APPLICATIONS OF THE

NATIONAL
POLICY &
PLANNING
SIMULATION MODEL

TO FINANCIAL AND ECONOMIC PROBLEMS IN THE TELECOMMUNICATIONS INDUSTRY

Prepared for and in collaboration with
the department of communications

by **sorēs inc.**

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1. INTRODUCTION

The scope of work, as originally conceived for the present phase of the N.P.P.S. project, was broad and addressed some key issues of the cross-subsidy problem, namely the detection of interregional, inter-services and intertemporal cross-subsidies and the process of determining a rate structure free of cross-subsidy. In the course of the project it was realized that the conceptual framework of the cross-subsidy problem area in general and specifically its inter-temporal aspects had not reached a level of maturity sufficient for direct implementation.

Concurrently, some critical issues were raised on the regulatory scene: CN/CP's request for interconnection with TCTS facilities, Quebec Telephone's request for admission to the TCTS, the hypothetical division of Bell Canada into two provincial carriers. In all instances, it was felt N.P.P.S. could provide some definite insight into the complex implications of any decision relating to these matters.

Consequently, the scope was slightly amended so as to redirect the thrust of the work towards two general objectives:

- first, to design and execute experiments relating to current regulatory matters with the use of N.P.P.S.
- second, to pursue the issue of cross-subsidy testing and rate setting as far as the conceptual framework and the existing software would allow.

With respect to the first problem area three specific issues were addressed.

The first consisted of defining the impact upon cost/revenue equilibria for the two provincial carriers resulting from a hypothetical division of Bell Canada. Toll related results were derived with the use of N.P.P.S. Further implications for toll and exchange were derived by combining these results with available benchmarks.

The application of CN/CP for interconnection with T.C.T.S., presently before C.R.T.C., reopened the controversy of the eventual costs and benefits derived from allowing competition in certain areas of the telecommunications industry. A side issue to this problem is the following: assume a competitor to the existing monopolistic carriers is allowed to offer a limited number of services without having to provide currently all basic services presently offered by the monopolistic carriers. What mechanisms should then be set up so as to insure that competition remains "fair" in the sense that none of the carriers in competition support a burden higher than any other? One key datum required to solve this problem is profitability measures for various services. N.P.P.S. was used to derive revenue/cost ratios based on the full allocation of costs concept both for public messages and private lines for selected origin-destination pairs. The results obtained highlight the difference in profitability between private lines and public messages and the large profitability variations from low to high traffic volume O-D pairs.

Quebec Telephone's recent request for admission to T.C.T.S. raised another question: Would Quebec Telephone be better off within T.C.T.S. than it is under the present agreement with Bell Canada? An experiment was designed in this context and analysed with N.P.P.S. It must be admitted that this exercise was rendered somewhat inconclusive by the under-representation of Quebec Telephone's facilities in the data base currently used in the model.

The above mentioned applications of the N.P.P.S. model constitute the main subjects treated in chapter two of this report.

With regard to the cross-subsidy problem area two avenues of investigation were explored.

Interregional incremental cross-subsidy tests were carried out. These had the double objective of searching for cross-subsidy:

- between Trans-Canada traffic and other services through the T.C.T.S. rate structure;
- between carriers through the revenue sharing schemes.

Three important conclusions were reached:

- given the importance of common costs, incremental tests are inadequate to detect any cross-subsidization phenomenon;
- the New Commonwealth sharing scheme would be basically inequitable when applied to the Canadian network;
- further, if this scheme were implemented, T.C.T.S. traffic would not necessarily be subject to a single rate structure. In other words, the principle of uniform Trans-Canada tariffs is inconsistent with the principles embodied in the New Commonwealth sharing scheme.

The problem of adjusting the rate structure, once a cross-subsidy phenemonon has been detected, was also readdressed. Recognizing that such a process would be iterative in nature and that the N.P.P.S. model may not be the best tool in such an instance, a simple macro-economic model was developed. It must be understood that such a simplified tool cannot replace N.P.P.S. but would certainly facilitate the initial steps when searching for a cross-subsidy free rate structure.

Chapter 3 of this report deals with work carried out in the area of cross-subsidy testing and rate setting.

Finally, it must be pointed out that in the course of this project, several minor modifications were made to the software and the data base of N.P.P.S. so as to render the model either more efficient or more representative. Although most of the changes carried out are reflected in the results presented in Chapters 2 and 3, the description of the changes, which do not represent any conceptual advancement, have been relegated to the last chapter of this report.

2. SELECTED APPLICATIONS OF THE N.P.P.S. MODEL

2.1 Hypothetical Division of Bell Canada

2.1.1 Introduction

In the fall of 1977, the media carried several comments to the effect that a division of Bell Canada into two provincial carriers would result in higher rates for its customers in the Province of Quebec. Following these reports, it was decided to address this issue with the N.P.P.S. model. An experiment was designed to isolate the relative cost and revenue contribution of both territories to Bell Canada's overall financial situation. It was recognized that N.P.P.S. would provide only partial information since it handles only toll traffic but it was felt also that additional information contained in available benchmarks when combined with results derived with N.P.P.S. would enable the project team to gain a definite insight into the question raised.

2.1.2 Assumptions and results

Due to the disaggregate structure of the model, relatively few software adjustments were needed for the treatment of this experiment.

The assumptions which were used for this simulation are listed below and have been substantiated in the previous phases of the N.P.P.S. project. It must be said that, if they somewhat affect overall results, they have no critical bearing on their comparative value.

- The peak-hour to total average business day traffic ratios are of 10%, 10% and 12% for regional, adjacent and non-adjacent traffic.
- Intra-regional private lines for which no data is available, are assumed to have circuit requirements equal to 40% of those of intra-regional switched services, on a trunk per trunk basis.
- To allow for multiplexing plan constraints, it is assumed that the maximum fill of a group corresponds to 90% of its total capacity and that demultiplexing to voice level occurs only at terminating points, in other words, that circuit requirements on the transmission network always amount to integer numbers of groups.

The division of toll related assets between the two provincial territories is exhibited on Table 2-1. From this table, it can be seen that approximately 70% of Bell Canada's toll assets are located in Ontario. Also of interest is the fact that the transmission network is more costly in Quebec than in Ontario, the investment per circuit-mile being $12. and $19. respectively. This can be explained by the higher concentration of population and consequently, the existence of more efficient transmission routes in Ontario.

TABLE 2-1

Division of Bell Canada
Assets Breakdown
($ 000)

	BONT	BQUE	BCAN
NODES			
TOTAL NUMBER	59	28	87
SWITCHING NODES	35	17	52
BRANCHING NODES	9	7	16
REGULAR NODES	15	4	19
LINKS			
TOTAL NUMBER	78	34	112
TOTAL DISTANCE	4263	1501	5764
CIRCUIT-MILES	21080760	4737840	25818600
INVEST. PER CIRCUIT-MILE	12.00	19.00	14.00
QUANTITIES OF FACILITIES			
SWITCHING MACHINES	39	19	58
TERMINAL REPEATERS	39	19	58
BRANCHING REPEATERS	26	8	34
REGULAR REPEATERS	82	25	107
VALUE OF ASSETS			
SWITCHING MACHINES	158600000	77000000	235600000
TERMINAL REPEATERS	170046280	43395940	213442220
BRANCHING REPEATERS	64558944	39792107	104351051
REGULAR REPEATERS	49265888	13816405	63082208
ACCOUNTING BREAKDOWN			
SWITCHING	158600000	77000000	235600000
TRANSMISSION-MULTIPLEXING	195028800	68325600	263354400
-OTHER	74558272	24263008	98821280
-TOTAL	269587072	92588608	362175680
GENERAL EQUIP.	9858972	3115766	12974738
LAND	2212500	650000	2862500
BUILDINGS	2212500	650000	2862500
STATION	0	0	0
PERCENTAGE BREAKDOWN			
SWITCHING	35.84	44.25	38.22
TRANSMISSION	60.93	53.21	58.75
GENERAL EQUIP.	2.23	1.79	2.10
LAND	.50	.37	.46
BUILDINGS	.50	.37	.46
STATION	.00	.00	.00
TOTAL ASSETS	442471044	174004374	616475418
INCURRED COSTS			
SWITCHING MACHINES	39650000	19250000	58900000
TERMINAL REPEATERS	44604640	11394725	55999312
BRANCHING REPEATERS	16954048	10437042	27391008
REGULAR REPEATERS	12942027	3817185	16759212
INC. COSTS BY ELEM. TYPE			
NODES	104930320	42576048	147506288
LINKS	9220153	2322785	11542938
TOTAL INCURRED COSTS	114150473	44898833	[illegible]

The allocation of fully allocated costs, pre- and post-settlement revenues between the two territories is shown on Table 2-2. Further disaggregation between public messages and private lines is also displayed. Due to the lesser degree of confidence attached to exogenous data pertaining to U.S. traffic, results concerning this type of traffic are shown separately in Table 2-3.

The sharing scheme is greatly affected by the division of Bell Canada due to shifts of large amounts of traffic from category to category. Quebec-Ontario traffic, for instance, which is regional traffic for Bell Canada, becomes adjacent traffic after division. Quebec-Manitoba traffic is similarly shifted from the adjacent to non-adjacent classification. In essence, the only comparison of interest is the one considering total toll costs and revenues as exhibited in section (c) of Table 2-2. Essential results are shown below.

Adjacent, Non-Adjacent and regional traffic	Ontario	Quebec	Bell Canada
Incurred costs			
$ million	99.8	38.6	138.4
%	72	28	100
Pre-settlement revenues			
$ million	221.4	106.6	328.0
%	68	32	100
Post-settlement revenues (T.C.T.S. scheme)			
$ million	239.6	88.2	327.8
%	73	27	100

In this regard, and if U.S. traffic is omitted from the comparison, it is estimated that 68% of the toll originating revenues of Bell Canada are attributable to Ontario while 72% of its toll related costs can be allocated to that province. However, the fact that facilities in Ontario carry more transit traffic than the ones in Quebec explains that all sharing schemes, except for the New Commonwealth, are more favourable to Ontario, its post-settlement revenues after division amounting to 73% of Bell Canada's post-settlement revenues.

Also of interest are the separate results provided for private lines. Revenue over cost ratios displayed in Table 2-2, indicate a large difference in profitability between private lines and public messages (1.53 vs 2.40). This difference is even more accute for Quebec (1.07 vs 2.28) due to the lower efficiency of the transmission network in this province.

TABLE 2-2

Division of Bell Canada
Costs and Revenues Allocations
(in $ millions)

	BONT			BQUE			BCAN		
	P.L.(1)	P.M.(2)	Total	P.L.	P.M.	Total	P.L.	P.M.	Total
(a) Adjacent and Non-adjacent Traffic									
Incurred Costs	8.1	27.2	35.3	2.0	11.9	13.9	7.1	15.7	22.8
Pre-settlement Revenue	8.5	53.3	61.8	5.4	42.6	48.0	8.4	30.8	39.2
Rev./Cost Ratio	1.05	1.96	1.75	2.70	3.58	3.45	1.18	1.96	1.72
Post-Settlement Revenue									
* New-Commonwealth	10.8	59.1	69.9	3.5	36.2	39.7	8.7	30.2	38.9
Rev./Cost ratio	1.33	2.17	1.98	1.75	3.05	2.86	1.23	1.92	1.70
* Old-Commonwealth	13.4	67.5	80.9	1.9	27.6	29.5	9.9	30.2	40.1
Rev./Cost Ratio	1.65	2.48	2.29	.95	2.32	2.13	1.39	1.92	1.75
* TCTS	13.2	66.7	79.9	1.9	27.6	29.5	9.7	29.3	39.0
Rev./Cost Ratio	1.63	2.45	2.27	.95	2.32	2.13	1.37	1.86	1.71
(b) Regional Traffic									
Incurred Costs	5.7	58.8	64.5	2.6	22.1	24.7	11.2	104.3	115.5
Collected Revenue	7.8	151.8	159.6	2.9	55.7	58.6	16.2	272.6	288.8
Rev./Cost Ratio	1.37	2.58	2.47	1.12	2.52	2.37	1.45	2.61	2.50
(c) Results for Regional + Adjacent + Non-adjacent Traffic									
Incurred Costs	13.8	86.0	99.8	4.6	34.0	38.6	18.4	120.0	138.4
Pre-settlement Revenue	16.3	205.1	221.4	8.3	98.3	106.6	24.6	303.4	328.0
Rev./Cost Ratio	1.18	2.38	2.22	1.80	2.89	2.76	1.34	2.53	2.37
Post-settlement Revenue									
* New-Commonwealth	18.6	210.9	229.5	6.4	91.9	98.3	25.0	302.8	327.8
Rev./Cost Ratio	1.35	2.45	2.30	1.39	2.70	2.55	1.36	2.52	2.37
* Old Commonwealth	21.3	219.3	240.6	4.9	83.3	88.2	26.0	302.8	328.8
Rev./Cost Ratio	1.54	2.55	2.41	1.07	2.45	2.28	1.41	2.52	2.38
* TCTS	21.1	218.5	239.6	4.9	83.3	88.2	25.9	301.9	327.8
Rev./Cost Ratio	1.53	2.54	2.40	1.07	2.45	2.28	1.41	2.52	2.37

(1) Private Lines

(2) Public Messages

TABLE 2-3

Division of Bell Canada
U.S. Traffic Related Costs and Revenues
($ millions)
No Private Lines to U.S. Assumed

	BONT	BQUE	BCAN
Incurred Costs	12.6	2.4	15.0
Collected Revenue	40.1	27.8	67.9
Post-Settlement Revenue	42.7	26.4	69.1
Rev./Cost Ratio	3.40	10.88	4.61

With respect to U.S. traffic, results must be considered with great caution. As it will be explained in chapter 4 of this report, Canada-U.S. revenues calculations are based on an exogenous ratio giving million of dollars of revenues per peak-hour C.C.S. The high revenue to cost ratios obtained results from two basic assumptions supplied to the model with regards to holding time and average $ revenue per C.C.S. The large difference in incurred costs between the two provinces results from routing assumptions used for U.S. traffic in N.P.P.S. The model assumes 11 Canadian entry points to the U.S., 5 of which are located in Ontario and one in Quebec. Consequently, a substantial amount of Canada to U.S. traffic is routed via Ontario. Since the sharing principle used in the model for U.S. traffic allows only for repayment of costs incurred by intermediate carriers and no participation in profit, post-settlement revenues as shown in Table 2-3 are not surprising.

2.1.3 Discussion

The purpose of this section is first to relate the results presented earlier to existing benchmarks and second to address the question of total revenues requirements for both provincial carriers after division of Bell Canada. Some key results derived with N.P.P.S. are compared to actual benchmarks in Table 2-4. When comparing N.P.P.S. estimates to actual benchmarks, it can be seen that the Bell network is quite reasonably represented considering that revenues derived from overseas calls are not taken into account by the model. The lower representativity of other carriers in N.P.P.S. becomes evident when comparing non-adjacent revenues estimated by the model to actual statistics.

It is also interesting to note that N.P.P.S. toll costs estimated at $ 138.4 million ,represent 65% of Bell's actual toll related costs of $ 235 million for 1976 (see Table 2-5) which indicates that costs and revenues are in reasonable alignment in the model. If one now considers the relative importance of Ontario originated revenues, the N.P.P.S. estimate of 66% appears quite satisfactory when compared to a 1975 actual value of 68%. The largest discrepancy when comparing revenues category by category is observed on the Bell to U.S. traffic, N.P.P.S. estimate of Ontario's participation being underestimated - 59% vs an actual value of 72%. The explanation for this discrepancy rests on the assumptions used to estimate U.S. traffic, which broadly speaking consisted in breaking down total Bell originated C.C.S. among the various demand points based on the distribution of actual trunks to the U.S. (see N.P.P.S. final report, 1977). This methodology obviously left some arbitrariness in the estimation of the respective usage of trunks by originating and transit traffic which led to the overestimation of U.S. traffic originating in Montreal.

