COMMUNICATIONS - SHARING RESOURCES

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ABSTRACT

This paper discusses how the conference theme of "Sharing Resources - Sharing Costs" is particularly true in the communications industry. Examples are drawn from the basic telephone network through to the most advanced computer communications networks now being offered - public, packet switched networks. Specific reference is made to the Datapac network offered by The Computer Communications Group of the TransCanada Telephone System.

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RESUME

Cette étude insiste sur l'importance des thèmes de cette conférence "Partage de Ressources" et "Partage des Frais" dans l'industrie de la communication. Des exemples sont relevées à partir des réseaux du système de téléphone jusqu'aux réseaux de communications par ordinateur, réseaux publics et les réseaux "packet switched". Nous étudions spécifiquement le réseau Datapac par le groupe de communications par ordinateur du système de téléphone trans-canadien.

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The conference theme is particularly appropriate for us since the sharing of resources and sharing costs is so close to our outlook on life in the communications industry. I hope to show today that the integration of communication and information science is a natural evolution and not something that is happening on an ad-hoc basis.

The real beginning of this evolution was about 100 years ago when the first telephone systems began. Telephone networks as we know them today did not exist. Each system consisted of dedicated, point-to-point connections. Each new system meant adding new equipment to handle the user's requirements. There was no sharing so each user bore the burden of the entire cost of "his" system. That there was no sharing of the resources involved did not make sense: all the equipment was not being used every minute of the day. People were paying for something they didn't use all the time. Also, a user of one system could not communicate with a user of another system. The systems were disjointed with no common bonds (other than the need to communicate with one other).

Then we added switches. Switches, as common equipment, made it possible to reduce the costs because some equipment was now being shared. However, the standards between the various telephone authorities weren't always compatible, and there was still some way to go before users could communicate with one another through the different telephone systems.

In the early 1900's, it became very apparent that a more rational approach was needed. What evolved is something that we are all familiar with - a universal voice network, which is based on agreed operating standards and technical characteristics. It was the only sensible way to go.

For the users, it was the most economic way to go. A user now pays on the basis of his use of the system resources. Rates for this arrangement are low because the costs of providing the system and the service can be distributed and shared over a much wider base.

These developments were fine for human communications, but in the 1960's the need for machine oriented communications was recognized, and the search for alternatives began in earnest.

Before I begin my discussion of what we have done for data communications, I think that it is important to review the role of communications networks.

The prime role of communications networks is the movement or exchange of information, whether in an audible, visual, or data format. By the effective application of this network function, other valuable resources can be developed, conserved, or put to more effective use. Even on the surface, the layman or businessman can easily comprehend that by the judicious utilization of the normal telephone or telegraph networks in lieu of travel or physical information delivery systems, time, economic, human, energy, and other physical resources can be conserved and put to more productive utilization on other endeavours. However, the life of every Canadian is becoming more affected by data communications networks and the computer systems which use them. The role of the common carrier is to provide an effective means of transmitting data between terminals and computers.

However, even with very large growth potential, these networks have finite capacities and capabilities. It is important that these Canadian communications resources are effectively developed, managed, and utilized. I shall give some examples of our experiences in progressing towards this goal.

To better appreciate some of the following discussion, it is helpful to have some background in basic communications terminology. In the short time provided, only the fundamentals can be given.

The national networks up to the early 1970's were primarily analog, as they were established mainly for the voice market. Thus, for the digital signals from data terminals to use these analog circuits, some sort of converter is required. It is called a data set or modem (modulator-demodulato Digital signals input to the modulator result in frequency tones on the analog circuit side. These frequency tones are transmitted along the analog circuit to the destination data set. Here the demodulator converts the frequency tones back into digital signals.

As a result of the superior performance, improved cost, and service flexibility of digital technology, the national communication networks will evolve from analog to digital, end-to-end.

Because of physical and economic limitations, a digital or analog signal is usually not carried end-to-end on a lengthy dedicated, discrete facility. Instead, they are multiplexed at a convenient location in the communication network with other signals to create a composite signal which is then carried on a trunk transmission facility. Near the destination, the signals are demultiplexed back to their original format. This trunk transmission facility could include one or many cable systems, microwave systems, or satellite systems, often interconnected by switching machines at nodal points. In most national systems, there are many stages or layers of multiplexing. Analog signals are usually frequency-division-multiplexed (FDM) where individual analog input signals are placed in discrete frequency slots within a wider bandwith, composite, analog signal. Digital signals are usually synchronous-time-division-multiplexed (STDM), where the individual digital input signals are placed in designated time slots within a higher rate, composite, digital signal.

