CANADA'S INTER-REGIONAL

TELECOMMUNICATIONS FACILITIES $\overset{v}{\supset}$

A POSITION PAPER

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FOREWORD

The 1970 Telecommission studies drew attention to several questions relating to long distance communications in Canada. They were of a sort to clearly warrant some further pursuit by the Department. As often happens in such undertakings, the explorations led to additional questions. Listed in random order, they took the shape of the following:

- * Are the relative costs of long distance and local calls to the user optimal from the point of view of national development? What is the basis for tariff policy in the present circumstances and what should it be for the future?
 - As new inter-regional and trans-Canadian communications facilities are introduced by one or another of the three national carriers, in the form of satellite systems, coaxial cables or microwave systems, what sort of shifts and dislocations might there occur in the sharing of traffic? Might there be under-loading or under-exploitation of some facilities that could lead to critical revenue and commercial viability problems? What opportunities or obstacles exist for various carriers in developing demand for capacity and traffic on their facilities?

- * Will the arrival and expansion of satellite facilities in both the intra-national and international scenes call for critical adaptations on the part of the terrestrial networks? Will the relative independence of satellite links of coastlines and coastal gateways lead to new gateway development resulting in different foreward and backhaul patterns for the terrestrial carriers? With what consequences?
 - Is the repartition of traffic by technical category, volume, message structure and the like between various facilities rational in the light of overall efficiency, marginal costs of extension, or minimal costs of carriage?
 - What are the consequences, for the development of Canadian inter-regional communications, of a virtually open international border on the south, with respect to switched circuits, leased line operations and revenue settlements?
- * What technical standards, operating practices or other factors facilitate, impeded or otherwise govern interconnection and traffic exchange between the various carriers? Would automatic routing at the circuit level be effective in a national emergency?

In a global context of international traffic, apparently growing at a significantly faster rate than intra- and inter-regional traffic, and in view of a continuously shifting balance between the number of telephones in North America relative to that in Europe and Japan, what might the longer range operating and interconnecting impacts be on the country's national carriers?

This is a sampling of questions of a sort which invariably lead to others; more detailed and more complex. The national stake in the interregional and international communications system requires that they be looked at objectively and competently.

It was promptly discovered that an operationally useful definition of what the inter-regional system might be, did not exist; that the plant and equipment related to long distance toll service could not be simply segregated from that serving short-haul toll and local functions; that the bookkeeping practices of each of the entities concerned were designed to fit their individual structures - be they provincial, national or international and did not admit of any easy aggregation into a coherent composite picture; that questions relating to returns on assets could not deduced in any relevant way from revenues; that, indeed, a valid restatement of any of these questions - let alone any inducement of answers - could not be made without the collaborative effort of the department and the carriers involved and not without some organization and time.

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A preliminary and very coarse assessment of the facilities affected, their capacities, the revenues impacted, and of the interconnecting regimens was assembled with the ready and complete co-operation of the carriers in the brief time allotted for the task. From the bulk of information offered and gathered, a condensed description of the aggregate was prepared in the form of the pages that follow. This description was deliberately and specifically prepared to serve as a point of departure for the important task which lies ahead.

It is immediately evident that a look in greater depth needs to be taken at the operational, inter-connective, resource exploitation aspects of the inter-regional complex and that such an undertaking should be launched promptly.

Accordingly, it is proposed that an Inter-Carrier Working Group be formed and address itself to the set of tasks outlined at the conclusion of this document. Whether or not the issues at stake can be disposed of by the simple accomplishment of these tasks, or whether the work of the group will need to be continued in some fashion with similiar or with broader terms of reference, are questions on which it may not be advisable to speculate until a significant part of the work outlined has been accomplished.

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INTRODUCTION

The complex interrelationship of carriers and facilities that provide the supra-structure of Canada's telecommunications capability is uniquely Canadian. This supra-structure has been developed by a dozen or so telecommunication carriers in a variety of competitive and cooperative postures, and it has served Canada well.

