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TECHNICAL PROBLEMS OF CANADIAN DATA NETWORK INTERWORKING

I - Identification of Data Network Interconnections

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Executive Summary

This report is the first of four on the technical problems of Canadian data network interworking. This investigation was undertaken for the Department of Communications under Department of Supply and Services contract OSU77-00319. The overall objective was to produce an appraisal of the technical problems and cost implications of possible future interconnections and interworking between the following Canadian data networks: Infoswitch, Datapac, Telex, TWX, dial telephone, and Infodat and Dataroute leased lines. The major emphasis was to be on the Datapac-Infoswitch and Infoswitch-dialed telephone interconnections.

The overall study is divided into four major areas, each with a separate report. These areas are:

(I) Identification of Data Network Interconnections

(II) Analysis of Datapac-Infoswitch Interworking

(III) Infoswitch-Dialed Networks Interconnection

(IV) Datapac/Infoswitch - Other Data Networks Interconnections

This report considers the first item: the identification of potentially desirable data network interconnections. The detailed objectives of this component of the study, as listed in the contract work statement, were as follows:

(1) For public data networks, taking into consideration
(a) the technical characteristics of existing and emerging data networks in Canada, and
(b) the future 10 year projected growth of different categories of data terminals, and their geographical location and concentrations in Canada, and
(c) the projected types and volumes of data traffic that will be placed separately on each of the various public data networks,
identify those combinations of data network interconnections that might be potentially desirable and are technically and economically feasible.

(2) For closed user groups, considering the potential traffic needs of large closed user groups such as those for COSTPRO, Electronic Funds Transfer Systems (EFTS) and the Government Telecommunications Agency (GTA), is there a need for interworking or interconnection between the public data networks?

The study indicates that all possible network interconnections and interworkings can be divided into three categories: range extension, access extension, and interworking. Range extension interconnections are where the services of one network are extended to a larger geographical area by an extension using some other communications service as a transport medium with the only protocol visible to the user being that of the target network. Access extension is where convenient access to a network is extended by utilizing some other communications service as a "front-end" to

the network or as a network access link. However, unlike range extension, in this case the user is aware of the access network protocol, and must use it to reach the target network. Finally, interworking occurs where two, or more, networks co-operate to provide the same service over a larger geographical area for their total set of users.

It is found that both the access extending (i.e., dial telephone - other networks) and the interworking (Infoswitch-Datapac, Telex-TWX and Telex/TWX - Infoswitch/Datapac) connections appear to be desirable from the user's point-of-view, and are technically and economically feasible. However, while some range extension services now exist, i.e. leased line-Telex, and others are technically feasible, the need for this type of service appears small, and the same benefit to users could be provided by either lower tariffs or by interworking.

The detailed observations and conclusions are listed below. It will be noted that none relate specifically to closed user groups. At this time neither COSTPRO nor EFTS communications requirements are sufficiently well defined to permit analysis as separate user groups. For these two groups the best estimate of their future service requirements indicates that they will be some combination of point-of-sale, inquiry-response and possibly remote batch. Hence to the extent that we considered these three applications, we considered COSTPRO and EFTS as completely as possible at the current time. The GTA situation is different, in that useful information exists with respect to traffic and terminal counts. However it is not a homogeneous group, but a collection of users whose requirements are the same as many non-governmental users. Hence any consideration of general user community includes all interconnections that are of interest to the GTA.

Finally, it should be noted that only limited data related to expected communications terminal growth is available. Hence, all growth projections should only be viewed as possible trends, and not as reliable predictions.

Data Communication Growth Trends

The number of terminals in most applications areas will grow at approximately 20% per year for the next few years (Section 2.2).

The number of point of sale terminals will increase more rapidly than the average, possibly up to 50% per year (Section 2.2.1).

By 1985, between 50 to 80% of all terminals could be point-of-sale (Section 2.2.1).

Remote batch terminals, while increasing at only 10% per year, and by 1985 amounting to only 2% of all terminals, will account for 50% of all data traffic (Section 2.2.2).

Tariff structures, along with increasing urbanization, tend to encourage centralization, leading to growth being concentrated in larger centres, especially Toronto (Sections 2.3, 2.6, 3.2.1).

Telex and TWX will grow at the same rate as the total economy (Section 2.5).

Telex and TWX growth past 1985 will depend greatly on the effect of service enhancements (Section 2.5.).

By 1985 Datapac will serve approximately 10% of all terminals. Infoswitch will serve fewer than Datapac (Section 2.4).

If Bell Canada's estimates are valid, Datapac will serve most of the remote batch terminals (Section 2.4).

Continued centralization indicates that the dial telephone will continue as a convenient and economic method for local data communications between low speed terminals and computers (e.g. time sharing) (Section 2.6).

Preferred Networks for Point-of-Sale Terminal Service

Continued centralization implies that leased lines and concentrators will continue as an effective long distance service (Section 2.6).

Dial telephone appears to be attractive for credit card verification activities (Section 2.2.1).

Credit card verification activities would benefit from Datapac-Infoswitch interworking (Section 2.2.1).

Credit card verification activities would benefit from dial telephone access to Datapac, Infoswitch and private leased line networks (Section 2.2.1).

For point-of-sale activities, depending on operation, leased line, packet switching and circuit switching all may be feasible (Section 2.2.1).

Range Extension Interconnections

Range extension interconnections of leased line to leased line, Datapac, Infoswitch, Telex or TWX are all feasible (Section 3.1).

Range extension interconnections effectively exist for Datapac, Infoswitch and Telex. (Section 3.2.3, 3.2.4.)

Range extension interconnections to packet switched services are of value to (1) users in the small number of centres not serviced by one but not both TCTS and CNCP, and (2) high volume users "remote" from their main computing centre (Section 2.3, 3.2.1, 3.2.3).

A major benefit of range extension interconnection for high volume users is the reduction in cost obtained by accessing on-mesh switching nodes (Section 3.2.3). Reduction in tariffs for high volume users would give identical benefits and hence these interconnections are not necessary from a service viewpoint (Section 3.2.5).

The need for most other range extension interconnections would be eliminated by providing Datapac-Infoswitch interworking (Section 3.2.5).

Leased line-leased line (Dataroute-Infodat) interconnection is only needed for a small group of cities serviced by either Dataroute or Infodat but not by both, and is of doubtful economic justification given the small number of users (Section 3.2.5).

Moreover, allowing users to connect both Dataroute and Infodat lines to the same computer would eliminate any small demand for Dataroute-Infodat interconnection (Section 3.2.5).

Access Extension Interconnections

Dial telephone access to Datapac, Infoswitch and private leased-line networks will continue to be of benefit to many users (Sections 2.2.1, 3.3).

Dial access exists for Datapac and Dataroute.

Dial access to Infoswitch and Infodat is technically and economically feasible (Section 3.3.3).

Interworking

Datapac-Infoswitch interworking is technically and economically feasible, and is of value to users (Section 3.4.2).

Connections within Infoswitch, namely Infoexchange to Infogram may be of possible interest to users. This interconnection appears to be of the same degree of complexity as Infoexchange-Datapac (Section 3.4.3).

Telex-TWX represent the same user community, and the users would benefit from interconnection. The connection is technically and economically feasible (Section 3.4.4).

Both Infocall and Datapac are close to being able to provide a Telex-TWX like service. Interworking either Telex or TWX with either Infocall or Datapac could provide a low cost nationwide message switching service. Such a service is technically feasible (Section 3.4.6).

Dial telephone access to Telex or TWX would benefit some users (Section 3.4.5).

EFTS

Several scenarios for the provision of EFTS, in the absence of carrier network interworking, are provided in Section 4. They are all technically feasible but the policy implications vary widely.

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1. INTRODUCTION

This report is the first of four reporting on a study of the technical problems of Canadian data network interworking. This study was undertaken for the Department of Communications under Department of Supply and Services contract OSU77-00319. The overall objective was to produce an appraisal of the technical problems and cost implications of possible future interconnections and interworking between the following Canadian data networks: Infoswitch, Datapac, Telex, TWX, dial telephone, and Infodat and Dataroute leased lines. The major emphasis was to be on the Datapac-Infoswitch and Infoswitch-dialed telephone interconnections.

