TELECOMMISSION

Study 8(d)

Multiservice Cable Telecommunication Systems – The Wired City

The Department of Communications

Study 8(d)

MULTISERVICE CABLE TELECOMMUNICATION SYSTEMS

THE WIRED CITY

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Information Canada
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This Report was prepared for the Department of Communications by a project team made up of representatives from various organizations and does not necessarily represent the views of the Department or of the federal Government, and no commitment for future action should be inferred from the recommendations of the participants.

This Report is to be considered as a background working paper and no effort has been made to edit it for uniformity of terminology with other studies.

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Submissions from Participants

The following organizations made formal submissions to Telecommission Study 8(d). Requests for copies of these submissions should be addressed to the respective originators.

1) The Canadian Broadcasting Corporation
2) The Canadian Cable Television Association
3) Canadian National/Canadian Pacific Telecommunications
4) The Electronics Industries Association
5) The Trans-Canada Telephone System

In addition the project team prepared a technical background report for the study, entitled "Fundamentals of Telecommunication Over Non Radiating Cable Media". This report is available on request from the Telecommission Registry.

Summary

Object

This investigation has been initiated to provide the Federal Department of Communications with information that will help establish telecommunication policy and legislation, in order to ensure the optimum evolution of telecommunications in Canada over the next three decades.

Content

It is one of fifty comprehensive studies of the Telecommunications Commission (Telecommission) on all aspects of telecommunications in Canada. This particular study investigates the present state of cable telecommunication systems in Canada. It explores the probable evolution from existing systems to future systems that could provide "total" telecommunication for Canadian cities. In addition the study considers the impact of multiservice cable telecommunication systems on urban areas, as well as the implications and advantages of substituting telecommunications for transportation.

The single most important application of new telecommunication technology will be in the cities and urban areas to alleviate problems of continuing population concentration

and traffic congestion due to the increased transportation requirements. It is quite clear that these trends cannot continue indefinitely and without bound, in fact the pollution problems created by the automobile and careless waste disposal are already starting to seriously affect Canadian cities, notably Toronto and Montreal.

The Wired City

There has been so much speculation over the past few years that the expression "Wired City" is rapidly becoming meaningless. In this report, "Wired City" means a city with a telecommunication system that provides a number of services. The sort of "Wired City" is determined by the type of telecommunication system used and the kind of services that it can carry.

At the present time, all Canadian cities have telecommunication systems that provide telephone, data and television service. Thus Canadian cities are already "Wired Cities".

In the future, the expression "Wired City" will mean a city with more than the conventional telecommunication or television (CATV) system. In fact it is already customary to consider a "Wired City" as a city with "total" telecommunication systems. Here "total" is used to imply that the number of services that the system could provide is limited only by the imagination and pocket-book of the subscriber.

This study considers only civilian telecommunication systems over the time-frame of 20 years. Military and other special purpose systems are not considered.

Intra-City Systems

This report begins with a review of the present status of telecommunication (telephone/data) and CATV systems in Canada. Next, an analysis of user needs, and types of services that might be provided on intra-city cable telecommunication systems circa 1985-1990 is presented. Then techniques that might be used to realize these systems are discussed. Certain problems arising in the transition of existing systems into future multi-service cable systems are also discussed.

It should be emphasized that, as far as the period 1970-1990 is concerned, many predictions about exotic telecommunication systems for the city are not likely to materialize. The reasons for this are not really technical, but economic and social. Sophisticated multi-service telecommunication systems will be extremely costly; existing systems have to be written off at the correct rate. The average subscriber may find no use for a computer capability in his home, and in addition certain services might be deleted because of some undesirable social side effects.

The technology to be used in the synthesis of multiservice telecommunication systems over the next 20 years is known. Present indications are that the multiservice telecommunication systems of the Canadian "Wired City" circa 1985-1990, will be switched cable systems (possibly utilizing a combination of coaxial cable and copper pairs). These systems will be capable of accommodating many more services than existing telecommunication or CATV systems.

Political, social and economic readjustments which might be required to implement any multiservice cable system are not considered, since this report is concerned only with technical feasibility.

<u>Assumptions</u>

The basic assumptions used in this report may be summarized as follows:

1. User needs produce a natural classification of the services into low, medium and high information rate categories, with service being either unidirectional or bi-directional.

2. Only existing technologies are considered (large scale integrated circuits, coaxial cables, etc.).
3. Government policy, legislation, and regulation will encourage the transition process from existing systems.
4. The trend in increasing population growth will be maintained and the demand for telecommunication services will continue to increase.

<u>Possible Multiservice Cable Telecommunication Systems</u>

The technology at this time indicates several possibilities in terms of future types of cable telecommunication systems. These are:

Systems utilizing

1. Multiple paired wires, each carrying single analog signals (as in the local distribution facilities of the present telecommunication system).
2. Sets of coaxial cables each carrying multiple analog signals. For this purpose the frequency division multiplex (FDM) technique would be used to combine signals.

3. Sets of coaxial cables each carrying multiple digital signals. For this purpose the time division multiplex (TDM) technique would be used to combine signals.
4. Sets of coaxial cables each carrying multiple digital and analog signals. The digital signals are used for low information rate services (such as telephone) and the analog signals are used for high information rate services (such as CATV).
5. Hybrid combinations of multiple paired wires and coaxial cables carrying analog and/or digital signals.

Digital systems offer signficant advantages in versatility for low and medium information rate services (such as voice, data transmission, videophone, facsimile, etc.) The present high cost of digital systems will be reduced by at least one order of magnitude with the use of large scale integrated circuits. In addition a unified digital system would be the natural choice for the optimum realization of a nation-wide computer utility structure.

Analog systems, on the other hand, offer the most efficient use of the spectrum in the case of non-digital high information rate services.

It is becoming more apparent that steps must now be taken to ensure the optimal interaction of telecommunication and computer systems. The present sophistication of telecommunication systems is largely due to the use of computers as functional elements. The future potential of computers will be greatly enhanced by the utilization of advanced telecommunication systems in making computing power available on a widespread basis. On the other hand, present telecommunication systems are narrow-band and have been optimized for voice traffic. Thus if the concept of the "Computer Utility" and a fully "Wired Canada" is ever to come to pass, a broadband multiservice system will be required.

Non-Technical Problems

Any multiservice cable system will give rise to regulatory and legislative problems, such as: ownership of the system itself, of terminal equipment, cables, amplifiers, etc. provision of service, the rate structure, performance and compatibility standards, maintenance of equipment, etc.

Since these questions were not part of the terms of reference for this study, they are not considered in this report.

Introduction

Eighty percent of the people of Canada live on less than ten percent of the land area. One hundred years ago 80 percent of the people lived in rural areas and the other 20 percent in the cities. The latter situation is now reversed. There has been a growing tendency for man to cluster in cities since the time of the industrial revolution, because these areas have been prime centres of employment and provided better standards of living. With the advent of multiservice telecommunication systems, it may be possible for men to enjoy again the advantages of living in less congested areas, and at the same time have at their disposal facilities for work, entertainment and other needs.

Multiservice telecommunication systems can provide not only means of developing new life patterns for city dwellers, but also solutions to many of the ills of urban living. Through the planned use of such systems, urban dwellers will be able to enjoy ordered, well defined and harmonious surroundings. They will have the opportunity of participating in society in a manner never before possible.

Present technological indications are that the intra-city telecommunication systems likely to be available in the 1980's will be switched broadband cable telecommunication systems. It is conceivable that such systems could be used by city planners to establish small, self-contained communities within or around large cities. The establishment of multiservice telecommunication systems may prove to be an absolute necessity if Canada is to find solutions to problems of pollution, urban traffic, intra- and inter-city transportation, etc. For example, such systems could offer facilities for people to work at home, or at specially designed "electronic work-centres" near their home, reducing substantially the need for further development of high capacity mass transit systems.

The increase in air, rail and automobile traffic, which is geared to the population growth, is likely to be maintained. The present practice of adding to the transportation facilities cannot continue indefinitely, for reasons of space limitation and pollution of the environment. An effective substitute for travel could be the use of sophisticated telecommunication facilities to create "pseudo-transportation". The telecommunication companies plan to add two way videophone service to their existing system, and this should be available on a widespread basis in the late nineteen seventies. Then the planned combination of video/voice/data services can in many instances be used as effective substitutes for physical travel, both in space as well as in time.

Another reason for the planning of multiservice telecommunication systems is the financial community's estimate that in the 1980's, almost all financial transactions will be conducted by electronic means.