In the 1970's, Canada faces, along with the rest of the world, a communications revolution. There will be increasing demands on the facilities interconnecting the various regions of the country and particular strains on the mechanisms for their development and utilization.

The purpose of this paper is to examine the concept of inter-regional facilities; to present an empirical picture of these facilities in the Canadian context; and, to survey the issues that will impact the course of their future development.

CONCEPT OF INTER-REGIONAL TELECOMMUNICATIONS FACILITIES

The telecommunications network is very complex. Intricate combinations of switching and transmission facilities enable a subscriber to communicate hundreds of yards or hundreds of miles with equal ease. Therefore, attempts at physical and/or economic identification of the facilities related to inter-regional communications, as opposed to regional or local communications, is extremely difficult. Nevertheless, it is suggested that the concept of "inter-regional" telecommunications facilities is a viable one to which meaning can be attached.

The key elements in this concept are:

- a) the areas which are considered as regions;
- b) the major transmission facilities that cross the regional boundaries; and,
- c) the switching facilities that are associated with the provision of inter-regional services.

In this paper, the regions have been identified as the geographical service areas of the major telephone systems. To a large degree, these areas coincide with national and provincial boundaries; therefore, in the case of nation-wide carriers, these boundaries reflect arbitrary regional boundaries that are largely compatible with those relating to the telephone systems. The significant exception is Bell Canada which operates throughout Ontario, Quebec, N.W.T., and Labrador.

A microwave system or a physical facility crossing a regional boundary can, at that point, clearly be identified as an inter-regional facility. It is, however, only a link in a continuous path for any given subscriber - subscriber communication. Thus, one must conceive of an arbitrary, discrete point in this path at which there is a transition from inter-regional to regional transmission facilities. The completion of this path for switched services involves also various switching offices. Thus, the total concept would require the inclusion of the switching required to complete the inter-regional portion of the transmission path.

To proceed from the conceptual level to a meaningful empirical presentation is a difficult step. First of all, it is very difficult to identify a suitable arbitrary transition point in the transmission facilities and there are, in fact, a variety of ways in which switching equipment can select alternative routings. Furthermore, a large portion of transmission and switching facilities is shared for both regional and inter-regional purposes. A standard carrier accounting system has not yet been established by the regulating authority. The accounting system in force by the TCTS was adopted from the FCC in the United States, the other carriers do not use it. For these reasons it is difficult to obtain relevant financial information. To compound the problems, the accounting systems of the telecommunications carriers do not provide for an identification of the relative investments, costs and revenues on this basis; therefore, financial data that relate accurately to inter-regional facilities are not available.

Given these constraints, the empirical picture of the Canadian situation has been primarily developed in terms of the transmission facilities that are readily identifiable as inter-regional in nature. However, reference has been made to switching facilities to provide an appreciation of the extent and nature of their relationship with the overall system.

THE CANADIAN SITUATION

Genera1

In Canada there are three telecommunication carriers or carrier groups that presently provide significant inter-regional facilities and a fourth that will become operational in the near future. They are the members of the Trans-Canada Telephone System along with other major connecting telephone organizations; Canadian National/Canadian Pacific Telecommunications; Canadian Overseas Telecommunications Corporation; and Telesat Canada.

Trans-Canada Telephone System

The members of the TCTS, in association with the other major interconnecting telephone organizations, own and operate a significant portion of Canada's inter-regional transmission facilities. These organizations also provide the facilities in Canada for international communications to the United States and to the COTC overseas gateway points.

