facilities are determined for each local switching centre. This information is organized in matrix form. On the basis of this information, optimization studies are undertaken by traffic engineering to determine the optimal incremental trunking additions and the timing of these trunking additions. Each exchange cable is identified by the switching centre numbers in which it terminates. (Figure 3.5 is indicative of the type of information to be stored in data banks.)

Local Switching Centres

Local Switching Centres	434	425	488
434		Cable Sizes Cable Lengths Planning Units	
425			
488			

Figure 3.5 A Simplified Diagram Showing Data With Respect to All Exchange Cables Connecting Local Switching Centres Within An Integral System (e.g. city)

3.7 Toll Switching

The expected increase in toll traffic into and out of the toll switching centre should be forecast over the five year budget planning horizon.

This increase in utilization is due to three components:

1) toll traffic entering an individual system (e.g. city);
2) toll traffic from within an individual system; and
3) toll traffic that uses the toll switching facilities but by-passes the system (e.g. city).

The present and expected increases in toll traffic may be determined for each local switching centre. The toll switching capacity requirements associated with each integral system (e.g. city) can be determined from the aggregate toll traffic over all the toll connecting trunks to local exchanges.

3.8 Toll Connecting Trunks to Local Exchanges

The impact of toll traffic on the toll trunking facilities should be forecast for each exchange area. The combined total toll and wide area service traffic into and out of each local switching centre in terms of planning units can be converted into a physical forecast for the toll connecting trunk facilities to local exchanges.

The development of detailed budgeting information for each class of plant and the associated support facilities represents the basic information required to convert costs into realistic rate structures.

IV THE DEMAND FOR TELECOMMUNICATION SERVICES

The marketing division should be responsible for the development of accurate forecasts in a format that is useful for categorizing costs and allows the allocation of these costs to services in a consistent manner. Therefore, specific information is required with respect to:

1) the classification of services,
2) the classification of subscriber groups, and
3) the volume and intensity of service within each classification.

4.1 Service Classifications

Volume 6 (October 1974) of the Transport Commission Cost Inquiry lists telecommunication services under the following classifications.

Table 4.1 Service Classifications for Telecommunication Services

Bell Canada and B.C. Telephone	CN/CP Telecommunications
1. Local Telephone	1. Local Telephone
2. Toll Telephone	2. Toll Telephone
3. TATS	3. Public Message Service
4. TWX, Datacom	4. TELEX, Data Telex
5. Multicom I and II	5. Broadband Exchange
6. Multicom III	6. Telenet, Private Networks
7. MSDS, Private Networks	7. Voice Grade Private Line
8. Local Private Line	8. Bulk Discount
9. Voice Grade Private Line	9. Above Voice Grade Private Line*
10. TELPAK	10. Below Voice Grade Private Line
11. Above Voice Grade Private Line*	11. Infodat
12. Below Voice Grade Private Line	12. Video
13. Data Route	13. Vertical**
14. Video	
15. Vertical**	

* Includes program. ** Not elsewhere classified.

These service classification present a reasonably comprehensive list of services that are offered within the telecommunications industry. Our objective now becomes one of developing a system for conversion of these services into physical facilities and related rate structures.

4.2 Measuring the Demand for Services

Within each class of plant there are several demands for service. Many of these demands are common to all types of plant. The degree of segregation of demand within each class of plant and between each class of plant necessary for capital expenditure and rate structure purposes can perhaps be best accomplished through determining the demand distribution for each type of service.

Present technology is capable of:

1) recording the number of calls made on each line,
2) the duration of the conversation,
3) the distance between connects,
4) the equipment utilized during the connect, and
5) the type of data being transmitted (voice or data).

This type of information can be used in the development of demand for each type of service and total demand in terms of common planning units. Consideration of the number of lines required, the traffic patterns in terms of CCS per line call attempts per line and/or holding times per call during the busy hour are necessary.

The development of common planning units allows correlation of the units of subscriber demand with the units of physical facilities; the idea being to have some basic units that are common to both demand and physical facilities.

A telephone system is not only sensitive to the physical numbers of local loops involved but is also responsive to the hundred call seconds (CCS) generated, the number of call attempts made and the volume of traffic leaving a central office area. The planning units to be used must consider all of these factors. For example:

A) SXS switching equipment utilization can be measured in terms of CCS. Cross-bar and electronic switching equipment are sensitive to both call attempts and CCS in measuring their utilization.

B) The design of trunking facilities requires measurement of incoming and outgoing traffic with respect to each switching centre. This traffic flow is measured in terms of both CCS and call attempts.

The traffic flow generated by each subscriber group can be measured in terms of CCS and call attempts. This traffic flow can then be related to the traffic flow generated by a ~~residential subscriber~~ within each class of plant. This information should be valuable in developing rate structures.

The number of lines required and the traffic patterns generated are very dependent on the terminal equipment in service and forecasted.

The amount of each type of subscriber terminal equipment required depends on the:

1) expansion expected within each exchange area;

2) new product lines (technology);

3) the intensity and direction of specific marketing strategies, and

4) the existing status of the marketing program within each individual exchange area. For example, the percentage of terminal equipment systems that are presently at or beyond capacity and a knowledge of the change in strategy that is placed on updating these systems is critical for budgeting purposes.

In summary the forecast should assess the demand for services in terms of terminal equipment for each individual local switching centre. This data is directed to the respective departments who convert the forecast into a total service requirement in terms of physical plant.