The overall study is divided into four major areas, each with a separate report. These areas are:

I - Identification of Data Network Interconnections

II - Analysis of Datapac-Infoswitch Interworking

III - Infoswitch-Dialed Networks Interconnection

IV - Datapac/Infoswitch - Other Data Networks Interconnections

This report considers the first item: the identification of potentially desirable data network interconnections, with comments on their technical and economic feasibility. The other topics are discussed in the companion reports [6-8]. The detailed objectives of this segment of the study, as listed in the contract work statement, were as follows:

1. For public data networks, taking into consideration

(a) the technical characteristics of existing and emerging data networks in Canada, and

(b) the future 10 year projected growth of different categories of data terminals, and their geographical location and concentrations in Canada, and

(c) the projected types and volumes of data traffic that will be placed separately on each of the various public data networks,

identify those combinations of data network interconnections that might be potentially desirable and are technically and economically feasible.

2. For closed user groups, considering the potential traffic needs of large closed user groups such as those for COSTPRO, Electronic Funds Transfer Systems (EFTS) and the Government Telecommunications Agency (GTA), is there a need for interworking or interconnection between the public data networks?

3. Because the exact nature of services and detailed traffic predictions for EFTS were not available at the time of preparation of this report, we were requested to examine possible network approaches for the provision of EFTS systems using Canada's public data networks in the absence of a carrier-provided internetwork service.

The advantages and disadvantages of each approach are to be discussed as they relate to the banks, big businesses, small businesses, the consumer, the common data carriers and the regulatory bodies.

The traffic data bases and projections of future growth were, to the extent possible, to be supplied by the Department of Communications. It was found, as the work progressed, that meaningful data of this nature were very scarce. Hence, estimates of much shorter duration than 10 years were used. This is not considered a serious disadvantage; the major trends are apparent, and with the rapid evolution in data communications, any detailed long term projections would only create a false sense of certainity about a very uncertain future.

The report does not specifically consider the closed user groups indicated under 2 above. First, with respect to COSTPRO, it has been shown [5] that the COSTPRO projections are of doubtful validity, and of a very general nature. Second, with respect to EFTS, these systems are still in the discussion stage. Comments from equipment manufacturers indicate that EFTS is still in the future, probably in the late 1980's [9]. Hence, for both these closed user groups the best estimate of their characteristics is that they will be some combination of current activities, i.e., point-of-sale (POS), inquiry-response, and possibly remote batch.

Hence, to the extent that we consider these three services, we have considered COSTPRO and EFTS to the depth possible based on current information. However, a number of approaches for the provision of EFTS systems using the packet-switched networks in the absence of carrier-provided internetworking are considered. The GTA is a different situation; here recent and reasonably detailed statistics on current use, but not growth, are available. However, as shown in [5], it is not a closed user group, but a collection of users, whose activities reflect essentially the same range of service requirements as non-government users. Hence, any consideration of the general population requirements will include all the interconnections that would be of interest to the GTA.

In summary, on the basis of currently available information, there is no need to consider the closed user group requirements separately, nor is it possible to do so meaningfully.

The questions of growth in number of terminals and traffic, and the effect of geographical location are discussed in Section 2 of the report. The indications are that all data communications activity except Telex/TWX will grow at a rate well above the general economy. The major growth area will be point-of-sale (POS), and it will represent the dominant area for new terminal acquisition.

However, remote batch will continue to be the dominant activity from a traffic viewpoint. It is projected that by 1985 Datapac and Infoswitch will each service less than 10% of the total terminal installations.

In Section 3, the various interworking combinations are considered for usefulness, and technical and economic feasibility. Interconnections can be divided into three classifications based on their purpose: range extension, access extending and interworking. It is found that both the access extending (i.e., dial telephone - other networks) and the interworking (Infoswitch-Datapac, Telex-TWX and Telex/TWX - Infoswitch/Datapac) connections appear to be desirable from the users' point-of-view, and are technically and economically feasible.

In Section 4, several approaches for the provision of EFTS systems using the two Canadian packet-switched networks, Datapac and Infoswitch, in the absence of common carrier-provided internetworking are discussed. The advantages and disadvantages of each approach for the banks, large and small businesses, the consumer, the common data carriers and the regulatory bodies are detailed. Although all the approaches are technically feasible, the economic and regulatory feasibility of some of the suggested approaches may be dubious.

For both Sections 2 and 3 the conclusions are summarized at the end of the section, and in Section 3, at the end of the major sub-sections. For convenient reference, the major conclusions are collected in point form in the Executive Summary.

2. PROJECTED GROWTH IN COMPUTER COMMUNICATIONS

2.1 Introduction

It is difficult to make a meaningful prediction of the anticipated overall growth in computer communications, and on an individual service basis it approaches the impossible. The carriers are in the best position to make such predictions, and indeed must do so for business planning purposes. However, in making such predictions they have knowledge of

1. their present customer base,
2. the historical growth rate, and
3. some idea, based on past sales experience, of the relationship between the type of service, the cost of the service, and the expected growth.

Consequently, in this section we will base our estimates primarily on carrier provided information, rather than on users' thinking, frequently wistful, of what they will do.

Estimates must be used with caution, especially for recently developed services. A classic example of the errors possible in predicting growth is the paper "Future Data Traffic", by R.W. Hough [1], projecting all data traffic in the U.S.A. up until 1990 (including mail, T.V., telephone). The conclusions developed there indicated that by 1990 video (i.e., Picturephone) traffic would amount to 100 times as much as all other data traffic combined. However, as we know, the picturephone was a commercial disaster. This was not due to technical reasons but resulted from neglect of human factors; picturephone was not what the users required. A very similar situation exists today with respect to data communications. There is a wide variety of communications services:

leased line, circuit switching, packet switching, and many proposed services based on applications of these, such as COSTPRO, Telidon and EFTS. They are all technically sound; all the applications are of strong interest to some people; however, it is too early to make reasonable estimates of growth rates since the growth will depend very strongly on human factors such as convenience and availability, and on the details of the services provided. Hence, while we shall present various projections, and comment on them, this is done with a strong warning that they should only be viewed as possible trends, and not as reliable predictions.

2.2 Growth in Selected Application Areas

Figure 1 shows a projection of the total Canadian terminal population for the period 1976 to 1982 as estimated by Bell Canada in 1978 [2]. With the exception of POS (inquiry-response) and remote batch the anticipated growth in each application area is about 20% per year. This agrees reasonably well with projections for 1976-1980 from the Datacom'76 survey of users which indicates about 15% per year [3, Figure 1].