An examination of the TCTS inter-regional transmission facilities indicates that they are provided primarily across Canada on two major microwave structures. Inter-regional facilities to the U.S. are provided on a combination of microwave and cable structures. The Trans-Canada route (TC-1) crosses most east-west regional boundaries, carrying a message channel with a nominal capacity of 780 two-way voice circuits. Usage of this channel in 1970 ranged between 85 and 100% in various cross sections. In Eastern Canada, portions of the structure carry a second message channel and in the case of Nova Scotia/New Brunswick, a second route has developed. It is expected that a second message channel, with a capacity of 1,200 two-way voice circuits, will be added to the TC-1 structure between Ontario and Alberta by 1972. In addition to the message channels the TC-1 microwave route also carries 2 to 3 two-way television channels over most of the route. It is difficult at this time to determine inter-regional investment

figures for this backbone route; however, a 1968 federal government study placed the total investment in the TC-1 system at 208 million (1963) dollars.

The second major route crossing the regions between Bell Canada and the B.C. Telephone Co. is designated as the interprovincial routes (IP-1). Inter-regionally, the system carries 1 message channel with a nominal capacity of 1,200 voice circuits. The 1970 usage of this channel ranged from 50 to 95%.

In general, these microwave routes have a present nominal capacity of 5 working and 1 protection two-way radio channels per structure. It is technically possible, by interstitial operation, to increase the capacity to 10 working and 2 protection two-way radio channels. Indications are that the large capacities which may be required in the future will be provided partially through wide band coaxial cable systems or satellites. Further extensions in channel capacity, which could be developed on these structures, are affected by various economic operational and technical considerations.

The members of the TCTS provide message facilities at 21 major U.S. border crossings. The facilities at these crossings are approximately 85% microwave and 15% cable.

In the network of the telephone systems, the control switching points (CSP's) are a vital element of the inter-regional facilities. For those services using the switched voice network, the inter-regional transmission path can be selected in a variety of ways by a combination of a number of toll, primary, sectional, and/or regional centers. While there are hierarchical homing arrangements, one cannot identify any portion of the hierarchy as devoted to interregional service. For example, high usage trunks between control switching points may permit direct inter-regional communications. Furthermore, any one of the higher level switching centers may also perform end office (i.e. local) switching functions.

It is perhaps sufficient to note, for the immediate purpose of this paper that the switching facilities are, in part, an integral part of TCTS inter-regional facilities. The portion of the 1,421 million dollar investment in switching that could be directly associated with these inter-regional facilities remains a question for further study. It might be noted, as switching costs rise and transmission costs decrease, that the trade-off between switching facilities and transmission facilities is tending to favour transmission.

Canadian National/Canadian Pacific Telecommunications

Canadian National and Canadian Pacific Telecommunications jointly own and operate a major inter-regional microwave system. This system spans the country from the West Coast to Moncton, New Brunswick and carries one service channel for message traffic. The channel has an installed capacity of 960 two-way voice channels and the assigned capacity on the majority of the system is in the order of 50%. Over portions of the system there is also one r.f. channel for television distribution. The joint investment in this system is in the order of 60 million dollars. The expansion potential of the system is five working and one protection channels.

Canadian National Telecommunications also provides major inter-regional radio relay facilities through the Yukon, the Northwest Territories and Newfoundland. In the North West there is a main microwave route along the Alaska Highway carrying one service channel with an installed capacity of 600 two-way voice channels. The working assignments are approaching 60% capacity. Between CNT and Alberta Government Telephones a 400 mile microwave system with an installed capacity of 300 two-way voice circuits links Hay River, N.W.T., with Peace River, Alberta. This system provides southward facilities for the 600 mile troposcatter system between Hay River and Victoria Island and the 1,300 mile pole line reaching Inuvik along the MacKenzie River. On the East Coast a microwave system from Nova Scotia to St. Johns, Newfoundland carries a service channel of 600 two-way voice channel capacity, almost loaded, and a TV service channel. The former system represents an investment of 26.8 million dollars; the latter 13 million dollars.

In addition to the microwave facilities, both Canadian National and Canadian Pacific Telecommunications own and operate a significant amount of open wire plant which follows their railway right-of-ways. In some inter-regional cross-sections the capacity is significant and approaches 10% of the radio relay capacity. The investment in the total open wire plant is also significant (approximately 67 million for CNT and 31 million for CPT). Much of this investment would, however, fall outside the scope of inter-regional facilities.

