FINAL REPORT

A GENERAL STUDY ON THE IMPACT OF INTEGRATED SERVICES DIGITAL NETWORK (ISDN) IMPLEMENTATION IN THE

MICROTEL PACIFIC RESEARCH LIMITED

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FINAL REPORT

A GENERAL STUDY ON THE IMPACT OF INTEGRATED SERVICES DIGITAL NETWORK (ISDN) IMPLEMENTATION IN THE CANADIAN TELECOMMUNICATIONS SYSTEM

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EXECUTIVE SUMMARY

Terms of Reference*

The objective of this study which has been commissioned by the Department of Communications, is to identify and assess the major impacts of a technical, economic, service and institutional nature, emerging from the standardization activities and the implementation of an Integrated Services Digital Network (ISDN) within the Canadian telecommunications system. The findings of the study are to assist the Department of Communications to formulate appropriate national positions on the new technology in order to best serve the public interest.

The scope of this report has been reduced with the agreement of the Department of Communications, from an initial identification of a significant number of issues to only the more critical aspects of ISDN which are of interest to the Department.

Work on standards for ISDN is directed towards the establishment of national ISDNs, which will interwork internationally, and which will extend down to the subscriber the "integrated services" which ISDNs are designed to provide. These integrated services will convey voice, data and image traffic to the subscriber in a common format, a digital bit stream, down a single physical path to his office or home.

Work at CCITT's Study Group XVIII is directed towards agreement on standards before the fact rather than after it. Some countries have an urgent need to replace or expand their existing networks with the latest digital technology, hence their support for ISDN studies which has resulted in the ISDN standardization process gaining momentum during the past Study Period from 1981 to 1984. While Canada has advanced the introduction of digital technology, the need to adapt the network for new services has been recognized and support for ISDN work has resulted in a substantial number of submissions to Geneva.

The full implementation of ISDN is one or two decades down the road. It is expected that not before the late 1980s will the average residential subscriber demonstrate an interest in the more sophisticated telecommunication features that it offers. It is expected, however, that some business and government institutions will have begun to exploit the new technology by 1986 (as witness the recent introduction in Canada of quasi-ISDN value-added services and facilities and the inauguration this year of the U.K. Integrated Digital Access system). It is important, therefore, to examine the issues opened up by ISDN, to ensure full exploitation of the opportunities it offers and to ensure a smooth evolution of the network infrastructure.

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* Contract Serial No. OST83-00376; File No. 12ST.36100-3-0328 (DSS)

It is understood that the Department of Communications wishes that Canada keep its options open - short-term and long-term. The CCITT has been at pains to provide for a variety of network structures that will accommodate differently structured national networks and ease the amalgamation of "dedicated networks" into national ISDNs. However, not all of the structural features described in CCITT Recommendations can be supported by any one national administration. Canada's ability to keep its options open depends on which of these features it adopts.

Six of the seven chapters in this report attempt to identify the options (or issues) that remain open. Each chapter ends with a short list of the issues raised by its subject matter. Some issues are technical and originate in the essential complexity of ISDN interconnection requirements. Other issues which pose economic, regulatory or political difficulties have not been occasioned by ISDN activities. Some have been precipitated by pre-ISDN events in the U.S.A. and elsewhere. Nevertheless, they have potential to assist or obstruct Canada's progress towards ISDN. Hence, the principal conclusion to be drawn in this report is that, while technical problems sparked by the ISDN concept will be competently dealt with by the experts involved, too many non-technical concerns remain which should be dealt with by more appropriate bodies.

The seven chapters referred to above are as follows:

Chapter 1 : Status of ISDN

Chapter 1 presents the ISDN concept, describing what it is and is not. It discusses where ISDN stands at this point in time and lists the factors which telecommunication agencies must take into account in planning their strategies.

Chapter 2 : Canadian Participants

This chapter attempts a profile of the four types of participants in the ISDN venture. These four participants consist of Users (residential and business), Telecommunications Carriers, VANs (non regulated carriers), and Suppliers of goods and services to both carriers and users.