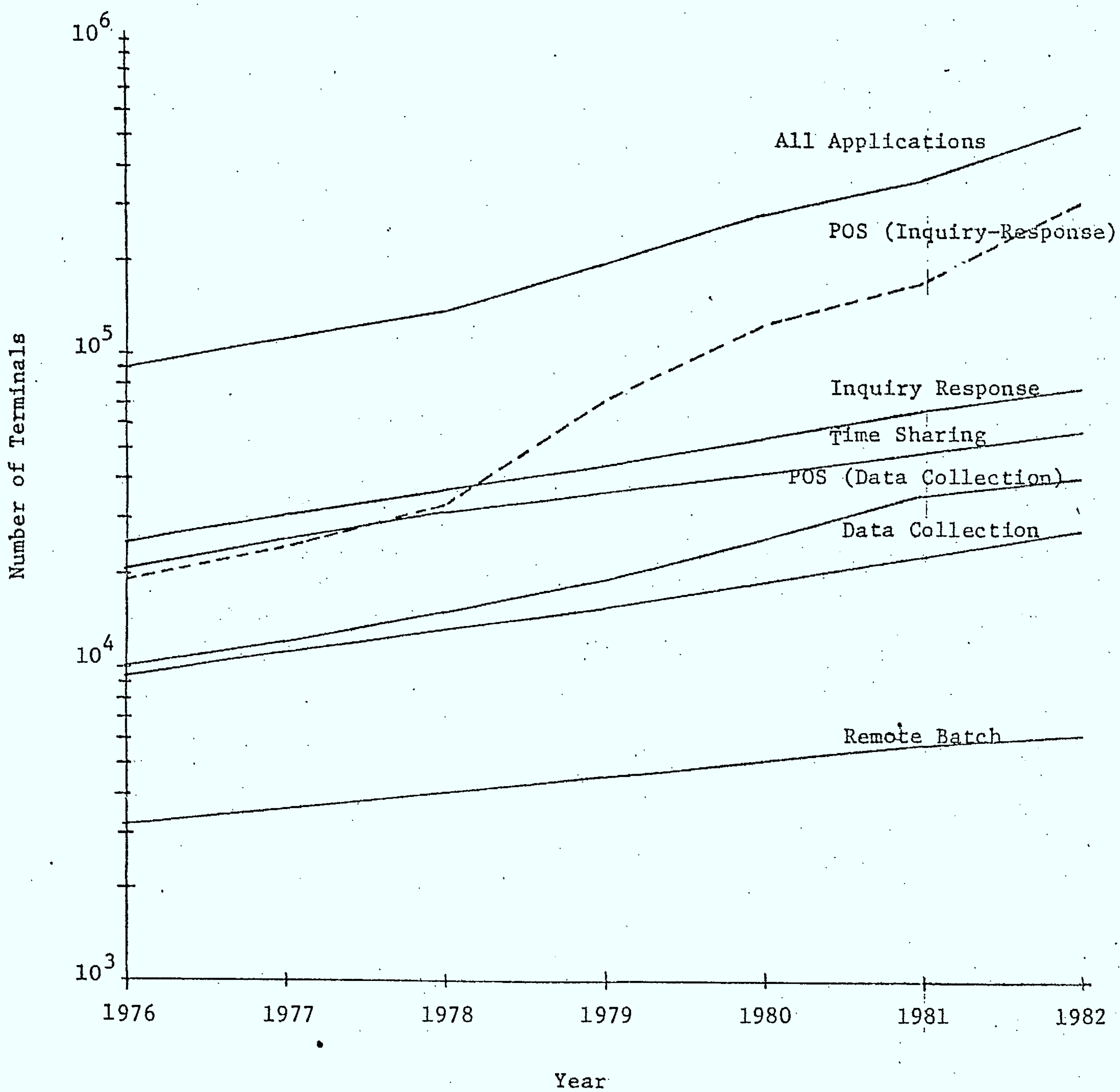

Figure 1: Projected Canadian Terminal Population

Two cautionary remarks are necessary with respect to interpreting Figure 1. First, the vertical scale in number of terminals is logarithmic. Hence equal separation between two upwards trending lines represents many more terminals at the right side of the figure than at the left side, and further a small variation in growth rate (slope of line) can represent a very large number of terminals over a few years' span. Second, any projection of growth at some constant percentage per year, represented by a straight line in the figure,

is basically unrealistic, since all growth must ultimately saturate. The point at which this saturation will occur depends significantly on the performance of the overall economy over the next few years, and hence is impossible to predict. It is unlikely that it will occur before 1985.

In conclusion, it would appear that terminal growth at the rate of 20% per year is a reasonable estimate for most activities, with POS applications (to be discussed in Section 2.2.1) having a considerably higher growth rate and Remote Batch (to be discussed in Section 2.2.2) having a somewhat lower value. It is not possible to predict which of the available communications services will be adopted by future terminal installations.

2.2.1 Consumer Point Of Sale

Discussions in the literature of consumer point of sale applications indicate that this is expected to be a major growth area for data networks. The traffic generated may be either of the inquiry-response type, as in credit verification calls, or may be of the transaction data type if the records of point of sale transactions are centralized. However, few discussions make any attempt to estimate values for either the expected traffic or number of terminals. Two projections, POS (inquiry-response) and POS (data collection), supplied by Bell Canada [2] are shown in Figure 1.

The POS (inquiry-response) terminal projection is particularly interesting. Over the period 1979 to 1982 the estimated growth rate varies between 30% and 120%, seemingly at random. The reason why Bell Canada split the POS data into two groups is unknown. A possible speculation is that the inquiry-response group represents activities such as credit card verification, while data collection represents detailed credit billing types of application.

Another estimate of point-of-sale terminals in the retail trade is 111,000 by 1983 [9]. This estimate was developed from the number and size of retail businesses operating in Canada. The estimate includes approximately half of the "point-of-value transfer locations" that currently exist in the retail sector.

While both of the above projections indicate strong growth for POS applications, the large discrepancy in magnitude makes a reasonable quantitative prediction difficult. However between 50% to 80% of all terminals could be of this class by 1985. A growth rate anywhere in the range of 25% to 50% seems possible.

The division of the growth in POS applications among communication services is not clear. Generally, these systems are characterized by many (and in the case of credit verification, simple) terminals which require access to one point, or perhaps to one of a very few alternate central points. In many cases local concentrators are used to multiplex the data before transmission. Some organizations are currently operating over private networks developed using

leased lines. Packet switching is an alternative that appears equally feasible. The Datapac 3201 service appears to have been designed with POS applications in mind. One company has been reported as using it for sales data collection from 190 stores across Canada [10]. It should be noted, however, that POS systems do not necessarily require continuous communications activity. Some systems record sales data locally, and transfer it to a central site upon demand during the evening. For such a situation circuit switching could be very appropriate. For credit verification applications either circuit switching or packet switching would seem reasonable. In all cases, the identity of the best service i.e., most economic, reliable, etc., depends on the specific application as well as the carrier.

Although the digital communication services provide possible methods of connecting POS terminals, the low cost, availability, and possible alternate use of the dial telephone system also make it very attractive to the small general retailer, especially for credit card verification. One of the immediate problems associated with placing point of sale traffic on the dial telephone network is the nature of the terminals. These may require, in addition to the handset, devices such as numeric keyboards, touch-tone keyboards, credit card bar code readers, or other gadgets which complicate the terminal and raise requirements for framing protocols. Such a transaction telephone was one of the first applications of microprocessors in the U.S.A. telephone system (1974) [12].

While it is impossible to predict what fraction of POS users will use a given communications service, it can be stated that interconnection and interworking will be required, particularly for credit verification type functions. Firstly, for economic reasons, no major system is likely to be wholely dial telephone oriented, but rather the dial telephone will be used to access the local port of a leased line, packet or circuit switched nationwide service.

Secondly, since it is unlikely that all credit card verification services will be on one network, some form of interworking is very desirable to allow a retailer on one network to access the credit verification services which use the other.

2.2.2 Remote Batch Terminals

The remote batch terminal estimates in Figure 1 appear reasonable. While the value in 1976 is approximately three times that reported in the Datacom'76 "leading edge" survey [3, Figure 20], that survey made no attempt to survey the total community and hence such a multiplier is not unreasonable.

The growth rate projection also appears reasonable. While remote batch activities continue to grow, it is an established technology relative to activities such as time share, inquiry-response, on line banking, etc. and hence should have a lower growth rate.

It is very important to note that the Datacom'76 survey showed that remote batch terminals, while only 5% of the total terminals, accounted for 73% of the data communications traffic, and normally represent high volume high speed communications. With a projected growth rate of only about half that for other applications, the remote batch terminals will be only approximately 2% of the total terminal population by 1985. However, they will still account for 50% of the total data traffic. Bell Canada projections for Datapac [4] indicate that in 1982 they expect approximately half the packets to be due to remote batch. Hence, in spite of their small numbers these terminals will be the dominant factor in designing network communications channels and switch buffer capacities.

2.3 Geographical Distribution

The geographical distribution of data terminals can be expected to be more concentrated than the distribution of the general population, because of the way in which commercial activity converges disproportionately at a very few major centres of population. As projected population growth shows further urbanization, commercial activity and the associated data terminals will show an even greater geographical concentration.

Communication tariffs from data carriers always show a decreasing per unit charge at longer distances. This has the effect of shrinking the distances between widely separated points as far as cost is concerned. The result is definitely to discourage decentralization of data handling facilities, and to prevent the fragmentation of processing among regional centres in favour of a single centre of concentration. In 1976 it was found that 67% of data traffic in Canada had the Toronto region as the computer location [3].

For these reasons, we see the geographical development of data networks very much in terms of the hub and spokes of a wheel. Even where the carrier has established a mesh communications network across the country, it is to be anticipated that the major traffic flows will be radial from single centres of concentration. It follows that the logical organization from the point of view of efficient use of communications facilities would be long leased line high volume trunks to and from remote concentrators and multiplexers. An example of this pertaining to off mesh points gaining access to the Datapac mesh network is considered in Section 3.2.3, and similarly for teletype zones in Section 3.2.4. It is observed here that similar reasoning applies to nationwide networks, and that for a sufficiently high volume of traffic, it becomes economical to by-pass the network by a leased trunk to the centre of concentration. The traffic volume necessary for such an arrangement to be economical, taking into account the extra access charges, would be something in excess of one third of the full 24 hour traffic capacity of the lines.