The annual or present equivalent cost of the physical plant and its impact on the total system, by class of plant, can then be calculated for each alternative available and the "optimal" cost alternative selected simultaneously with a just and reasonable rate structure. Table 4.2 is representative of the terminal equipment forecast desired by exchange area. Table 4.2 is not intended to be in final form. A detailed study of all terminal equipment is necessary to develop the most desirable terminal equipment categories.

4.3 Planning Units

There are three basic planning units recommended. They are: Terminals/ 1) lines (subscriber loops), 2) CCS and 3) call attempts (CA). A knowledge of CCS and call attempts allows one to calculate holding times.

$$CCS = \frac{(CA)\ (\text{holding time})}{100}$$

These three basic planning units can be used to forecast the physical plant requirements.

Table 4.2 Terminal-Equipment Data by Exchange Area

Exchange Area ______________________________

	YEAR (Jan.1)				
	1976	1977	1978	1979	1980
<u>TOTAL TERMINALS</u>	Actual	Forecasted			
Residential - Indiv.					
Business - Indiv.					
Business - PBX(0-5 TRKS)					
PBX(6-10 TRKS)					
PBX(10-20 ")					
PABX(0-5 ")					
PABX(6-10 ")					
(10-20 ")					
(20+)					
Centrex (CTX) ( )					
" (CTX) ( )					
Coin Box					
Multi-Party Service					
Indiv.Private Line (Voice)					
Indiv.Private Line (Data)					
Network-Private Line (Voice)					
Network-Private Line (Data)					
Telex (TWX)					
Wats					
Video					
Remote Control Monitoring					
a) Enterphone					
b) Meter Reading					
c) Banking					
d) Others					
<u>Telephones</u>					
Residential-Indiv: DIAL					
TT					
EXT					
Business DIAL					
TT					
EXT					

This information may be used for 1) budgeting, 2) facilities design and 3) developing rate structures.

Each subscriber group generates a certain demand which can be measured in terms of the three planning units.

The subscriber demand is measured, as indicated in Table 4.3, in terms of the terminal equipment requirements.

4.3.1 Budgeting

The forecasted demand in Table 4.2 represents the basis for the data in Table 4.3. Table 4.3 allows the development of planning unit data with respect to each class of plant that can be converted to the requirements for physical facilities. Capital budgeting estimates can be developed from this data that should be reasonably accurate.

4.3.2 Facilities Design

Subscriber loops are recorded in terms of the number of subscriber loops or lines required. Detailed information regarding demand on each physical feeder cable system is required for the actual design with respect to additions required. However, cost per subscriber loop should be valuable for budgeting purposes. Additions to local switching equipment design is dependent on knowing the terminal equipment being added, the number of subscriber loops added, the CCS and call attempts (CA) generated by each type of terminal equipment, and the incoming traffic through toll and local connnecting trunks. This information is generated in Table 4.3 and can be converted to the requirements for physical facilities.

Additions to trunking (exchange trunks and toll connecting trunks to exchanges) requires a knowledge of the CCS incoming and outgoing from the exchange area. The call attempts (CA) information under trunking in Table 4.3 is required for switching equipment design. The CCS requirements can be converted to physical trunk requirements.

Table 4.3 Total Demand for Services in Terms of Planning Units

Exchange Area ____________ Year ______

TOTAL TERMINALS	Subscriber Loops					Exchange Trunking				Toll Connecting Trunks to Exchanges				Local Switching	
	Loops	CCS			CA	CCS			CA	CCS			CA	CCS	CA
		In	Out	Total		In	Out	Total		In	Out	Total			
Residential - Indiv.															
Business - Indiv.															
Business - PBX(0-5 TRKS)															
PBX(6-10 TRKS)															
PBX(10-20 ")															
PABX(0-5 ")															
PABX(6-10 ")															
(10-20 ")															
(20+)															
Centrex (CTX) ( )															
" (CTX) ( )															
Coin Box															
Multi-Party Service															
Indiv.Private Line (Voice)															
Indiv.Private Line (Data)															
Network-Private Line (Voice)															
Network-Private Line (Data)															
Telex (TWX)															
Wats															
Video															
Remote Control Monitoring															
a) Enterphone															
b) Meter Reading															
c) Banking															
d) Others															
Telephone Summary															
Residential-Indiv: DIAL															
TT															
EXT															
Business. DIAL															
TT															
EXT															

*CA = Call Attempts

V RATE STRUCTURES

The development of specific rate structures for each service offered will not be detailed in this report. However, a basic framework for developing rates as part of the total system framework for the evaluation of capital expenditures is outlined.

Rate structures should be developed to generate sufficient revenues to offset all costs including profits. Therefore, the conversion of costs into rate structures should satisfy the fundamental equations of:

Incremental Revenues = Incremental Costs and/or

Total Revenues = Total Costs

The system recommended for costing of the physical facilities is based on the traffic load generated by the terminal equipment (Table 4.2 and Table 4.3). Therefore, subscribers can be grouped by terminal equipment and either an annual equivalent cost or a present equivalent cost (these cost equations are fully defined in Section VI) can be developed for each subscriber group. These costs can then be used as a basis for developing rates structures for each subscriber group.

5.1 Terminal Equipment

It is suggested that the terminal equipment be charged directly to the customer. This charge may be paid for on initial installation or over a period of time at the discretion of the customer and the carrier (these costs may be part of the monthly charges). This equipment is utilized entirely by each individual subscriber and should be paid for by each individual subscriber.

5.2 Local Facilities

A comprehensive study is suggested to determine the most satisfactory grouping of terminal equipment for budgeting and rate making purposes.

The annual equivalent cost of residential telephone service within any individual integral system should act as the basis for all rate structures within the system.