TABLE 2-4

Division of Bell Canada
Comparison Between N.P.P.S. Estimates and Available Benchmarks

Categories of Traffic as defined Before Division	Total Originating Revenues ($ million)				Relative Portion of Ontario (%)		N.P.P.S. 1972 Estimates Over Actual (%)	
	1972 (NPPS Data Base)		1975 Actual Data(1)		N.P.P.S.	1975 Actual	1972	1975
	Ont.	Que.	Ont.	Que.				
Total Revenues	261.5	134.4	436.3	202.1	66	68	85	62
Intra	195.1	93.7	255.2	130.0	68	66	90	75
Adjacent	9.1	4.6	16.2	7.4	66	69	93(2)	58
Non-Adjacent	17.2	8.3	50.5	17.4	67	74	38(3)	38
U.S.	40.1	27.8	74.2	29.4	59	72	100(3)	66
Overseas	-	-	40.0	17.9	-	69	-	-

Notes: (1) Except for total revenues where breakdown is actual, all values are estimated by applying average revenue/call for Bell Canada for the traffic considered to number of messages originating in each province.

(2) The benchmark for this year includes overseas traffic.

(3) Since U.S. revenues were calibrated on this basis.

Source for actual statistics: D.O.C.

In order to assess the impact of a hypothetical division of Bell Canada on the two provincial carriers, local exchange costs and revenues must be introduced. Table 2-5 presents actual aggregate cost-revenue figures both for local and toll services in Bell Canada. Also shown on this table are selected ratios setting in isolation the relative importance of Quebec and Ontario. All figures have been extracted from various documents submitted by Bell Canada to C.R.T.C. as evidence for rate increase applications.

No conclusion can be directly drawn from the values shown, since the breakdown of costs between the two provinces is not provided. If one assumes however that the average local cost per telephone is identical for both provinces, Table 2-6 can be developed. It is our view that this assumption is quite reasonable given that the business/residential composition of both systems is quite comparable and that the rural/urban structure of population would rather favour Ontario which shows higher population concentration. Therefore, if anything, the average local cost per telephone should be lower in Ontario.

Table 2-6 shows an estimated breakdown of Bell Canada local costs and revenues between the provinces of Quebec and Ontario. These are then added to similar figures for toll related costs. Total revenues and costs figures so derived indicate that, while the profitability of the toll networks are quite comparable in both provinces, the overall profitability after inclusion of the local network is higher in Ontario, the relative burden imposed by the local network on toll network being smaller in this province. It follows that, in order to maintain revenues/costs equilibria for two independent provincial carriers, rate adjustments to the favor of Ontario residents and to the disfavor of Quebec residents would have to be implemented. It must be pointed out also that these conclusions are based on the existing T.C.T.S. revenue sharing scheme. The new T.C.T.S. scheme, to be gradually implemented over a 10 year period starting in 1978, recognizes however the differing magnitudes among carriers of the burden imposed by the local network and is aimed at rectifying this situation. Such a scheme would tend to improve to some extent the situation of an independent Quebec carrier.

TABLE 2-5

Division of Bell Canada

Introduction of Local Services Costs/Revenues Selected Benchmarks

1976 Benchmarks
($ Millions)

	Causally Related Costs	Revenues	Revenues/Costs
Local Services	775	585	0.75
Toll Services	235	765	3.25
Total*	1,010	1,350	1.34

Other Selected Benchmarks (1977)

	Ontario	Quebec
Relative Importance of Business in		
Total Revenues: Local Services	58%	57%
Toll Services	59%	60%
Revenues Collected from Local Services As a Percentage of Total	49%	58%
Provincial Contributions in		
Local Revenues	60%	40%
Toll Revenues	68%	32%
Number of Telephones in Service (1976)		
(Thousand)	5,088	3,210
(%)	61%	39%

(*) The difference of $340 million between total costs and revenues goes toward covering Bell Canada's "common costs".

Source: D.O.C.

TABLE 2-6

Division of Bell Canada

Estimation of Causally Related Costs for Quebec and Ontario Starting From 1976-77 Benchmarks

($ Millions)

	Ontario	Quebec	Bell Canada
Revenues From Local Services(1)	351	234	585
Causally Related Local Costs(2)	475	300	775
Pre-settlement Revenues From Toll Services(3)	520	245	765
Causally Related Toll Costs(4)	172	63	235
Total Pre-settlement Revenues (Local + Toll)	871	479	1,350
Total Costs (Local + Toll)	647	363	1,010
Overall Pre-settlement Revenues/ Costs Ratio	1.35	1.32	1.34
Post-settlement Revenues for Toll(5)	558	207	765
Total Post-settlement Revenues	909	441	1,350
Overall Post-settlement Revenues/ Costs Ratio	1.40	1.21	1.34

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(1) By applying 1977 actual ratios (60/40) to 1976 total local revenues.

(2) By applying 1977 actual telephone repartition (61/39) to total local 1976 local costs.

(3) By applying 1977 actual ratios (68/32) to 1976 total toll revenues.

(4) By applying NPPS estimated ratios (72/28) to total toll costs.

(5) By applying NPPS estimated ratios (73/27) to total toll revenues.

2.2 Profitability Analysis for Selected O-D Pairs

2.2.1 Introduction

As pointed out in the introduction of this report, a key element for setting up the rules of "fair" competition consists of profitability measures for various services. The definition of services for this exercise must ultimately reflect and encompass the categories in which competition will be allowed. At the most disaggregated level a service can be defined by an origin-destination pair. In this chapter we present fully allocated costs and collected revenues both for public messages and private lines, for 306 such O-D pairs resulting in all possible pair combinations between 18 cities. These cities were deliberately taken from Bell Canada's territory for the following reasons:

- The CN/CP application was aimed essentially at interconnection with Bell Canada.
- The Bell network is the most suitably represented regional network in the N.P.P.S. model.
- Introduction of interregional pairs would have severely complicated the problem since the profitability of such pairs would have to be based on post-settlement revenues which in turn, with the Old Commonwealth or T.C.T.S. sharing schemes, are not defined on an O-D per O-D basis.

It must also be pointed out that this analysis carried out in the context of competition, provides an interesting input to the problem of cross-subsidization in the telecommunications industry. So far, in the N.P.P.S. research effort, the phenomenon of cross-subsidy has been closely related to the inability of a service to repay its incremental costs. If a more stringent definition of cross-subsidy is used, namely the inability of a service to repay its fully allocated costs including a fair share of common costs (which is basically the underlying philosophy of F.C.C. methods 1 and 7) results provided in this section are of substantial relevance.

2.2.2 Assumptions and Results

Simulation assumptions are identical to those used in the Bell experiment shown in Section 2.1.

Detailed results for both public messages and private lines are displayed on an O-D per O-D basis in Tables 2-7 through 2-9.

Aggregate results for the 18 cities concerned and for services originating and terminating in a given city appear in Tables 2-10 and 2-11. Also shown in these tables are comparable figures for the entire intraregional Bell network. It can be seen that the overall revenue/cost ratio for the 18 cities considered is substantially higher than the average ratio derived for all Bell intraregional toll services. Further, large variations exist from city to city; these seem to be governed by two factors:

- the volume of traffic generated by the city itself;
- the volume of traffic generated in the area.

This last factor explains why relatively small cities in South-Western Ontario show a high profitability attributable mainly to the high efficiency of the transmission and switching networks in this heavily populated area.

When considering private lines, the most important point to note is their lower profitability when compared to public messages. It must be remembered however that these profitability figures are based on an assumed number and geographical distribution of intraregional private lines which both affect the cost allocation process. As shown in Table 2-9, assumed private lines between Hamilton and Toronto yield a revenue to cost ratio of 4.8. Consequently, if the assumed number of private lines was increased in concentrated population areas and decreased in other areas the average cost/revenue ratio for this service could be drastically improved. This example shows clearly how relatively minor changes in services configuration can affect the overall cost allocation process and subsequently any rate structure based on it.

Finally, we would like to attach two qualifications to the results presented in this section.

Most of the N.P.P.S. data base dates back to 1972 (the updating of this data base is further discussed in chapter 4 of this report). Therefore, absolute costs and revenues figures shown herein certainly do not represent the present situation. The observations which have been made, however, solely rest on their relative values when compared to one another and therefore remain in our opinion, quite valid.

It must also be remembered that cost figures developed by N.P.P.S. result from an overall optimization of the Canadian toll network. Overall optimization does not guarantee the optimal use of subsets of the network. It is quite possible, for instance, that a particular O-D may be penalized by the optimization process. Consequently, the confidence which can be attached to the results increases with the level of aggregation.

TABLE 2-7

Comparison between revenues and fully allocated costs for selected O-D pairs - Public messages ($1-000/year)

Origin \ Destination	Drummondville	Granby	Hamilton	Kitchener	London	Montreal	Niagara Falls	Ottawa	Quebec	Riviere-du-Loup	Sault-Ste-Marie	Sherbrooke	Sudbury	Thunder Bay	Timmins	Trois-Rivieres	Toronto	Windsor
Drummondville	—	87 / 160	84 / 43	7 / 22	5 / 19	389 / 1815	5 / 14	66 / 184	104 / 332	18 / 7	3 / 4	31 / 158	6 / 18	4 / 4	13 / 5	79 / 242	50 / 178	5 / 14
Granby	92 / 158	—	16 / 51	9 / 31	7 / 27	523 / 2962	7 / 21	89 / 273	92 / 280	15 / 7	4 / 6	61 / 212	7 / 23	5 / 5	17 / 7	75 / 220	70 / 252	7 / 20
Hamilton	133 / 43	13 / 45	—	224 / 1198	178 / 817	154 / 793	198 / 803	95 / 500	25 / 109	5 / 3	76 / 65	149 / 50	44 / 164	86 / 40	91 / 31	15 / 62	593 / 7177	110 / 381
Kitchener	6 / 21	9 / 30	235 / 1217	—	182 / 706	99 / 454	85 / 271	71 / 252	29 / 107	2 / 1	56 / 46	6 / 24	59 / 112	17 / 21	40 / 19	10 / 37	530 / 4081	124 / 248
London	7 / 19	9 / 26	166 / 875	197 / 703	—	101 / 302	59 / 220	56 / 200	9 / 16	4 / 2	41 / 50	7 / 22	25 / 56	20 / 25	74 / 18	12 / 32	228 / 2296	185 / 490
Montreal	333 / 1604	506 / 2608	166 / 775	90 / 412	76 / 417	—	83 / 320	670 / 3028	524 / 3261	105 / 76	233 / 211	184 / 1673	69 / 285	130 / 143	253 / 100	425 / 2325	1838 / 9582	187 / 721
Niagara Falls	5 / 14	7 / 20	207 / 839	87 / 271	61 / 216	88 / 346	—	48 / 162	12 / 45	1 / 1	11 / 17	5 / 6	26 / 53	7 / 8	15 / 9	7 / 23	401 / 2597	35 / 100
Ottawa	67 / 171	89 / 255	94 / 489	112 / 243	46 / 188	766 / 3271	45 / 157	—	59 / 312	33 / 16	61 / 50	53 / 198	69 / 211	80 / 92	120 / 43	119 / 355	544 / 3018	58 / 124
Quebec	110 / 308	96 / 264	28 / 101	38 / 105	7 / 21	581 / 3225	12 / 44	58 / 335	—	194 / 67	19 / 27	87 / 349	6 / 12	5 / 6	36 / 20	196 / 681	102 / 545	40 / 85
Riviere du-Loup	7 / 8	7 / 8	3 / 4	1 / 2	1 / 2	70 / 93	1 / 1	14 / 18	406 / 77	—	1 / 1	8 / 10	1 / 1	1 / 1	1 / 0	16 / 17	20 / 27	1 / 1
Sault-Ste-Marie	2 / 4	3 / 6	27 / 56	26 / 48	25 / 52	107 / 223	8 / 18	24 / 54	13 / 28	1 / 0	—	3 / 5	567 / 69	43 / 35	56 / 22	5 / 10	97 / 290	30 / 48
Sherbrooke	37 / 156	66 / 211	211 / 54	6 / 25	6 / 22	173 / 1838	5 / 16	54 / 208	78 / 371	22 / 9	4 / 5	—	8 / 19	4 / 5	11 / 6	43 / 194	40 / 201	6 / 18
Sudbury	6 / 17	7 / 22	52 / 175	65 / 113	35 / 80	79 / 313	26 / 55	66 / 239	4 / 14	1 / 1	98 / 68	5 / 18	—	56 / 62	56 / 56	11 / 33	608 / 1526	39 / 74
Thunder Bay	4 / 3	5 / 5	87 / 41	16 / 22	28 / 36	168 / 194	7 / 9	91 / 111	4 / 5	1 / 0	61 / 35	4 / 5	37 / 63	—	56 / 11	8 / 9	558 / 812	23 / 26
Timmins	6 / 6	8 / 7	32 / 27	20 / 21	19 / 19	121 / 118	10 / 9	50 / 48	22 / 22	0 / 0	44 / 22	6 / 6	42 / 59	20 / 12	—	12 / 11	138 / 154	17 / 17
Trois Rivieres	80 / 235	74 / 216	18 / 63	10 / 37	9 / 33	445 / 2592	7 / 23	118 / 373	201 / 711	36 / 15	7 / 10	41 / 192	15 / 33	8 / 9	22 / 10	—	69 / 300	11 / 30
Toronto	45 / 156	63 / 223	561 / 6796	390 / 3716	306 / 2076	1784 / 9485	393 / 2430	514 / 3164	78 / 428	47 / 25	141 / 254	36 / 179	464 / 1083	510 / 704	216 / 132	63 / 270	—	252 / 1136
Windsor	5 / 14	7 / 20	121 / 389	124 / 246	182 / 490	204 / 759	36 / 102	45 / 129	33 / 86	1 / 1	38 / 46	6 / 18	40 / 73	24 / 26	41 / 16	11 / 30	296 / 1241	—