2.4 Datapac and Infoswitch Growth

Only limited information for Datapac, and no information for Infoswitch, is available with respect to expected growth. In Figure 2 is shown the projected growth for Datapac (Bell Canada, 1976) [4]. The interesting feature is that by 1982 the total estimated Datapac growth rate is

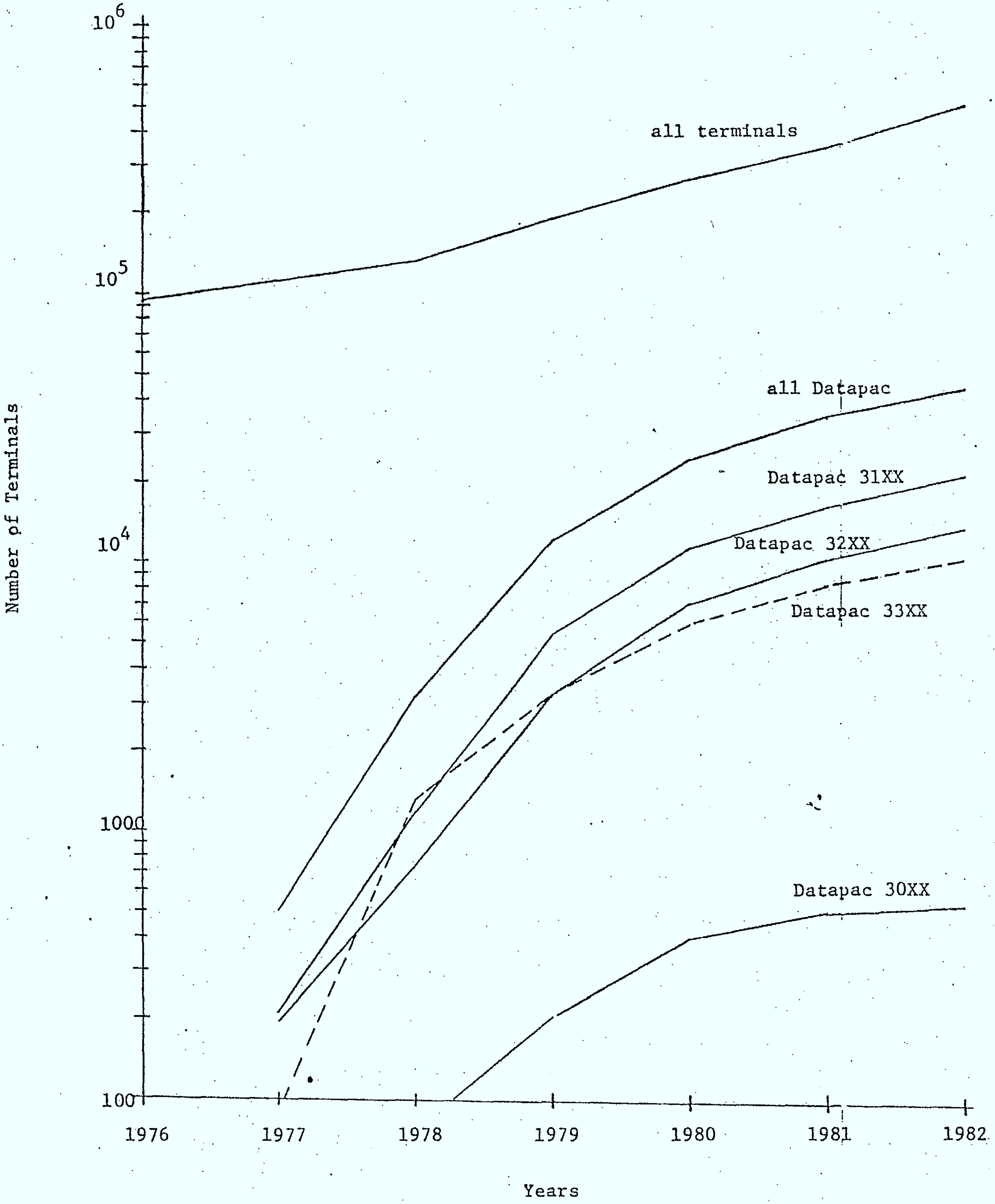

Figure 2: Projected Datapac Terminal Population

levelling out to approximately the same rate as for the total terminal estimates of Figure 1, with the number of Datapac terminals being approximately 10% of the total. Further, considered on an incremental basis, the estimated new Datapac installations range from 15% (1979) to 6% (1982) of the estimated total terminal installations.

These observations must be used with care. The data in both figures represents "stale" estimates; unfortunately more recent estimates are not available. Further, there are some identifiable errors, namely, the values for Datapac 33XX service. This service for remote batch terminals was only recently announced. Further the number of such applications projected for this service by 1982 exceeds by approximately two times the total estimated population of remote batch terminals. Against these observations it must be noted that both estimates were produced by the same organization, and that their view of trends should not have changed significantly in the period between the two estimates. Hence one is left with two alternatives: (1) the two sets of data are reasonably consistant which leads to the conclusion Datapac will only service about 10% of the total terminals (this is not necessarily equivalent to 10% of the communication traffic) or (2) at least one set of data is faulty, which leads to no conclusion being possible.

One area where the estimates appear significant is for remote batch processing applications. The estimates in Figure 1 appear reasonable. For example, the value in 1976 is approximately three times those reported in the Datacom'76 "leading edge" survey [3, Figure 20]. The Datapac 33XX service estimates in Figure 2 exceed the estimated terminal count from Figure 1. While this is impossible, and the estimates for 33XX service are obviously high since the first of this series, 3303, was not officially announced until April 1979, it should be noted that these estimates imply that Bell Canada expects to capture <u>all</u> the users of this service. This application accounts for approximately 70% of the data communications traffic in Canada (Datacom'76 [3]). Economic analysis contained in [5] tends to confirm that such a capture is possible. Against the economic arguments, however, there are the questions of convenience, reliability, etc., that are impossible to assess. Hence, while such a capture is possible, the growth rate is impossible to predict.

No estimates are available for the expected number of Infoswitch installations. Based on relative economic analysis as reported in [5], it is unlikely that Infoswitch will be more popular than Datapac. Therefore it is probable that Infoswitch will also only capture a small share of the market.

2.5 Telex and TWX Growth

The number of Telex and TWX terminals is relatively small, in the order of 40,000 with approximately 90% being Telex. Data filed with the CRTC indicate that the carriers anticipate a growth in revenues in this area of 6 to 7% per year over the 1978 to 1982 period. Undoubtedly part of this increase will be made up by increased usage of existing terminals, hence the increase in number of terminals will be less than 6%. This is of the same order of growth that is typically predicted for the economy as a whole.

On the surface there is little reason to expect any dramatic deviation from these slow growth predictions. However, two users on asynchronous Infocall can use Infocall to provide a Telex-like service at greatly reduced costs. Permanently connected Datapac 3101 could be easily enhanced to do the same thing. Such connections would, of course, lack the existing large Telex and TWX subscriber list. Some sort of merged Telex-Infocall or TWX-Datapac (or combination) could greatly alter the economics of this service and lead to significant changes. In this regard it should be noted that discussions of extensions to Telex are already taking place in CCITT. Hence, because of the possible interconnection with other services, the long term future for Telex-TWX is unlikely to be the slow growth forecast by the carriers. A prediction of when, and by how much, the terminal counts and traffic flow will be altered is impossible since it depends on the offering of a new service. However, given the normal slow development of Telex and TWX separately, and slow large scale acceptance of new services, it is unlikely that any major change will occur before 1985.

2.6 Summary - Projected Growth

On the basis of the limited information available it appears as if the number of data communications terminals in many applications will continue to grow at a rate in the order of 20% per year until at least 1985. It is very probable that POS applications will grow at up to twice that rate, and will provide over half the terminal count by 1985. Remote batch applications will grow at a lower rate, but by 1985 will still account for 50% of the total data communications traffic.

The traditional message switching services, Telex and TWX, will probably grow at about the same rate as the overall economy in the short term. Beyond that, interworking with Infoswitch or Datapac, or improvements due to new technology, will probably cause major changes in services and costs. The timing of such a change cannot be predicted.