The cost per residential subscriber will vary to some degree in different residential areas within the system (e.g. city) but using an average cost per residential subscriber within the system (e.g. city) should not cause undue discrimination with respect to any individual residential subscriber. Therefore, costing by residential area, for example, would appear to be unwarranted.

A residential telephone should be considered as a privilege open to every permanent resident. Therefore, if a conversion of the residential subscriber costs to a residential rate structure generates a residential rate that is considered to be unquestionably high, some subsidization by other subscriber groups is desirable. This subsidization may be justified, if for no other reason, on the basis that business subscribers are presently being subsidized for the telecommunication services they subscribe to through tax deductions. (Telecommunications services are an allowable expense to a business and thus fully tax deductible.)

The incremental costs of the additional subscribers within any integral system is likely to vary from year to year. These incremental costs, for rate purposes, should be averaged into the existing costs by subscriber group. Thus, the rate base is based on moving average costs. This approach causes some subsidization within subscriber groups in addition to the possible subsidization of residential subscribers by other subscriber groups. Subsidization internal to the subscriber group is not considered detrimental to the proposed system unless subscribers in older areas receive service of a lower quality than new subscribers due to advances in technology. Close monitoring of the system is necessary to insure that a reasonable percentage of the budget is allocated to updating facilities in older areas within the system.

5.3 Toll Facilities

Rate structures to cover the costs with respect to toll facilities should be directly related to usage for all subscriber groups.

The above framework for developing rate structures is suggested as a nucleus for developing final rate structures that consider such additional factors as value of service, excess capacities, level of service required and possible price breaks based on demand.

VI THE TOTAL COST MODEL

Cost data performs several useful objectives. Within this report we are mainly concerned with the development of costs, both capital and operating, in a format that will satisfy the following objectives:

(1) budgeting,

(2) the conversion of costs into corresponding rate structures,

(3) monitoring costs for comparison purposes between areas within an individual company,

(4) monitoring costs for comparison purposes between companies, and

(5) the organization of cost data for optimization studies.

This particular report has mainly concentrated on the formating of cost data for budgeting purposes, however, it is important to keep the total picture in perspective realizing that the cost data should be in a format that satisfies the needs of the total system.

There are several important factors that must be considered in any complete interactive model to satisfy the above objectives. These include:

1. Economies of scale - for example:

   A) the installation cost per pair varies significantly as a function of cable size.

   B) the material cost per pair varies significantly by gauge.

2. Technology - the specific technology used within any class of plant can have a significant impact on costs.

3. Population density - the number of subscribers within an exchange area per unit of area affects the cost.

4. Subscriber mix - The subscriber mix within any specific exchange area affects the cost.
5. Growth rates - the rate of growth within exchange areas has a bearing on costs. Abnormally high growth rates tend to raise costs through increased inefficiencies. For example, many temporary installations are made as an emergency measure. Growth rates also directly affect the age of plant in service and the excess capacity considerations.
6. Age of plant in service - the age of plant in service directly affects costs and must be reflected in any cost comparison model.
7. Excess capacity - excess capacity may result for several reasons (e.g. economies of scale, growth rates, inflation and technology) and do have an impact on costs.
8. Geographic location - geographic location may result in differences in costs through differences in such factors as:
   A) soil conditions,
   B) labor rates,
   C) material costs,
   D) building costs, and
   E) land costs.

The above considerations emphasize the need for a uniform system in developing costs and also stress the complexity of the problem.

This report has suggested that demand data be developed by exchange area in terms of "planning units." Therefore, the cost data should be in a format that can be converted to a cost in terms of physical lines and planning units.

Within the telecommunications industry there are five main categories under which costs are developed. They are:

1) construction (C),

2) movement (M),

3) retirement (X),

4) maintenance (R), and

5) shop work (S).

The cost model suggested is intended to function within this framework.

The objectives also suggest that the total cost model have the capability to develop both embedded costs and incremental costs on a continuing basis. The cost framework for the model outlined is capable of calculating both embedded and incremental costs providing data banks are structured to supply the data required.

6.1 The Measurement of Total Costs

In designing a uniform system for the measurement of total costs and a uniform method for converting these total costs to service rates and useful comparative measures, the basic fundamental equation that must be satisfied is:

Total Revenues = Total Costs, and/or Incremental Revenue = Incremental Cost

This study will concentrate on the development of the framework for the total costs. All costs will be developed in units that allow conversion to a cost per physical line. Service demand is forecast in terms of planning units by customer group and service type. Therefore, a conversion of costs into rate structures can be achieved in a systematic manner.

There are three basic components in any total cost model.

(1) An after-tax cash flow requirement (ATCFR). This requirement includes repayment of capital invested and an after-tax rate of return on the investment. (The opportunity cost of capital.) The required rate-of-return to meet the investors' threshold of acceptability will be referred to hereafter as, (MARR) the minimum attractive rate of return.

(2) An income tax requirement, and

(3) An operating cost requirement.

Figure 6.1 is a simplified schematic of a corporate cash flow diagram. This diagram specifically shows the basic relationship between total revenues and total costs and the major factors that contribute to the total cost structure.

6.1.1 Data Requirements

There are certain common data that must be considered in any investment analysis. This data falls into two basic categories:

1) capital costs, and

2) operating costs,

and is usually evaluated on the basis of:

1) a rate of return analysis, and/or

2) a net present value analysis, and/or

3) an annual cost analysis.