Destination

Origin

Costs / **Revenues**

TABLE 2-8

Revenues/costs ratios for selected O-D pairs Public messages

	Drummondville	Granby	Hamilton	Kitchener	London	Montreal	Niagara Falls	Ottawa	Quebec	Rivière-du-Loup	Sault-Ste-Marie	Sherbrooke	Sudbury	Thunder Bay	Timmins	Trois-Rivières	Toronto	Windsor
Drummondville	———	1.84	.51	3.14	3.8	4.67	2.8	2.79	3.19	.39	1.33	5.1	3.	1.	.38	3.06	3.56	2.8
Granby	1.72	———	3.19	3.44	3.86	5.66	3.	3.07	3.04	.47	1.5	3.59	3.28	1.	.41	2.93	3.6	2.86
Hamilton	3.10	3.46	———	5.35	4.59	5.15	4.06	5.26	4.36	.6	.86	.36	3.73	.47	.34	4.13	12.1	3.46
Kitchener	3.5	3.33	5.18	———	3.88	4.59	3.19	3.55	3.69	.5	.82	4.	1.90	1.24	.47	3.7	7.7	2.
London	2.71	2.89	5.27	3.57	———	2.99	3.73	3.54	1.78	.5	1.22	3.14	2.24	1.25	.24	2.67	10.07	2.65
Montreal	4.82	5.15	4.67	4.58	5.49	———	3.86	4.52	6.22	.72	.91	9.12	4.13	1.1	.40	5.47	5.21	3.91
Niagara Falls	2.8	2.86	4.05	3.11	3.54	3.93	———	3.37	3.75	1.	1.55	1.2	2.04	1.14	.6	3.29	6.48	2.86
Ottawa	2.55	2.87	4.67	2.17	4.09	4.27	3.49	———	5.29	.48	.82	3.74	3.06	1.15	.36	2.98	5.55	2.14
Quebec	2.8	2.75	3.61	2.76	3.	5.55	3.67	5.78	———	.34	1.42	4.01	2.	1.2	.56	3.47	5.34	2.12
Rivière-du-Loup	1.14	1.14	1.33	2.	2.	1.33	1.	1.29	.19	———	1.	1.25	1.	1.	0.	1.06	1.35	1.
Sault-Ste-Marie	2.	2.	2.07	1.85	1.93	2.08	2.25	2.25	2.15	0.	———	1.67	.12	.81	.39	2.	2.99	1.6
Sherbrooke	4.22	3.20	.26	4.17	3.67	10.62	3.2	3.85	4.76	.41	1.25	———	2.37	1.25	.55	4.51	5.02	3.
Sudbury	2.83	3.14	3.37	1.74	2.29	3.96	2.12	3.62	3.5	1.	.69	3.6	———	1.11	1.	3.	2.51	1.90
Thunder Bay	.75	1.	.47	1.37	1.29	1.15	1.29	1.22	1.25	0.	.57	1.25	1.7	———	.2	1.12	1.46	1.13
Timmins	1.	.87	.84	1.05	1.	.98	.9	.96	1.	-	.5	1.	1.4	.6	———	.92	1.12	1.
Trois-Rivières	2.94	2.92	3.5	3.7	3.67	5.82	3.29	3.16	3.54	.42	1.43	4.68	2.2	1.12	.45	———	4.35	2.73
Toronto	3.47	3.54	12.11	9.53	6.78	5.32	6.18	6.16	5.49	.53	1.80	4.97	2.33	1.38	.61	4.29	———	4.51
Windsor	2.8	2.86	3.21	1.98	2.69	3.72	2.83	2.86	2.61	1.	1.21	3.	1.82	1.08	.39	2.73	4.19	———

TABLE 2-9

Comparison between revenues and fully allocated costs for selected O-D pairs - Private lines - ($1,000/year)

	Drummondville	Granby	Hamilton	Kitchener	London	Montreal	Niagara Falls	Ottawa	Quebec	Rivière-du-Loup	Sault-Ste-Marie	Sherbrooke	Sudbury	Thunder Bay	Timmins	Trois-Rivières	Toronto
Granby	17/11																
Hamilton																	
Kitchener			37/66														
London			51/90	32/110													
Montreal	78/148	121/206	122/234	91/180	104/235												
Niagara Falls			50/42	21/23	44/38	90/122											
Ottawa		21/31	35/60	26/43	36/73	153/455											
Quebec	32/29	32/30				140/450		21/56									
Rivière-du-Loup									38/32								
Sault-Ste-Marie																	
Sherbrooke	9/37	12/15				63/235		19/30	21/38								
Sudbury						62/138					38/59						
Thunder Bay																	
Timmins																	
Trois-Rivières	5/13	17/20				165/276		28/42	55/52			5/17					
Toronto			112/539	61/281	114/373	1164/2526	152/219	232/410	75/166		66/114	31/74	154/277	307/489	90/91	44/83	
Windsor			50/42		117/162	191/333											141/195

Origin	Destination
	Costs / Revenues

TABLE 2-10

Summary of Costs and Revenues for Selected O/D Pairs for Public Messages

Traffic originating from	Costs	Revenues	Rev/Cost ratio
Drummondville	956	3,219	3.37
Granby	1,096	4,555	4.16
Hamilton	2,189	12,281	5.61
Kitchener	1,560	7,647	4.90
London	1,200	5,352	4.46
Montréal	5,872	27,557	4.69
Niagara Falls	1,023	4,727	4.62
Ottawa	2,415	9,193	3.81
Québec	1,615	6,195	3.84
Rivière-du-Loup	559	271	2.06
Sault-Ste-Marie	1,037	968	.93
Sherbrooke	774	3,358	4.34
Sudbury	1,214	2,866	2.36
ThunderBay	1,158	1,387	1.20
Timmins	567	558	.98
Trois-Rivières	1,171	4,882	4.17
Toronto	5,863	32,257	5.50
Windsor	1,214	3,686	3.04
Total Selected Cities	31,483	130,959	4.16
Total Bell intra-traffic	104,300	272,600	2.61

TABLE 2-11

Summary of Costs and Revenue for Selected O/D Pairs for Private Lines

Traffic terminating and originating in	Costs	Revenue	Rev/Cost Ratio
Drummondville	141	238	1.69
Granby	220	313	1.42
Hamilton	457	1,073	2.35
Kitchener	268	703	2.62
London	498	1,081	2.17
Montreal	2,544	5,538	2,18
Niagara Falls	357	444	1.24
Ottawa	571	1,200	2.10
Quebec	414	853	2.06
Rivière-du-Loup	38	32	1.19
Sault-Ste-Marie	104	173	1.66
Sherbrooke	160	446	2.79
Sudbury	254	475	1.87
ThunderBay	307	489	1.59
Timmins	90	91	1.01
Trois-Rivières	319	503	1.58
Toronto	2,743	5,837	2.13
Windsor	499	732	1.47
Total Selected Cities	4,992	10,111	2.03
Total Bell intra-regional private lines	11,200	16,200	1.45

2.3 The Case of Quebec Telephone

2.3.1 Introduction

Quebec Telephone recent application for entry into T.C.T.S. was rejected by T.C.T.S., the main argument being that their actual settlement with Bell Canada was fair and that they would not gain by joining T.C.T.S. It was also pointed out that T.C.T.S. is an association of the most important carriers only, and this at the rate of one per province. Various tests were performed with N.P.P.S. in order to simulate post-settlement revenues for Quebec Telephone using different sharing schemes. In the following sections, the representation of Quebec Telephone in the model is described and the results of N.P.P.S. main blocks are displayed. Special emphasis is put on the implications of various sharing schemes.

Since Quebec Telephone has not been an issue as such so far, its representation in N.P.P.S. is far from being adequate and the derived results will be qualified accordingly.

2.3.2 Present Representation in N.P.P.S.

Two switching points are presently considered in N.P.P.S.: Rimouski which is a level 3 node homing on Quebec and Blanc Sablon, a toll center homing on Rimouski. The various trunks originating/terminating in Quebec Telephone are given below:

Link	Type	Nb. of Circuits
Rimouski - Quebec	Final	104
Rimouski - Blanc-Sablon	Final	47
Rimouski - Montreal	High-usage	83
Rimouski - Rivière-du-Loup	High-usage	21
Rimouski - Chicoutimi	High-usage	15
Rimouski - St.John (N.B.)	High-usage	6
Rimouski - New Castle	High-usage	5
Rimouski - Cornerbrooke	High-usage	5

The transmission network consists of 7 nodes and 8 links which, broadly speaking, join Rimouski to Bell Canada westward and to CNP/NFLD eastward as shown on the map of Figure 4-2, Chapter 4.

2.3.3 Main Results

Costing Block.

The results of the costing block for Quebec Telephone appear in Table 2-12 where they can be compared to similar N.P.P.S. estimates for other carriers. The facilities described in the previous section represent reproduction costs of $ 17.9 millions and corresponding incurred costs of $ 4.6 millions per annum.

Traffic and Usage of Switching Network.

N.P.P.S. peak-hour traffic (C.C.S.) estimates are as follows:

	Traffic Originating In	
	Quebec Tel.	Bell Canada for comparison
Regional Traffic	1	239,932
Adjacent Traffic	505	3,835
Non-Adjacent Traffic	43	6,518
Traffic with U.S.A.	3	23,421

As expected, most of Quebec Tel originating traffic is towards adjacent carriers.

The usage of the switching network for this estimated traffic is summarized in Table 2-13. It can be seen that all links are much under-used. Also of interest is the fact that the usage of the switching network may be very asymetrical. The final link Quebec-Rimouski, for instance, carries two traffic components to Quebec City and 21 in the other direction as explained by the diagram of Figure 2-1.

Usage of Transmission Network.

The usage of Quebec Tel transmission facilities is summarized in Table 2-14.

It appears that Quebec Tel transmission network, as represented in N.P.P.S., is much under-utilized. It should be noted that the optimization of the transmission network results in the routing of the Quebec Tel to Newfoundland traffic via New Brunswick which is certainly not in the best interest of Quebec Tel, and presumably not the actual situation.

It is also known that Bell Canada has leasing arrangements with Quebec Tel for the use of a certain number of channels (most presumably for survivability purposes) which significantly affects the overall usage of the latter's transmission network.

TABLE 2-12

N.P.P.S. Estimates of Quebec Tel.'s Assets and Incurred Costs
($ 000)

COST AND ASSET STATISTICS BY COMPANY

NOTE: FIGURES APPLY TO TOTAL COMPANY ASSETS AND COSTS
RESULTS PRODUCED BY NPPS SYSTEM 1321 FEB 28,'78

	BCT	AGT	SASK	MANT	BCAN	QUET	NBT	MTT
DES								
TOTAL NUMBER	22	23	20	10	87	7	11	13
SWITCHING NODES	12	7	6	3	52	2	6	6
BRANCHING NODES	7	7	4	4	16	0	3	4
REGULAR NODES	3	9	10	3	19	5	2	3
NKS								
TOTAL NUMBER	26	31	24	16	112	8	16	15
TOTAL DISTANCE	1875	1978	1043	791	5764	669	806	636
CIRCUIT-MILES	3945840	5440080	3193080	2055240	25818600	856200	1510320	1277280
INVEST. PER CIRCUIT-MILE	15.00	12.00	11.00	14.00	15.00	11.00	21.00	23.00
QUANTITIES OF FACILITIES								
SWITCHING MACHINES	13	8	6	3	58	2	6	6
TERMINAL REPEATERS	13	8	6	3	58	2	6	6
BRANCHING REPEATERS	8	9	6	7	34	1	5	6
REGULAR REPEATERS	38	40	21	16	107	18	15	12
LUE OF ASSETS								
SWITCHING MACHINES	45213913	28289715	22148481	10732892	246073392	6018522	19732955	18924941
TERMINAL REPEATERS	22476243	20980050	13885256	6753701	246770226	3197118	16170623	14082961
BRANCHING REPEATERS	21383442	27654151	13295449	16538358	104351051	649799	10811035	12625574
REGULAR REPEATERS	22110080	21534112	11293022	8370413	63082208	8072070	7223206	5491709
ACCOUNTING BREAKDOWN								
SWITCHING	45213904	28289712	22148480	10732892	246073392	6018522	19732944	18924928
TRANSMISSION-MULTIPLEXING	28082400	36158400	19411200	15676800	263354400	2347200	19545600	18979200
-OTHER	31425120	29172672	16296299	13792611	132149296	7859104	12466679	11177066
-TOTAL	59507520	65331072	35707499	29469411	395503696	10206304	32012279	30156266
GENERAL EQUIP.	4374646	3374688	1941222	1543054	12974738	1187682	1542579	1443972
LAND	1043750	731250	412500	325000	2862500	262500	324999	300000
BUILDINGS	1043750	731250	412500	325000	2862500	262500	324999	300000
STATION	0	0	0	0	0	0	0	0
RCENTAGE BREAKDOWN								
SWITCHING	40.67	28.73	36.54	25.32	37.27	33.55	36.58	37.02
TRANSMISSION	53.52	66.35	58.90	69.51	59.90	56.90	59.35	58.99
GENERAL EQUIP.	3.93	3.43	3.20	3.64	1.97	6.62	2.86	2.82
LAND	.94	.74	.68	.77	.43	1.46	.60	.59
BUILDINGS	.94	.74	.68	.77	.43	1.46	.60	.59
STATION	.00	.00	.00	.00	.00	.00	.00	.00
TAL ASSETS	111183570	98457972	60622201	42395357	660276826	17937508	53937800	51125166
INCURRED COSTS								
SWITCHING MACHINES	11032191	5629651	5204892	2221708	61518080	1504630	4893770	4655532
TERMINAL REPEATERS	5751884	4437929	3424034	1482935	64731056	840274	4196299	3627660
BRANCHING REPEATERS	5465416	5848855	3279682	3631886	27391008	171686	2807412	3253853
REGULAR REPEATERS	5745791	4587784	2866247	1804011	16759212	2065325	1830282	1382924
C. COSTS BY ELEM. TYPE								
NODES	22925104	17295616	13222270	7777807	158856064	3157645	12136793	11900446
LINKS	5070036	3208579	1552585	1362733	11542938	1424270	1590970	1019523
TAL INCURRED COSTS	27995140	20504195	14774855	9140540	170399002	4581915	13727763	12919969

TABLE 2-13

Usage of Quebec Tel. switching facilities
(Sample of most important links)
Usage

Link description O-D	Type	#	Circuits	Direction	Theoretical capacity(1) C.C.S.	# of traffic components	Traffic offered C.C.S.	Traffic carried C.C.S.	Required # of circuits (1)	
Rimouski-Quebec	Final		104	R - Q	1,316	6	88	88	8)	21
				Q - R	1,316	26	199	199	13)	
Rimouski-Montreal	H.U.		83	R - M	1,436	63	295	295	11)	19
				M - R	1,436	57	191	291	8)	
Rimouski-Rivière-du-Loup	H.U.		21	R-Riv.	270	1	17	17	2)	4
				Riv.-R	270	1	18	18	2)	
Rimouski-Chicoutimi	H.U.		15	R - C	168	2	57	57	4)	8
				C - R	168	2	47	47	4)	
Blanc-Sablon-Rimouski	Final		47	B - R	479	14	16	16	3)	6
				R - B	479	12	11	11	3)	

(1) Assuming: 1% of loss on finals
10% of overflow on H.U.'s

TABLE 2-14

Usage of Quebec Tel. Transmission Facilities

	From Rimouski Westward	From Rimouski Eastward
Available Circuits	3 X 480 = 1,440	5 X 480 = 2,400
Protection Circuits	480	480
TV Use	none	none
Used Circuits: Total	336	60

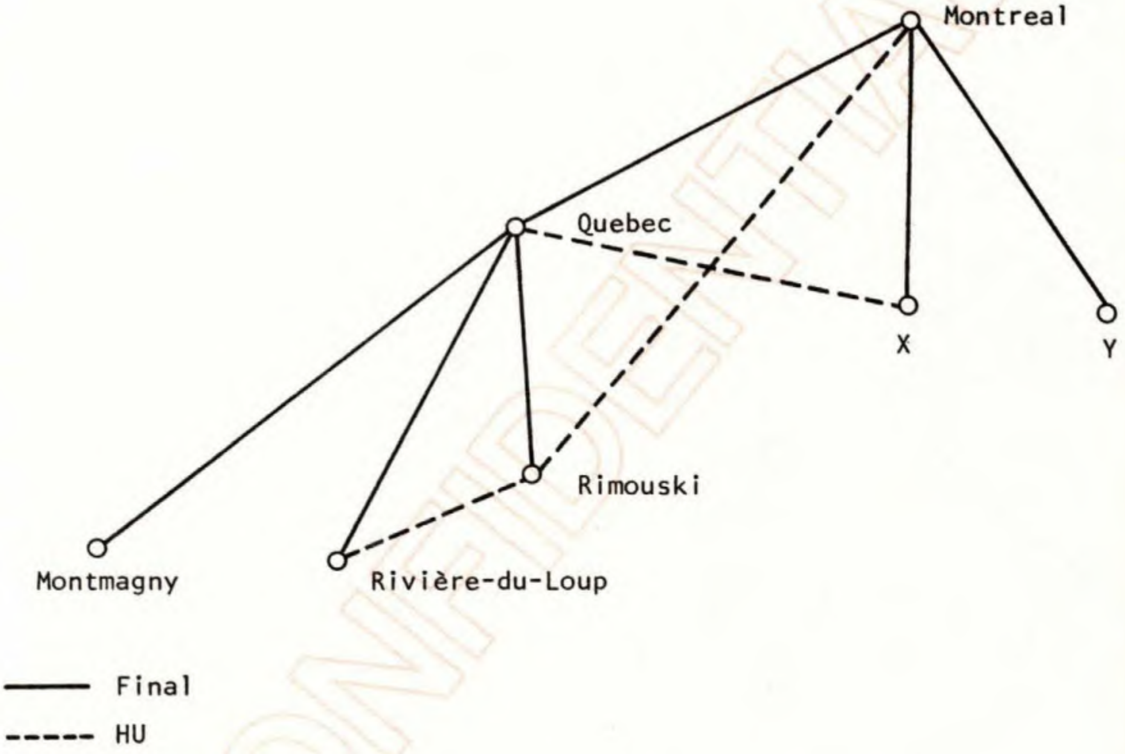
Detail:

Rimouski to Chicoutimi	24	Rimouski to Blanc-Sablon	60
Rimouski to Cornerbrooke	12		
Rimouski to Montreal	108		
Rimouski to Newcastle	12		
Rimouski to Rivière-du-Loup	24		
Rimouski to St. John	12		
Rimouski to Sherbrooke	12		
Rimouski to Quebec	132		

Used Circuits as a Percentage of Available Circuits	23.3%	.025%

FIGURE 2-1

Asymetry of a Hierarchical Switching Network



Traffic between Rimouski and X will be routed as follows:

R ⟶ X : Rimouski - Montreal - X
X ⟶ R : X - Quebec - Rimouski

Revenues.