The impact of telecommunication systems on our social and economic well being is so important that purely technological considerations cannot and should not be the sole guides for their future development. The implementation of future telecommunication systems will either aggravate or ease the many problems encountered in various fields of human communication, education, transportation, etc. In some cases, it may even create new problems that are difficult to evaluate, such as the threat to individual freedom from centralized data banks.

Sometimes the effects of telecommunication systems are quite direct and obvious. In particular, McLuhan's views on the effects of TV have become clichés of the day.

These effects may be quite indirect and subtle. For example, the effects of TV programming on a listener's intellectual and social attitudes cannot be directly assessed. Nevertheless, if future intra-city multiservice telecommunication systems are to be beneficial, they will need to be more complex and sophisticated than the present telecommunication and CATV systems.

Existing Telecommunication Systems

The telecommunication system shown in figure 1 provides telephone and data services, and is the telecommunication system which at present makes Canadian cities qualify as "Wired Cities".

In any telecommunication system, the services that the system provides to users are achieved through the transmission of electrical signals. Every service, that is every particular signal, takes up a certain amount of spectrum. The number of services that could be provided is limited by the spectrum capability of the system. The spectrum of a given system is sometimes referred to as its usable bandwidth. These electrical signals can either be in analog form, in digital form, or they can be hybrid.

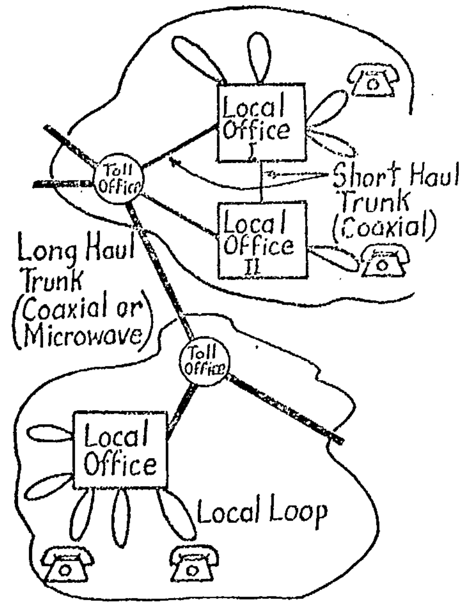


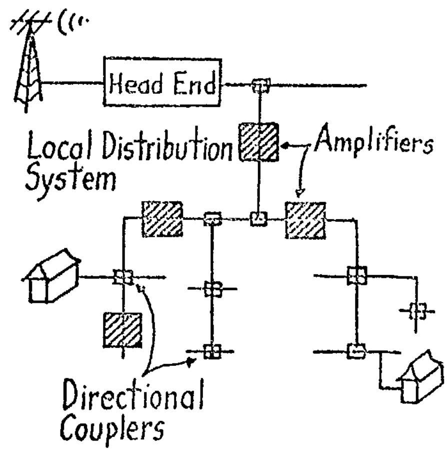
Fig. 1

In order to appreciate what is involved in the operation of a telecommunication system, it is convenient to consider the system as consisting of four basic parts. These are:

- long haul transmission facilities;
- switching facilities;
- local distribution facilities; and
- terminal facilities.

The synthesis of a cable telecommunication system involves tradeoffs between switching, transmission, distribution and terminal facilities. In addition, consideration has to be given to the type of signal processing to be used; this determines whether or not the electrical signals should be in analog or digital form, and how they should be combined (multiplexed) on the cable system. It determines whether frequency division multiplexing (FDM), time division multiplexing (TDM), or some combination of both should be used.

In the typical telecommunication system of figure 1, subscribers are connected to local switching offices via pairs of copper wires called "loops". These local offices are then connected to toll offices by multipaired cables. Long haul transmission facilities consisting of coaxial cables or microwave relays interconnect the various toll offices. The subscriber terminals are telephone sets, or teletype units and computers when data is being handled by the system. At the present time the electrical signals travel through the telecommunication system in analog form, and frequency division multiplexing techniques are employed to separate them.



CATV System
Fig. 2

The cable television system of figure 2, on the other hand, has no switching facilities. It uses coaxial cable for local distribution. There are at present no long haul transmission facilities interconnecting CATV systems. The terminals are television sets at the subscriber's dwelling, and antennas, amplifiers, mixers, etc. at the "headend". The signals travel through the system in analog form, and frequency divison multiplexing techniques are employed to separate them.

In addition to their different topological structures, other technical differences exist between the various cable systems, such as the rate at which the information can be transmitted, and its directionality. Information rates can be low, medium or high, and the direction of information flow can be uni-directional (as in CATV) or bi-directional (as in telephony). Table I summarizes these characteristics and presents some typical examples.

Table I

Directionality	Information Rate	Typical Example
Uni-Directional	Low	Meter Reading
	Medium	Radio
	High	CATV
Bi-Directional	Low	Telephone Telex/TWX
	Medium	Computer to User, User to Computer, Videophone
	High	Computer-to-Computer

In the not too distant future, the typical user will require much closer integration of the various services that will become available (videophone , bi-directional educational televison, computer aided instruction, etc.). Thus planners of future telecommunication systems must provide for versatility and adaptability to user demands for additional services as well as for the phasing out of services that have not received public acceptance.

The First Principle

Once "integrative versatility" is accepted as the first principle, the next consideration is the choice of the best transmission medium. At present, there is increasing congestion of the radio spectrum within certain cities. The broadcasting industry is the main user of this spectrum, but many channels are also allocated to mobile radio. Telecommunication and CATV systems in a city use the non-radiating medium of pairs of wires or coaxial cable. The choice of a transmission medium, radiating or non-radiating, is dictated by the following:

Choice Transmission Medium

a) Suitability of the medium for the service required (telecommunication with aircraft requires use of the radio spectrum).

b) Availability of spectrum (as mentioned above the radio spectrum is already overcrowded in certain cities).

c) Relative cost (with due regard to system versatility).

The radio spectrum is becoming so scarce in certain cities that (b) is possibly the most important consideration. It suggests the choice of a non-radiating transmission medium for city applications, provided that (a) and (c) can be satisfied.

<u>The Second Principle</u>

This report accepts as the second principle the necessity of non-radiating media for urban telecommunication systems.

<u>The Third Principle</u>

The third principle is the assumption of a date in the mid-nineteen-eighties for the implementation of multiservice cable telecommunication systems on a national scale. Considering the time scale required for the conversion of new technologies into mass production, the assumed target date for possible implementation eliminates any serious consideration of more exotic telecommunication systems and techniques. This leads to the fourth principle, namely that the only technologies considered are those which at present

<u>The Fourth Principle</u>

are sufficiently near to the mass production stage to allow for their widespread use in the nineteen eighties.

The cost of new multiservice cable telecommunication systems, or the capital requirements for converting existing telecommunication and CATV systems to multiservice systems are of primary importance. These costs and capital outlays cannot be estimated without first defining in some detail the proposed systems. This report, therefore, is mainly concerned with technical feasibility and system description, and not with actual cost details. It is unrealistic, if not impossible at this time, to assign monetary values to the differences in flexibility, maintainability, adaptability, reliability and many other characteristics between present and future cable systems and associated services.

The problem of capital investment in present systems is inescapable. For example, the telecommunications industry has a $7 billion investment at stake in existing facilities, which has to be taken into account in the planning and development of future multiservice telecommunication systems.

Telecommission Study 6(d) is directly related to the present study. It was conducted in the form of an invitational seminar sponsored by three Federal Government departments and held at the University of Ottawa in June 1970. Participants and panelists from Universities, Government and Industry explored some of the social, political, economic and technical problems associated with the realization of "total" telecommunication systems for Canada over the next 15 to 20 years. The report of the Seminar will be published along with the other Telecommission Reports.

The concept of the future "Wired City" has caught the imagination of many, but for this ideal to become a reality, considerable readjustment of the present balance in the telecommunications industry will be required.

Needs, Services and System Properties

Telecommunication systems are designed to provide services corresponding to estimated subscriber needs and demands. There is a direct relationship between a given service and the properties of the system providing it. In order to establish this relationship, it is necessary to analyze subscriber needs, and have a thorough understanding of the system's properties.

With the implementation of new systems made available through advanced technology, specific details of many of the needs that will develop cannot now be foreseen. Therefore, it is essential that any system be so designed as to permit its ready adaptation to new demands for more and different types of services, and this adaptability should continue over a long period of time.

Subscriber Service

A subscriber service provides a connection between points in a system such that the subscribers can exchange information through their respective terminal devices. The typical example is the telephone service. The nature of the connection is temporary, that is switching facilities are utilized for a limited period of time, and then are released for use by other subscribers. This sharing of switching facilities keeps costs down, but limits the number of subscribers that can be served at any given time. Thus one important characteristic of this type of system is its traffic handling capability.