In general, Canadian National/Canadian Pacific Telecommunications provide both line switching and message switching facilities. The fact that they are a "national carrier" makes it difficult to consider a subdivision of switching facilities which would identify those associated with inter-regional services. In any case, these national functions have not warranted accounting practices which would segregate regional assets from inter-regional assets.

Telesat Canada

Telesat Canada will, in 1973, provide Canada with a domestic satellite system. The space segment will consist of two satellites in orbit and a satellite in reserve, representing an investment of approximately \$65,000,000. This figure includes all common, start-up costs. The initial working capacity of the system will be 10 r.f. channels.

The earth segment of the system will initially include two heavy route stations; five network television stations; two or three northern telecommunications stations; one regional telecommunications stations; and approximately 25 remote television stations. These facilities will require an investment in the order of \$25,000,000.

The proposed configuration of the earth segment and utilitization of the system indicates that two r.f. channels will provide a heavy route capability between Central Canada and the West Coast while a third r.f. channel will provide another route, of lesser capacity, between the East Coast and Central Canada. Two channels will be used for message facilities into the North and three channels will be dedicated to television distribution. It is estimated that the revenues from the lease of these eight channels will be in the order of \$24,000,000 annually.

The expansion capabilities of the system are represented by the two r.f. channels that remain. Further expansion of the system is possible, either through the use of the back-up satellite on an interruptible basis, or through the launch of the reserve satellite, combined with the construction of additional earth station facilities.

Canadian Overseas Telecommunication Corporation

The COTC, a Canadian Crown Corporation, owns and operates facilities for "off-shore" international communications. It also provides leased circuits between Newfoundland and the mainland, using excess capacity in its cable system. The Corporation's facilities include submarine cables in the Pacific and Atlantic and a satellite earth terminal working into the Intelsat system.

COTC operates approximately 145 cable circuits between Eastern Canada and Europe. These circuits are in cables, either jointly owned with other countries or the circuits are obtained through the ownership of indefeasible rights of usage in cables owned by other international carriers. In June, 1971, a new Canada/Bermuda cable will go into operation; 60 of the cable's 480 circuits are expected to be in use at that time for Canadian traffic. Current planning also calls for a 1,840 circuit cable (CANTAT 2) for trans-Atlantic in service in 1974. COTC operate 80 cable circuits between the West Coast and countries in the Pacific area. 16 of these circuits are used by U.S. carriers. The Corporation's current investment in ocean plant is in the order of 61 million dollars.

Communication Satellite earth terminal facilities on the East Coast (Mill Village) carry 119 two-way voice channels between Canada and Europe using the Intelsat system. In 1972, a new earth station on the West Coast will carry an additional 39 two-way voice circuits to countries in the Pacific area, also using the Intelsat system. At present, approximately 40 circuits from U.S. communication satellite earth stations enter Canada by terrestrial facilities. Where these circuits carry transit traffic, the onward transmission is by terrestrial facilities. COTC's current investment in earth terminals is in the order of 10 million dollars with an equivalent investment in the space segment of Intelsat.

The inland extension of cable and satellite circuits is provided by other telecommunication carriers. Therefore, COTC transmission facilities in Canada are limited. The only facilities worthy of note are the overland cables on Vancouver Island and Newfoundland, the submarine cable between Newfoundland and the mainland, and the Corporation's shared ownership (with Eastern Telephone and Telegraph and the British Post Office) in a microwave system which provides the inland extension facilities for the TAT 1 and TAT II cables.

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The Composite Picture

In summary, Canada is served inter-regionally by four major carrier groups. One of these, the COTC, operates only internationally; therefore, it's inter-regional facilities within Canada are limited. It does, however, impact domestic facilities through its requirements for inward extension and the location of its own Canadian entry points.