N.P.P.S. estimates of originated revenues for public messages appear below:

($'000)

	Quebec Tel.	Bell Canada
Regional Traffic	Negligible	272,618
Adjacent Traffic	1,221	10,495
Non-Adjacent Traffic	127	20,316
U.S.A. Traffic	9	67,858

By combining these results with those of the costing block shown in Table 2-12, one notes that the ratio of (collected revenues/total incurred costs) is of .3 for Quebec Tel while it amounts to 2.19 for Bell Canada. We are fairly confident that all the qualifications of the model cannot explain this one to seven relationship, and that a large amount of this difference must be tied to the effect of economies of scale and indivisibilities.

Revenue Sharing.

The sharing block, which up to now mainly focused on T.C.T.S. carriers has been upgraded so as to show fully allocated cost and revenues as well as New Commonwealth revenue sharing for O/D pairs selected by the user. All traffic with Quebec Tel was thus analyzed and a summary of results is presented in Table 2-15. Reference is made to the previous section to interpret costs incurred by Bell Canada for traffic between Quebec Tel and Newfoundland since this traffic is routed via Rivière-du-Loup and New Brunswick, using Bell Canada transmission facilities.

The outstanding feature of these results is that most carriers do not recover their fully allocated incurred costs.

If one considers however the low utilization of both switching and transmission networks this results is not surprising with a full allocation of costs methodology. According to the data base, there are 223 trunks between Quebec Tel and Bell Canada while 52 would suffice to accommodate the traffic generated by N.P.P.S. In other words, both carriers incur switching costs which are four times what they should normally be. This is further aggravated by the underutilization of the transmission network, since this little amount of traffic gets ultimately charged for the entire cost of a 3-channel transmission route.

Table 2-16 presents results of various sharing schemes assuming an enlargement of T.C.T.S. to include Quebec Tel. The basic differences between the New Commonwealth and the other two sharing schemes are clearly highlighted by these results, both latter schemes allowing for recoupment of TransCanada traffic related costs plus a share of the overall T.C.T.S. profit.

TABLE 2-15

Quebec Tel. cost and revenue analysis(1)
($000)

	BCT	AGT	SASK	MANT	BCAN	QUE T.	NBT	MTT	Total
Non-adjacent TCTS									
Traffic:									
Incurred costs	3	4	6	6	148	535	38	113	845
collected revenues	14	13	4	13	0	112	-	61	217
Traffic with BCAN									
Incurred costs	-	-	-	-	2,568	2,527	-	-	5,095
Collected revenues	-	-	-	-	1,084	1,163	-	-	2,247
Traffic with NBT									
Incurred costs	-	-	-	-	205	170	348	-	723
Collected revenues	-	-	-	-	-	138	137	-	275
Regional traffic									
Incurred costs	-	-	-	-	-	269	-	-	269
Collected revenues	-	-	-	-	-	negligible	-	-	1
Traffic with NFL									
Incurred costs	-	-	-	-	73	1,039	47	131	1,290
Collected revenues	-	-	-	-	-	18	-	-	18
Traffic with USA									
Incurred costs	-	-	-	-	17	6	-	-	23
Collected revenues	-	-	-	-	-	9	-	-	9
Total									
Incurred costs	3	4	6	6	3,011	4,546	427	244	8,247
Collected revenues	14	13	4	13	1,084	1,441	137	61	2,766

(1) Public messages and private lines combined.

TABLE 2-16

Settlement for Quebec Tel. as a member of enlarged TCTS
($000)

	Adjacent	Non-adjacent	Total
Incurred costs	2,697	535	3,232
Assigned plants	10,577	2,098	12,675
Pre-settlement revenues	1,301	112	1,413
rev/cost	.48	.21	.44
Post-settlement revenues			
- New Common.	-	-	1,141
rev/cost			.35
- Old Common.	1,204	853	2,057
rev/cost	.45	1.59	.64
- TCTS	1,204	815	2,015
rev/cost	.45	1.52	.62

2.3.4 Discussion

Given the under-representation of Quebec Tel in the N.P.P.S. model, it is our view that no definite conclusion can be drawn from this experiment. The population represented in N.P.P.S. amounts to approximately 50 000 while official statistics estimate the actual population served by Quebec Tel to be ten times larger. Data available at D.O.C. shows only two toll centers in this territory, namely Blanc Sablon and New Carlisle. It is our belief that no substantial improvement would be achieved by the introduction of this last minor node and that the large discrepancy between the N.P.P.S. results and actual benchmarks can only be explained by the absence in the data base of a whole string of minor toll centers.

The sole knowledge of the relative position of Quebec Tel within the Canadian network allows for a certain number of points to be made. Given its position, the only portion of revenues which would ultimately be affected by a change of status of Quebec Tel to full T.C.T.S. member would be for traffic with M.T.T. and the Western Provinces. Revenues sharing with Bell Canada, an adjacent type settlement, would still be settled separately. According to actual benchmarks, revenues generated by Trans-Canada represent 17% of toll revenues and 10% of total operating revenues. It is quite probable that Quebec Tel might be better off by settling directly with T.C.T.S. members rather than through Bell Canada. Given the amounts involved, however, it is doubtful that it would lead to drastic changes in Quebec Tel's overall financial position.

What would be of greater interest in the long term for Quebec Tel is the possibility of obtaining, as a member of T.C.T.S., major rerouting of the TransCanada traffic to the Eastern Provinces through its own network, hence increasing the use and efficiency of its facilities. This, however, would come in direct conflict with the interests of New Brunswick Telephone, presently a member of T.C.T.S. In addition, there is no evidence that this routing would be more economical for T.C.T.S. as a whole.

3. FURTHER PROBING INTO THE CROSS-SUBSIDY PROBLEM AREA

3.1 Interregional Cross-Subsidy Tests

3.1.1 Introduction

In the previous phase of the N.P.P.S. project a methodology for detecting cross-subsidies was developed. The underlying philosophy was incremental in nature and defined the cross-subsidy to a service as the difference between its incremental contributions to costs and revenues. This methodology was applied to a certain number of service categories: public messages vs private lines, short distance vs long distance toll traffic ... All incremental tests were satisfied, which cast a definite doubt on the applicability and validity of the proposed methodology in the context of the telecommunications industry. All tests having been performed at the national level, it was felt however, that before discarding this approach completely, a last area of possible cross-subsidization should be investigated: that is cross-subsidization between carriers. A testing methodology was proposed for this purpose. It was implemented during this phase of the project and yield the results presented in this section.

3.1.2 Methodology

Two types of tests were considered.

i) Incremental cost test for interregional traffic originating in one carrier's territory. The purpose of this series of test was to ensure that the total costs incurred by all TCTS member for interregional traffic originating in company X are at least covered by revenues collected by X.

ii) Incremental cost test for interregional traffic using one carrier's facilities. This series of tests was carried out to check whether post-settlement revenues for carrier X cover the costs it incurs for all TCTS interregional traffic using its facilities.

Before performing any particular test, results of the sharing block which relate pre- and post-settlement revenues to incurred costs, were analysed. Since fully allocated costs are much larger than incremental costs, any carrier recovering its fully allocated costs would definitely satisfy incremental cost-tests.

Overall pre- and post-settlement revenue to cost ratios for T.C.T.S. partners are shown below.

Companies

	BCT	AGT	SASK	MANT	BELL	NBT	MTT
Pre-settlement	2.0	2.29	1.04	2.67	1.96	.73	1.19
Post-settlement							
- New Commonwealth	1.80	2.15	1.31	2.73	1.92	.91	1.17
- Old Commonwealth	1.79	1.72	1.75	2.28	1.92	1.17	1.29
- T.C.T.S.	1.75	1.82	1.74	2.44	1.86	1.16	1.27

From this table it is clear that the only possible problem area would be the Eastern carriers. Our investigation consequently focussed on NBT and MTT.

The testing methodology employed consisted of three simulations the steps of which are outlined on the following page.

3.1.3 Results

Incurred costs derived according to the previously outlined methodology appear in table 3-1.

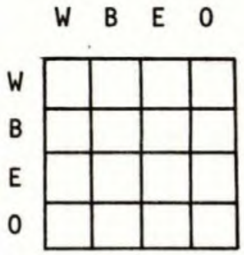
From this table it follows that the incremental costs to TCTS carriers of traffic originating in Eastern carriers is equal to (151.08 - 150.41) = \$.67 millions. Similarly, costs incurred by Eastern carriers for all Canadian interregional traffic are estimated at (14.20 - 13.29) = \$.91 millions. Pre- and post-settlement revenues for the Eastern carriers are estimated to be:

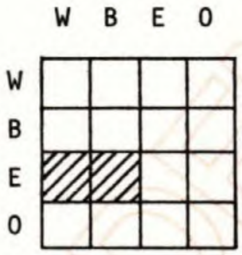
	\$ millions
Pre-settlement	11.9
Post-settlement	
- New Commonwealth	12.6
- Old Commonwealth	15.0
- TCTS	14.9

Simulation Methodology

Simulation 1	Simulation 2	Simulation 3
Comparison scenario	Test 1	Test 2

a) Define relevant traffic matrix as shown below where traffic is set to zero in shaded areas.





W: Western TCTS B: Bell E: Eastern O: Other

b) Dimension switching and transmission networks.

c) Compute corresponding incurred costs for:

All TCTS carriers: C_t for Eastern carriers only: C_e	All TCTS carriers: $C_{t'}$	Eastern carriers only: $C_{e'}$

d) Calculate incurred costs

-	$(C_t - C_{t'})$	$(C_e - C_{e'})$

3) Compare to appropriate revenue

-	Eastern carriers originating interregional revenues	Eastern carriers post-settlement interregional revenues.

TABLE 3-1

Interregional cross-subsidy tests: Simulations results

Simulation	Traffic NOT considered		Incurred costs of dimensioned network ($ millions)			
			Western Carriers	Bell and Que. Tel.	Eastern Carriers	Total
1 (base case)	None	Switching	21.48	56.05	8.35	85.88
		Transmission	20.89	38.46	5.85	65.20
		Total	42.37	94.51	14.20	151.08
2	Interregional traffic originating in NBT and MTT	Switching	21.48	55.85	8.35	85.58
		Transmission	20.89	38.24	5,60	64.73
		Total	42.37	94.09	13.95	150.41
3	Interregional traffic terminating or going through NBT and MTT	Switching	21.48	55.85	8.15	85.48
		Transmission	20.85	37.66	5.14	63.65
		Total	42.33	93.51	13.29	149.13

General simulations assumptions:

a) Maximum efficiency of multiplexing: 90%

b) Peak-hour to total day traffic ratios:
- regional : 10%
- adjacent : 10%
- non-adjacent: 12%

For incremental costs cross-subsidy tests can then be developed:

	Incremental cost	Incremental revenue	Revenue/cost ratio
Series 1	.67	11.9	17.8
Series 2			
- New Commonwealth	.91	12.6	13.8
- Old Commonwealth	.91	15.0	16.5
- TCTS	.91	14.9	16.4

3.1.4 Discussion

From the high revenues to cost ratios obtained, it can be inferred that interregional incremental cost tests will remain inconclusive even if growth reserve and model qualifications (treatment of survivability, approximation to multiplexing plan ...) are considered.

This application further confirms a conclusion reached in the previous phase of the N.P.P.S. research effort, namely that incremental cost tests are not a tool sufficiently powerful for the detection of cross-subsidies in the telecommunications industry where a large portion of costs is fixed.

The results provided in this section also point out an important feature of the New Commonwealth sharing scheme when applied to Trans-Canada traffic. As pointed out in the case of NBT, it does not necessarily ensure costs recovery for all carriers although total Trans-Canada revenues substantially exceed total incurred costs. Conversely, in both Old Commonwealth and TCTS schemes, sharing of the total excess revenues occurs only after repayment of all carrier's costs.

It follows that implementation of a New Commonwealth type sharing scheme for Trans-Canada traffic would result:

- either in major adjustments of regional toll rates
- or in the existence of a multiple tariff structure for Trans-Canada traffic

in order to ensure overall cost/revenue equilibrium at the carrier level.

Another critical aspect of the New Commonwealth sharing scheme was put in evidence in the course of this project. Although it does not directly relate to the issue addressed in this section, it is best reported here. The principle behind the New Commonwealth sharing scheme is that, on an O-D basis, all costs incurring carriers recover their costs and the resulting profit (or loss) is shared equally by the originating and terminating partners. When applied to the Canadian Network, this scheme leads, in certain cases, to a redistribution of revenues of questionable equity. Our point is best illustrated by what would happen to adjacent traffic between Bell and Manitoba, should the scheme be implemented.

Incurred costs, pre- and post-settlement revenues associated with public messages traffic are displayed in table 3-2. Since some overflow traffic to Winnipeg is routed via Regina, some costs are also incurred by Saskatchewan.

The high profitability of this traffic for Manitoba results from:

- a high overall revenue/cost ratio attributable to the efficiency of the Bell network;
- the fact that Manitoba would receive through redistribution 50% of the total profit or 43% of total revenues while incurring only 30% of the costs.

It must be remembered that the New Commonwealth sharing scheme was primarily intended for country to country settlements (e.g. traffic between Canada and the U.K.). In this context, the type of problems evidenced earlier did not occur since each partner incurred costs of a similar magnitude.

Given the scheme's shortcomings pointed out in this section, it is doubtful that such a redistribution process would be either practical or equitable for the Canadian terrestrial network.

3.2 Elaboration of a Simplified Model for Use in Lieu of N.P.P.S. in an Iterative Rate Setting Process

3.2.1 Introduction

In the last phase of the N.P.P.S. project, emphasis was placed on the definition of costing procedures and testing methodologies which would enable the regulator to detect cross-subsidies between services and carriers. Although one cannot consider the team's effort conclusive as yet in these areas, one must start thinking of a machinery which would guide the regulator in taking corrective action once such phenomena have been found.