The growth will continue to be concentrated in major cities, with Toronto being the dominant area. This concentration means that the dial telephone will continue to be a convenient and economic method of local data communications, with leased lines with concentrators continuing to be economic for long distance activities. The Datapac and Infoswitch networks will probably have less than 10% of the terminals by 1985. However, it is very probable that these networks will carry a much greater fraction of the data traffic.

In view of the rapidly changing nature of data communications, computers and terminals, the cost and usefulness of a service may change rapidly. Hence, while the above projections indicate general trends, there is little point in trying to obtain a more detailed breakdown. It should also be noted that some aspects of computer communication may be very sensitive to the overall economy. In particular, depending on economic conditions firms may advance or defer the large investment needed for POS. Therefore one should not be greatly surprised when reality differs from the projections.

3. POTENTIAL AREAS FOR INTERWORKING AND INTERCONNECTION

3.1 Introduction

One can make an argument that there is a real user need for every combination of interconnections between pairs of data communications services. Similarly one can argue that all such interconnections are technically feasible, since connecting the two services to a single computer would provide an interconnection mechanism. The real questions are: how much simpler the interconnection can be made than a computer, and whether there is sufficient demand to justify the cost of the resulting interconnections. The question of demand will be discussed in the following sections, while the detailed technical considerations are covered primarily in the companion reports [6-8].

Before discussing a method of classifying interconnections, the common feature of interconnection speeds must be considered. In Table 1 are shown the data transmission speeds available for the various services. It will be noted that the speeds available are essentially the same across all services. Further the most common speeds for data transmission, 300, 600, 1200 and 2400 bit/s [3,5], are universal for the data communications services. Hence there is no significant data transmission speed capability barrier to interconnection provided both end points operate at the same speed.

Table 1

Line Speeds Available

Asynchronous:

	50,	75,	110,	134.5,	150,	300,	600,	1200
Dataroute	X	X	X	X	X	X	X	X
Infodat	X	X	X	X	X	X	X	X
Infoexchange			X	X		X	X	X
Infocall			X	X		X	X	X
Datapac 3101			X		X	X	X	X
Telex	X	X	X					

Synchronous:

	1200,	2400,	4800,	9600,	19200,	50000
Dataroute	X	X	X	X	X	X
Infodat	X	X	X	X	X	X
Infoexchange	X	X	X	X		
Datapac	X	X	X	X		
Infogram	X	X	X	X		

Connections between different speed end-points are not available, except for the packet systems, due to lack of flow control protocols to prevent overrun, etc. This restriction would obviously also apply to any interconnection. Some speed change could be accommodated by inserting multiplexors or concentrators for cases of several low speed terminals connecting to one higher speed system. (The packet networks normally fall into this class when the end-points are at different speeds.) Providing more general speed changing than this requires the provision of storage and flow control mechanisms, i.e., converting the interconnection to a packet or message system. It also means that the higher speed end would be operating much below rated speed, which is wasteful of channel capacity. However, given the wide range of speeds available on modern terminals, and the wide range of speeds supported by the carriers, we see no need for a general speed-changing interconnection. Hence, for the balance of the discussion we will assume that speed change does not occur except for packet or message networks.

All possible network interconnections and interworkings can be classified into three categories: range extension, access extension, and interworking. Range extension interconnections are where the services of one network are extended to a larger geographical area by an extension using some other communications service as a transport medium with the only protocol visible to the user being that of the target network. Access extension is where convenient access to a network is extended by utilizing some other communications service as a "front-end" to the network or as a network access link. However, unlike range extension, in this case the user is aware of the access network protocol, and must use it to reach the target network. Finally, interworking occurs where two, or more, networks co-operate to provide the same service over a larger geographical area or for their total set of users. Each of these classifications, and the interconnections that it includes, will be discussed in the following sections.

3.2 Range Extension Interconnections

3.2.1 Introduction

Data communications networks are usually represented in terms of a national grid, which does not show the amount of traffic in the branches or the effect of nonlinear tariffs. In terms of traffic volumes [3] and the effects of tariffs (Section 2.3 above), the appropriate topology is that of a hub (Toronto area) with spokes reaching out to other parts of the country. Clearly then, important potential interconnections are those which extend the range of economical communications from the hub. One would expect the extension of range to follow from employing communications facilities at near capacity, especially at longer distances. This suggests digital leased line trunks operating near full capacity and primarily in the East-West direction. Accordingly, we review interconnections with leased line services under the general heading of range extension interconnections.

3.2.2 Leased Line - Leased Line (Dataroute-Infodat)

Generally these services operate at the same line speeds (see Table I), service the same areas and have identical tariffs. Interconnection would require some elastic buffer storage because of different primary clocks and an interface to convert the framing to the specifications of the two systems. Certain cities are serviced by one network rather than the other, so that for these geographic locations there can be a requirement for interconnection.

The following are on Dataroute but not Infodat:

Trois Rivieres	Chatham
Jonquiere	Brantford
Sherbrooke	St. Catherines
Fredricton	Lethbridge
Charlottetown	Brandon

The following are on Infodat but not Dataroute:

Brampton	Oakville

In addition, the link from Sudbury to Thunder Bay, which exists in Dataroute, is absent in Infodat. In the latter case, connection is via Toronto and Winnipeg with a corresponding increase in tariff. Thus messages from Sudbury westward, or Thunder Bay eastward would wish to travel by Dataroute at least for the first lap of the journey.

Leased digital lines may often require analogue extensions to reach destinations past a network terminal point.

3.2.3 Leased Line - Datapac/Infoswitch

Leased line connections into Datapac service are technically feasible; indeed a form of such connection is used by the carrier to provide Datapac 3000 and 3101 service to subscribers in cities that do not yet have a physical switching node. There are reasons to look at the Datapac tariff charges, for very heavy users who are located off the main mesh; that is, in Grades 4, 5, and 6 service areas. This may be a rare requirement since most heavy users are likely to be located in Grades 1, 2, or 3 service areas. Nevertheless, for points off the main switching node mesh, the tariff includes transmission to the nearest switch node before proceeding onwards to the destination. Indeed, if the latter is also in the source city, then it is necessary to pay for the transmission distance to the switching node and return. For heavy users, the mandatory connection from source to switching node might be replaced by a digital leased line so that access to Datapac is made at the switching node.

If a leased line is used to access Datapac at a switching node, the economic advantage can be estimated from the tariffs. Datapac usage charges over the replaced link are saved, and the node charges at the switching node are much less than at off-mesh nodes. On the other hand, the digital leased line that replaces the Datapac link incurs access charges at each end as well as usage costs. The question revolves around whether the traffic volume is sufficient to average out the additional increment in access charges to advantage. The volume of traffic required to achieve this economic advantage is greater at higher line speeds (bits/sec.) but is less at longer distances.

Some indication of this trade-off between line speed and distance for Grade 5 and 6 offices is shown approximately in Figure 3. For traffic volumes in the region marked "leased line" it is economically advantageous to access the Datapac mesh by a leased line trunk to a switching node. For higher speeds and lower volumes falling in the region marked "packet" it remains advantageous, from the tariffs, to directly access Datapac. In some applications, therefore, it might be economically desirable from the user's point of view, to access Datapac only at a switching node, and to use a leased line to transmit to that point.

Similar alternative arrangements can exist with Infodat and Infoswitch, whereby Infodat trunk lines are used to access Infoswitch at the most economical point. Since Infodat