The Trans-Canada Telephone System and the Canadian National/Canadian Pacific Telecommunications own and operate interregional transmission facilities. Across the country these facilities provide, in general, a total capability of 3 working channels for message traffic and 2 two-way channels for television distribution. Utilization of the message channels in 1970 points to early requirements for increased capacity. An additional message channel is already planned by TCTS for a major portion of the TC-1 route in 1972. Total nominal capacity of the three routes stands at 15 working plus 3 protection r.f. channels. Further capacity is possible and is a function of a variety of engineering considerations.

Telesat's facilities will provide, in 1973, an increase in capacity equivalent to 960 two-way voice channels between Central Canada and the West Coast and a 150 two-way voice channel between Central Canada and the East Coast. The capacity of the latter may be increased at a later date through the use of other technology. There will be also, three satellite channels used for the distribution of network television. The use of these three channels for TV will possibly release some terrestrial capacity for other uses; however, the degree of the impact will depend on final network configuration. The telephone systems provide most of the switching facilities in Canada. The message voice toll switching hierarchy includes 2 Regional Centers, 7 Sectional Centers, 27 Primary Centers and approximately 200 Toll Centers or Toll Points. Canadian National/ Canadian Pacific Telecommunications also have switching facilities. However, these are somewhat specialized and are primarily associated with their teletypewriter exchange systems, broadband exchange systems, and dedicated switching systems. Categorization of switching facilities as inter-regional, regional or local is difficult.

THE FUTURE

Observations on the Canadian Experience

The basic inter-regional facilities in Canada all bear the mark of some degree of co-operative planning and effort. Two of the main microwave routes have developed through the co-operative efforts of the members of the Trans-Canada Telephone System. Their efforts have evolved to the point where planning and engineering of the essential elements of the TCTS system is focused in centralized groups. The other major microwave system is jointly owned by Canadian National and Canadian Pacific Telecommunications. Finally, both these two major carrier groups share, with others, in the ownership of the newest member of the industry, Telesat Canada.

There exists, on the other hand, mutually exclusive situations in the industry which impact the development and utilization of interregional facilities. Major competition takes place between the telephone organizations and the railway carriers for those services which fall between their respective monopoly areas, (i.e. public telephone service and public telegraph services). In pursuit of their role, the telephone systems have developed a vast network which reaches into most locations where service is required. This sophisticated network includes the total range of switching, transmission, local distribution facilities and station equipment. On the other hand, the railway carriers, outside of the areas where they provide telephone service, have limited local distribution facilities and limited traffic acquisition possibilities, consequently, the major modern plant of the railway carriers is centered in their inter-regional microwave facilities, and specialized switching facilities and station equipment. The corollary of this fact is that there is no parallel to the "local exchange/toll message" service distinction that applies to telephone organizations. The case of Telesat Canada is clearly one of an inter-regional carrier. The economics of communication satellites precludes any other application, taking into consideration immediately available technology.

It is apparent, in the Canadian context, that the telephone companies have developed the major switched telecommunications network with completely integrated inter-regional, regional, and local distribution facilities. Their switching facilities and local distribution facilities are, in general, neither duplicated nor supplemented by those of other carriers. The regional facilities are not duplicated except

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on some heavy cross-section routes. However, the inter-regional facilities of the telco network are paralleled in many areas by other competitive, transmission facilities.

Issues on the Horizon

Given the particular fact that the Canadian experience has led to the development of inter-regional transmission facilities under differing ownership and control, there are issues for the future that appear to emerge.

The three basic microwave systems that exist today generally satisfy the requirements that have been expressed in the past for route diversity and "a competitive alternative". Therefore, it seems logical that immediate future requirements will be provided, in large measure, by augmentation of these main routes. Questions will undoubtedly arise as to the desirable augmentation and loading of the specific routes. These will, in turn, raise issues concerning the interconnection of facilities. It is apparent that the responses to these questions will not rest solely on technical considerations. Much broader issues relating to national telecommunications capabilities; the continuing viability of all the carriers and their respective roles will undoubtedly require consideration.