TABLE 3-2

Adjacent settlement for
Bell Canada and Manitoba Telephone
($000)

	SASK	MANT	BELL	TOTAL
Originated revenues	-	6,241	6,976	13,216
Incurred costs	43	1,451	3,262	4,756
New Commonwealth post-settlement revenues	43	5,681	7,492	13,216
Revenues/Costs	1.0	3.92	2.30	2.78
For comparison				
post-settlement revenues				
- Old Commonwealth	120	4,032	9,064	13,216
- TCTS	120	4,381	8,715	13,216

A general methodology was proposed a few years ago(1) and is summarized in the flow-chart of Figure 3-1. Broadly speaking, it amounts to the following: given a demand matrix, associated costs and revenues are derived by use of an appropriate costing model. Costs and revenues are then compared for detection of cross-subsidy. Once such phenomenon has been evidenced, the rate structure is adjusted. Taking into consideration demand elasticities and cross-elasticities, a revised demand matrix is developed. The process is repeated until the rate structure is found to be cross-subsidy free.

This procedure requires two vital modules: a demand model and a costing model. Our concern, in this phase of the N.P.P.S. project, lies with the costing model. It should be pointed out, however, that developing an appropriate demand model and gathering the data it requires (elasticities and cross-elasticities) is not foreseen to be a simple exercise. The various applications made so far with N.P.P.S. have shown that the model can satisfactorily be used as a costing tool and has reasonable flexibility with regards to the costing approaches which may be chosen. The advantage of the model is that it is based on a realistic representation of the operation of the network; this, however, yields a rather complex tool, awkward to operate on an iterative basis.

The purpose of this section is to demonstrate that simple tools of reasonable accuracy can be developed for use in lieu of N.P.P.S. in the initial steps of an iterative rate setting process. Depending on the methodology used for cross-subsidy testing, these macro-models should encompass one or several costing philosophies.

The model we present in this section was initially designed so as to enable the calculation of incremental costs. Consequently it was built to estimate the costs of an optimally dimensioned network rather than of an existing network. Further, U.S. traffic and private lines have not been considered.

3.2.2 Characteristics of the model

The principle features of the model are the following:

i) Operations are simulated at an aggregate level, i.e. on a company to company basis. The basic units of work, however, remain the same: C.C.S., trunks, number of nodes...

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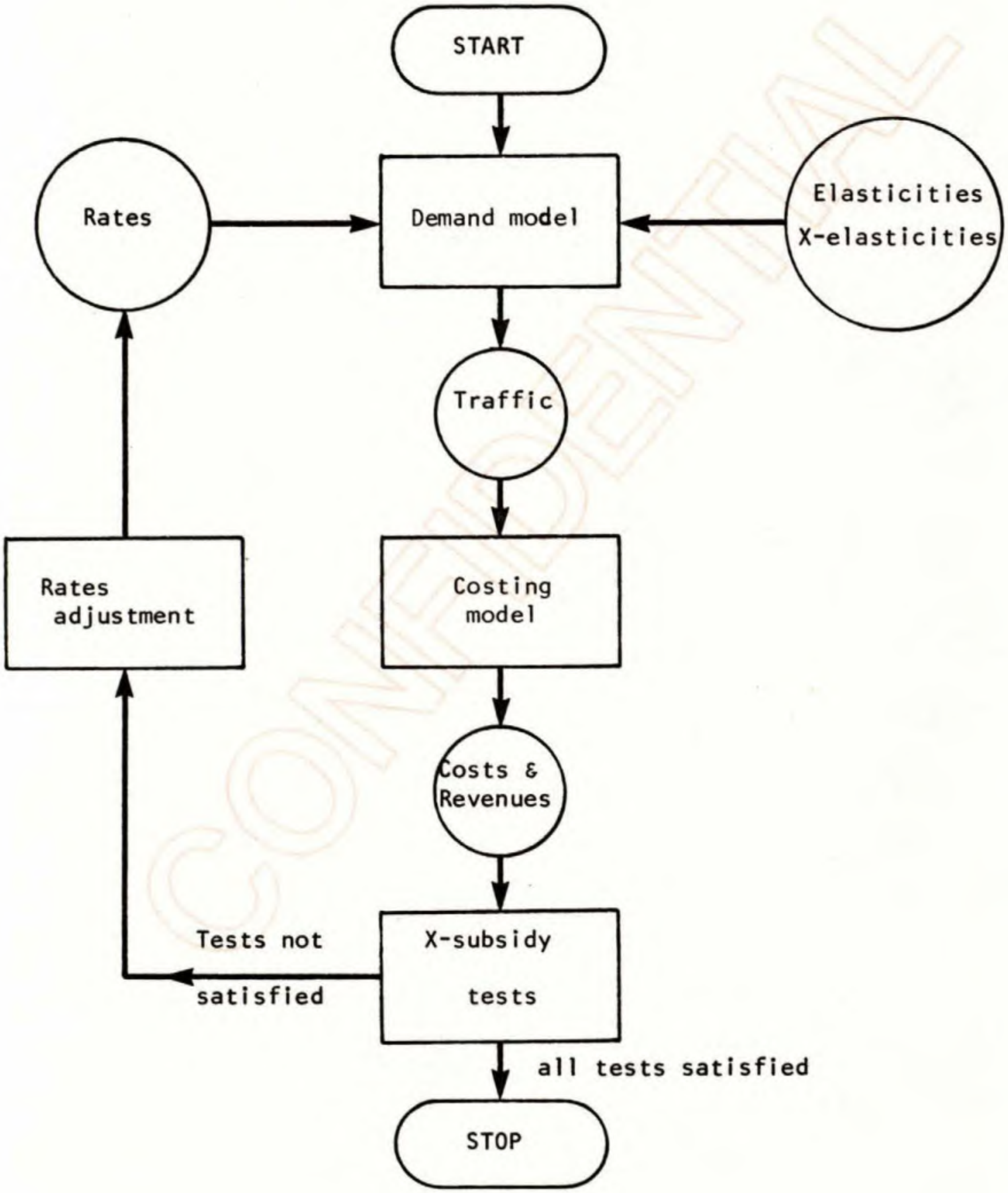
(1) "Quelques aspects sur la question de l'interfinancement" Guy Saint-Cyr, Université Laval - 1976.

Figure 3-1

Rate setting algorithms



ii) It is easy to operate and requires very little execution time, making it appropriate for an iterative process.

iii) The structure of the switching and transmission networks is not required. The data base is quite reduced as can be seen from table 3-3. It includes populations and number of nodes in a carrier's territory as well as geographical considerations: surfaces, distances...

iv) Results are reasonably close to those produced by N.P.P.S. under similar conditions.

3.2.3 Methodology

The model consists of five basics steps:

i) The definition of an aggregate traffic matrix by use of a gravity model.

ii) The translation of the traffic matrix into a total trunks matrix taking into account the effect of traffic volume on the efficiency of the switching network.

iii) The translation of trunks into switching costs.

iv) The translation of trunks into circuit-requirements on the transmission network and into transmission costs.

v) The translation of the traffic matrix into a generated revenue matrix.

For all steps, the experience gained in N.P.P.S. provided significant insight on the types of causal relationship to be tested.

The selection of the best possible relationships was done by use of a stepwise multiple regression model. All tests were performed on disaggregate data derived with N.P.P.S.

3.2.4 The model

Step 1. Intercompany traffic matrix

The general relationship tested was of the form:

$$T_{ij} = k \frac{N_i^{\alpha} N_j^{\beta} P_i^{\gamma} P_j^{\delta}}{D_{ij}^{\xi}}$$

TABLE 3-3

Macro-Model Data Base

	BCT	AGT	SASK	MANT	BCAN	QUET	NBT	MTT	NFL
Population (thousand)	1,557	1,026	356	580	10,177	52	275	402	176
Number of Switching Nodes	12	7	6	3	52	2	6	7	3
Adjacent Distance West-East (miles)	450	350	387.5	1,025	462.5	250	200	462.5	-
Surface of Populated Area (thousand square miles)	91	124	144	66	312.5	42.0	28.3	21.4	42.8
Border to Border Width of Territory Served (miles)	338	288	375	280	1,145	880	250	200	262

where

T_{ij} : average business day traffic from company i to company j (in C.C.S.)

N_i (N_j): number of demand points in company i (j)

P_i (P_j): estimated population served by company i (j) (in thousands)

D_{ij} : distance between companies i and j gravity centers (in miles).

The best results were obtained by using different formulae for regional, adjacent and non-adjacent traffic.

These are the following:

- For regional traffic:

$$T_{ij} = \exp.\ (3.06)\ N_i^{1.87}\ P_i^{.46}$$

- For adjacent traffic:

$$T_{ij} = \exp.\ (5.5)\ \frac{P_i^{.8}\ P_j^{.82}}{\overset{1.21}{D_{ij}}}$$

- For non-adjacent traffic:

$$T_{ij} = \exp.\ \frac{(4.46)\ N_i^{-.19} N_j^{-.19} P_i^{1.19} P_j^{1.22}}{1.74}$$

R-squared factors for these regressions were all superior to 97% and T-values proved significance of the coefficients at the 5% level.

Table 3-4 presents a sample of estimated traffic figures versus N.P.P.S. benchmarks.

Step 2. Intercompany trunk matrix

In order to account for switching efficiency variations depending upon traffic volume, relationships of the following form were tested:

TABLE 3-4

N.P.P.S. Versus Macro-Model Average Business Day Traffic Estimates (C.C.S.)

- Regional Traffic

	N.P.P.S.	MACRO-MODEL
BCT	95,955	67,335
AGT	23,791	20,233
SASK	7,937	9,282
MANT	2,391	3,180
BCAN	2,399,314	2,502,544
QUET	-	-
NBT	7,957	8,235
MTT	6,671	9,820
NFL	3,116	1,829

- Interregional Traffic from Bell-Canada

Traffic from BCAN to	N.P.P.S.	MACRO-MODEL
BCT	13,599	16,395
AGT	15,937	16,275
SASK	5,421	6,804
MANT	19,466	17,925
QUET	4,100	6,547
NBT	14,787	15,131
MTT	15,195	16,895
NFL	4,240	3,458

$$NC_{ij} = k\, N_i^{\alpha}\, N_j^{\beta}\, (T_{ij}/\, N_iN_j)^{\gamma}$$

where

NC_{ij}: number of trunks from company i to company j. The best results were obtained for the following set of coefficients yielding a multiple R^2 of 90% and passing a 5% T-significance test.

k = exp. (-4.23)
α = .72
β = .85
γ = 1.004

A sample of values estimated with this formula are compared to N.P.P.S. estimates in Table 3-5.

Step 3. Estimation of switching costs

Since the switching costs of a company depend mainly on the number of switching machines and total number of originating/terminating trunks the following formulation was tested:

$$SC_i = \alpha\, N_i + \beta \sum_{J=1}^{9} (NC_{ij} + NC_{ji}) + \gamma$$

where

SC_i : incurred switching costs for company i (in thousands per annum)

Regression analysis resulted in the following set of coefficients which satisfy usual statistical tests at the 5% confidence level.

α = 726.6
β = .8
γ = 395.5

N.P.P.S. versus macro-model estimates are displayed on Table 3-6.

Step 4. Estimation of transmission costs

This calculation can be broken down into three operations:

- the transformation of trunks into actual circuit requirements after multiplexing;

TABLE 3-5

N.P.P.S. versus Macro-Model
Number of Trunks to/from BCAN

Traffic between BCAN and	N.P.P.S.	MACRO-MODEL
BCT	104	115
AGT	120	125
SASK	113	54
MANT	122	154
BCAN	10,769	13,980
QUET	50	90
NBT	172	153
MTT	122	176
NFL	62	44

TABLE 3-6

N.P.P.S. versus Macro-Model
Incurred Switching Costs ($1,000)

	N.P.P.S.	MACRO-MODEL
BCT	9,900	9,800
AGT	4,500	5,500
SASK	4,600	4,400
MANT	2,000	2,100
BCAN	55,300	60,500
QUET	750	1,200
NBT	4,700	4,300
MTT	3,700	4,400

- the estimation of transmission fixed costs which constitute a large portion of total transmission costs;

- the estimation of transmission variable costs.

All relationships presented here satisfy standard statistical tests at the 5% significance level.

Circuit requirements after multiplexing are best estimated by the formula:

$$CR_{ij} = NC_{ij} / _{m} + \exp. (1.293) NC_{ij}^{.504}$$

where

CR_{ij} : circuit requirements between company i and company j

m : maximum fill of a group specified by the user and expressed in the form of a coefficient $\leqslant$ 1.

A sample of N.P.P.S. versus this model estimates is shown in Table 3-7.

Since the fixed costs of the transmission network depend not only on the density of the territory served but also its spread, some exogeneous variable had to be introduced. The surface of the populated area was selected as the most representative. It is well recognized that some arbitrariness exists in such a measure. Values fed to the model can be seen on Table 3-3.

The relationship selected is the following:

$$TFC_{i} = \exp\ (5.23)\ \ S_{i}^{.535}\ \ N_{i}^{.355}$$

where

TFC_{i} : total incurred transmission fixed costs in company i ($ thousands per annum)

S_{i} : surface of populated area in company j (thousands of square miles)

It must be pointed out that, although this relationship satisfies 5% confidence statistical tests, it is by far the weakest ling in this model.

TABLE 3-7

N.P.P.S. versus Macro-Model
Number of Circuits
After Multiplexing (Sample)

Traffic	N.P.P.S.	MACRO-MODEL
BCT - BCT	804	876
AGT - BCT	156	279
AGT - AGT	324	353
SASK - BCT	108	57
SASK - AGT	240	140
SASK - SASK	204	185
MANT - BCT	36	69
MANT - AGT	60	107
MANT - SASK	132	102
MANT - MANT	60	93

The variable transmission costs depend mainly on the originating/terminating circuit requirements, through traffic circuit requirements and some measure of the width of the territory (the Canadian Network being longitudinal in nature)

The formula selected is as follows:

$$TVC_j = D_{ii} \ (8.8 \times 10^{-4} \ NOT_i + 7.6 \ \ 10^{-4} \ NTH_i) + 640.7$$

where

TVC_i : total variable transmission costs in company i ($ thousands per annum)

D_{ii} : border to border width of the territory served (miles)

NOT : total originating/terminating circuit requirements

NTH_i : total through traffic circuit requirements.

Both last variables are obtained by appropriate summation in the company to company circuit requirement matrix.

N.P.P.S. versus macro-model estimates of the transmission costs are shown in Table 3-8.

Step 5. Estimation of revenues

As expected revenues are in almost linear relationship with traffic. For a better fit, three separate formulae were derived for regional, adjacent and non-adjacent traffic.

These are the following:

$$R_{ij} = \alpha T_{ij} + \beta$$

where

R_{ij} : revenues derived from traffic originating in company i and terminating in company j ($ thousands per annum)

with	α	β
for regional traffic	.1133	- 46.8
adjacent traffic	.3315	-370.8
non-adjacent traffic	.405	-28.1

TABLE 3-8

N.P.P.S. versus Macro-Model Transmission costs estimates ($000)

	N.P.P.S.			MACRO-MODEL		
	Fixed	Variable	Total	Fixed	Variable	Total
BCT	6,200	1,400	7,600	5,000	1,000	6,000
AGT	4,200	1,100	5,300	4,900	1,100	6,000
SASK	3,400	1,500	4,900	5,000	1,600	6,600
MANT	2,100	1,000	3,100	2,600	1,200	3,800
BCAN	21,300	14,900	36,200	16,400	17,800	34,200
QUET	2,200	50	2,250	1,800	700	2,500
NBT	2,000	1,400	3,400	2,100	1,100	3,200
MTT	1,700	800	2,500	1,800	800	2,600

All models satisfy standard statistical tests at the 5% confidence level.