Because users are the least visible of these participants and the least informed, the issues listed in the conclusion of this chapter suggest that any attempt to identify the potential users for ISDN, is unlikely to be successful without first cataloging in a way meaningful to future users, the service types that ISDN is capable of providing. The recommendations in this chapter also call for the establishment of some ground rules whereby both user and carrier will know their respective areas of responsibility for the user network access.

Chapter 3 : User and Network Interworking

This chapter deals with the variety of ways a user may access ISDN and the choices open to him - namely choice of service, choice of interface with the network, and choice of the possible configurations that his CPE (Customer Premises Equipment) may assume. Much work has been done in specifying these options and this work is almost complete.

Network to network interworking is seen as the major critical issue for Canada. The problems that have arisen have not been caused by ISDN but it is believed that ISDN may aggravate them. For this reason, active participation regionally and internationally in the standardization process is recommended during this, the design stage of ISDN.

Chapter 4 : ISDN Numbering Plan

Interworking between national ISDNs demands an ISDN Numbering Plan which, the CCITT advises, should evolve from the existing Telephone Numbering Plan. This chapter lists the limitations of the North American telephone numbering plan and the problems precipitated by the U.S.A. attempt to add a network-selection component to the existing 10-digit number. The implications of this network selection component, a de facto standard, are of immediate concern to Canada. ISDN could provide the occasion for Canada to reexamine its need to establish its own numbering system.

Chapter 5 : Technical and Economic Considerations

Chapter 5 describes two aspects of ISDN that are attracting research into new technologies namely digitization of voice, image and data traffic, and research into copper-wire transmission techniques. Two major areas for further study are basic research into low-resolution image compression techniques and a fibre optic interface for high resolution image traffic.

Chapter 6 : International Participants

Chapter 6 describes the role played by telecommunication administrations and agencies that exercise or may exercise a powerful influence on CCITT standards activities. The Federal Communications Commission (FCC) position and its (four-fold) agenda raises three contentious issues for Canada. The strategy of the CEPT* members is described as also the points at which they are at variance with U.S. and Canadian positions. The objectives of the ANSI/T1 Committee are also assessed.

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* Conference Europeenne des Administrations des Postes et des Telecommunications.

Chapter 7: Policy Approaches for Canada

The report concludes with the policy positions on ISDN that Canada could take at the national, regional (North American), and international levels. As the issues raised by ISDN are not solely technical issues, it is recommended that the Department of Communication extends its investigation into ISDN by enlisting the aid of other appropriate government departments and industry sectors in order to identify Canadian concerns, establish Canada's priorities, and to invigilate ISDN standardization activities.

Conclusions

CCITT Recommendations to date show the progress being made towards the design to a flexible ISDN to accommodate a range of philosophies based on the different administrative policies of each* yet all moving towards an ultimate ISDN concept that they believe will benefit them. CCITT has adequately demonstrated the ability to solve the technical issues as they are identified.

Fundamental political issues have emerged since the 1982 AT&T divestiture and the competitive U.S. environment. These are:

- Who is responsible for Canadian-U.S. negotiations in both technical and policy matters?
- Will the U.S. be establishing de facto standards away from the CCITT international forum?

This report can only point to these issues. It is for joint Government-Industry policy makers to address them. Now is the time to take action rather than after the U.S. has established de facto standards.

These issues emerge in the area of network-to-network interworking where guidance is urgently required on the following current subjects:

- An ISDN Numbering Plan for North America.
- Ground rules for international interworking, both cross-border and intercontinental.
- New tariff structures and principles and the assessment of their effect on Canadian-U.S. communications.