Either net present value analysis (the present equivalent cost

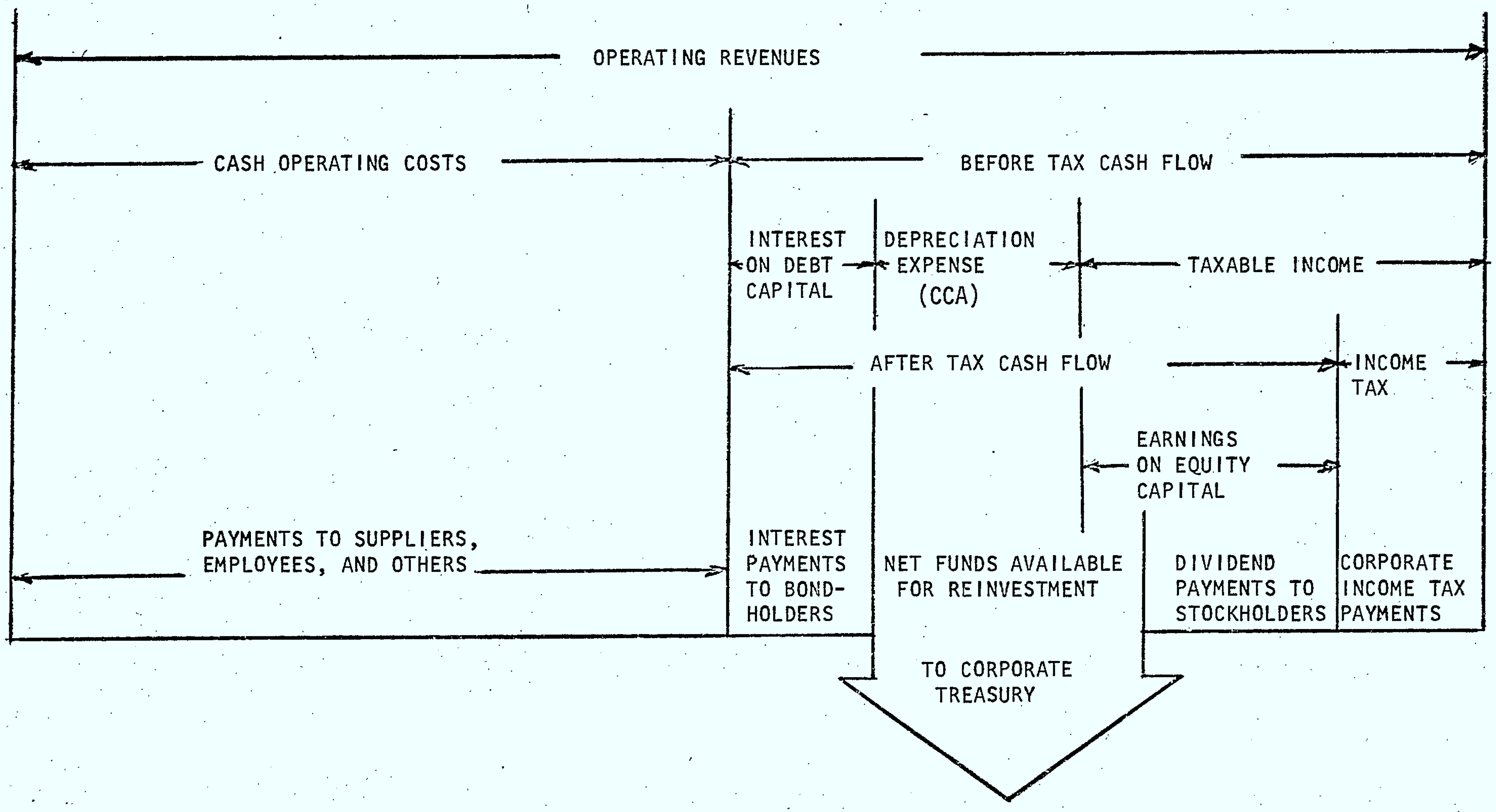

Figure 6.1 A SIMPLIFIED SCHEMATIC OF THE CORPORATE FLOW OF CASH

[12] Smith p. 227.

approach) and/or the annual cost approach (annual equivalent cost approach) will be applied to the data for evaluation purposes.

Capital Cost Factors

1) Land
2) Buildings
3) Equipment
4) Working capital
5) Construction costs (installation costs)
6) Retirement costs (salvage values may represent either positive or negative cash flows).

Operating Cost Factors

1) Direct labor costs.
2) Direct material costs.
3) Overhead
   (A) engineering
   (B) administration
   (C) maintenance
   (D) marketing
   (E) research and development

Additional Financial Data

1) Income tax rate
2) Debt-equity ratio
3) Estimated economic life
4) Interest rate on equity capital

5) Interest on debt capital

6) Composite cost of capital

7) Minimum attractive rate of return = MARR

8) Inflation rate

9) Recession rate

10) Capital cost allowance (depreciation)

The equations listed below use basically the same notation as use by Smith [12]. Derivations of the equations to follow are in Chapter 10 [12].