A sample of N.P.P.S. versus macro-model estimates appear in Table 3-9.

TABLE 3-9

N.P.P.S. versus Macro-Model
Sample of revenues estimates.
Traffic terminating in BCT
($000)

Traffic originating from	N.P.P.S.	MACRO
BCT	9,792	7,582
AGT	4,386	5,276
SASK	689	1,072
MANT	1,191	1,096
BCAN	7,994	6,620
QUET	14	0
NBT	76	56
MTT	122	90
NFL	26	12

Overall results

Results displayed previously all relate to the performance of a given step of the model. When linking all five steps, the results shown in Table 3-10 are obtained. It is important to remember, as defined in the introduction to this section, that all cost figures relate to an optimally dimensioned network.

It is interesting to note that reasonable estimates can be obtained with a very crude model.

TABLE 3-10

N.P.P.S. versus Macro-Model
Overall Costs and Revenues Estimation
($ millions per annum)

	N.P.P.S.			MACRO-MODEL		
	Costs	Revenues	Rev./Cost	Costs	Revenues	Rev./Cost
BCT	17.4	29.4	1.40	15.8	22.0	1.39
AGT	10.1	20.1	1.99	11.6	18.2	1.57
SASK	9.4	7.5	.80	11.0	7.9	.72
MANT	4.9	11.3	2.31	6.0	9.9	1.65
BCAN	91.5	306.1	3.35	94.7	319.6	3.37
QUET	3	1.3	.43	3.6	2.0	.56
NBT	8.1	6.0	.74	7.5	7.3	.96
MTT	6.6	7.8	1.18	7.0	10.2	1.46
NFL	-	3.0	-	4.6	1.9	.41

TABLE 3-11

N.P.P.S. versus Macro-Model
Estimation of costs/revenues of the optimally dimensioned network resulting from a division of Bell Canada

	N.P.P.S.			MACRO-MODEL		
	Costs	Revenues	Rev./Costs	Costs	Revenues	Rev./Costs
Ontario	62.5	206.9	3.31	58.0	203.4	3.50
Quebec	28.6	99.2	3.47	26.6	119.3	4.48
Ontario/ Total (%)	69	68	-	69	63	-

In order to test the validity of this model outside its range of calibration it was applied to the problem of a hypothetical division of Bell Canada. The results obtained were then compared to N.P.P.S. estimates. The comparison is displayed in Table 3-11 and shows that the quality of the results is not substantially downgraded by moving out of the range of calibration.

This macro-model has been installed on C.R.C. computing facilities. A brief documentation is given in appendix 1.

3.2.5 Discussion

The work presented in this section should not be considered as a finished product readily usable but rather as the proof that, given a costing methodology, relatively crude models of easy implementation can be designed for use in the initial steps of long iterative processes. Their level of accuracy is such, however, that the final steps would have to be carried out by more sophisticated costing tools, like the N.P.P.S. model.

4. MODEL STREAMLINING

In the course of the project a certain number of additions and modifications were made to NPPS to the effect of making the model more representative and more efficient.

Selective changes only were made to the data base. It is recognized however that practical applications of the model are seriously hampered by the age of the information it presently contains. The first section of this chapter gives a brief diagnosis of the data base deficiencies and a certain number of recommendations as to how a preliminary updating could be achieved. The changes implemented for the purposes of this phase are also described.

Changes and additions were also made to the software. They are fully described in section 2 of this chapter. None of these presents major conceptual advancement but, given the complexity of the model, a substantial amount of time had to be invested in their implementation. These modifications include:

- the incorporation of toll related costs in the local network to all blocks of the model;
- the linking to the costing block of an aging, indexing and depreciation routine to allow the user to work either with reproduction or embedded assets and costs;
- the redifinition of TCTS and Old Commonwealth sharing schemes to treat adjacent and non adjacent settlements separately;
- the calculation of Canada-US revenues;
- a revised approximation of the multiplexing plan;
- the creation of utility programs to allow further flexibility in the definition of simulations and the interpretation of results.

4.1 <u>Data Base Streamlining</u>

4.1.1 Suggested Upgrading of the Data Base

The data base presently contained in NPPS is the result of an original data base defined in 1973 being partially updated over a period of 5 years. In addition, the information which has been introduced over this period of time was often based on statistics developed prior to 1973. The traffic generator for instance has been calibrated on 1971 actual data. The overall result is that the NPPS data base:

- first, is outdated;
- second, has no definite unique age which prevents the use of general inflators as a first approximation for results upgrading.

It is therefore important that the data base be subject to a major overhaul if NPPS results are to be used on other than a relative basis. Appendix 2 gives a comprehensive list of date required by the model. It further indicates the date at which information presently contained was entered in NPPS, the source of information as well as the date at which this source was developed. This should constitute the basic document for planning and implementing the update of the NPPS data base.

It is recognized that DOC encounters serious difficulty in obtaining actual data from the carriers. Taking this into account and based on our knowledge of available data, a list of priorities to be considered as a strict minimum has been developed and appears below.

i) Network

- Redesign transmission network from scratch, based on D.O.C.'s computerized R.F. channels data base.
- Obtain as much information as possible on overall impact of multiplexing plan on average channel load. (e.g. find out for instance whether multiplexing efficiency is homogeneous over whole network)
- Check for new switching nodes and changes in hierarchical structure.
- Obtain revised intra-toll trunks. If not available use trunk specifications obtained after dimensioning the network for projected demand 3 years in the future.
- Obtain revised inter and intra regional private line counts.

ii) Traffic

If new toll traffic survey is not available, evaluate general 1971-78 increase with available statistics:

- average increase in toll messages by traffic category;
- average revenue increase minus average rate increase by traffic category. This would account for eventual changes in traffic characteristics (e.g. holding time).

Then update gravity model coefficients so as to yield the previously estimated increases when using up-to-date population figures.

Information relating to profiles and all categories is of secondary importance since it is certainly more static in time and affects only revenue calculations (cost calculations are based on peak hour usage only).

iii) Costs

- Obtain new cost valuation functions both for switching and transmission networks. If not available, update by use of overall telecommunications industry inflator. This however would not take into account certain evolutions in technological choices (e.g. retirement of step-by-step machines, introduction of electronic switching, use of jumbo groups...).
- Define suitable data base for aging/indexing algorithms.
- With each new fiscal year, update carrier's financial data.

iv) Revenues

Input

- new TCTS public messages and private lines rate structures;
- new Bell regional public messages rate structure.

4.1.2 Modifications Undertaken During this Phase of the Project

Switching Network

In order to improve Quebec Tel representation, Blanc Sablon, a toll center homing on Rimouski, was introduced. A final trunk of 47 circuits was assumed to link the two cities.

Transmission Network

Preliminary simulation work on the applications detailed in chapter 2 led to the discovery of several inconsistencies in the transmission network. Two general areas were concerned: the area extending between Quebec Tel and M.T.T. and the Sudbury-Thunder Bay area.

Given the former description of the transmission network and due to a saturation on the only route linking MTT westward, some traffic between MTT and NBT was routed via Newfoundland. The particular situation encountered is fully described in Table 4-1 and graphically illustrated on the map of Figure 4-1. An in-depth investigation of D.O.C.'s computerized data base led to the major adjustments described in Table 4-2 and shown graphically on Figure 4-2.

It was also discovered that the Northern Ontario network was highly over-represented with no less than five routes linking Sudbury to Thunder Bay. It seems probable that these errors were introduced when the network was expanded from 24 to 60 and then from 60 to 98 nodes. The modifications made to this part of the network are listed in Table 4-3.

TABLE 4-1

Former usage of Quebec Tel. transmission facilities

	From Rimouski Eastward		From Rimouski Westward	
Available circuits	3 x 480 = 1,440		5 x 480 = 2,400	
Circuits reserved for protection	480		480	
TV use	none		none	
Circuits used:				
Total:	420		132	
Detail:	Rimo. to Chicoutimi	24	Rimo. to Cornerbrooke	12
	Montreal	96		
	Newcastle	12		
	Riv.-du-Loup	24		
	Saint John	12		
	Sherbrooke	12		
	Quebec	120		
	Saint John to Halifax	96	Saint John to Halifax	96
	Halifax to Kentville	24	Halifax to Kentville	24
Used circuits as a percentage of available circuits	29.2%		5.5%	

FIGURE 4.1

FORMER TRANSMISSION NETWORK
(QUET - NBT - MTT)

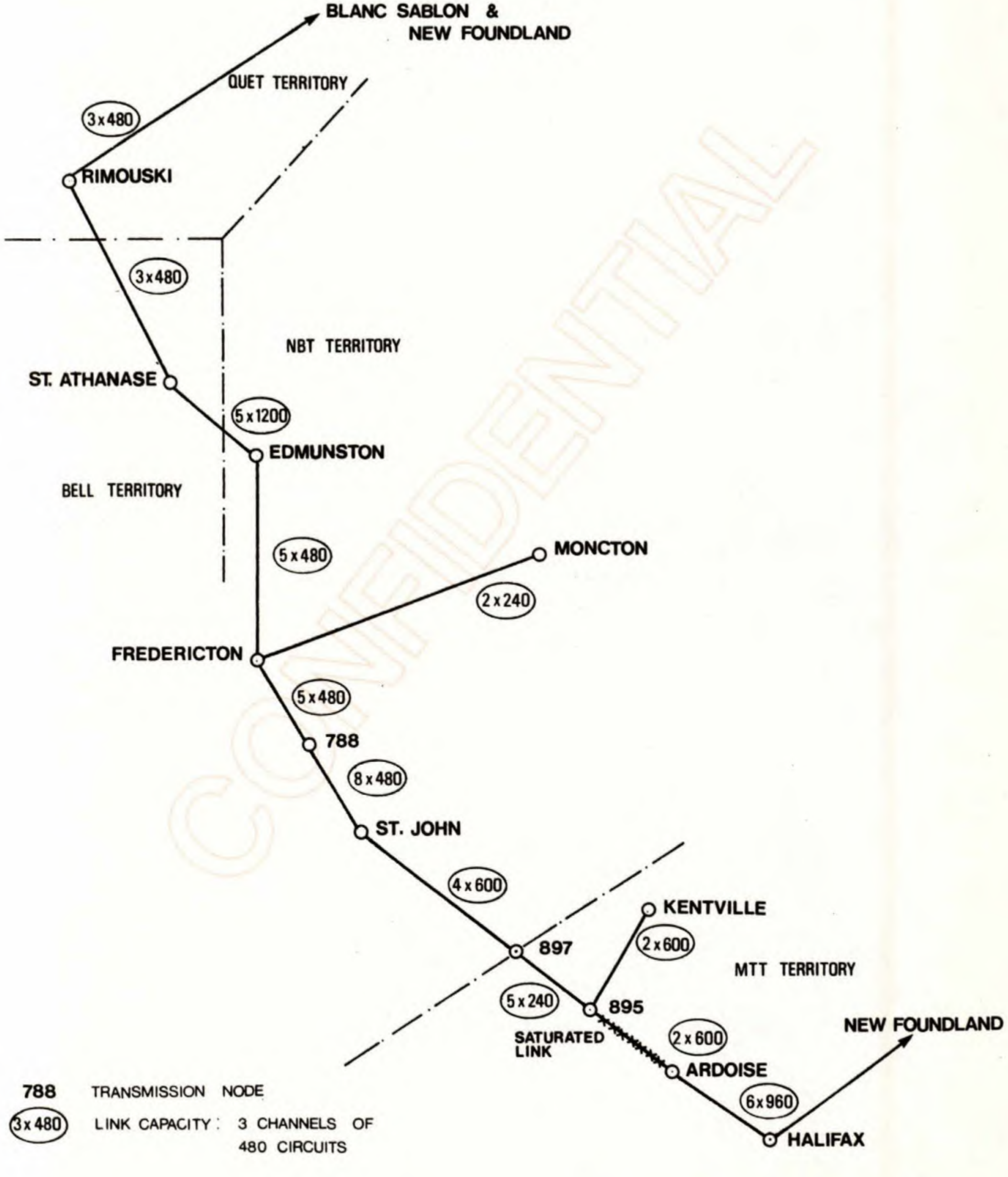


TABLE 4-2

Eastern Transmission Network Modifications

. Link STAT - RIMO was replaced by RIMO - RIVI

capacity: 3 x 480

distance: 65 miles - 30 miles into QUET territory
- 35 miles into BCAN territory

. Junction Repeater SUMM was added

owner : NBT

. Link RIVI - SUMM was added

capacity: 2 x 1200

distance: 63 miles - 60 miles into BCAN territory
- 3 miles into NBT territory

. Link SUMM - EDMU was added

capacity: 2 x 1200

distance: 26 miles

owner : NBT

. Link SUMM - MONC was added

capacity: 2 x 1200

distance: 226 miles

owner : NBT

. Link MONC - HALI was added

capacity: 2 x 960

distance: 124 miles - 57 miles into NBT territory
- 67 miles into MTT territory

STAT = St.Athanase
RIMO = Rimouski
HALI = Halifax
SUMM = Summit Depot
RIVI = Rivière-du Loup
EDMU = Edmunston
MONC = Moncton

FIGURE 4.2

NEW TRANSMISSION NETWORK
(QUET - NBT - MTT)