System Properties

Two other major characteristics of a telecommunication system are information rate and directionality. The information rate can be low (Voice/Data), medium (Videophone), or high (Television), and the directionality uni- or bi-directional. Information rate is usually expressed in terms of bandwidth (in Hertz) for analog signals, and in bit rate (in bits per second) for digital signals.

The term "bauds" is often used to refer to the rate of a transmission line. It normally indicates the signalling rate used in the line, not the capacity of the line. It refers to the number of times the line condition changes per second. If the line condition represents the presence or absence of one bit, then the signalling rate is the same as the information rate, in bits per second. If, however, the line can be in one of four possible states, then one line condition represents two bits instead of one. If it can be in eight possible states, each state condition represents three bits, etc.; one "baud" may be equal to one or more bits depending on the number of coding states possible on the line.

Table 1 summarizes the information rates of some existing services.

Table 2

Information rate	Maximum bit rate	Typical Type of Service
Low	50K bits/sec	Telex/TWX voice
Medium	7M bits/sec	Videophone
High	50M bits/sec	Television

The maxima indicated in Table 2 assume no redundancy is removed from the signal. Reduction factors of 5 to 10 are theoretically possible, but are costly at present.

Cable Telecommunication Services

The following types of services are subscriber services that have different system characteristics.

<u>CATV Service</u>

CATV service is area selective, transmission is one way, the signal is analog, and no switching is involved other than channel selection at the subscriber end. The information is in the form of moving picture and voice, and its rate is high.

A certain amount of signal processing is usually involved, because it is often necessary to translate the frequencies of certain channels received off-the-air. Other than this the signal is simply amplified to an adequate level at various locations, and the bandwidth of each channel is identical with the bandwidth of the received signal, (i.e. approximately 6 MHz).

The distances involved in typical CATV systems are relatively short (typical long trunks are of the order of 20 miles, using 50 to 60 amplifiers) because of the degradation of the signal in passing through each amplifier. Amplifiers are required at approximately every 2,000 feet along the cable.

<u>Telephone Service</u>

Telephone service is point selective, involves highly sophisticated switching, the signal is analog, and the transmission is two way and symmetrical. The information is in the form of voice, and its rate is low.

Although the information remains in analog form, the signal may be processed many times when two subscribers talking with each other do not live in the same exchange area. The switching centres are highly developed in the major cities, and they provide facilities for direct long distance dialing with automatic recording of the toll charges.

<u>IRTV Service</u>

Information Retrieval by Television is a typical example of the new type of services that are becoming available. Audio-Visual programs are requested from a central film and videotape library by telephone, and transmitted to television monitors in schools via coaxial cables. The information rate is low and bi-directional on one medium, but high and uni-directional on the other.

This system is in fact a hybrid system, creating a greater potential utilization of the cable distribution system through the use of the telephone and an information library as a complement. It is feasible to include a two way voice channel on the cable, but this would only be practical if all the transmission facilities were to be dedicated.

The information has to be transformed into a form suitable for television viewing. It is then transmitted as a video signal if the cable is dedicated, or translated to one of 12 television channels if the same cable provides the service to many locations.

Data Service

Data service is at present provided over telecommunication facilities. Transmission can be one way or two way, the information rate low or medium, and the service dedicated or switched.

Because the service is provided over voice channels, the information is usually transmitted in analog form, using amplitude modulation or phase shift modulation (frequency shift keying). MODEMs (MODulator-DEModulators) are necessary at both ends of the telecommunication facilities.

The rapid growth of data service has completely altered the predicted pattern of telephone service growth, and in some areas, in New York in particular, the traffic load is far greater than had been predicted for the present. This is an example of how technological progress can create needs that are difficult to predict and evaluate.

In terms of system parameters, data service is more compatible with wideband coaxial cable than narrow band copper pairs. With appropriate coding, a large number of data channels could be carried on a single coaxial cable, without interfering with each other. The necessary data processing and switching equipment is at present expensive, but large scale integration techniques will be bringing the cost down in the foreseeable future.

Correspondence Between Type of Service, and System Properties.

The number of subscriber services which could be provided by a total telecommunication system is very high. For example a preliminary list of 117 services drawn up at the Stanford Research Institute is included at the end of this section. This list classifies the various services in terms of specific system properties.

It should be emphasized that many of these services, though technically feasible, may never obtain public acceptance. Some, obviously, will cater only to a limited number of subscribers, and will be offered at a price. This list is included to emphasize the relation between type of service and system properties. It is instructive to note that 88 of these services require a central computer or library for data storage. This shows the close relation that will eventually exist between telecommunication systems and computers.

Of the services listed, 77 require two-way low information rate, 26 require one-way high information rate and two-way low information rate, and eight require high information rate both ways.

A large number of these services could be provided on existing telecommunication facilities, but if they were made available in too short a period of time, they would greatly tax the traffic handling capabilities of these facilities and possibly degrade the quality of many of the existing service offerings. If it is judged that new services are desirable and that they would receive public acceptance, it might not be sufficient to add them on the existing facilities; a certain amount of re-designing would have to be done as, for example, is the case for the proposed picturephone service, which might be provided by a six wire or coaxial cable system. In fact, no existing system could provide two way high information rate services on a national scale. If a new system was to be planned to meet such a demand, it could easily be designed to accommodate additional one-way or two-way services of low and medium information rates.

A number of existing telecommunication companies have expressed an interest in a pilot project of a multiservice cable telecommunication system. In particular, Bell Canada is considering the possibility of dedicating four pairs of copper wires, as well as a pair of coaxial cables to each dwelling in the Erin Mills New Town development project in Toronto, their object being to experiment with new service offerings. In addition a number of other telecommunication companies, for example Maritime Telephone and Telegraph, and British Columbia Telephone Company, have expressed similar interests. CATV companies have expressed a desire to be designated as telecommunication common carriers, and thus be able to enter into the telecommunication business.

Table II, taken from the Rostow report, presents another list of telecommunication services likely to become available in the future. The system parameters are limited to information rate and directionality.

Table II

Service	System Parameters	
Advertising	1, m, or h	1
Alarm (burglar, fire, etc.)		1
Banking		2
Facsimile	m	1 or 2
Emergency Communications		1 or 2
Communication between Computers	1, m, or h	2
Mobile Communications		2
Teletype Communications		2
Computer - time sharing		2
Meter Reading (Utilities)		1
Home Shopping	1, or m	1 or 2
CATV	h	1
IRTV	1, or m	1 or 2
Telephone		2
Computer Aided Instruction (CAI)		2
Videophone	m	2
Voting		2
Vehicle Traffic Control	1, m or h	1 or 2

l = low rate

m = medium rate

h = high rate

1 = one way

2 = two way

Further Comments On The Requirements For Various Services

The telecommunication systems of the future will be different from the present systems in the following manner:

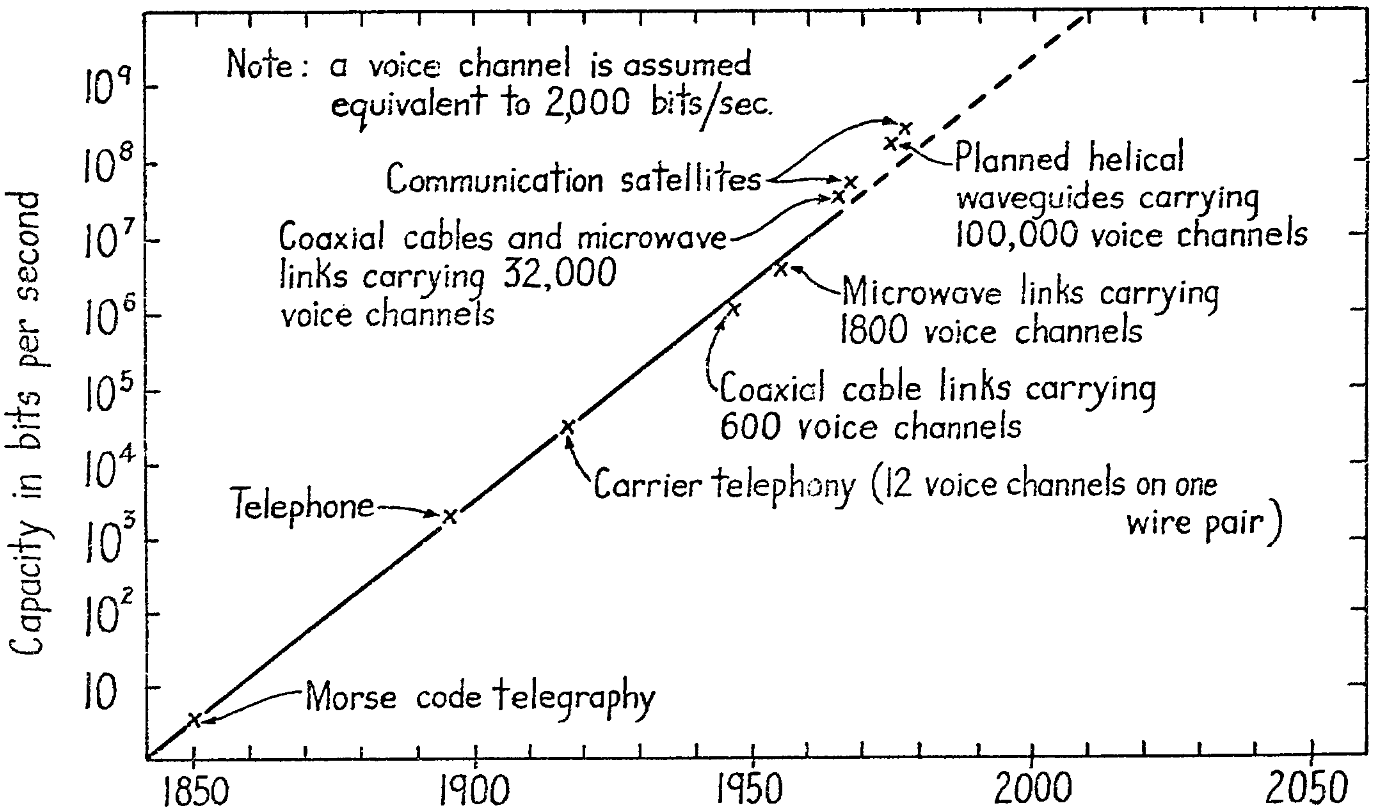
1. Multiplicity of services.
2. Increased traffic handling capability.
3. Increase in the number of medium and high information rate services.
4. Increase in the number of two way services.