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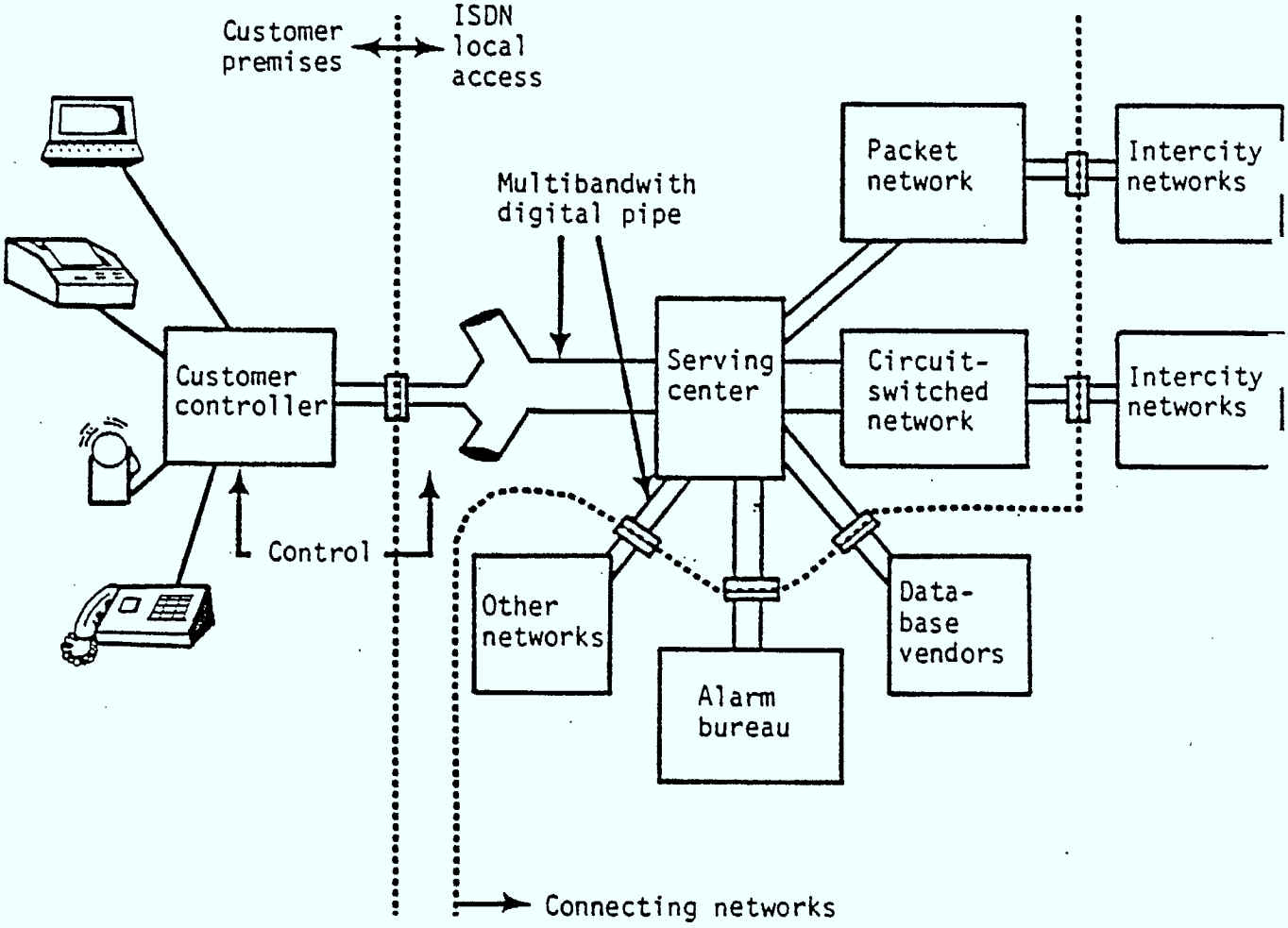
* of the CEPT stance vis a vis North American positions, Chapter 6.



Note: From "ISDN" Irwin Dorros IEEE Communications Magazine - March, 1981

FIGURE 1.1

(Section 1.1 refers)

THE DIGITAL PIPE WITH INTEGRATED ACCESS

1. STATUS OF ISDN

1.1 ISDN Concept

In 1972 the CCITT started an investigation into the use of digital transmission and digital switching techniques for the telephone (voice) network. Concurrently, work was also underway on the development of standards for data networks. These specialized networks were referred to as Integrated Digital Networks (IDNs). In Canada and in the U.S. digital components had already been introduced into the network and Pulse Code Modulation (PCM) of voice streams on systems of 24 channel capacity had been in operation for approximately a decade.