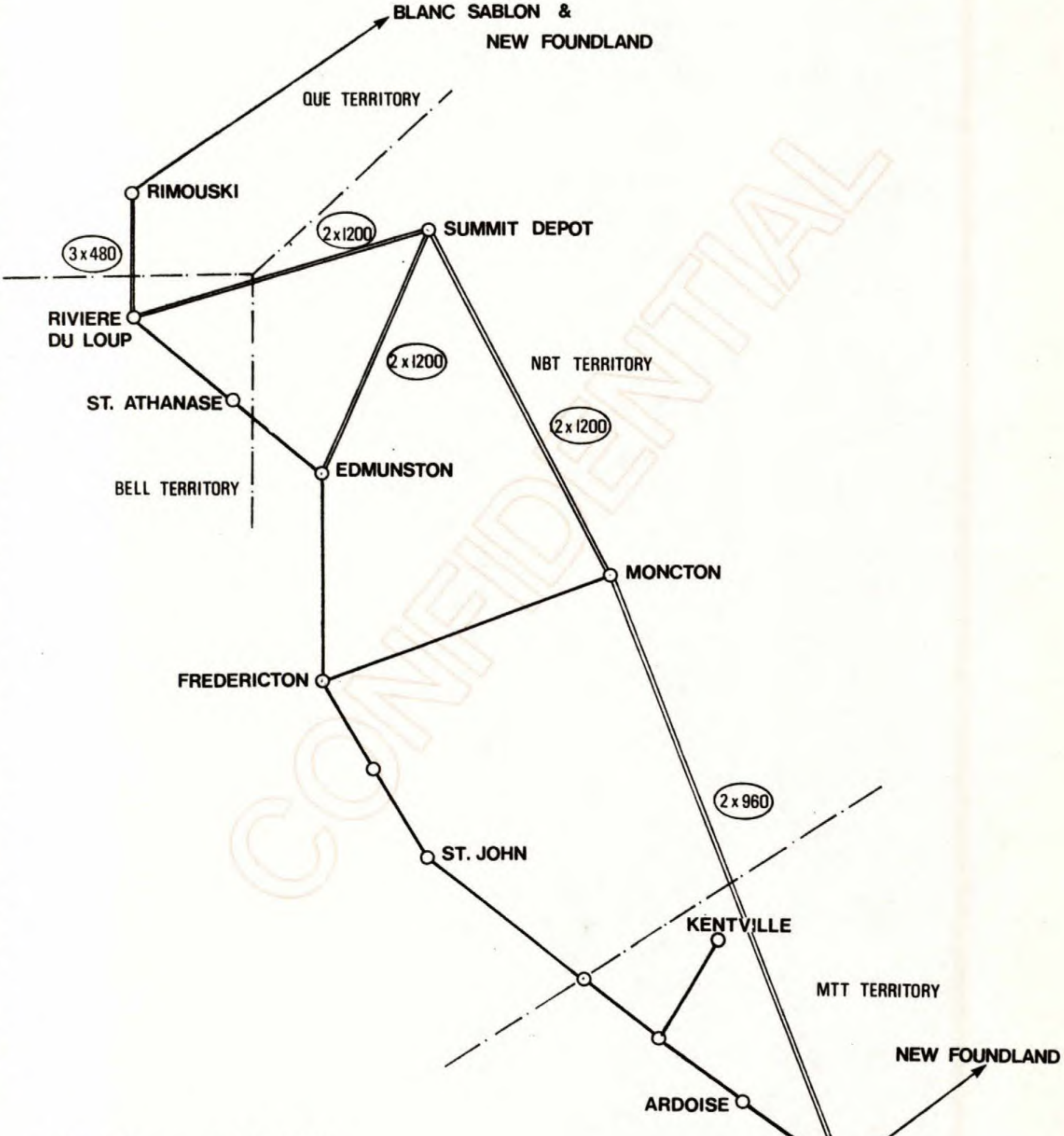


TABLE 4-3

Northern Ontario Network Modifications

- Link 570-STUR was taken out
- Link COCH-NELI was replaced by COCH-STUR
    - capacity: 5 x 960
    - distance: 30 miles
- Link ROSS-PANA was taken out
- Distance for link ROSS-COLD was corrected (90 miles instead of 330 miles)
- Link PANA-BARR was taken out
- Link KILW-TROU was replaced by HUNT-TROU
    - distance: 54 miles
- Capacity of link KILW-HUNT was corrected
    - 6 x 260 instead of 2 x 260
- Link ORIL-TROUT was taken out
- Link KILW-BARR was taken out
- Capacity of link STUR-NORT was corrected
    - 6 x 480 instead of 5 x 480
- Capacity of link MIDL-BARR was corrected
    - 4 x 960 instead of 2 x 1800

NOTE: STUR = Sturgeon Falls
PANA = Panache
ROSS = Rossport
KILW = Kilworthy
HUNT = Huntville
BARR = Barrie
MIDL = Midland
COCH = Cochrane
COLD = Coldwell
NELI = Nellie Lake
TROU = Trout Creek
ORIL = Orillia
NORT - North Bay

In both instances, the system ROUTE which has been designed to retreive information selectively from D.O.C.'s R.F. channel data base proved an efficient and powerful tool.

4.2 Software Adjustments

This section only briefly discusses the adjustments undertaken and their impact on overall results. Detailed software implications can be found in the updated user's manual and system's documentation dated March 31, 1978.

4.2.1 Inclusion of Toll Related Costs in the Local Network

Incremental toll related costs and assets due to the use of local facilities have been incorporated into the costing and the sharing blocks. Separate treatment is provided for their switching and transmission components.

It must be recognized that toll related local costs are incurred only by originating and terminating traffic. Consequently, their treatment in the sharing block is quite different from the one used for other toll costs.

Comparative results of the costing block before and after implementation of this feature will be found on Table 4-4. The cost increase attributable to the use of local facilities never exceeds 6.6% and will not therefore result in determinant changes in the sharing block as can be seen from Table 4-5.

Since this adjustment was introduced in the latest phase of the project, it is not reflected in the results discussed in previous sections.

4.2.2 Redefinition of the Old Commonwealth and TCTS sharing schemes

The principle behind both schemes is that carriers first recoup their incurred costs and then share the excess revenues at the prorata of either their assigned plant or their incurred costs. What had been misunderstood in the previous phases of this project is that these principles are applied separately to adjacent and non-adjacent traffic. Provision has been made in NPPS for the calculations of separate settlements. The results obtained are significantly different from those derived when assuming a combined adjacent and non-adjacent settlement as can be seen in Table 4-6. All simulations shown in the previous chapters incorporate this modification.

4.2.3 Estimation of Canada-US revenues

The estimation of Canada-US traffic related revenues has been added to the model. It is achieved with the use of an exogeneous ratio giving yearly revenues per peak-hour C.C.S.

TABLE 4-4

Costing Block Results
($1000)

a) Assets	BCT	AGT	SASK	MANT	BCAN	QUET	NBT	MT
Switching assets								
. without local assets	44,600	28,000	22,000	10,600	235,600	6,000	19,600	18,800
. with local assets	45,210	28,290	22,150	10,730	246,070	6,020	19,730	18,920
. local switching assets	610	290	150	130	10,470	20	130	120
as % of switching assets	1.3%	1.0%	.6%	1.2%	4.3%	.3%	.7%	.6%
Transmission assets								
. without local assets	19,540	19,350	13,190	5,930	213,440	3,080	15,460	13,310
. with local assets	22,480	20,980	13,890	6,750	246,770	3,200	16,170	14,080
. local transmission assets	2,240	1,630	700	820	33,330	120	710	770
as % of transmission assets	13.1%	7.8%	5.%	12.1%	13.5%	3.7%	4.4%	5.5%
Total assets								
. without local assets	107,640	96,540	59,780	41,440	616,480	17,800	53,100	50,230
. with local assets	111,180	98,460	60,620	42,400	660,280	17,940	53,940	51,130
. local assets	3,540	1,920	840	960	43,800	140	840	900
as % of total assets	3.2%	1.95%	1.4%	2.3%	6.6%	.8%	1.6%	1.8%

TABLE 4-4 (Continued)

Costing Block Results
($1000)

b) Incurred costs	BCT	AGT	SASK	MANT	BCAN	QUET	NBT	MTT
Switching costs								
. without local costs	10,880	5,570	5,170	2,190	58,900	1,500	4,860	4,620
. with local costs	11,030	5,630	5,200	2,220	61,520	1,505	4,830	4,660
. local switching costs	150	60	30	30	2,620	5	30	40
Transmission assets								
. without local costs	5,000	4,090	3,250	1,300	56,000	810	4,010	3,430
. with local costs	5,750	4,440	3,420	1,480	64,730	840	4,200	3,630
. local transmission costs	750	350	170	180	8,730	30	190	200
Total Incurred costs								
. without local costs	27,100	20,090	14,570	8,930	159,050	4,545	13,510	12,680
. with local costs	28,000	20,500	14,770	9,140	170,400	4,580	13,730	12,920
. local incurred costs	900	410	200	210	11,350	35	220	240

TABLE 4-5

Comparative Results of the Sharing Block for Bell Canada ($1,000,000)

	without local assets & costs	with local assets & costs
Total installed assets	616.8	660.6
Regional traffic		
. incurred costs	115.5	125.4
. assets	449.6	487.7
. rev/cost ratio	2.5	2.3
Adjacent + Non-adjacent traffic		
. incurred costs	22.8	23.2
. assets	87.4	88.8
. collected revenues	39.2	39.2
. post-settlement revenues		
(i) New Commonwealth	38.9	38.8
rev/cost	1.7	1.67
(ii) Old Commonwealth	40.1	39.9
rev/cost	1.75	1.72
(iii) TCTS	39.	38.9
rev/cost	1.71	1.68

TABLE 4-6

Modified application of revenue sharing schemes

Old Commonwealth post-settlement revenues

	Before modification		After modification	
		Rev/Cost Ratio		Rev/Cost Ratio
BCT	12.6	1.6	12.2	1.55
AGT	15.1	1.6	13.9	1.47
SASK	11.6	1.6	11.3	1.57
MANT	7.4	1.6	9.7	2.11
BCAN	25.2	1.6	29.0	1.83
NBT	11.1	1.6	8.5	1.20
MTT	8.7	1.6	7.4	1.20

TCTS post-settlement revenues

	Before modification		After modification	
		Rev/Cost Ratio		Rev/Cost Ratio
BCT	12.4	1.58	12.0	1.53
AGT	16.0	1.70	14.5	1.54
SASK	11.6	1.60	11.3	1.56
MANT	7.7	1.67	10.3	2.24
BCAN	24.6	1.56	28.2	1.78
NBT	10.9	1.57	8.4	1.19
MTT	8.6	1.57	7.3	1.18

The calibration of this ratio was obtained by combining actual Bell revenues statistics to estimated peak-hour C.C.S. introduced in NPPS to represent Bell Canada to US traffic. To keep revenues in line with estimated traffic, this calibration was performed on 1971 data.

All simulations shown in the previous chapters assumed that Canada-US originated revenues represent on the average \$2,500 of yearly revenues per peak-hour C.C.S.

It must be remembered that, when developing the data for NPPS, traffic to the US was assumed to have similar holding time characteristics as the Bell interregional traffic (see NPPS final report, March 1977). This assumption obviously affects the overall cost allocation and revenue calculation as outlined below:

- Actual messages to the US
- times assumed call duration gives A.B.D. and peak-hour C.C.S.
- times assumed revenue per peak-hour C.C.S. gives
- Actual Canada-US revenues

in other words:

$$\underset{\text{(messages)}}{\text{Benchmark}_1} \times X \times Y = \underset{\text{(revenues)}}{\text{Benchmark}_2}$$

where:

X (peak-hour C.C.S./message) affects the cost allocation

Y (\$/peak-hour C.C.S.) affects the revenue calculation with only their product being known.

By comparing the assumed \$/peak-hour C.C.S. derived for the US to similar figures for adjacent and non-adjacent traffic in Canada and shown below, it can be inferred that the assumptions used for US traffic are reasonably realistic given the higher efficiency and lower costs of the US network.

	\$'000 of yearly revenues per peak-hour CCS
Assumed value Canada-US	2.50
NPPS estimate adjacent traffic	3.60
NPPS estimate trans-Canada traffic	3.73

4.2.4 Approximation to multiplexing plan constraints

The approximation to multiplexing plan constraints is performed in two steps.

First, a maximum group load is assumed. (A value of 90% was used for all simulations presented in this report). Total circuit requirements are then rounded upwards to the next multiple of 12 to represent an integer number of groups. This operation is applied to joint public messages and public lines circuit requirements. For cost allocation purposes, the additional circuits required to approximate the multiplexing plan are shared between public messages and private lines at the prorata of their original requirements as shown in the following hypothetical illustrative example.

	PM	PL	Total
Original circuit requirements	14	9	23
Circuits required after allowance for maximum fill	-	-	26
Circuits required assuming integer number of groups	-	-	36
Basis for cost allocation	$\frac{36x14}{23} = 22$	$\frac{36x9}{23} = 14$	36

4.2.5 Translation of Reproduction Costs into Historical Costs(1)

General

Costs incurred by carrier over a given year can be expressed as a percentage of the Net Telephone Plant, that is to say the Gross Telephone Plant (i.e. total investment at historical costs) less accumulated depreciation. This is a practical and efficient approach since all the information required is included in the carrier's yearly financial statements. With a costing model like NPPS, the difficulty rests in a suitable estimation of the original cost of the Gross Telephone Plant given the existing configuration of the network. Up to now, the embedded investment has been approximated in NPPS by costing all facilities at their reproduction cost, the argument for such an approximation being that cost escalation over years was more or less offset by productivity gains in the telecommunications industry.

---

(1) For further background on this tropic, see NPPS final report, March 1977.

Concurrently, a comprehensive aging, indexing and depreciation (AID) algorithm has been developed and tested. The purpose of this module is to translate the reproduction value of assets into their actual book value given a certain number of characteristics of the equipment considered.

This algorithm has been linked to the NPPS model in this phase of the project. Improvements to the AID routine and major simulation options available are described in this section. Since this work was undertaken in the later part of this phase of the project, it is not reflected in the results presented in the previous sections.

Added features of the AID routine and simulation options

Features added to the AID routine in the course of this project are the following:

i) The type of survival curve used in the depreciation algorithm can vary over the asset life span.

ii) The algorithm allows for a switch of depreciation method from ASL to ELG during the life of a mass property type asset as has been the case for Bell Canada and A.G.T. in the recent past. Further, a transition period during which one method applies to certain vintages while the other is used for other vintages can be simulated.

In order to allow maximum flexibility in costing methodologies employed, the possibility of working with reproduction costs has been kept in the costing block. Also left as an option is the possibility of using either actual benchmarks or values derived by the AID routine for yearly and accumulated depreciation.

More details with regards to the various options open to the user will be found in the User's Manual, March 1978.

Data requirements

Data required by the AID routine consist of 50 entries per carrier. Due to limited information on certain carriers, it has been assumed for the present exercise that, with the exception of growth rates, all carrier's characteristics are identical to those of Bell Canada. Data introduced in the model are displayed in Table 4-7.

Results

Table 4-8 shows an application example of the module described previously to the case of Bell Canada. Given the assumptions used and identified in Table 4-7, it is estimated that for Bell Canada the original cost of Gross Telephone Plant represents close to 90% of the

TABLE 4-7

AID Input Data

	Switching	Transmission	General	Land	Building
Maximum life (T)	50	40	40	-	90
Reference year (N)	40	30	-	-	75
Average life	21	14	19	-	31
Salvage rate	.02	.02	.02	-	.02
Inflation rate	1.02	1.02	1.02	1.02	1.02
Type of property	Integrated	Integrated	Mass	-	Integrated
SRV curve type	-	-	L.00	-	-
Retirement rate	.02	.02	-	-	.02
Depreciation method:					
- ASL used over (yrs)	-	-	40	-	-
- ELG used over (yrs)	-	-	2	-	-
Growth Rate:					
- BCT	1.18	1.233	1.304	1.1	1.073
- AGT	1.167	1.215	1.281	1.092	1.068
- MANT	1.105	1.136	1.177	1.058	1.043
- SASK	1.092	1.118	1.154	1.051	1.037
- BELL	1.121	1.157	1.205	1.067	1.049
- NBT	1.134	1.173	1.225	1.074	1.054
- MTT	1.144	1.186	1.243	1.08	1.059
- NFLD	1.194	1.25	1.326	1.107	1.079

Source: D.O.C.

value of facilities at reproduction costs. Estimated vs actual data pertaining to depreciation are also displayed in Table 4-8 and large discrepancies can be noted. It must be recognized that the data used for this simulation is very hypothetical and will have to be refined in the light of certain conclusions reached after sensitivity analysis. The annual and accumulated depreciation rates are essentially sensitive to:

- the depreciation method
- the reference year
- the useful life
- the inflation and growth rates

as highlighted by certain selected tests shown in Table 4-8.

An application of the improved costing block incorporating the above data and results is shown on Table 4-9 where it can be compared with similar output based on reproduction valuation functions and benchmark data for depreciation.

4.2.6 Creation of Certain Utility Programs

Two series of such programs were designed and implemented. Their full description can be found in the updated system's documentation dated March 31, 1978.

Alterations of the traffic matrix

This program allows the user to update all entries or selected subsets of the traffic matrix by multiplying the original values by a corrective factor. It is particularly useful for cross-subsidy tests where selected traffic components have to be set to zero or for scenarios relating to prospective use of the network whereby a certain growth on traffic has to be assumed.

Cost/Revenue analysis of selected streams

This series of programs, which is an appendage to the sharing block, allows the cost/revenue analysis of selected streams. The selection of origin destination pairs may be either node - or company - oriented. This tool was specifically designed for the applications shown in chapter 2 of this report.