The increase in the number of two way services is expected to be particularly dramatic in medium and high information rate types. This will affect significantly the traffic handling requirements of future telecommunication systems. In particular, the cost and complexity of switching facilities will increase considerably.

Some new services will surely become available, such as home movies on demand, facsimile, computer-aided instruction, etc. Also, experts in computer science are forecasting that the interconnection of large computers may be necessary to solve very complex problems. These services have a high information rate, of the order of that of a television channel, and will require a wideband medium for transmission and distribution.

At the present time, coaxial cable is most attractive as an intra city distribution medium, and it is expected that it will be used in ever increasing quantities in local trunks and distribution facilities of future telecommunication systems.

Figure 3 shows the evolution of telecommunication services by the time periods that have elapsed between the introduction of various services of increasing information rates. The services are specified in terms of their voice channel capability, but the vertical axis has been calibrated in terms of their overall information rate, in bits per second.



Evolution of the telecommunication services

Fig. 3

List of Services

		TWO WAY	SYMMETRIC	POINT TO POINT	AREA SELECTIVE	VOICE/DATA	T.V. TYPE DISPLAY	ONE WAY	CENTRAL COMPUTER/ LIBRARY	
Business - Work at Home										
1. Secretarial assistance	✓	X	X	X		X				
2. Person-to-person communications	✓	X	X	X		X				
3. Computer-assisted meetings	✓	X	X	X		X				
4. Electronic mail	✓				X	X		X	X	
5. Adding machine functions	✓	X	X	X		X			X	
6. Access to company files	✓	X	X	X		X			X	
7. Message recording	✓					X			X	
Business - Commerce										
8. Shopping transactions	✓	X		X		X	X		X	
9. Grocery price list(information and orders)	✓	X	X	X		X			X	
10. "Cashless society"transactions	✓	X	X	X		X			X	
11. Dedicated newspaper	✓	X	X	X		X			X	
12. Banking	✓	X	X	X		X			X	
13. Answering services	✓	X	X	X		X			X	
14. Real estate listings	✓	X		X		X	X		X	
15. Better Business Bureau	✓	X	X	X		X			X	
16. Special sale information	✓	X		X		X	X		X	
17. Budget preparation and monitoring	✓								X	
Videoconferencing										
Political										
18. Council meetings, other local meetings	✓				X		X	X	X	
19. Voter views and participation	✓	X	X	X		X			X	
20. Nationwide voting surveys and voting	✓	X	X	X		X			X	
21. Debates on local issues	✓	X	X	X			X		X	

List of Services

	TWO WAY	SYMMETRIC	POINT TO POINT	AREA SELECTIVE	VOICE/DATA	T.V. TYPE DISPLAY	ONE WAY	CENTRAL COMPUTER/ LIBRARY	
Political cont'd.									
22. Free political channel for candidates ✓	X			X	X	X		X	
23. Access to elected officials ✓	X		X		X	X		X	
Social Services - State and Federal Governments. ✓									
24. Social Security	X	X	X		X			X	
25. Immigration and naturalization	X	X	X		X			X	
26. Taxes	X	X	X		X			X	
27. Weather Bureau Information	X		X		X	X		X	
28. Courts	X	X	X		X			X	
29. Index of social services	X	X	X		X			X	
30. General Postal Information	X	X	X		X			X	
31. Welfare	X	X	X		X			X	
32. Vocational counseling	X	X	X		X	X		X	
33. Employment service	X	X	X		X			X	
34. Disaster warnings and evacuation control	X	X		X	X			X	
35. Marriage counseling	X	X	X		X	X		X	
Health ✓									
36. Remote diagnosis ✓	X	X	X		X	X		X	
37. Emergency medical information ✓	X		X		X	X		X	
38. Drugs ✓	X	X	X		X			X	
39. Health insurance ✓	X	X	X		X			X	
40. Medicare claim processing ✓	X	X	X		X			X	
41. Prescription communication (doctor-to-pharmacy.)	X	X	X		X			X	
42. Dietetic meal planning and scheduling	X	X	X		X			X	
43. Ambulance/doctor/hospital coordination	X	X	X		X			X	
44. Outpatient services	X	X	X		X			X	
45. Medical and dental appointments and reminders.	X	X	X		X			X	

List of Services

Health Cont'd.	TWO WAY	SYMMETRIC	POINT TO POINT	AREA SELECTIVE	VOICE/DATA	T.V. TYPE DISPLAY	ONE WAY	CENTRAL COMPUTER/ LIBRARY
46. Advice on simple problems	X	X	X		X			X
47. Doctor directory	X	X	X		X			X
48. Immunization information	X	X	X		X			X
49. Mental Health center(psychiatric consultation)	X	X	X		X			X
50. Suicide prevention center	X	X	X		X			X
51. Alcoholics Anonymous	X	X	X		X			X
Household								
52. Water, electric, and gas meter reading	X	X	X		X			X
53. Alarm systems	X	X	X		X			X
54. Operate household services (turn lights on, light up furnace, etc).	X	X	X		X			X
55. Recipe file	X	X	X		X			X
56. Telegrams	X	X	X		X			
57. Mail and messages	X	X	X		X			
58. Daily calendar (reminders about appointments).	X	X	X		X			X
59. Address book	X	X	X		X			X
60. Equipment maintenance reminders	X	X	X		X			X
61. Christmas lists	X	X	X		X			X
62. Generate shopping lists,weekly menu .	X	X	X		X			X
63. Cleaning information	X	X	X		X			X
64. Food storage information	X	X	X		X			X
65. Keeping track of food supply,household items.	X	X	X		X			X
Agriculture								
66. Soil conditions	X	X	X		X			X
67. Fertilizers	X	X	X		X			X
68. Insecticides	X	X	X		X			X
69. Gardening	X	X	X		X			X
70. Seasonal crops	X	X	X		X			X
Education								
71. Correspondence schools	X		X		X			X
72. Computer tutor	X	X	X		X			X

List of Services Education Cont'd.	TWO-WAY	SYMMETRIC	POINT TO POINT	AREA SELECTIVE	VOICE/DATA	T.V. TYPE DISPLAY	ONE-WAY	CENTRAL COMPUTER/ LIBRARY
73. Computer-aided instruction	X	X	X		X			X
74. School-related communications	X		X		X	X		
75. College catalog and related information	X	X	X		X			X
76. Adult courses, evening courses	X		X	X		X		
77. Seminars	X			X		X		
78. Consultation with teachers, professors	X	X	X		X	X		
Transportation - Travel								
79. Department of Motor Vehicles	X		X		X	X		X
80. Road conditions	X		X		X	X		X
81. Travel advice	X		X		X	X		X
82. Traffic conditions	X		X		X	X		X
83. Vehicle maintenance reminders	X	X	X		X			X
84. Taxi service	X	X	X		X			
85. Bus route scheduling, flight and train schedules	X	X	X		X			X
86. Maps	X		X		X	X		X
87. Travel accommodations	X	X	X		X			
88. Fares and ticket reservation	X		X		X	X		
89. Tour information	X		X		X	X		
90. Travel and car insurance	X	X	X		X			
91. Passports	X	X	X		X			
Recreation								
92. Skiing (snow conditions)	X	X	X		X			
93. Camping (areas, facilities)	X		X		X	X		
94. Tennis (courts, partners)	X	X	X		X			
95. Golfing (courses etc)	X		X		X	X		
96. Picnic Areas (facilities available)	X		X		X	X		
97. Flying (lessons, airports)	X		X		X	X		
98. Fishing (season, permit, etc)	X		X		X	X		
99. Hunting (season, permit, etc)	X	X	X		X			