By 1980 there was widespread recognition that significant economies could be achieved by using digital techniques to handle a wide range of voice, data and image traffic. It was also recognized that such an integrated network should be accessible to the user through a single port. This concept was called an Integrated Services Digital Network (ISDN). Studies pursued during the CCITT 1981-1984 Plenary Period sought to show how an ISDN could be implemented over a period of time.

CCITT recognized that the transition from an existing network to a comprehensive ISDN may take one to two decades; that some functions of ISDN may never be implemented within a given ISDN; and that en route to an ISDN existing networks and terminal equipment would have to be accommodated. Hence, the overall approach would be evolutionary with enhancements being added in a flexible and modular fashion.

The ISDN concept is outlined in CCITT Rec. I.120.* This Recommendation, while indicating that "the ISDN will support a wide range of voice and non-voice applications in the network", also includes statements such as, "as far as practicable new services introduced into an ISDN should be arranged to be compatible with 64 kbit/s switched digital connections" and "ISDNs will be based on the concepts developed for telephone IDNs ...". These latter two statements have caused some confusion since they imply a somewhat rigid adherence to telephony principles rather than describing a network concept which is suited to a wide range of both voice and non-voice services.

While the ISDN user-network interfaces are based on some predicted wiring arrangements and terminal characteristics and make assumptions about the nature of future services, the ISDN studies do not explicitly define the Customer Premises Equipment

* References to CCITT I-Series Recommendations are to those in effect at Study Group XVIII's Final Meeting, Geneva, May-June 1984.

(CPE) and wiring. It is assumed that cooperation between Operating Administrations and terminal suppliers will ensure a suitable mapping of terminals and network, though it could happen that terminal and network arrangements may differ from country to country. Whether these arrangements will be planned in a controlled fashion is yet to be determined. Terminal portability was proposed as one of the ISDN guiding parameters.

As a result of the work carried out in the 1981-84 Study Period of CCITT, a number of guiding principles for the ISDN are emerging, including the following:

- Digital connectivity, end-to-end.
- Access to a range of services via a single port.
- Improved signalling, independent of a message path for circuit-switched traffic.
- Improved control of network quality and utilization.
- A common ISDN numbering plan for all services.
- Greater control for the user over choice of service.
- Wider choice of service, to be matched by user-friendly aids.

1.2 Misunderstandings of ISDN

The concept of ISDN has been misunderstood in at least five respects and much confusion and hostility remains because of it.

i) Multiple ISDNs

The ISDN concept envisons a single ISDN for each country (or for each community administered by a single agency).

The singularity of a (national) ISDN lies first, in the single access path that each subscriber will need to access the services ISDN will provide. Secondly, although these services may be carried by (several) networks, these networks by interworking, will form one ISDN, from the viewpoint of the user.

During the transition period and pending integration with ISDN there will be separate and distinct networks, and it is now recognized that some networks will always remain separate and distinct because of the limited or exclusive range of the services they offer. Nevertheless, the thrust behind CCITT's standards activities is to encourage the amalgamation of such networks into a single ISDN, where feasible. References to "multiple" ISDNs, therefore, are

not in accord with the ISDN concept. Nevertheless, the expression "multiple ISDNs" is commonly, if mistakenly, used.

ii) Services versus Network

An ISDN is essentially a network which integrates voice, data and image traffic. Existing data communication services, which at present do not share transmission circuits with voice traffic, are referred to loosely as "dedicated networks". When these "networks" are integrated into ISDN, the services they provide will not be displaced. (Notwithstanding the concerns expressed at a recent panel discussion on ISDN held in Virginia, U.S.).* They will simply be aggregated on the one ISDN and be more easily accessible for that reason.

iii) Private Lines

Concern has also been expressed in the U.S.** that private-leased lines will not be offered by ISDN. This has never been the intention of CCITT. ISDN is a switched (circuit and/or packet) network. Private 64 kbit/s lines on a "virtual" basis can be provided by this network, and this may eventually be extended to other bit rates. Permanent digital connections at various transmission rates can be provided outside the switched network today using common backbone transmission facilities and dedicated digital access. It is hoped that some private line users will eventually migrate to ISDN when this becomes economically preferable. For example, it is the intention in the U.K. to adjust tariffs in order to encourage this migration though it is recognized that there will always be a demand for private lines.

iv) Transitional versus Ultimate ISDN

It was recognized that some limitations would exist in early implementations of the ISDN concept. However, it was intended that standards would be developed in accordance with the long-term view of ISDN as far as possible. The need to consider both long and short-term views has led to some confusion by observers as to the direction being taken, particularly regarding short-term service capabilities.