The introduction of high capacity cable routes will also occur during the next few years. Cable facilities will initially appear at binding points to meet intra-regional requirements; however, they will most certainly impact inter-regional capabilities. The high investments required for cable and the need for rights of way indicate that the development of a backbone cable route in the future must be considered in the context of the overall Canadian situation.

In the matter of international communications, the continuing development of cable and satellite systems point to other issues that could impact the development of inter-regional transmission capabilities. In the past, off-shore communications have utilized submarine cables. Consequently, entry ports have been at coastal locations. The expanding use of satellites for international communications now permits the location of entry ports anywhere in Eastern Canada. Such options, combined with options concerning the use of high capacity cables, have significant implications for domestic inter-regional facilities.

The domestic satellite system, which will enter service in 1973, poses other significant issues for the future. It adds another dimension to the alternatives for the development and utilization of inter-regional facilities. The nature of satellite communications indicates that Telesat facilities have a natural propensity for certain types of traffic applications and certain network configurations. The optimum use of the satellite facilities clearly indicates the need for a continual effort for developments, both technical and operational that will permit it to best contribute to Canada's inter-regional capabilities.

CONCLUSION

Inter-regional transmission facilities form a vital part of Canada's total telecommunications capability. These are provided, both nationally and internationally, essentially by four operating carriers or groups of carriers. In the case of the interconnecting telephone systems, the inter-regional facilities have developed as an integral part of their overall network, to an extent that they are most difficult to isolate from it. In the case of the other telecommunication carriers, their facilities are essentially developing outside of this network, either as international extensions to it, or as parallel facilities.

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The issues of the future, relating to the country's inter-regional capabilities, suggest that the mechanisms which have evolved for their development and utilization should be reassessed by the interested parties.

OUTLINE OF TASKS

INTER-CARRIER WORKING GROUP

- 1. Propose an operational definition of what might be termed as "Canadian Inter-Regional Facilities" through:
 - a) The identification of appropriate Regions;
 - b) The identification of the basic back-bone transmission facilities;
 - c) The description of principal "Branch" and "Nodal" parameters, noting the points of interface between Inter-Regional and Regional Facilities;
 - d) A distinction between physical and nominal elements, where Regional and Inter-Regional facilities are physically inseparable.
- 2. Describe in general technical and operational terms, the major facility extension programs in the 1970's that will impact the above facilities with particular reference to:
 - a) Transmission Facilities such as microwave systems, coaxial cable systems, waveguide systems, and communication satellites.
 - b) Nodal Facilities such as circuit, message and network switching.
- 3. Describe the interconnecting and inter-operating arrangements presently practiced and, where applicable, suggest practices which would further the rational development and utilization of the inter-regional facilities of the four major telecommunication carriers or carrier groups.

4. Develop an approximate model, both in terms of current operations and those envisaged by 1980, which would describe the nature of the traffic, traffic patterns, and traffic volumes which is interregional in nature.

Assess the manner of traffic assignment, in terms of criteria relating to efficiency and resource utilization on the basis of:

- a) Present methods of repartition and assignment;
- b) Other methods of repartition assuming a unified authority represented by the Working Group.
- 5. Describe, through the special extension of the above tasks, the northward extensions within the major regions across the 54th parallel.

6. Identify the resources required for a unified approach to the development, utilization and maintenance of Canadian interregional facilities with particular reference to:

- a) Demand analysis and traffic engineering;
- b) Economic Analysis;
- c) Operational and engineering standards; interfaces; installation and maintenance practices; and training;
- d) Hardware specification and procurement;
- e) System research and development.

Indicate where possible, the probable sources of such resources among the participating groups, government, universities, and other organizations and institutions. 7. Formulate suggestions, observations and requirements from a technical operating point of view with regard to administrative priorities appropriate to the operation of inter-regional facilities. This final part of the exercise is not to be viewed as comprehensive or exhaustive, but rather a listing of administrative implications arising from operational and technical concerns.

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