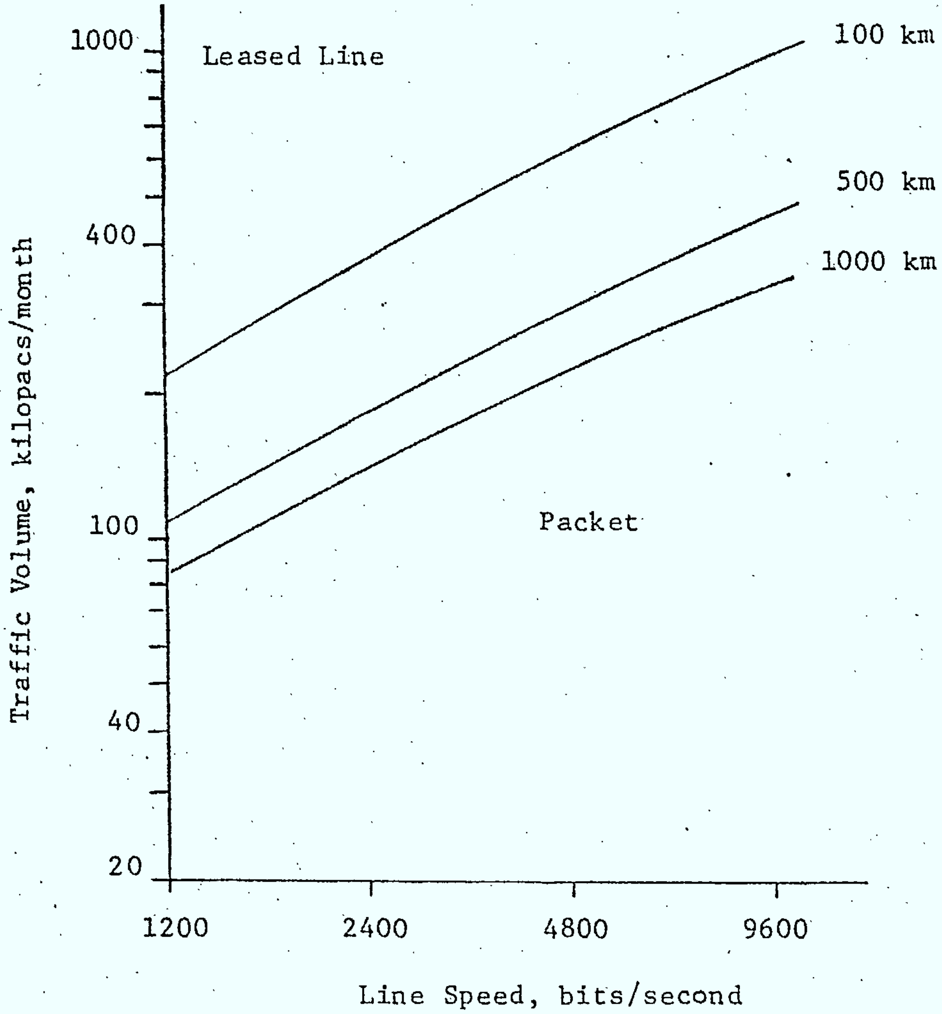

Figure 3: Example of Range Extension Economics: Leased Line and Datapac

and Dataroute are the underlying networks in each carrier's system, such alternatives are technically feasible. For those locations which are only serviced by one carrier (See Section 4.2.2) it might be necessary to have an interconnection between leased line services in order to implement such range extension alternatives. In these cases,. interconnection between Dataroute and Infodat would be required.

3.2.4 Leased Line - Telex/TWX

A connection into the Telex/TWX networks via a leased line has the effect of extending the range of access of these networks. Teletype charges are based on zones which are fairly large; indeed, two stations on opposite sides of, but near a boundary will find the charges not fairly related to the distance between them. A station with a large volume of data directed to terminals in a neighbouring zone might very well find considerable economic advantage in taking a leased line into that zone and joining the teletype network at a local office there. (This option exists for Telex.) The volume of traffic involved must be sufficient to average out the penalty of the additional leased line access charges.

3.2.5 Summary - Range Extending Interconnections

The usefulness of leased line extensions to Datapac, Infoswitch, Telex and TWX to provide lower cost service for high volume users located at some distance from their primary destination is obvious. This facility exists for Telex. It could be easily provided for Datapac or Infoswitch since it would, in most cases, involve a connection with Dataroute or Infodat, respectively, which are the underlying communications links for these services. It should be noted, however, that such interconnections do not increase the number of users nor provide increased access. The equivalent benefits to the user could be provided by introducing volume sensitivity in the tariffs.

There would appear to be some application for range extension interconnections of Infoswitch via Dataroute, and Datapac via Infodat to service the regions that are not covered by both Datapac and Infoswitch service. (The number of such locations is small, and interworking between Datapac and Infoswitch would eliminate the need for any such arrangement.) The interconnection is simple, being to a switching computer, rather than to another communication line.

With respect to Dataroute-Infodat interconnection, there is potential need only where an area is served only by one network. The connection is technically feasible, but may not be economically feasible given the limited application. It may be simpler to allow any users that require such service to make the interconnection via their computer systems, thus avoiding the need for a direct connection.

3.3 Access Extension Interconnections

3.3.1 Introduction

An access extension interconnection is one that extends the convenience of, and the geographical area for, access to a data communications service without modifying the basic service provided. In our view such an extension occurs when the dial telephone system is used to access either private networks constructed from leased lines or public networks such as Datapac and Infoswitch. In such cases the telephone network does not enhance the basic network service, but provides a convenient and ubiquitous access mechanism to the service for low speed asynchronous systems such as key-driven terminals. This type of access is of great value to many users, and as will be discussed in the following sections, either exists or could be easily provided.

The dial telephone system represents a vast number of possible sources of data; i.e., terminals from which data may be entered after dialing the number of a computer host. It might be noted that, in principle, such access interconnections could be symmetric, i.e., not only could users access the data communications network via the dial telephone system, but the network could also place outgoing calls if required. The need for this latter facility does not appear to be as great as for the former. In particular, for outgoing calls the network must know the user location (telephone number) unlike the incoming call case where the user, as source only, may move around at will.

3.3.2 Dial Telephone System and Leased Line

The dial telephone system is a very attractive communications system because of the wide availability of access to the network, since millions of private and commercial customers are already interconnected by an extensive circuit switching system. However, for data transfer, the circuit connections are not easily made symmetrical in direction with respect to call initiation. To go from a digital leased line to a dial telephone destination requires a gateway comprising at least a processor and autodialer to access the telephone system. Because of the protocol to operate these as well as the coupler, modem, and answer back device at the destination, the channel is not as transparent from end to end.

The telephone line is also limited in the data speeds that it can carry. Of course, a higher speed leased line can be partitioned into subchannels of lower speeds. Arrangements whereby a leased line service finds its destination in the telephone network is similar to inter-city tie-line services that replace individual long distance calls for customers with heavy traffic requirements. The difference occurs in data communications in the extra technical requirements at the gateway and at the receiver. There does not seem to be a single user type that would lead to a large aggregate demand for this type of interconnection.

The connection from dial telephone to digital leased line is already available under Dataroute; therefore, it is certainly technically feasible. CRTC has recently approved the interconnection of the dial telephone network with Infodat.

3.3.3 Dial Telephone System - Datapac/Infoswitch

Dial telephone access into Datapac currently exists, and CNCP has recently received permission from CRTC for such an interconnection for Infoswitch. The fact that the carriers are providing such a service clearly indicates its potential application. Technical details on how it can be provided will be found in a companion report [6].

The requirement for placing outgoing calls from the data network over the telephone network to a user system are less obvious and have been discussed somewhat in Section 3.3.2. One possibility is to provide an improved Telex/TWX type of service, but this seems of limited value to users unless this forms part of a more general interworking as will be discussed in Section 3.4. The most obvious applications for such dial-out service are automatic dialing and recording of data from remote stations, i.e., weather instrumentation, and returning batch type results to a user from a computer some period of time after the user had originated the request.

While the demand for placing outgoing calls from the data network over the telephone network is unlikely to be high, neither is the system very complex since an addressing plan, CCITT Recommendation X.121, exists to carry telephone numbers across public packet switching networks. The technical problems of such a service are discussed fully for Infoswitch in a companion report [6]. The situation for Datapac would be very similar to Infocall and Infogram accessing the dial telephone network but somewhat simplified because the same carrier operates both systems.

It might be noted that the current cost of permanent low speed (i.e., 300 bit/sec) Datapac and Infoswitch connections is $60/month. On the other hand the cost of a telephone plus modem is approximately $35/month [5]. Consequently the economic penalty to a user of not having dial-out is not large.

3.3.4 Summary - Access Extension Interconnection

The use of the dialed telephone system to provide access to private networks consisting of leased lines, and to the public Datapac and Infoswitch networks is of great value to many users. It is of particular value to public time share computing services, and to private computing facilities providing time share computing to widely distributed users (i.e. not all in the same building). It also appears that it has applications for POS credit verification applications with transaction telephone sets. Such access connections already exist for the TCTS services, and are technically and economically feasible for the CNCP services.

The value of dial-out from leased line or public data networks to the telephone system is less clear. It is obviously technically feasible, consisting of essentially a call originating modem plus some control logic. However, the number of users is probably small, and the economic penalty to a user of not having such a service is probably minor.