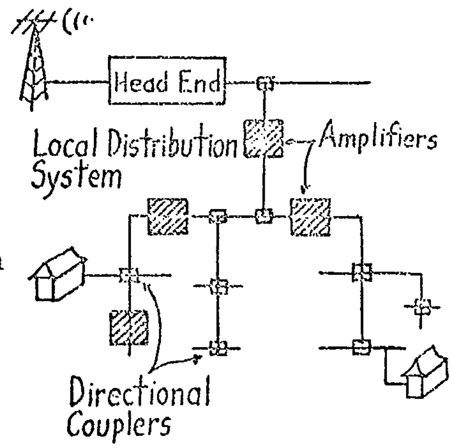
List of Services

Recreation (Cont'd)	TWO-WAY	SYMMETRIC	POINT TO POINT	AREA SELECTIVE	VOICE/DATA	T.V. TYPE DISPLAY	ONE-WAY	CENTRAL COMPUTER/ LIBRARY
100. Boating	X		X		X	X		
101. Hobbies	X	X	X			X		
102. Games (Chess, bridge)	X	X	X		X	X		
Entertainment								
103. Current cultural events	X			X	X	X		
104. Local plays, movies	X	X	X		X			
105. Ticket reservations	X	X	X		X			X
106. Restaurant reservations	X	X	X		X			X
107. Computer dating X	X	X	X		X			X
Radio Services								
Information - General								
108. Index of all services available	X	X	X		X			X
109. Library	X	X	X		X			X
110. Dictionaries	X	X	X		X			X
111. Encyclopedias	X	X	X		X			X
112. Expanded yellow page service	X	X	X		X			X
113. Stock market information	X	X	X		X			X
114. Newspapers	X	X	X		X			X
115. Magazines	X		X		X	X		X
116. Recent book publications (lists and abstracts).	X	X	X		X			X
117. Telephone area codes	X	X	X		X			X

Existing Cable Telecommunications Systems

Community Antenna Television Systems

Cable television systems or Community Antenna Television (CATV) systems (figure 4) as they are usually called, receive television and FM signals off-the-air from broadcasting stations and distribute these signals via coaxial cables to their subscribers. These systems in effect provide a one way broadband service. Each subscriber pays an initial installment charge (approximately $15.00) and a monthly charge (approximately $5.00).



CATV System

Fig. 4

In September 1969, there were approximately 317 CATV systems in Canada serving over 926,000 households (over 22 per cent of the urban households in Canada). This represents a 45 per cent increase over the number of subscribers in 1968. These CATV systems employ about 1,400 people and in 1968 had a revenue of over $30 million. At present more than 35 CATV systems provide additional programmes on a closed circuit basis. The total investment in CATV plant in Canada is of the order of $100 million.

Limitations of Existing CATV Systems

The present CATV distribution systems are not readily adaptable to bi-directional transmission. They distribute simultaneously many televison and FM broadcast stations using frequency division multiplexing techniques.

Existing CATV systems are capable of accommodating 25 to 30 TV channels. However, there are a number of problems associated with the provision and utilization of this high channel capacity. First, the operators of CATV systems in Canada find that their reception is limited to eight to 10 off-the-air channels. To provide additional channels on a closed circuit basis requires large expenditures for programming and costly studio equipment which cannot be supported by a small CATV operation. In addition the average (Canadian) home receiver is of VHF type and is capable of receiving only 12 channels. This receiver limitation can be overcome in various ways; nevertheless any proposed solution will have to pass the tests of economic viability and public acceptance.

Future of CATV Systems

The additional capacity of CATV systems can be used to provide educational services to schools, training hospitals and other educational institutions. Although this has been proposed, there are many technical and management compatibility problems to be solved before it becomes a reality.

Another extension of the present CATV system could be the inclusion of a dial-up service for special programmes. There are many other wide band uni-directional services that could be provided on CATV type systems. Although these services would not require any modifications to the layout of the existing CATV network, modifications will be required to the electronic components of the system. In particular the amplifiers would have to be capable of providing the number of channels desired, and adapters would be required at certain reception points to distribute specific services to the selected subscriber(s).

Telecommunication Systems Owned and Operated by Telephone Companies

In Canada there are 13 major telephone companies, that own and operate approximately 2,000 intra-city telecommunication systems. The Telephone Association of Canada (established in 1921) and the Trans-Canada Telephone System (established in 1931) oversee the operation and interconnection of these systems. The Canadian Telephone Industry employs over 75,000 people, has an investment in facilities of over $6.5 billion, and an annual revenue of over $1 billion. In addition the telephone companies own over 70 per cent of all the coaxial cable that is used in CATV systems. This represents about 50 million feet of cable.

Limitations of Existing Telecommunication Systems

The present telecommunication systems owned and operated by the telephone companies, although highly developed and employing sophisticated switching techniques, utilize pairs of copper wires in their local distribution facilities. These wires have relatively small spectrum capabilities compared to coaxial cables, and are thus suitable for handling voice and low speed data signals only. That is, existing telecommunication systems are narrow-band (less than 50 KHz), and are designed and optimized for voice telecommunication. They employ analog signal processing techniques, and therefore, are not natural candidates for handling digital data, transmission.

<u>Future of Telecommunication Systems</u>

The projections of Bell Canada as presented to the Canadian Transportation Commission rate hearings in 1968 are summarized in <u>Table 3.</u> They are used here to illustrate the possible transitions that a telephone company owned telecommunication system is likely to undergo.

<u>Data Handling Capabilities</u>

From these projections it can be seen that the capabilities of future telecommunication systems will be increased to provide for medium speed (50 Kb/sec) data telecommunication. Furthermore, it is expected that by 1988, Touch Tone telephones will make up about 40 per cent of the total number of telephones in Canada, thus providing simple data input terminals.

<u>Videophone Capabilities</u>

Videophone service promises to remove the distance restriction for face-to-face meetings, much the same way as telegraph removed it for the written word and telephone for the spoken word.

The telephone companies envisage their video system developing initially as an adjunct to their existing telecommunication system, sharing the same long haul and local distribution facilities.

Certain telephone companies are considering dedicating either a pair of coaxial cables or three pairs of copper wires for local distribution followed by a gradual introduction of videophone services over the next 10 to 15 years. The use of six wires per subscriber would transform telephone company telecommunication systems into 1 MHz switched systems, capable of providing both videophone and a variety of other medium speed services. The use of coaxial cable in place of copper pairs would transform the system into a 300 MHz switched system capable of "total" telecommunication.

Future Video Type Capabilities

The Bell System in the U.S. is experimenting with various computer display schemes designed to be compatible with the videophone. It is possible to envisage a videophone incorporating special display capabilities allowing interactive use with computers. The development of equipment for making permanent copies, and the inclusion of colour in the video service, present challenges for the future.

Telecommunication Systems Owned and Operated by Canadian National/Canadian Pacific

Canadian National (CN) Telecommunications and Canadian Pacific (CP) Telecommunications started pooling their resources in 1947 to become CN/CP Telecommunications. The CN/CP although not a member of the Trans-Canada Telephone System (TCTS) is a well established telecommunications company which provides telephone and data services in a number of Canadian cities. At present CN/CP employ 4600 people with an investment in telecommunication facilities of over $0.5 billion (as against the $6.5 billion TCTS one) and have an annual revenue of over $95 million.

It should be noted that a large portion of the local distribution in the CN/CP system is leased from telephone companies.

A detailed description of the switched data services offered by CN/CP is given in Table 6.