With solid state electronic and large scale integration components, we now have the reliable technology at low cost to perform STDM in a digital format. One of the first public data communications networks in Canada (and indeed, in the world) using this technology was The Dataroute, introduced by CCG in 1973.

The Dataroute is a good example of how CCG made more efficient use of communications resources. Before its introduction, data circuits of 110 bps to 9600 bps were usually provided to customers by utilization of an analog circuit with data sets. There were shortcomings with this approach. One was that the quality of these circuits was optimized for voice requirements. Voice communications could tolerate certain noise conditions that cause errors with data transmission, particularly with the higher data speeds. Secondly, there was poor utilization of the 3-4 KHz bandwidth available, particularly with the lower data speeds. That is, a 300 bps data signal used the same voice channel as a 9600 bps data signal. CCG felt that many benefits could be derived for all customers, large and small, by the development of a shared public nation wide digital data network. At the same time, digital technology was becoming very reliable and more cost effective. Thus, in 1973, CCG introduced The Dataroute, one of the first such public digital networks in the world. Soon afterward, CNCP announced their Infodat network, built on a similar concept.

Dataroute is in essence a collection of low to high-speed time-division-multiplexers configured as a coast-to-coast network, with additional features built in. Because of Dataroute's digital technology, many benefits were derived. One was cost reduction. In a space formerly occupied by 12 normal voice channels, 500 data circuits of 110 bps could be carried. This cost benefit of this sharing was passed on to the customer in the form of lower rates, up to a 90% reduction in some cases.

Because The Dataroute is a shared public network, certain diagnostic and operational features are built in which might not be economic on private systems. Dataroute personnel from a central office can remotely loopback and test almost any Dataroute circuit in the surrounding area, thus saving valuable travel time. Another Dataroute feature is a minicomputer-based monitoring system which allows 24 hour surveillance of the network at CCG's Network Control Centre (NCC) in Ottawa. Any failure or high error rates are detected by the system. These capabilities, along with other CCG data services are connected into CCG's customer service centre, providing centralized customer reporting and maintenance.

Besides providing direct digital services to data customers, Dataroute provides CCG with a solid digital backbone on which to build other digital services. One example is CCG's most recently announced network, Datapac, Canada's first public packet network.

The Datapac Network is a public packet-switched data network providing usage-sensitive tariffed services to some 55 locations across Canada and to many cities in the United States. Datapac went into commercial operation in June 1977. CNCP have also announced a similar network called Infoswitch.

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Before discussing Datapac further, it would be appropriate to explain what packet-switching is. In data communications there are three basic forms of network services: private line, circuit-switched, and packet-switching. Other services such as message switching are usually built on to these networks. With private line, an end-to-end analog or digital communications channel is dedicated to a pair of users for as long as the service is subscribed to. The user usually pays for the service based on a fixed monthly rate, whether it is used or not. For users with high volumes, high utilizations, and long connect times to a single destination, this often is the most economic approach. The Dataroute is an example of a dedicated service.

With switched based services, users are given a dedicated access line to the nearest switching office for which he pays a fixed monthly rate. However, the communications path on the trunk between the switches is only provided to the users when they wish to transfer information. A link is dedicated to the user when a call is established, similar to when a person dials a telephone number. The user pays for the connect-time, with the timed rate depending on distance. However, even with circuit-switching there are some applications where the average circuit utilization is very low. In these cases, packet-switching is often the most efficient medium.

In circuit-switching, a dedicated link is established over the trunk between the two end users. With packet-switching, the trunk is dynamically shared. All user data is formatted into variable length blocks or packets, each with its own address at the header, and mixed with other users' data on the trunk, thus making efficient use of its trunks circuits. The user only pays for network usage based on the amount of data sent, not the duration of the call.

Apart from the economic advantages to many users, a packet network provides additional quality and reliability. Each data packet is sent through the network in a store-and-forward fashion and includes error detection codes such as Cyclic Redundancy Check (CRC). If and when an error is detected by the network, the packet is automatically retransmitted thus correcting the error. In the case of Datapac, each switching node is at least doubly connected to its neighbours. If a trunk or node should fail, the data is automatically rerouted, with no loss to the customer. This provides the customer with a very reliable, virtually error-free, end-to-end data circuit.