3.4 Network Interworking

3.4.1 Introduction

Network interworking occurs when two networks co-operate to provide a service to the user. One example is the telephone system, which consists of several independent carriers co-operating so closely that the result is (usually) invisible to the user. However, the co-operation need not be that close and the common service may be less general than the services which either of the networks provide separately.

Two obvious examples of potential interworking are

In both these cases the carrier services being provided are so similar that they obviously are intended for the same community of users. Further, it is obvious that some users will be forced to use both services because neither service provides all required user to user linkages. As an example we may cite the companies which are subscribers to TWX.

However there are other interworkings of potential value. One such area is Infoexchange - Datapac and Infoexchange-Infocall/Infogram to service users that normally require circuit (packet) switching but must occasionally communicate with other users who are packet (circuit) users. The second such area is the combination of Telex/TWX with dial telephone with Datapac/Infoswitch to provide a universal message switching system accessable from any terminal and/or computer in the nation.

These various possible systems will be discussed in the following sections.

3.4.2 Datapac - Infoswitch Interworking

The Infocall/Infogram services provided by Infoswitch are almost identical to those of Datapac and will service essentially the same user community. Hence it appears as if many users will have an apparently free choice of which network they choose, with the choice being based only on cost and quality of service, rather than type of service. However, "community of interest" considerations, i.e., EFTS, may require a large group of users to adopt one particular network. This adoption will probably not be the best for every individual user due to cost, user location, or other applications for which the user requires access to the other network. Interworking would eliminate this need for "community-of-interest" users to be on the same network, and hence would be of value to many users by allowing them to choose the optimum network based on their overall data communications requirements. Interworking potentially also allows increased reliability by allowing alternate paths, depending upon the number and location of gateways.

The techniques of providing such interworking are discussed in detail in a companion report [7]. The conclusion reached is that such interworking is technically and economically feasible.

3.4.3 Infoswitch Interconnections

Within Infoswitch, between Infocall and Infoexchange no interconnection problems exist since the terminals may operate in either Infocall mode or Infoexchange mode. The service mode is part of the addressing protocol at call connect time. This assumes that both terminals are operating at the same line speed and that either, both are synchronous, or both asynchronous. If these conditions are not met, the connection is not feasible without great difficulty.

Interconnection between Infoexchange and Infogram is similar technically to a connection between Infoexchange and Datapac as examined in [7]. However, since there are problems concerning charges, reliability, etc., when two different carriers are involved, it should be administratively simpler. It should also be noted that, given the effective interchangeability of Infoexchange and Infocall as source terminals, there is no need for an asynchronous Infoexchange to Infogram interconnection, since asynchronous Infocall to Infogram already exists. Hence the need is for synchronous Infoexchange and Infocall connections to Infocall, but the demand for this type of service is unpredictable.

3.4.4 Telex-TWX

These services have, essentially, the same user community. The current situation is analogous to having two separate dial telephone systems. Accordingly, interconnection makes very good common sense from the user point of view since it avoids the requirement for duplicate services. The interconnection of these services has taken place in the U.S.A. under Western Union [11] and therefore the technical and economic feasibility of interconnection has been proven. The estimates of growth of these services by the carriers is rather modest (order of 6% per year).

3.4.5 Telex/TWX - Dial Telephone System

An interconnection between teletype and the dial telephone service may be attractive in those applications where the receiver may be unattended, or where a hard copy is required at the receiver. For example, point of sale data may be processed through a dispatcher device to deliver orders in print at a supplier or warehouse teletype.

3.4.6 Telex/TWX - Infoswitch/Datapac

It may be desirable for some users of Datapac to be able to call a teletype terminal and leave a hard copy message. Some modifications may be required to the Datapac NIM but these seem reasonable, and the interconnection is technically feasible. An international standard, X.121, is available to assist in the network addressing that would be required.

In the reverse direction, a teletype terminal could dial the nearest NIM as a destination, where the packet forming functions are performed. Because the NIM address and the eventual receiver address must both be supplied from the source, there is a double addressing problem. Depending on how this double addressing problem is handled, either a specialized Datapac NIM for Telex/TWX, or a gateway between Telex/TWX and Datapac is required.

The above arguments also apply to Telex/TWX connections to Infoswitch. It would appear that asynchronous Infocall would be the simplest option for such interworking.

This interworking appears to offer the possibility of a universal nationwide message switching service with many extra service features, possibly some aspects of "electronic mail". However before any serious analysis can be performed, very detailed characteristics of the expected traffic would be required. An essential component of this information would be traffic statistics for current Telex and TWX service.

3.4.7 Summary - Interworking

The most significant interworking considered above was Datapac-Infoswitch. Since both these networks will be providing international connections, it seems logical that they should also be compatible on the national scene. The interworking would be of value to the user. Interworking, considered fully in [7], is feasible.

The second area for possible interworking is Telex-TWX. Interworking is technically feasible and is desirable from the user viewpoint.

An area that requires further study is Telex/TWX-Datapac/Infoswitch interworking. This system appears feasible, but detailed knowledge of possible traffic is required to evaluate the economics of such a service.

3.5 Summary - Interworking and Interconnection

The major area of useful interconnection in the near future is using dial telephone to access private networks based on leased lines, or public packet or circuit switched networks. Such access is of immediate use to many users.

Interworking of Infoswitch and Datapac, and of Telex and TWX, is of value to many users. Since Infoswitch and Datapac are new services, and will be growing, it seems reasonable that interworking be introduced earlier to allow the users the maximum degree of choice. Interworking of Telex and TWX would eliminate the anomaly of two identical disjoint services serving the same user base.

For the longer term, an interworking of Telex/TWX/Infoswitch/Datapac should be carefully studied.

4. APPROACHES FOR THE PROVISION OF EFTS

4.1 Introduction

This section explores several network approaches for the provision of Electronic Funds Transfer Systems (EFTS) based on the use of Canada's Public Data Networks (PDNs) in the absence of carrier provided interconnection. The advantages and disadvantages of each approach are discussed with the focus on the implications of each system for the banks, big businesses, small businesses, the consumer, the common data carriers and the regulatory bodies. The degree of interworking provided by the banks as a group is also examined.

An EFTS system, for the purposes of this discussion, contains two types of traffic. The first type, called interbank traffic, relates to the transfer of payments among Canada's banks for the clearing of cheques, etc. This is the type of traffic one would expect in a Canadian Payments Association clearing house. The second type of traffic, referred to in this Chapter is interbranch traffic. This traffic includes not only the transfers required among the branches of each bank, but also the transactions between individual branches and EFTS customers. For a large retail chain, the EFTS traffic may be routed from the store, through the business' own computer, to the bank branch. A small retail business, which consists, perhaps, of a single outlet, would probably route EFTS traffic directly from the

Point-of-Sale terminal to the bank branch. The two types of traffic place different demands on an EFTS system with respect to the requirements for interworking.

The individual EFTS systems are discussed in the following sections. They are presented roughly in their order of complexity with respect to the additional interworking facilities they require.

4.2 All Banks Use One PDN

The first scenario for the provision of EFTS involves all the banks acting in a united fashion to choose one of the two PDNs for all interbank and interbranch EFTS traffic. In this EFTS system, the provision of PDN interworking by the carriers becomes immaterial from the banks' view-point. The banks may also benefit from "industry-wide" commonality in the use of subscriber access protocols and services. However, they would tend to become "locked in" to the particular PDN which they originally chose, since it would require a very large effort to move the entire EFTS system from one PDN to the other. Therefore, the banks would be sacrificing any benefits which might be obtainable from carrier competition.

A large business may not be very significantly affected by the adoption of this type of EFTS system. The corporation could make a free choice between the PDNs for the provision of communications between its corporate computer(s) and its POS terminals. However, the corporate computer would have to connect to the banks' chosen PDN to actually interface with the bank's EFTS computer. For a large business, the added cost of a single connection to either PDN would be small.

For a small business, this type of EFTS system might actually be advantageous. Although forced to place its POS terminals on the PDN chosen by the banks for EFTS, the small business would benefit from the fact that all the banks are available on the particular PDN. Therefore, the firm could do business with any of the banks without penalty - all would be equally accessible to it.

From the carriers' viewpoints, this would be a highly undesirable means for the provision of EFTS. Although the amount of traffic involved in EFTS systems is not known, it could potentially grow to be quite large. If one carrier captured all of this traffic, it could jeopardize the viability of the other carrier's PDN. Any reduction in competition could result in price increases for the consumer, and is therefore an important concern for the regulatory bodies.