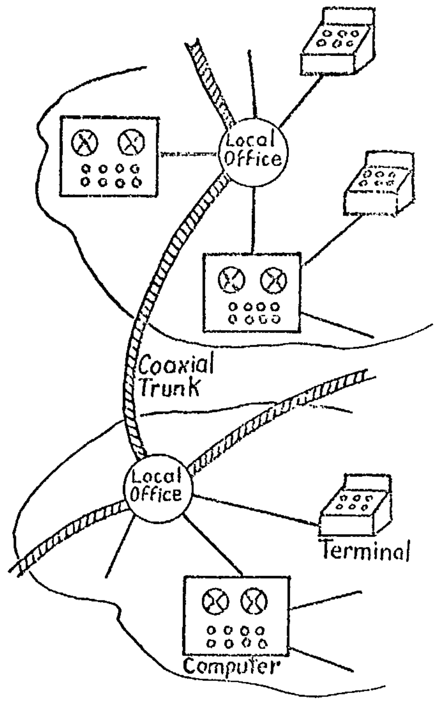
Data Telecommunication Systems

With the advent of time-sharing techniques for digital computers and the advances in telecommunication technology, new entities called "Computer Utilities" are emerging. The concept of a computer utility, dictates that each user be provided via a telecommunication system with the equivalent of a private computer capability whenever and wherever required.

Initially, all data processing companies were privately owned and connected to subscribers via rented telecommunication facilities. Recently a number of telecommunication systems have started providing data services.

In present data processing systems, most if not all subscriber terminals, are of the low speed (typically 100 words per minute) type. In the future there will likely be increasing use of higher speed terminals incorporating computer graphic, video, CRT capabilities. To connect such terminals to remotely located computers, will require high speed (broadband) telecommunication facilities.

A set of interconnected computers that are accessible from remote terminals is referred to as a Multi-Access Computer System (see Figure 5). There are many possible telecommunication/computer architectures for a computer utility, but the trend seems to be towards configurations as shown in Figure 5. The dimensions of such a system would depend on:



Multi-Access Computer System

Fig. 5

1) The location and number of computers and terminals.
2) The type of telecommunication system used for data telecommunication.

At present, most of the data telecommunication is done via existing telecommunication facilities. These facilities were originally designed for voice traffic and its low bandwidth (4 KHz) requirements. Thus there are well defined data rates (bit rates) that can be achieved. Therefore, all existing Multi-Access Computer Systems have to adjust their input - output speeds to those of their telecommunication facilities.

There are additional problems whenever data communication is attempted on lines designed for voice traffic. It can be shown that for data communication over telecommunication facilities, the efficiency of utilization of a given channel as a percentage of total utilization time of the channel is of the order of 2 - 5 per cent. At the present time, one method used to increase the efficiency of data communication over telecommunication facilities involves the use of a computer as a multiplexer - concentrator.

Tables 4 and 6 indicate the types of data telecommunication facilities available from Bell Canada and CN/CP. Tables 4 and 6 show at present telecommunication facilities can (in parts) carry data at speeds of 50 K bits/sec. Table 5 shows the hierarchy of present and planned digital (Bell Canada) high capacity systems for the period 1970-1980.

Regardless of how the Computer Utility for Canada will be achieved, the ultimate data/telecommunication system configuration of the Utility will be dictated by whether or not there should be centralization of computer facilities, and whether there should be a relatively small number of large computers or a large number of relatively small computers. The Science Council of Canada recently set up a study group to investigate certain problems related to the anticipated widespread use of computers, and their report should be available shortly. In addition, most of the studies of section five of the Telecommission are devoted to computer systems and associated problems.

Ownership

The question of who should provide the telecommunication facilities as well as the computer hardware and software for the Computer Utility is outside of the terms of reference for this study. One choice is the existing telecommunication industry, which already has a $7 billion investment in facilities, and which is almost entirely Canadian owned. The pros and cons of their entry have been made to Parliament in a Department of Communications report: "Participation by Telecommunication Carriers in Public Data Processing". It should be noted here, that the telecommunication company CN/CP is already in the public data processing field, and the pros and cons of permitting this company to continue to offer such services is discussed in the above-mentioned report.

PROJECTED GROWTH OF BELL CANADA TELECOMMUNICATION SYSTEM

TABLE 3

	Total Telephones (millions)	Number Touch Tone Telephones (Data Sets) (millions)	(in percent of lines in service)			Expected Long Haul Circuits	Long Haul Facilities (excluding Satellites) (in percent of long haul circuits)				Short Haul Trunk (percent of circuits)		
			Step by Step	Cross-bar	Elect-ronic		Cable Carrier	Coaxial Cable	Open Wire Carrier	Micro-wave	Phy-sical* Circuits	Non Phy-sical or Coaxial	Micro-Wave
1970	6	.4	53%	39%	8%	13,000	5%	0	1%	94%	80%	16%	4%
1978	8.9	3.3	30%	40%	30%	49,000	1%	8%	0	91%	4%	92%	4%
1988	12.8	10.5	--	36%	64%	148,000	0%	21%	0	79%	5%	90%	5%

* Physical implies more than 1 circuit per pair of wire

BELL CANADA FACILITIES FOR DATA SERVICE

TABLE 4

Name of Service	Bit rate; K bit/sec	Availability	Charges		Remarks
			Inter-city	Intra-city	
Dataphone	2	Presently	rental of private line	normal long distance charges	a) 1/2 Duplex transmission b) There are more than 2000 Dataphone sets used in Networks and Dedicated facilities
Dataline I	2.4 to 4.8	Presently	Access line charge of $100 per month, 10¢ per minute for distances up to 350 miles	10¢ a minute for distances up to 350 miles	a) Full Duplex; four wire transmission b) There are more than 150 Access lines in Canada.
Wideband	50	Mid 1970	No Rates Finalized To Date		a) Full Duplex; six wire transmission. b) The service will be offered in major Canadian cities. c) The wide band switches will have a 1 MHz capability for videophone.

COMMON CARRIER DIGITAL SYSTEMS FOR CANADA - (BELL CANADA)

TABLE 5

Name of Carrier System	Type of Cable	Bit Rate M bit/sec	Availability	Remarks
T_1	Copper pairs	1.5	Multiplex equipment and line presently available	24 voice channels
T_2	Coaxial or special type of paired wires	6	no plan to make a special line for this carrier (multiplex equipment available 1974)	a) one picturephone channel b) could be used to transfer 250,000 words each 60 bits long, from one computer to another in 2.5 seconds c) this is faster than the highest data transfer rate from today's magnetic tapes and disks
T_3	Coaxial	46	no plans to make a special line for this carrier (multiplex equipment available 1977-1980)	a) one black and white TV channel b) could be used to transfer 250,000 words each 60 bits long from one computer to another in 320 milliseconds
T_4	Coaxial	281	Multiplex equipment as well as line (cable) will be available 1977 - 1980	a) 6 black and white, or 3 colour TV channels b) could be used to transfer 250,000 words each 60 bits long from one computer to another in 50 milli-seconds c) the bit rate of 281M bit /sec compares with the internal processing rate of 600M bit/sec of todays very fast computers. This rate of 600M bit/sec is very close to the limit imposed by the transit time of signals on wires inside the computer.

CANADIAN NATIONAL - CANADIAN PACIFIC

FACILITIES FOR SWITCHED DATA SERVICE

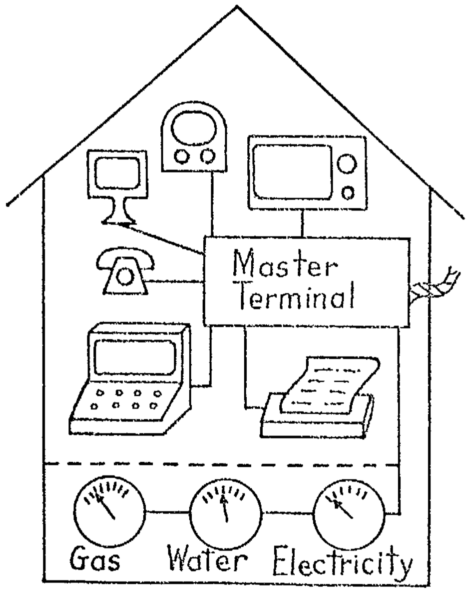
TABLE 6

NAME OF SERVICE	BAUD RATE	AVAIL-ABILITY	CHARGES		REMARKS
			INTER-CITY	INTRA-CITY	
Telex	50	Now	10¢ to 90¢ per minute depending on distance	10¢ per minute	Serves 20,000 subscribers in Canada; conforms to CCITT standards for connection to 300,000 subscribers in Europe and also inter-connects with 30,000 telex subscribers in the United States and Mexico
Data/Telex	Any code or speed up to 180 baud	Now	10¢ to 90¢ per minute depending on distance	10¢ per minute; or $20. per month flat rate for computer time sharing	Generally used for intra-company service. Equipment provided for DC or EIA interface. Permits customers to connect a variety of equipment to computers at any code or speed up to 180 baud.
Broadband Exchange Service 4KHZ	600 to 4800 baud	Now	Termination Charges $100. per mongh plus usage charges starting at 10¢ per minute depending in distance & speed of transmission	$100. per month plus 10¢ per minute usage charge	Four wire operation throughout permits two way simultaneous transmission of data. Can be provided on two wire basis for voice communication.
Broadband Exchange Service 108 KHZ	50,000 baud	Now	Rates quoted on request	Rates quoted on request	Switches have capability for switching frequencies up to 108 KHZ; typical use on microwave group (60-108KHZ) would provide 50 K bit service.