Similar to Dataroute, Datapac has a Control System built in as part of its original design, which allows efficient, rapid and remote surveillance, control, diagnosis, and maintenance of the network from one or more sites. The overall Dataroute and Datapac networks are monitored 24 hours a day from the NCC. Since Datapac uses The Dataroute for its trunks and access lines, this sharing provides a means of conserving valuable human and economic resources.

Datapac was and still is one of the few such networks in commercial operation in the world. The switching nodes used in Datapac are SL-10 data network processors manufactured by Northern Telecom Limited (NTL) and developed by Bell-Northern Research (BNR). The SL-10 hardware and software is a true modular multiprocessor packet-switching system, such that even with the failure of one control processor in a node, the machine will continue to operate with no loss of customer data. The SL-10 is 100% Canadian; only a handful of other manufacturers in the world presently offer similar commercial packet-switching products for sale.

Another area which makes more effective use of computer communications resources is the utilization of standards. In this case, they are the internationally approved communications interface standards or Recommendations of the International Telephone and Telegraph Consultative Committee (CCITT), an agency of the United Nations based in Geneva. For high speed customers, Datapac provides a synchronous interface compatible with (CCITT Recommendation) X.25.

For slower speed terminals Datapac provides an asynchronous interface, compatible with Recommendations X.3, X.28, and X.29. Right now CCG is implementing the full specification along with some national parameters defined specifically for the Canadian market. For planned international interconnection with other packet networks, Datapac will use Recommendation X.75. These standards are being adopted by carriers, manufacturers, and users all over the world, including the U.S., Canada, Europe, and Japan.

Now that we have seen how the basic Datapac network has been put together in terms of the sharing of technology, resources, and standards, I would like to address very briefly how users can gain access to the network and derive some of the benefits of this sharing.

We provide five Datapac access services at this time. I shall describe each of these and point out how we again apply the principle of sharing.

The first service provided on Datapac was Datapac 3000 service. Devices accessing the network on this service are required to provide an interface which we call SNAP or the Standard Network Access Protocol. This protocol or set of conventions is compatible with the CCITT Recommendation X.25 mentionned earlier. The protocol defines the manner in which calls are set-up, maintained, and cleared through Datapac by intelligent Data Terminating Equipment (DTE).

These DTE's may be host computers, intelligent front end processors, intelligent terminal concentrators, or intelligent terminals. (Intelligence here refers to the "programmability" of a device in terms of its communications control functions.) We have had an extensive campaign geared to getting the manufacturers of these kinds of devices to implement the X.25 standard in their product lines. We have had some success to date, but the real thrust is expected in the latter half of 1979 and in 1980.

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The X.25 protocol permits the sharing of a single medium or high speed line by many logical devices. In fact, the protocol specifies that up to 4095 logical connections can be made over one link. The real-life situations dictate that other considerations such as traffic loads and processor capacities significantly reduce the number to order of tens or hundreds. But the capability in the protocol remains if these factors are removed.

To the terminal user, the beauty of this arrangement is that his connection to a computer appears as real as if he were next door to the computer and connected by a strand of copper wire. There are other, tangible benefits such as a reduction of capital or expense dollars for hardware which can also be realized.

This service provides full duplex, synchronous capabilities at speeds ranging from 1200 bps to 9600 bps. Higher speeds will be offered in the future.

I mentionned earlier that Datapac provides an asynchronous interface for slower speed terminals. Typically, terminals in this category are teletypewriter - compatible and operate in the 110-1200 bps speed range. We call the Datapac access service for these devices Datapac 3101. This service requires the use of a shared concentrator called a NIM or Network Interface Machine. A NIM handles the X.25 packet assembly/disassembly conversions and terminal control functions.

There are several ways in which a user can access Datapac using Datapac 3101. We offer public dial ports in the 55 cities across Canada where direct access to Datapac is provided. These ports are shared among many users on a first-come, first-served contention basis. Because these ports are shared, we recover the cost of our resources by charging a holding time charge for the length of time a user remains connected to the port. For many, this is a very acceptable way of accessing the network because their connect times are low and they do not use the ports very much at any one time.