ATCFR = after-tax cash flow requirement

AEC = annual equivalent cost = AER = annual equivalent revenue required

PEC = present equivalent cost = PER = present equivalent revenue required

AEX = AER - AEC

PEX = PER - PEC

M = operating costs

AEM = annual equivalent operating costs

B = first cost = installed cost

V = salvage value

n = number of periods (usually years)

t = the income tax rate

CCA = capital cost allowance

AECCA = annual equivalent capital cost allowance

PECCA = the present equivalent capital cost allowance

(a/p) = annual equivalent of a present sum $[i\,(1 + i]^n]/(1 + 1)^n - 1]$

(P/a) = present equivalent of an annual sum $[(1 + i)^n - 1]/[i(1 + i)^n]$

(a/f) = annual equivalent of a future sum $i/[(1 + i)^n - 1]$

(p/f) = present equivalent of a future sum $1/[(1 + i)^n]$

r_d = debt rate

i_d = interest rate on debt capital

i_e = interest rate on equity capital

i_c = composite cost of capital

i_a = minimum attractive rate of return (MARR) = $i_c - tr_d i_d$

Actual cash flow calculations will be made using the following equations:

1) Annual equivalent cost equation (AEC) considers total costs including profit

$$AEC = AEM + [B(a/p)_n^{i_a} - V(a/f)_n^{i_a} - t\,(AECCA)]/(1 - t)$$

2) Present equivalent cost equation (PEC)

$$PEC = PEM + [B - V(P/f)_n^{i_a} - t\,(PECCA)]/(1 - t)$$

3) $AEX = (AER - AEM)\,(1 - t) - B(a/p)_n^{i_a} + V(a/f)_n^{i_a} + t\,(AECCA)$

4) $PEX = (PER - PEM)\,(1 - t) - B + V(p/f)_n^{i_a} + t\,(PECCA)$

*For a proof note page 236 in Smith [12].

6.2 Budgeting

The major emphasis in this study has been to design a budgeting system for a typical Canadian city, an integral system within the total Canadian telecommunications network. The city may represent the total operations of an individual carrier or just one integral unit within the total operations of an individual carrier.

The organizational structure for a telecommunications carrier usually comprises at least the five distinct functional disciplines of:

1) research and development;
2) administration,
3) marketing,
4) engineering, and
5) physical facilities (plant).

A schematic breakdown of this structure is shown in Figure 6.2.

In order to operate an effective budgeting system for a telecommunications carrier demand forecasts for each individual service offered should be developed for each integral system by exchange area. These forecasts must be converted to requirements in terms of physical facilities. The total demand for services can then be derived and compared to the existing facilities available to meet this demand. The additional facilities necessary to meet a desired service level can be determined and converted into capital and operating budget requirements. Figure 6.3 gives one an overview of the budgeting process.

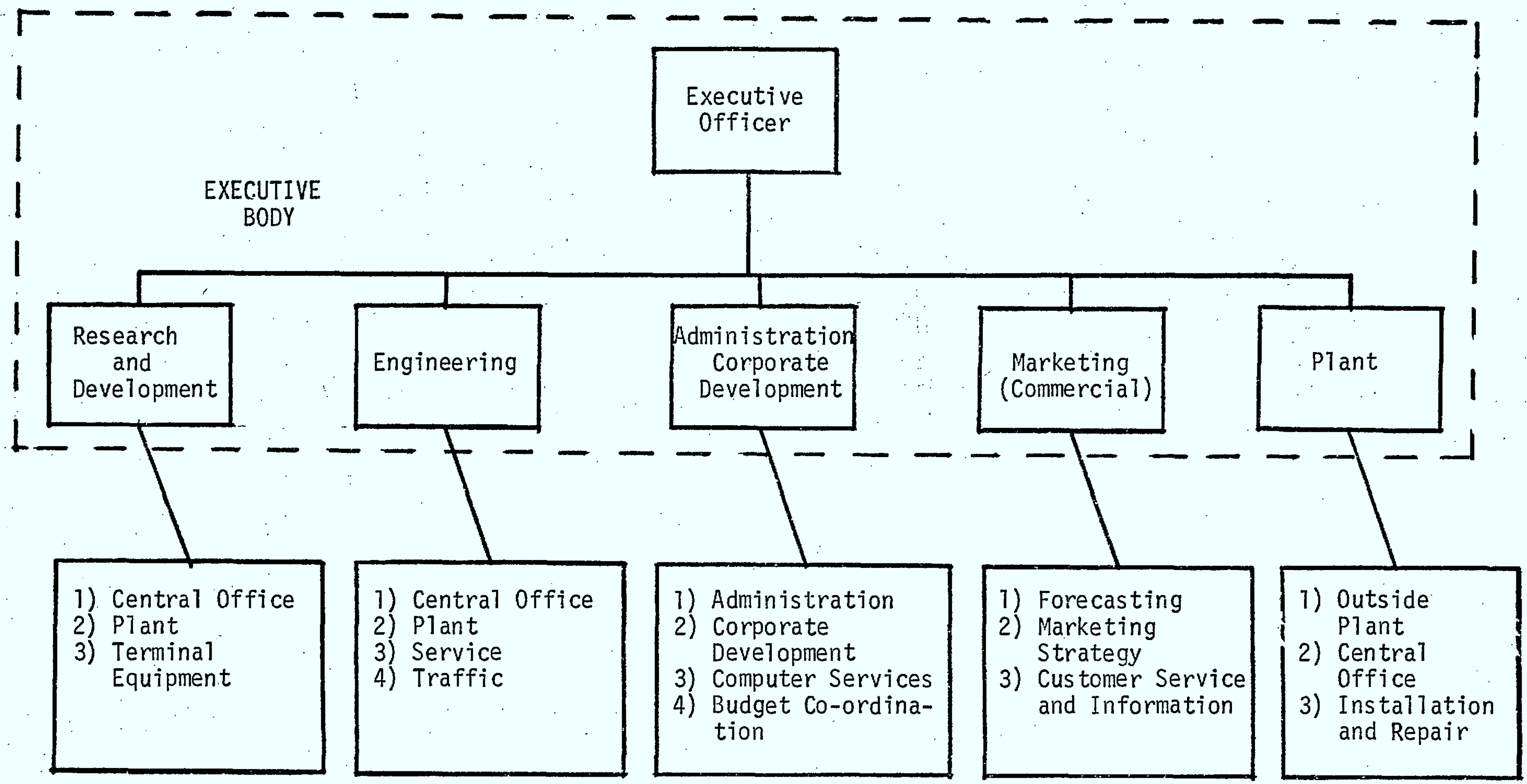

Figure 6.2 A Simplified Organizational Structure for a Telecommunications Company