Future Multiservice Cable Telecommunication Systems

In this section, multiservice cable telecommunication systems are discussed from a point of view of their general structure. In principle, these systems should be "total" telecommunication systems capable of providing more services than existing systems and readily adaptable to new and different service offerings.

A "total" telecommunication system could provide: telephone, videophone, television, radio, computer, facsimile and utility metering services, to each home (see Figure 6). The various services provided on such a telecommunication system, can be divided into three classes:



Subscriber Services
Fig. 6

1. Broadcast

   Commercial and Instructional TV

   Commercial and Instructional Radio

2. Real Time Point to Point

   Telephone

   Videophone

   Telegraph and Teletype

   Certain Computer Services

3. Store and Forward

   Computer Services (time sharing and instruction)

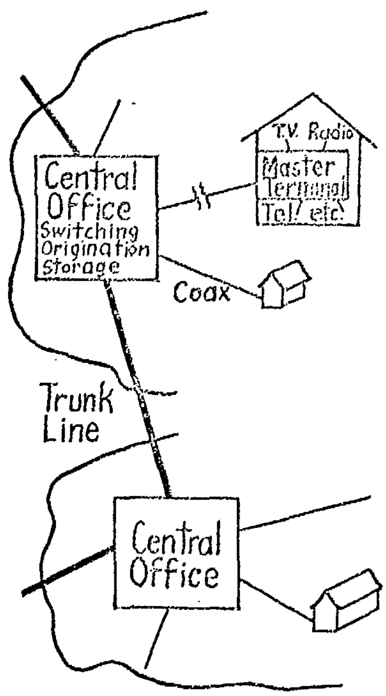
Facsimile (newsprint and magazines, library access)

Financial Transactions (banking and remote purchasing)

Interrogating (polling and meter reading)

Mail

To achieve these capabilities for each home a switched multiservice cable telecommunication system would be required. As has been previously pointed out, although existing telecommunication systems are highly developed and employ sophisticated switching, they have been optimized for voice telecommunication, and are, therefore, not a natural choice for data telecommunication. They are also narrow band in that they utilize pairs of copper wires to provide service to each home. This use of copper wires limits the usable bandwidth of the overall system and in effect the number of services that can be simultaneously provided on it.



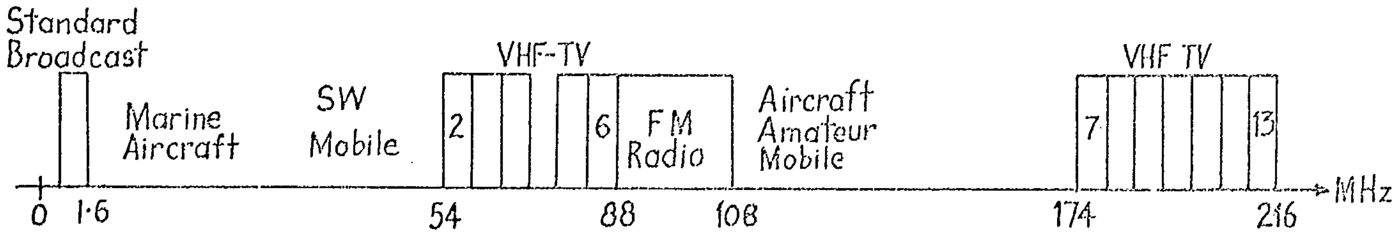
Switched Coaxial-Cable System

Fig. 7

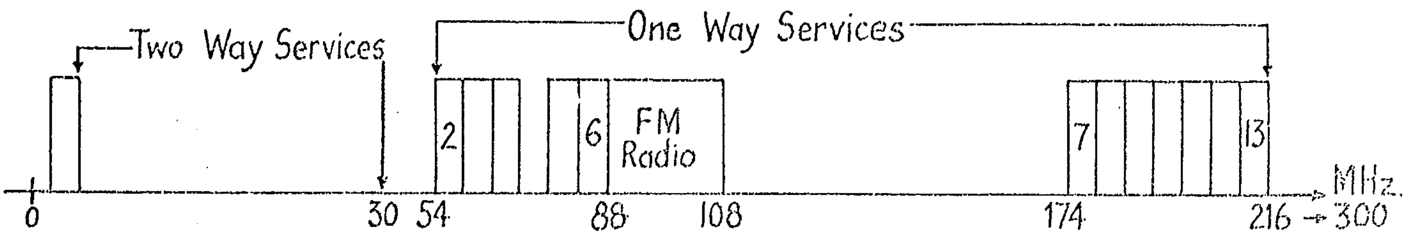
Switched Coaxial Cable Telecommunication Systems

The bandwidth of existing telecommunication systems could theoretically be increased substantially if their copper pairs were replaced by coaxial cables. The resulting system would be a switched coaxial cable system (see Figure 7). It could be capable, with the use of suitable signal processing, of providing "total" telecommunication services to each home. This system has the same philosophy of operation as existing telecommunication systems, but with the additional feature that it has a usable bandwidth two orders of magnitude greater. Therefore, it could accommodate many more services. Some idea of the bandwidth gained by the use of coaxial cable can be obtained from Figure 8 which compares the spectrum (usable bandwidth) of a typical coaxial cable with the Department of Communications allocation of the Radio Spectrum and with the usable bandwidth of a typical copper pair.

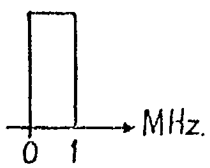
If existing telecommunication systems were to evolve into switched coaxial cable systems, all Canadian cities would become "totally Wired Cities". It would be possible to build into such systems varying degrees of sophistication and complexity, depending on the type of signal processing used. The most sophisticated systems would be the ones in which all the signals are digital and time division multiplexing techniques are used. Furthermore, the use of computers for switching and for the performance of many other logical functions would make these systems very flexible. In addition such systems would allow the separation of hard-



D.O.C. Allocation of the Radio Spectrum



Possible Coaxial Cable Spectrum Allocation



Usable Spectrum of Typical Copper Pair

Fig. 8

ware (the system itself) from the software (the type of services the system provides).

The centralization of hardware in a national telecommunication system has a number of advantages and disadvantages from non-technical points of view. Since these considerations are outside of the terms of reference of this study, they are not pursued further here.

To convey some appreciation for the large costs involved in the establishment of a multiservice telecommunication system the example shown in Figure 7 will be used. In order to provide the following capabilities to each home:

4 voice/data channels;

12 TV channels, one-way-area selective;

12 TV channels, one-way-subscriber selective;

4 TV channels, two-way-area selective;

an investment of the order of $5,000 per subscriber would be required, assuming a density of 500 subscribers per square mile. This corresponds to ten times the cost of providing only telephone service. Another way of putting this is, instead of a $7 billion investment as in the existing telecommunication facilities an investment of the order of $70 billion would be required to provide such a system for the entire country.

The above example illustrates one possibility for a switched coaxial cable system that has the configuration of the existing telecommunication system. The advantage of this type of system is that it can be realized by superimposing a coaxial cable structure on the existing paired wire facilities without interrupting the existing service, and then changing over when the new plant is installed.

There are of course many other possibilities for multiservice coaxial cable systems. The wide bandwidth of the coaxial cable allows the trade-off of bandwidth for switching. In fact other configurations of multiservice cable systems have been proposed. For example, the Rediffusion system "Dial a Programme" (figure 9), utilizes a distribution system containing many cables, with each cable carrying a single 6 MHz channel. This type of system reduces the number of amplifiers for a given distance, but increases the length of cable required to service a given area. A subscriber is connected to the system via a single cable, and a local switching arrangement which allows the selection of a particular cable in the trunk.

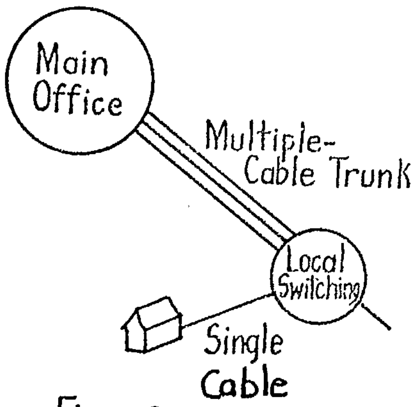


Fig. 9

The system in figure 8 could provide high speed data on one of the cables in its trunk, high quality video on another, and the switching could be set up to allow any subscriber access to all or any given selection of the cables in the trunk. The construction costs for such a system would vary with the number of cables in the trunk, the type of signal processing used and the types of service provided.