We also offer private dial ports for those users who wish to control the amount of contention at their ports or to enhance the operation of their system on the network.

Some users will use a port at such a sufficiently high rate that they will benefit from a dedicated connection to the network. The resource - the line in this case, is highly utilized, and there is no benefit in sharing on this portion of the network.

Datapac 3201 offers a means of access to the network for polled, asynchronous terminals, specifically electronic cash registers (ECR's) and any associated controllers or credit check pads.

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This service is aimed at retailers' point of sale systems where on-line data capture and credit checks are important. The major retail chains and smaller operators of specialty and variety stores will find this service particularly attractive. The typical Datapac 3201 configuration shows a NIM polling the ECR's on shared, multi-point facilities. For example, we could run a facility down the main street of Calgary and pick up ten different retailers, each with one or two ECR's in a store. Each store would have its own connection to the network. The low rates for this service reflect the reduction in our costs of serving these stores because of the sharing of the facility.

In addition, the NIM performs a polling function that normally resides in each host computer, thus the "polling" resource is shared as well. This capability for the network to do the polling relieves a major overhead expense, in both hardware and software terms, for most host computer polling environments. The concentration and control functions of an X.25 interface also help make this possible.

Another Datapac access service which has a similar configuration to Datapac 3201 is Datapac 3203. In this instance, the NIM polls financial teleprinters over the shared, multi-point facilities. Again, the sharing concept at the network access level has made it possible for us to lower our costs and hence our rates. And some more customers can afford the implementation of an on-line information system as a result.

Thus far, I have addressed systems which are basically comprised of short message, transaction-oriented applications. There are other types of application which can be served by the packet switching networks.

In February of this year, we announced that we would provide Datapac 3303 service. This service supports the IBM 3270 Terminal Display System and its many emulators. These devices are used in many branches of information based systems. The traffic from some of the applications can be served by packet technology.

The typical operating environment for these devices is in multi-point, dedicated line configurations in which each customer pays for full use of facilities, even though the actual use for information transfer itself is quite low. There is a lot of communications overhead when polling multi-point terminals or concentrators in trans Canada configurations. By having a NIM perform this polling function in a "local" polling arrangement and by removing the physical polling routines from the front end processor, we are again able to optimize the network resources by sharing these resources among these 3270 users. But we are also sharing the same resources on the "backbone" network among the Datapac 3000, 3101, 3201, and 3203 users.

We have plans to support other types of applications, such as batch and possibly message, and these will evolve with the growth of the existing Datapac access services.

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The existence and development of packet networks in other countries around the world supports the direction of the sharing philosophy that we have seen in Canada's packet switching network. Packet networks are now fully operational in the U.S.A., France, Britain, and Spain. Japan and the major European community will be offering packet network services by mid 1980, and many other countries will operating packet networks in the 1980's. For the Canadian user of information services, there is a real opportunity to communicate effectively and economically on an international basis.

Ever since we announced Datapac, we have indicated our intention to connect with other packet networks around the world. Last May we began offering service to the continental U.S.A. when we connected with the value-added, packet networks, Telenet and TYMNET. Later this year, we will begin offering service to Britain through the International Packet Switching Service provided by the British Post Office. Connections to other packet networks will follow.

The current arrangements with the American networks allows users of Datapac 3000 and 3101 services in Canada to communicate with users of compatible services in the U.S.A. Several multinational corporations have begun to use these services for their day-to-day operations. Large American bibliographic data base retrieval services are accessed daily by Canadian terminal users. Some Canadian service bureaux using Datapac 3000 service have U.S. terminal users accessing the services and data bases they offer.

The rates and services characteristics of these international services provide an excellent opportunity for the Canadian shared processor industry to expand the scope of their operations beyond Canadian borders. All these opportunities would not even be available if the communications resources of Canada and other countries were not shared.

In the future, we can see the sharing of our resources extend beyond the milestones we have achieved for data communications. With digital technology expanding at an ever increasing pace, there will be more pressure to merge the voice and data networks. This merger presents many possible scenarios about how we can use communications. Only the bounds of our imagination will be the limits of these uses.

Our continuing commitment to the principle of sharing resources in communications will ensure that communications capabilities are not the barriers to the effective transfer of information among users, wherever they may reside.