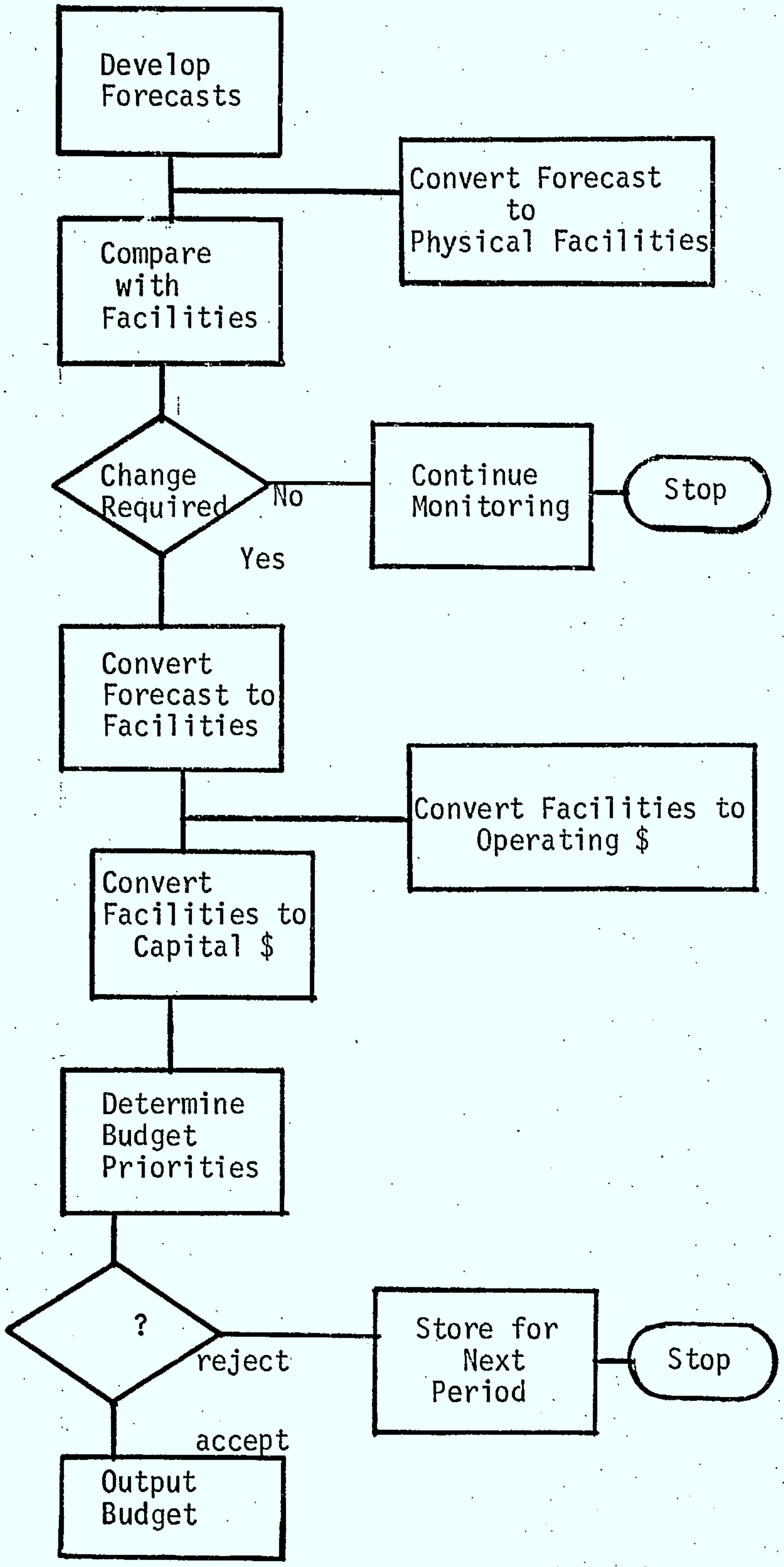

Figure 6.3 Budgeting Flow Chart for a Telecommunications Carrier

6.2.1 Budget Priority Ratings

A priority rating of individual budget programs should be directly related to the short and long term objectives of the company. However, these objectives are often not clearly defined and may result in certain budgeted areas taking precedence over other areas that are to the detriment of the long range objectives of the company. In order to develop an effective priority rating system some distinction between basic growth requirements and special projects seems desirable.

A. Basic Growth

This category represents those programs that are necessary to supply a predetermined level of service to all subscribers within the system (e.g. city or community). This category can be expected to represent the major percentage of the total budget. Basic growth includes:

(1) expanding the existing system;

(2) movement within the existing system; and

(3) mandatory replacement within the existing system.

Basic growth accounts for the major portion of the budget and represents necessary expenditures to meet a predetermined service level. However, much can be done with respect to reducing these expenditures and still maintain desirable service levels.

B. Special Programs

Special programs represent those programs that are initiated at various levels within the organization to upgrade specific areas within the system and in turn contribute to a more effective total system. These expenditures include such programs as:

1) replacement and/or updating facilities in older areas;

2) implementation of specific market strategies including (1) new pro-

ducts, (2) new product lines, (3) and new service concepts;

3) reorganization of the administrative structure;

4) special research and development projects; and

5) special equipment replacement programs.