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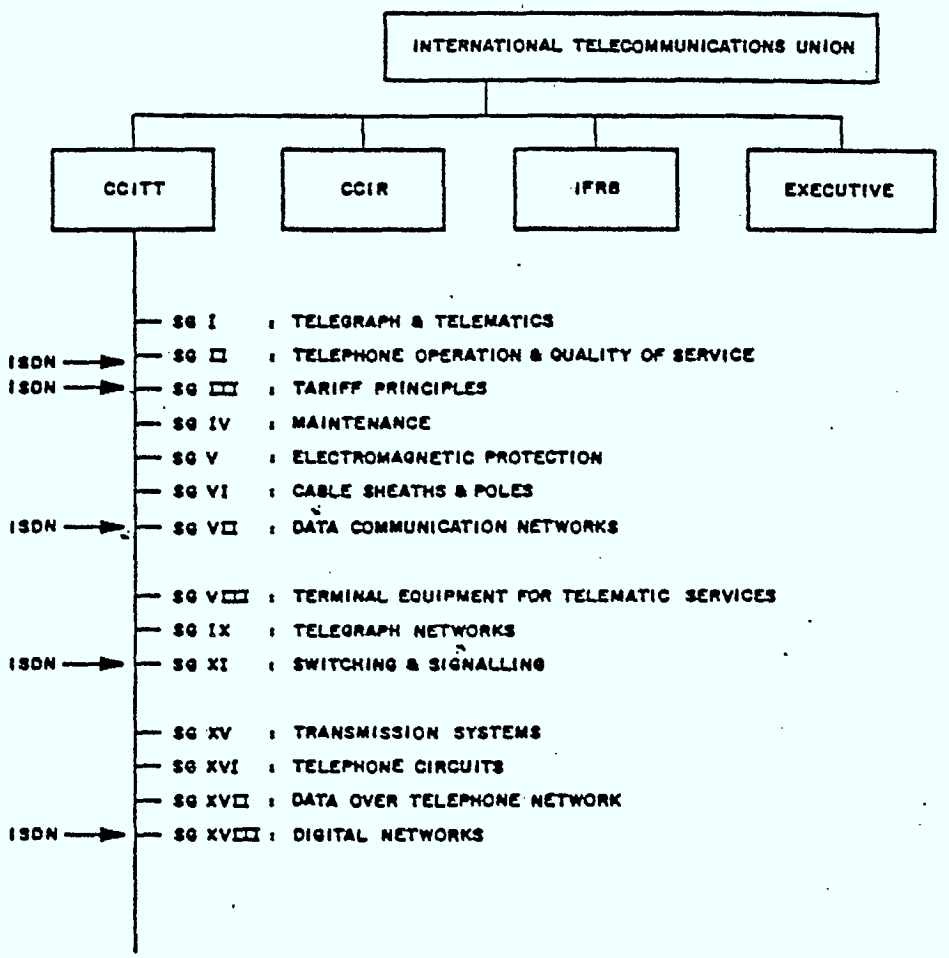
* Twelfth Annual Telecommunications Policy Research Conference, April 1984. Section II, C of "ISDN: Issues for the Future Global Communications System."

** cf First Report on ISDN. FCC General Docket 83-841 para. 52 et seq., April 1984.



Organization Of The CCITT Within The ITU

FIGURE 1.3

v) ISDN-Telephony Based

The intention that ISDN will evolve from the public telephone network has also caused confusion. The CCITT appears to have been overly emphatic in recognizing the ubiquity of the telephone system. However, there is a firm intention that ISDN must accommodate a wide variety of services over and above PCM of voice streams. In fact, the ISDN concept (implicitly described in I-Series and Questions providing guidance to the 1985-1988 work) indicates clearly a concern for the provision of services below and above 64 kbit/s and the intent to work concurrently on circuit and packet switching access capabilities and network interworking.