4.3 All Inter-Bank Traffic on One PDN

In this EFTS scenario, each bank independently chooses a PDN for inter-branch traffic, with all the inter-bank traffic carried on one particular PDN by mutual agreement among the banks. As a result, some banks may suffer the fairly small disadvantage of requiring connections to both nets; one for their inter-branch traffic and the other for the inter-bank traffic. However, this disadvantage is offset by the fact that each bank would be free to choose the PDN which it perceived to best meet that bank's needs for interbranch traffic. Also, each bank would be free to move its inter-branch traffic from one PDN to the other if the bank became dissatisfied with the service offered.

The implications of this EFTS system for large business would be even less significant than in the previous scenario. Corporations would be free to choose either PDN for their intra-corporate communications. Some of them may have to obtain a connection to the other PDN for their corporate computer(s) to interface with the EFTS services provided by the bank of their choice. However, the corporation could judiciously choose a bank which offered EFTS service on the PDN to which the corporation already was connected, if it wished to do so.

Small businesses probably cannot afford to move their POS terminals from one PDN to the other, even occasionally. Therefore, a small business may be limited to the subset of banks which offer EFTS service on the PDN to which the business' POS terminals connect. If the business has a strong preference for one particular bank, then it is forced to connect its terminals to the PDN chosen by the bank. The small business can only make a free choice of PDN if it is prepared to be flexible about its choice of banks.

From the carrier viewpoint, this scenario is much more desirable than the previous one, especially for the carrier which lost all the EFTS traffic. Competition is preserved, which is of interest both to the consumers and the regulatory agencies. However, there is a possibility that the banks which connect to both nets may somehow offer their customers a general gateway service between the PDNs.

4.4 All Banks on Both PDNs

In this scenario, each bank uses both networks for inter-branch traffic. Inter-bank traffic is handled in an ad hoc manner, using individual pairwise connections between banks on whichever PDN is most convenient. The result is that there is some inter-bank traffic on each PDN.

The banks suffer the small penalty of being required to obtain connections to both PDNs, for this scenario. However, the advantages are very significant. Each bank could switch traffic at will from one PDN to the other for reliability, improved service, or selective routing to optimize tariff costs. This would force the carriers into an openly competitive situation, but one in which there would probably be a good portion of traffic on each of the two PDNs.

This scenario may be optimal for both large and small business, since they could obtain EFTS service on the network of their choice from the bank of their choice. Small businesses would be able to switch to any bank easily, without changing the terminals' network connections.

This scenario appears to have no direct effect on the consumer.

From the regulatory viewpoint, this scenario certainly enhances competition. However, it suggests a number of bank computers attached to both networks in the absence of carrier provided gateways. A logical conclusion is that banks may, in some way, provide internetwork gateway services to at least large customers. This may be very difficult to detect. Also, although the interworking service offered by the banks would be competitive in price, it might also be very non-standard.

4.5 Inter-Bank Virtual Circuit Level Gateway

In this scenario, each bank connects to the PDN which it has individually selected. Inter-bank traffic between banks on different PDNs is routed through a common gateway, which operates at the virtual call level by concatenating virtual calls on the two PDNs. This is identical to the type of gateway which the carriers themselves would provide, although in this scenario the gateway is provided by the banks acting as a group.

From the banks' standpoint, this alternative requires each bank to connect to only a single PDN for the provision of EFTS service. Furthermore, a standard gateway would be used for all inter-bank traffic destined for the other net. However, each bank loses some of the flexibility which it had in the last scenario, for dynamic allocation of traffic for reliability and tariff cost optimization.

For both big and small businesses, this scenario for the provision of EFTS is very similar to the scenario in which all inter-bank traffic is handled on one PDN. Large corporations may find that their choice of a PDN for the intra-corporation net and their choice of a bank are at odds; they may be required to obtain connections to both PDNs. Small banks will find both their choice of banks to be constrained by their choice of PDN and their choice of PDN will be constrained by their choice of banks.

This scenario appears to have no direct effect on the consumer.

If two gateways were implemented, one in the west and one in the east, the gateways could always choose to route cross country traffic over the more economical PDN. This may be perceived as a disadvantage by the carriers. There may also be some regulatory difficulties pertaining to the operation of a value added network by a value added carrier.

4.6 Inter-Bank Application Level Gateway

This scenario is identical to the last one, except that the bank-provided virtual circuit gateway(s) between the PDNs are replaced by bank-provided gateway(s) which "understand", and participate in, the EFTS inter-bank traffic application. In the previous scenario, each bank would establish virtual calls to every other bank for the transmission of inter-bank traffic. Some of these calls would be routed through the gateway. For this scenario, each bank would establish virtual calls to the gateway itself. The gateway would receive all the inter-bank traffic from each bank, and would act as a clearing-house whose task is to receive and deliver all the inter-bank EFTS traffic (possibly even regardless of whether or not the traffic requires internetwork transmission).

The advantages and disadvantages to all parties would be identical to those discussed for the previous scenario, except that the banks might benefit from an added reduction in the software required to support inter-bank traffic if this "smart" gateway is adopted.

4.7 An Inter-Bank Value Added Network

For this scenario, each bank would individually choose a PDN for inter-branch EFTS traffic. Inter-bank EFTS traffic would be handled by a special "bank network" which would be a value added network consisting of leased lines for data trunks and bank-owned switches for nodes. This would provide the banks with complete control over the services available on the bank net and may enhance the security of interbranch traffic. (This point may be of over-riding importance from the bank's point of view.) However, the banks would be faced with the task of acting in concert to perform the network administration functions.

The impact of this scenario on small and large businesses would not be significantly different from some of the other approaches for the provision of EFTS. Depending on which PDN the business EFTS customer chose, some subset of the banks would have EFTS systems available to him. Large business users may require connections to both PDNs, while small businesses would become locked in to one PDN and one subset of the banks.

The provision of EFTS based on this approach would imply a substantial loss of potential revenue for the carriers. Also, there may be regulatory difficulties related to value added networking.

4.8 An Inter-Bank and Inter-Branch Value Added Network

This approach expands the "bank net" discussed in the last section to include the inter-branch traffic as well as the inter-bank traffic. In this scenario, businesses would attach directly to this "bank net" to obtain EFTS services. This would have an added advantage for the banks; they not only sell EFTS services to customers, but also sell the communications services by which those services are available.

The large businesses may not be significantly affected by this approach to the provision of EFTS. They are still free to choose between the PDNs for their own intra-corporation communications. Perhaps the banks, acting in the role of a value added carrier, could also offer services on the "bank net" for this purpose.

Small businesses, which would attach their POS terminals directly to the "bank net", might view it as a double edged sword. On the one hand, the bank net would be partially more respectful, cognizant, and reactive to the long-term needs of the small business EFTS customer than the common carriers. On the other hand, the small businesses would definitely be locked into the "bank net", and may be required to use services, as part of a total package, which could be more economically purchased elsewhere (such as from a service bureau).

The carriers would definitely lose a large amount of revenue from the PDNs in this scenario. However, this revenue would be partially recovered from an increased use of leased lines as data trunks in the "bank net". However, this may act to dampen the extension of PDN services to an increasing number of locations; the growth of PDNs may be stunted to the detriment of non-EFTS customers. Also, the carriers may be forced to enter into competition with some of the services offered by the new network.

Obviously, this scenario is fraught with difficult regulatory issues relating to value added carriage and to the restriction of "bank net" services to services pertaining only to EFTS.

4.9 Summary - Provision of EFTS

The above sections present several alternatives for the provision of EFTS systems, based upon the use of Datapac and Infoswitch in the absence of carrier-provided interworking. All of these approaches are technically feasible. Each of them has advantages and disadvantages which must be traded-off based on the amount of traffic, number of customers of various types and the regulatory environment, before the relative merit of each approach can be determined. Also, depending on the types of services and amount of traffic involved, not all of the alternatives may be feasible from an economic or regulatory viewpoint.

The approach discussed in Section 4.2 is rather unlikely due to the amount of sacrifice of individual bank independence which is involved. The alternatives presented in Section 4.6 and 4.7 require not only united action on the part of the banks, but might also be fairly expensive. Section 4.8 presents a scenario which could be unworkable for either of those two reasons, and which also evokes potential regulatory difficulties. Of the remaining approaches, the one presented in Section 4.5 is most similar to an EFTS system which uses carrier-provided interworking.

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