Limited resources often suggest sacrificing certain special programs in lieu of basic growth budgeting requirements. Caution should be exercised in this area. Special projects should represent some percentage of the total budget to maintain the long run economic viability of any carrier and thereby the long run economic viability of the system as a whole.

6.3 Data Formats

Data banks should be established as a source of information to accomplish the objectives of budgeting, rate-making and various comparisons to improve the overall effectiveness of the company. To maintain uniformity throughout the system these data banks should develop cost information by class of plant within each exchange area.

Within each telecommunications company a system of sub-accounts exist. Information from these sub-accounts is assigned to the main accounts of C, M, X, R and S on a regular basis. Capital cost allocations are concerned with construction (C) and retirement (X) accounts. Operating expenses are assigned to movement (M), maintenance (R) and shop (S).

6.3.1 Capital Costs

Costs are normally developed within the telecommunications industry on a unit basis (the number of different units used and the degree of cost breakdowns varies with the carrier). For capital budgeting and monitoring purposes a unit construction cost is desirable.

In order to develop unit construction costs a detailed list of all units within each class of plant and the associated cost data is necessary. Table 6.1 is suggested as a format for recording cost data. Table 6.2 is a suggested format for developing capital budgeting and related cost information by exchange area. This form is designed to record information by individual job which should be helpful in setting final budget priorities.

The method of budgeting recommended in this report is a five year rolling budget. Table 6.2 gives the analyst the budget information for the current year. The budget information for the succeeding four years can be computer generated through trend analysis and the development of indices for each parameter. Using this methodology the five year budget can be updated on an annual basis to reflect changes in such factors as technology, economic trends and growth rates.

Table 6.3 and Table 6.4 represent capital investment summaries by exchange area and by company respectively.

6.3.2 Operating Costs

The development of a unit cost for operating costs in the same manner as construction unit costs is not recommended. The system would require a tremendous amount of effort and additional paperwork on the part of all plant personnel and would be difficult to administer and monitor. Plus, the usefulness of operating costs developed to this degree of refinement is questionable. Therefore, it is recommended that operating costs be developed by class of plant within each exchange area under the major categories of movement (M), maintenance (R) and shop (S). This information can be used to develop unit operating costs by class of

Table 6.1 Unit Construction Costs by Class of Plant

Year ________ Class of Plant ______________________________

Unit Code	Acct. Code	Type of Plant	Unit	Direct Material			Direct Labor			Overhead			Unit Constr. Cost $
				Unit Cost $	OH Costs (%-DM)	Total Cost $	Hours	OH Costs (%-DL)	Total Cost $	Indir. Mat'l (%-DM)	Super-vision (%-DL)	Engr. (%-DL)	

plant as a percentage of unit construction costs. These costs will be useful in conducting total cost and/or incremental cost studies.

Table 6.2 Capital Budgeting Information by Exchange Area

Year ____________ Exchange Area ________________________________ Class of Plant ______________

Job. No.	Unit Code	Acct. Code	Unit	Units Req'd	Unit Constr. Cost	Total Estimated Cost	Estimated Economic Life	Estimated Salvage Value

Table 6.3 Capital Investment Summary by Exchange Area for the XYZ Telephone Company

Exchange Area ______________________________

ACCT. CODE	TYPE	1976	1977	1978	1979	1980	1981
		(Actual)	(Forecasted)				
	SUPPORT FACILITIES						
	Land						
	Buildings						
	Office: Equipment						
	Furniture						
	OPERATING FACILITIES						
1.	Station Equipment						
	Inventory						
	Phones						
	Large PABX						
	Package PABX						
	Teletype						
	Coin Stations						
	Radio/Pager						
	Radio Base						
	Fire Alarms						
	Building Cable						
	Work Equip. Tools						
2.	Subscriber Loops						
	Land						
	Inventory						
	Pole Lines						
	Aerial Cable						
	U/G Conduit						
	U/G Cable						
	Buried Cable						
	Co-Ax Cable						
	Drop Wire						
	Work Equip. - Tools						
3.	Local Switching						
	Land						
	Buildings						
	Inventory						
	Office Equipment						
	C.O.E. Manual						
	C.O.E. SXS						

ACCT. CODE	TYPE	1976 (Actual)	1977	1978	1979 (Forecasted)	1980	1981
	C.O.E. X-BAR						
	C.O.E. Electronic						
	C.O.E. Digital						
	C.O.E. Circuits						
	C.O.E. Tools & Test						
	Tandem Switching						
	Work Equip. Tools						
4.	Exchange Trunking (Between Exchanges)						
	Land						
	Inventory						
	Pole Linea						
	Aerial Cable						
	U/G Conduit						
	U/G Cable						
	Co-Ax Cable						
	Work Equip. Tools						
5.	Toll Connecting Trunks (To Local Exchanges)						
	Land						
	Inventory						
	Pole Lines						
	Aerial Cable						
	U/G Conduit						
	U/G Cable						
	Buried Cable						
	Co-Ax Cable						
	Work Equip. Tools						
6.	Toll Switching						
	Land						
	Buildings						
	Office Equipment						
	Inventory						
	Office Equipment						
	C.O.E. Manual						
	C.O.E. SXS						
	C.O.E. X-Bar						
	C.O.E. Electronic						
	C.O.E. Digital						
	Work Equip. Tools						