1.3 Status of CCITT Studies

The end of the 1981-1984 Study Period will be marked by the approval of a set of Draft Recommendations in the I-Series prepared by Study Group XVIII. These cover both general principles and specific standards for ISDN. To these must be added other Series Recommendations (e.g. G, Q, X, V) prepared by other Study Groups, which cover various digital systems components, configurations and procedures. These are also applicable to ISDN, (Figure 1.3 refers).

As might be expected, the initial work considered first the development of the conceptual principles, however it was recognized from an early point in the ISDN studies, that the need for some standards was self evident and could be worked on immediately. Two of these standards areas were user-network interfaces and network signalling procedures. The latter study was already underway in the CCS7* studies (although the draft proposals were subsequently modified as the needs of ISDN were better identified). The user-network interfaces have now been defined.** While it is likely that both the electrical and the procedural characteristics may undergo some refinement as the implementation phases proceed, the level of agreement reached indicates a strong determination to work towards a set of universal interfaces.

The urgency assigned to the work in both the interface and common channel signalling areas can be seen by the fact that special interregnum meetings (between Study Periods) are planned for both subject areas. It is recognized that once these are defined, Administrations and Suppliers can make a first step in the provision of new and enhanced services.

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* CCS or Common Channel Signalling systems propose the assignment of all signalling functions (call establishment, routing, call release, etc.) to circuits that are physically separate from those used by voice and data traffic.

** I.430 Basic Digital Interface (192 kbit/s) and I.431 Primary Rate Digital Interface (1.544 or 2.048 Mbit/s).

In addition to refinement of the current work, CCITT has identified a number of major thrusts to be pursued during the next Plenary Period. The current access interfaces are limited to relatively low bit rate signals. Broadband switched services require consideration. The core network definition is only in the preliminary stage and further work is required on the location and characteristics of future network intelligence, interworking with other networks, an integrated numbering plan, low bit rate voice techniques and improved network maintenance principles.

1.4 Telecommunication Administrations and RPOAs: Strategies and Considerations

Because Telecommunication Administrations or Recognized Private Operating Agencies (RPOAs) in the various industrialized nations are at different stages of development of their networks, their approach to implementing ISDN also differs. In fact, the more advanced the network the more difficult it may be to implement ISDN in its purest sense, in the short-term. Fortunately the "ISDN experts" have managed to keep both the needs of a developing network and an advanced concept in mind while developing their recommendations. In addition, by restricting these standards to the critical areas a high level of design freedom is still left in the hands of the designers of the national networks.

In Canada the early introduction of digital techniques has provided a backbone facility for the carriage of digital traffic. However, the investment in current digital switching plant will dictate to some degree the speed with which new capabilities can be incorporated into the network, particularly if they involve hardware changes. In those areas where replacement is dictated by normal growth or obsolescence, it is important that the most advanced capability is procured consistent with international technical and service trends.

A second factor in the implementation of ISDN, is the elapsed time between the definition stage and the achieving of sufficient penetration in the network to consider it an accomplished fact. A seven to ten year period may elapse between a decision to introduce ISDN and the point where widespread provision of ISDN service is possible. This elapsed time includes the specification, design and procurement of equipment to initiate the service in the early years and the adjustment of tariffs, acceptance of new services and economic capabilities to meet demand growth as the ISDN matures.