Either of the systems of figure 7 or figure 9 could be used to provide "total" telecommunication. The technology required for the implementation of these systems is now well known and it would be possible to realize them, on a national scale, within 10 to 15 years.

Limitations of the Human Receiver

Man finds himself in the middle of an information explosion, in which the computer far exceeds his abilities to calculate; telecommunication channels already deliver far more information than his brain can process and absorb, and this information capacity of telecommunication systems is increasing almost without bound. The limitations of the human as a receiver and processor of information is illustrated in Table 7. This Table shows the channel capacities to the brain possessed by the eye and the ear, as compared with the potential capacities of a single video (TV) telecommunication channel.

Information Carrying Capacity of Telecommunication Channel	Information Carrying Capacity of Human Channels	Processing Capacity of Human Brain From all Sources
Audio = 10K bits/sec Video = 50M bits/sec	Ear = 10K bits/sec Eye = 1M bit/sec	40 bits/sec

Table 7

A preliminary inspection of Table 7 indicates that a large amount of the capacity of a single TV channel cannot be exploited for video transmission to humans because of the 40 bit/sec processing capacity of the human brain. It is indeed for this reason that there is so much redundant (repetitive) transmission in the ordinary broadcast television signal. In fact all audio/visual equipment intended for human use is constrained in its ultimate information carrying capacity by the processing limitations of the human brain and the channel capacities of the ear and eye that provide the input to the brain.

Terminal Equipment in Multi-Service Telecommunication Systems

Terminal equipment must be compatible with and in principle an extension of human senses. Hearing and vision are, and will remain the most important senses that can be extended by the use of present and foreseeable telecommunication systems. In addition, for bi-directional services, terminal equipment must have transmitting and receiving capabilities.

Audio Terminal Equipment

The variety of audio services available in multi-service cable telecommunication systems will increase in the future, but the rate of total growth will remain approximately as at present. The total volume of these services will be dominant, but fortunately, the required bit rates are low, and expensive terminals are not required.

Video Terminal Equipment

The demand for visual telecommunication will undoubtedly increase with the introduction of videophone and computer visual displays.

The technical requirements for television type visual display and those for alphanumeric character displays (information retrieval, computer output, etc.) are not at present compatible. The former has poor resolution but is excellent for real time moving picture display. The latter must have high resolution, but the real time aspect is usually unimportant. The "universal" display capable of producing both quality graphical displays and a moving colour TV picture is not available at present.

Video Recording Equipment

Video recording equipment allows recording for later playback. It can be considered a large capacity high speed memory system. There are presently various types of video recorders available, but they are continually being refined and modified, and are expensive. The price of home entertainment units is still relatively high ($600-$800).

Character Generators "ROM" Memories

Visual display terminals will likely incorporate character generators that permit the writing of alpha-numeric characters on a screen. These characters are stored in a read only memory (ROM), the price of which is gradually decreasing with continuing technical advances in solid state technology and more widespread usage.

Hard Copy

"Hard copy" capabilities for visual display terminals are just becoming available, but are still in an early stage of development, and expensive. It is expected that there will be an increasing use of facsimile type devices that can produce both line diagrams and alpha-numeric text.

The Substitution of Telecommunication For Transportation

The similarities between telecommunication and transportation systems have been known for a long time. These similarities are both topological and functional. Both these two systems provide contractions in the space/time frame.

Although there has been considerable progress in each of these two fields, they continue to develop independently. It is becoming more evident that if problems of urban living are to be successfully tackled, there will have to be closer interaction between the disciplines of telecommunication and transportation. Hopefully this interaction will generate radically new techniques for the planning, design and implementation of future cities as well as for urban renewal in existing ones.

The concept of substituting telecommunication for transportation is not new. Progress in this field has been continuous ever since man started using smoke signals to carry messages over long distances. In fact, all telecommunications are substitutes for travel in time, if not in space. Today many possibilities exist for substituting electronic telecommunication for travel in space as well as in time. Compared to individual income, the cost of transportation is rising, and that of telecommunication can be expected to decrease. At the same time the sophistication of electronic telecommunication systems is increasing, and it is, therefore, desirable to determine as soon as possible the extent to which substitution can be made, and what effects it would have on our lives.

The benefits of substitution will depend not only on the appreciation of what substitutions are technologically possible but also, and just as important, on whether such substitutions are economically, sociologically and psychologically desirable. A challenge for the future will be to develop a multidisciplinary approach for studying and modelling those substitutions that are feasible and desirable.

The Promise For The Future

The next three decades will see man in a continuous transition away from a largely mechanical environment dependent on transportation towards a telecommunication one, in which his experiences will be increasingly based on the use of electronic devices. This transition will profoundly alter (for better or worse) the shape and characteristics of most of our ways of life.

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Appendix

Terms of Reference For Telecommission Study 8(d).

This appendix contains copies of the "Original" terms of reference which was written at the beginning of the study in August 1969. After the preliminary report of Study 8(d) was prepared in March 1970, the Project Team modified the "Original" and produced a "Revised" terms of reference which more precisely defined the investigation and considerations for the Final Report.

TERMS OF REFERENCE FOR A TECHNICAL STUDY OF "SPECIAL SERVICES PROVIDED BY WIDE BAND INTRA CITY CABLE DISTRIBUTION SYSTEMS"

GENERAL

The Department of Communications is entrusted with the responsibility to ensure the optimum development of telecommunication services in Canada.

Advances in coaxial cable technology continue to make practical an ever increasing variety of telecommunication services. It is necessary now to re-examine the whole area of coaxial cable systems so that a realistic assessment of their potential can be made. The development of multi purpose shared services coaxial cable systems promises high quality, effective and efficient means of communication previously unimaginable. The rapid advances in research and development since the 1950's and the growing convergence of a host of communication services present a number of serious problems which have to be resolved before coaxial cable systems can truly come into their own. Foremost among these problems are those of design, construction and operation of such cable systems, what services are possible and feasible and when these services could be made available.

In order to get a continuous and realistic projection of the future of coaxial cable systems the Department requires current, accurate and authoritative information on technological problems which arise from the use of coaxial cable systems to provide a number of different services. Specifically the Department has to know what coaxial cable systems are technologically possible, what they will cost and the type of services they could provide.

TERMS OF REFERENCE

In order to accomplish the objectives outlined above, a number of specific requirements have to be met. Specifically, the Department has to ascertain:-

(1) What is the true potential with respect to type and quantity of shared services that could be provided within a city on a common coaxial cable system, with the present and anticipated technology?

(2) What is the structure of multi-purpose coaxial cable systems that could simultaneously provide many one way and two way services?

(3) What is the construction costs for such systems?

(4) How could multi purpose coaxial cable systems tie into existing and proposed inter city telecommunication facilities?

Revised

Terms of Reference
for
Telecommission Study 8(d)

General

The Department of Communications is entrusted with the responsibility to ensure the optimum development of telecommunication services in Canada.

Advances in cable technology continue to make practical an ever increasing variety of telecommunication services. It is necessary now to re-examine the whole area of cable telecommunication systems so that a realistic assessment of their potential can be made. The development of multi-purpose shared services cable systems promises high quality, effective and efficient means of communication previously unimaginable. The rapid advances in research and development since the 1950's and the growing convergence of a host of communication services present a number of serious problems which have to be resolved before cable systems can truly come into their own. Foremost among these problems are those of design, construction and operation of such cable systems, what services are possible and feasible and when these services could be made available.

In order to get a continuous and realistic projection of the future of cable telecommunication systems the Department requires current, accurate and authoritative information on technological problems which arise from the use of cable systems to provide a number of different services. Specifically the Department has to know what cable telecommunication systems will be technologically possible, the type of services they could provide, and their impact on and use in alleviating congestion in other physical transportation and communication systems.

Terms of Reference

In order to accomplish the objectives outlined above, a number of specific requirements have to be met. Specifically, the Department has to ascertain: -

(1) What is the state of existing cable telecommunication systems in Canada with respect to their physical structure, limitations and capabilities?

(2) What is the structure of optimum multi-service cable telecommunication systems that could simultaneously provide many one way and two way services?

(3) What is the relationship between services and system properties?

(4) What is likely to be the impact of advanced telecommunication technology on other types of physical communication as well as its possible uses in solving urban congestion problems?

(5) How could the transition of (1) to (2) above, occur?