TABLE 4-8

Aging, Indexing and Depreciation Module

	GTP at hist. cost as % of rep. cost	Example of application to the case of Bell Canada			
		Accumulated Dep. rate		Annual Depreciation Rate	
		AID	Benchmark	AID	Benchmark
Switching	87.3%	37.0%	27.2%	7.6%	4.5%
Transmission	89.7%	33.8%	29.1%	8.0%	5.9%
General	92.1%	16.7%	35.1%	6.1%	9.6%
Building	71.2%	44.0%	25.9%	4.3%	3.2%

Selected Sensitivity Tests

Assumed variatious(1)	Annual depreciation rate - Switching AID estimates (%)
Base case	7.6
Reference year: 25 (vs 40)	5.7
Maximum life : 45 (vs 50)	10.4
Inflation rate: 1923-67: 1.010) 1968-72: 1.065)-(vs 1.02)	7.6
Growth rate : 1923-52: 1.06) 1953-72: 1.15)-(vs 1.12)	7.8

---

(1) Numbers in brackets are the original values used for the base case.

TABLE 4-9

Comparative results of various options available in costing block.
Bell Canada
($ ' 000)

VALUE OF ASSETS	Case A	Case B	Case C
SWITCHING MACHINES	248298500	216764533	216764533
TERMINAL REPEATERS	253881347	227541657	227552181
BRANCHING REPEATERS	104351017	93485461	93492147
REGULAR REPEATERS	63082400	56144292	56165640
ACCOUNTING BREAKDOWN			
SWITCHING	248298496	216764528	216764528
TRANSMISSION-MULTIPLEXING	263354400	236228891	236228891
-OTHER	139260625	124916642	124916642
-TOTAL	402615025	361145533	361145533
GENERAL EQUIP.	12974738	11949670	11962576
LAND	2862500	2038098	2063747
BUILDINGS	2862500	2038099	2038098
STATION	0	0	0
PERCENTAGE BREAKDOWN			
SWITCHING	37.08	36.50	36.49
TRANSMISSION	60.13	60.81	60.80
GENERAL EQUIP.	1.94	2.01	2.01
LAND	.43	.34	.35
BUILDINGS	.43	.34	.34
STATION	.00	.00	.00
TOTAL ASSETS	669613259	593935928	593974482
INCURRED COSTS			
SWITCHING MACHINES	62074352	54190784	58309296
TERMINAL REPEATERS	66594160	59694064	63213872
BRANCHING REPEATERS	27391008	24544704	25962624
REGULAR REPEATERS	16759212	14938677	15612612
INC. COSTS BY ELEM. TYPE			
NODES	161275440	143079840	152349792
LINKS	11542938	10287909	10748138
TOTAL INCURRED COSTS	172818378	153367749	163097930
HOLDING COSTS			
SWITCHING MACHINES	32030256	27962400	32080912
TERMINAL REPEATERS	35874256	32161600	35680384
BRANCHING REPEATERS	14764611	13233086	14650214
REGULAR REPEATERS	9079090	8101878	8774425
HOLDING COSTS BY ELEM. TYPE			
NODES	85493824	75878016	85145552
LINKS	6253726	5580152	6039753
INC. COSTS BY PLANT TYPE			
SWITCHING	62074352	54190784	58309276
TRANSMISSION	105570272	94699056	100479760
GENERAL EQUIP.	3800446	3500229	3348066
LAND	686283	488664	494718
BUILDINGS	686283	488820	466151
STATION	0	0	0

Case A: Reproduction costs and actual depreciation figures.
Case B: Historical costs and actual depreciation figures.
Case C: Historical costs and calculated depreciation.

APPENDIX 1

MACRO-MODEL USAGE AND DOCUMENTATION

1. USER'S GUIDE

General information pertaining to access to the system can be found in the N.P.P.S. User's Manual. The macro-model consists of one program and one file. In its present form the data file stored under the name MACDAT cannot be updated conversationnally. Any data modification must be undertaken with the context editor. The program itself is activated by typing the keyword MACRO. The various simulations options left to the user's discretion are the following:

- Choice of a peak-hour to total day traffic ratio.
- Generation of private line data as a percentage of company to company public message trunks.
- Choice of a maximum group loading for multiplexing.
- Display of various intermediate results.

A sample terminal session appears on exhibit 1.

EXHIBIT 1

Sample Terminal Session with the Macro-Model

```
 MACRO.
 ENTER PEAK HOUR TO TOTAL DAY RATIOS
 FOR REG.,ADJ.&NON-ADJ. TRAFFIC(E.G. .10,.10,.12)
?.10,.10,.12

 DO YOU WANT TO SEE THE  TRAFFIC MATRIX?
?NO

DO YOU WANT TO SEE THE MATRIX OF NB OF CIRCUITS?
?NO

 DO YOU WANT TO SEE THE REVENUE MATRIX
?NO

                                   SWITCHING COSTS($1,000)

          BCT       AGT       SASK      MANT      BCAN      QUET      NBT       MTT       NFL

          9763.     5511.     4368.     2148.     60485.    1158.     4345.     4407.     1896.

 DO YOU WANT PRIVATE LINES TO BE CONSIDERED?
?NO



   ENTER MULTIPLEX FACTOR(E.G. .9)
?.9

 DO YOU WANT TO SEE THE MATRIX OF NUMBER OF CIRCUITS AFTER MULTIPLEXING?
?NO

                                TRANSMISSION FIXED COSTS($1,000)

          BCT       AGT       SASK      MANT      BCAN      QUET      NBT       MTT       NFL

          5041.     4913.     5039.     2595.     16417.    1765.     2110.     1817.     2084.


                                TRANSMISSION VARIABLE COSTS($1,000)

          BCT       AGT       SASK      MANT      BCAN      QUET      NBT       MTT       NFL

           989.     1167.     1573.     1239.     17843.     724.     1072.      786.      670.


                                  TOTAL   COSTS($1,000)

          BCT       AGT       SASK      MANT      BCAN      QUET      NBT       MTT       NFL

         15794.    11591.    10979.     5981.     94744.    3646.     7527.     7011.     4650.


                                  TOTAL REVENUES($1,000)

          BCT       AGT       SASK      MANT      BCAN      QUET      NBT       MTT       NFL

         22046.    18221.     7939.     9868.    319627.    1966.     7277.     10228.    1859.

 *STOP* 0
```

2. DOCUMENTATION

2.1 Data file MACDAT - Logical unit no 1

This file contains information pertaining to the nine considered carriers in the following sequence.

Record 1: Population per carrier

Record 2: Number of demand points per carrier

Record 3: Distance between company i and company (i + 1) gravity centers

Record 4: Border to border distance for each carrier

Record 5: Surface of populated area per carrier (1)

All information is stored in free format.

2.2 Program

Identification:

Source program: SMACRO

Object deck: RMACRO

Load module: MACRO

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(1) Note: The surface of populated areas was defined as follows.

The island's surface for NFLT

The entire province's surface for MTT and NBT

For Bell Canada, the populated area was assumed to be the area south of the 50th parallel, excepting QUET territory, the surface of which was estimated as being Gaspé plus a 50 mile band on the north coast from Tadoussac to Blanc Sablon.

For Manitoba, it was measured as the surface south of a straight line going from the 50th parallel at the Ontario border, to the 55th parallel at the Saskatchewan border.

For Saskatchewan and Alberta, it was assumed to be the area south of the 55th parallel.

For British Columbia, it was measured as the surface south of a straight line going from the 55th parallel at the Alberta border to the westmost point of the BC-US border.

Principal variables:

R(I,J) : Revenue collected by company I from traffic with company J.

SWC(I) : Switching costs incurred by company I

TFC(I) : Transmission fixed costs incurred by company I

TVC(J) : Transmission variable costs incurred by company I

P(I) : Population of company I

N(I) : Number of switching nodes of company I

T(I,J) : Traffic in C.C.S. from company I to J

D(I,J) : Average distance between companies I & J

S(I) : Surface of populated area for company I

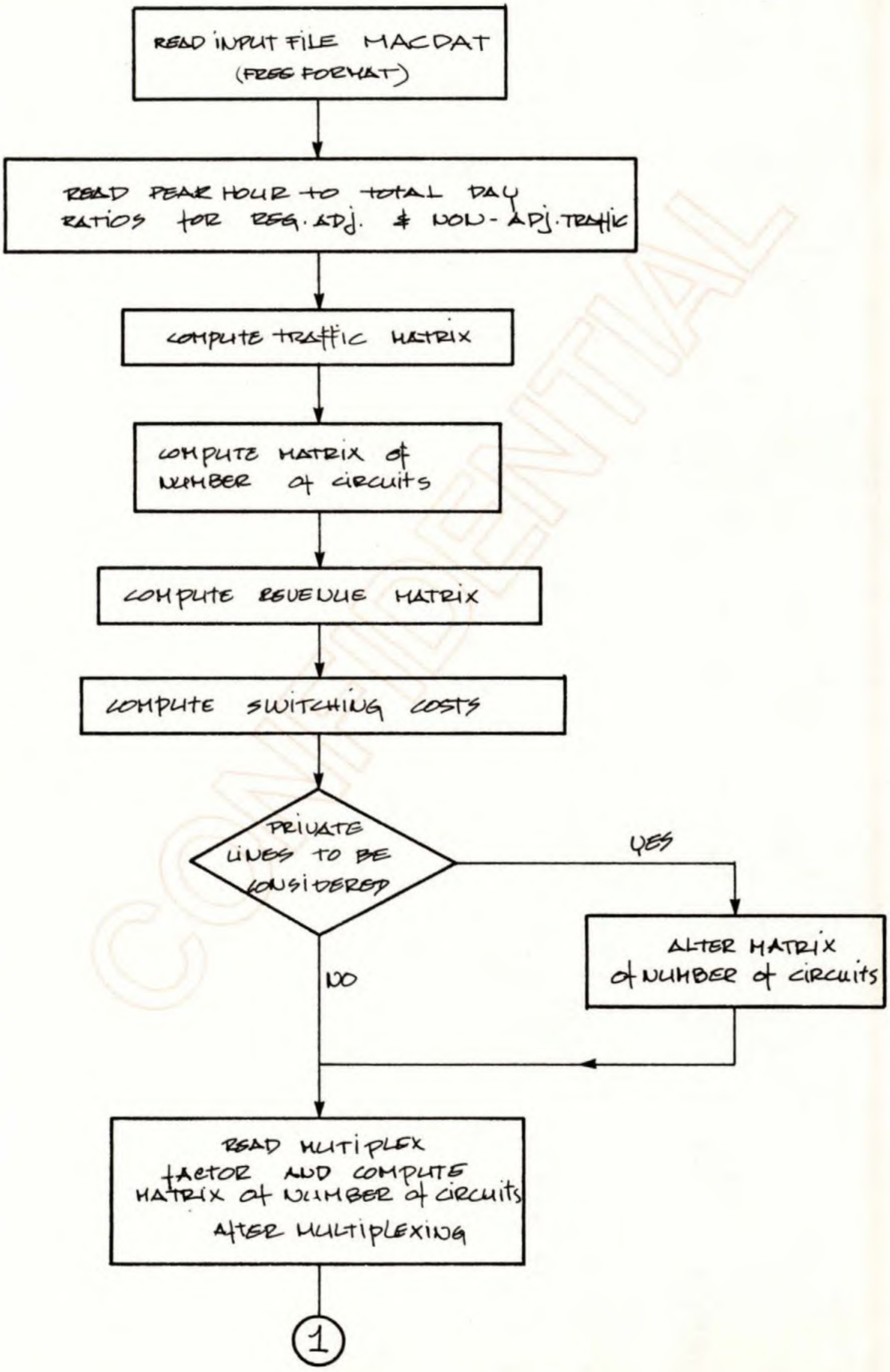
Logic

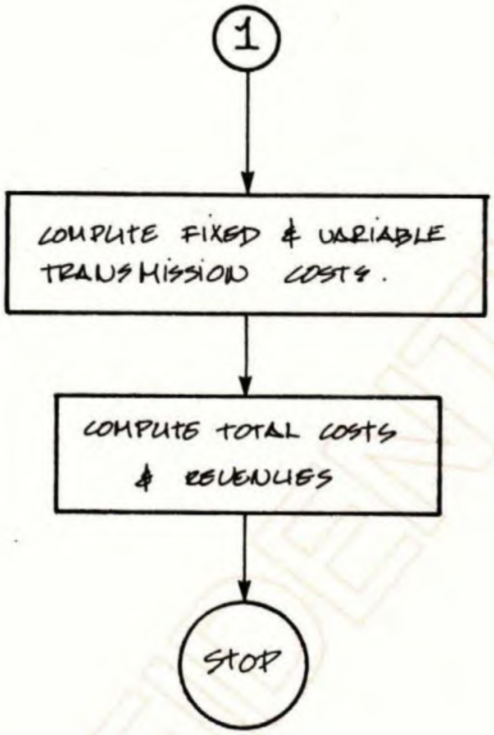
The logic of the program is given by the flow-chart appearing on exhibit 2.

EXHIBIT 2

Macro-Model
Flow-Chart

MACRO




1
COMPUTE FIXED & VARIABLE TRANSMISSION COSTS.
COMPUTE TOTAL COSTS & REVENUES
STOP

APPENDIX 2

N.P.P.S. Data Base Requirements

N.P.P.S. Data Requirements

	Items	Date of entry in N.P.P.S.	Source	Date
Traffic	Population figures	1973-1978	Census	1972
	- Average business day traffic raw data for calibration Traffic profiles - call durations.	1973	DOC. 17 cities A.B.D. traffic survey	1971
	Split between direct dialing, operator assisted, person to person.	1973	DOC.	unknown
	Traffic to US: peak-hour CCS to US for each Canadian city	1977	Estimated from total messages and number of trunks to US (see NPPS final report 1977)	1972
Network	- Transmission Full description of transmission nodes and links (number of channels, channel sizes, length) Entry points to the U.S.	70% 1973 30% 1973-1978	DOC.data base. Computerized and installed on CRC system	permanently updated
	Efficiency of multiplexing plan Origin, destination and number of 1way/2 way dedicated video channels	-	Assumed	
	- Switching List of switching nodes with hierarchical category List of finals, high-usage, full groups with origin, destination, number of trunks	30% 1973 30% 1975 40% 1977	DOC. Inter-toll trunks study (only partial information on toll centres - see final report,1977)	1970
	Trunks to the U.S.	1977		
	Border crossing points for U.S. trunks	1977	Assumed -	
	- Private lines - interregional	1975	D.O.C.	unknown
	- regional	-	Assumed	

Reproduction costs			
Switching equipment cost functions	1973	DOC	unknown
Transmission cost functions (terminal, junction, regular repeaters)	1973	"A Simplified Model of the Canadian Terrestrial Trunk Communication Network" R. R. Bowen	1973-74
Multiplexing costs	1973		
Toll related costs in local network	1977	Local Service Cost Study - Bell Canada	1975
Historical costs			
Data required by aging/indexing routines by company and by accounting category - growth,retirement and salvage rates - maximum life, average life, survival curve - depreciation method - inflation & productivity gain rates	1978	DOC	unknown
Incurred costs (as a percentage of historical costs)			
Costs of capital (average interest rate, return on common/preferred equity, tax rate, deferred taxes, working capital) Operating costs	1977	In financial statements published by carriers	1973-76
Revenues			
Public messages			
Interregional - TCTS rate structure	1973	DOC	1972
Regional - Bell rate structure	1977	DOC	1972 for consistency
Private lines - interregional TCTS rate - regional:assumed identical to interrogional	1973	DOC	1972