ACCT. CODE	TYPE	1976 (Actual)	1977	1978	1979 (Forecasted)	1980	1981
7.	Toll Trunking						
	Land						
	Inventory						
	Pole Lines						
	Aerial Cable						
	Buried Cable						
	Co-Ax Cable						
	Microwave						
	Satellite						
	Work Equip. Tools						

Table 6.4 Capital Investment Summary for An Integral System of the XYZ Telephone Company

System ______________

	1976 (Actual)	1977	1978	1979	1980
		(Forecasted)			
SUPPORT FACILITIES					
Land					
Buildings					
Office Equipment Furniture					
Inventory					
OPERATING FACILITIES					
Land					
Buildings					
Office Equip. & Furniture					
Work Equip. - Vehicles & Tools					
Inventory					
Station Equipment					
Subscriber Loops					
Local Switching					
Exchange Trunking					
Toll Trunking (To Exchanges)					
Toll Switching					
Toll Trunking (Intercity)					
Total Utility Plant In Service					
Total Debt Issued					
Total Debt Recalled					
Total Debt Outstanding					
Total Equity Issued					
Total Equity Recalled					
Total Equity Outstanding					
Interest Lost During Construction					
Net Total Investment					

VII CONCLUSIONS AND RECOMMENDATIONS

An integrated system can be developed for the Canadian telecommunications network to evaluate capital expenditure proposals in a manner that should assure, in the final analysis, just and reasonable rate structures.

Continual communication and close cooperation between carriers, regulatory bodies and a central cost monitoring agency should be beneficial to all parties concerned.

Formats have been developed for cost data information by exchange area to be used in budgeting and cost comparison studies. This information can serve as a basis for developing average embedded costs and current incremental costs.

The exchange area is considered to be the most acceptable unit as a basis for developing demand and cost data. For example, detailed capital budgeting information should definitely be developed by exchange area. Plus, the exchange area represents an ideal building block for any type of study that may be undertaken.

7.1 Recommendation for Additional Studies

This study has made some major recommendations regarding the framework for evaluating capital expenditures within the telecommunications industry. Within this framework many indepth studies are necessary before a total Canadian system can be fully implemented. The following list of studies is not intended to be all inclusive but does suggest some of the major areas of concentration.

1) Completion of the final total framework. This study has concentrated on local exchange facilities. The toll network has been discussed briefly but should be considered in more depth.

The overall philosophy suggested in the report should be fully discussed with each carrier and regulator to assess the acceptability and feasibility of the system.

2) A system for comparison of cost data between carriers requires consideration of such factors as

1) geographic area,
2) economies of scale,
3) age of plant,
4) growth rates (plant utilization)
5) technology,
6) population density, and
7) subscriber mix.

A comprehensive study is necessary to develop a method of measuring the impact of differences in these cost factors between areas and companies before any useful cost comparisons can be made.

3) Optimization Studies

Useful optimization methods should be developed for optimization studies within each class of plant. Significant economies of scale exist with respect to a large number of plant facilities (e.g. cable size and gauge, conduit configurations, and central office size and type). Some measure of consistency in the manner in which optimization studies are conducted between companies is desirable.

4) Forecasting - The telecommunications industry is highly capital intensive and reasonably long lead times are required on equipment orders. For these reasons over/under utilization of facilities is not desirable. Assuming an acceptable level of service without undue excess capacity in facilities requires considerable effort on behalf of forecasting personnel to search for more optimal forecasting techniques. Several studies in this area would be beneficial.

VIII REFERENCES

1. Alberta Public Utilities Board Decision No. E76090. July 8, 1976.

2. Baer, W. S., Bridger, M. M. Impact of Competition on An Independent Telephone Company. Public Utilities Fortnightly. October 23, 1975.

3. Balk, W. L. and Shafritz, J. M., Editors. Public Utility Productivity: Management and Measurement. Published by the New York State Dept. of Public Service, 44 Holland Avenue, Albany, New York 12208. August 1975.

4. Bland, M. H. Roundup of CCS: Types, Use, Future With CO, Traffic Considerations. Engineer and Management. November 1, 1971.

5. Breary, D. Computer Aided Planning of the United Kingdom Trunk Network. Telecommunication Journal, Vol. 38, 1971.

6. Cuccia, C. L. - Comparative Costs of Telecommunication Systems. Telecommunications. October, 1971.

7. Duffy, E. T. - Centralized Common Control. Telephony. December 20, 1971.

8. Engineering Economy - American Telephone and Telegraph Company Engineering Department. Revised August 1973.

9. Horn, F. W. ABC of the Telephone - Cable Inside and Out. Volume 5. Lee's abc of the Telephone. Box 1057, Chicago, Illinois, 60690, 1974.

10. Marsh, D. J. - Common Control Traffic Considerations. Telephony. December 20, 1971.

11. Notes for Engineering Economics Courses. American Telephone and Telegraph Co., Engineering Department, 1966.

12. Smith, G. W. Engineering Economy: Analysis of Capital Expenditures. The Iowa State University Press, Ames, Iowa. Second Edition. 1973.

13. Snavely, King and Tucker - Components and Factors of Cost of Service, Volume 3. Oct. 1974.

14. Snavely, King and Tucker - Costing Manual - October, 1974.

15. Snavely, King and Tucker - Characteristics of Telecommunications Costs. Volume 5. Oct. 1974.

16. Terreault, C. - Planning the Telecommunications Network of the Future. Telsis 2/4.

A SYSTEMS FRAMEWORK FOR THE EVALUATION OF CAPITAL EXPENDITURE PROPOSALS IN THE TELECOMMUNICATIONS CARRIER INDUSTRY