In justifying the introduction of new capabilities or enhancements to existing facilities, there are several factors the Telecommunication Administrations (or RPOAs) will consider. Network changes may be proposed that will allow existing services to meet demand growth in a more cost effective manner or new service

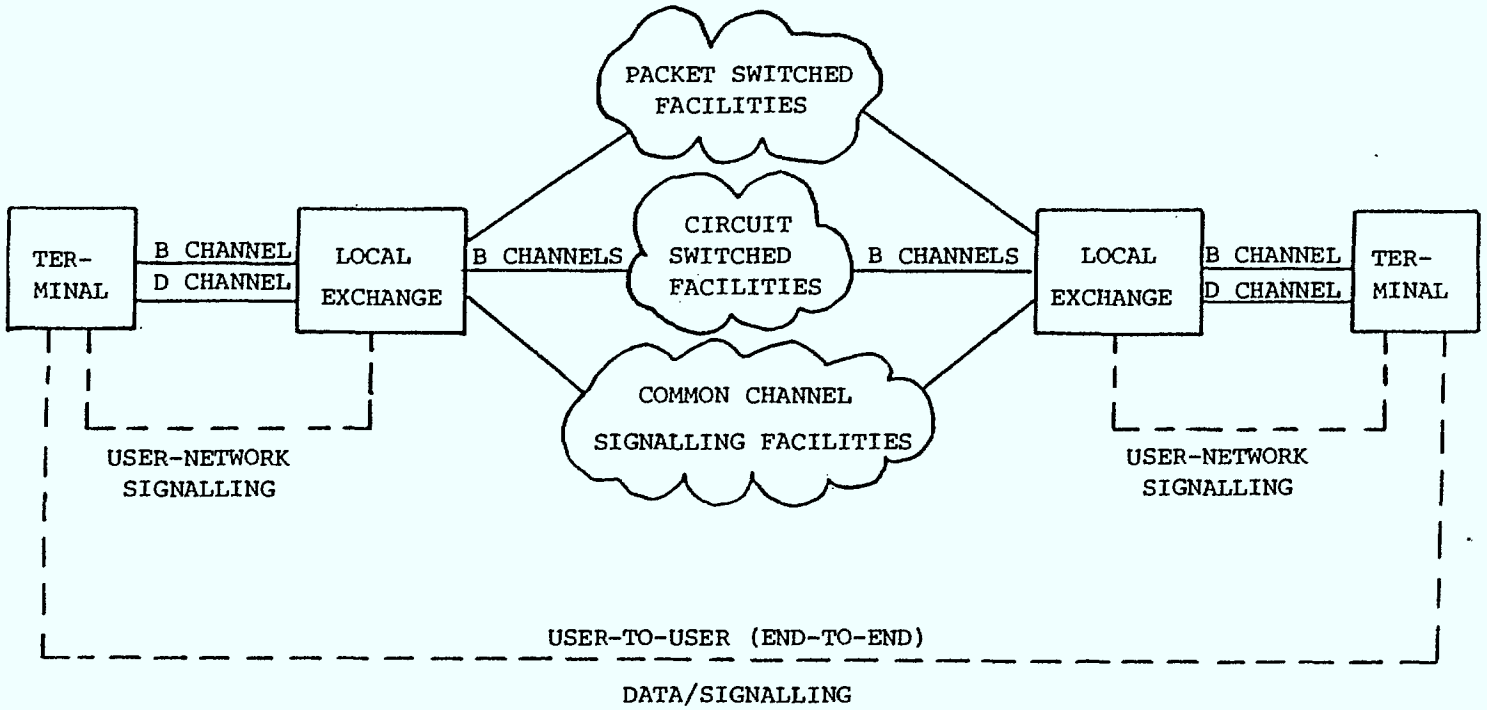


FIGURE 1.5 (i)

FUNCTIONAL MODEL OF ISDN

offerings proposed in order to improve short-term revenues. These two aspects are the more acceptable reasons for ISDN support. However, changes to the network may also be justified by a need for strategic positioning of the industry to meet new challenges. These could include competition, unforeseen service demand, flexibility for new service opportunities and requirements for higher quality or reliability.

The Telecommunication Administration (or RPOA) is generally limited in the amount of capital available for its annual procurement of new equipment so that the introduction of ISDN will be arranged to cause the least perturbation in its operations consistent with the need to maintain a viable business.

1.5 ISDN Reference Models

ISDN studies have made use of reference models both to describe how ISDN could work and to describe a procedure or methodology for setting standards for it. Hence the two major models used are the functional model and the procedural model.

i) Functional Model:

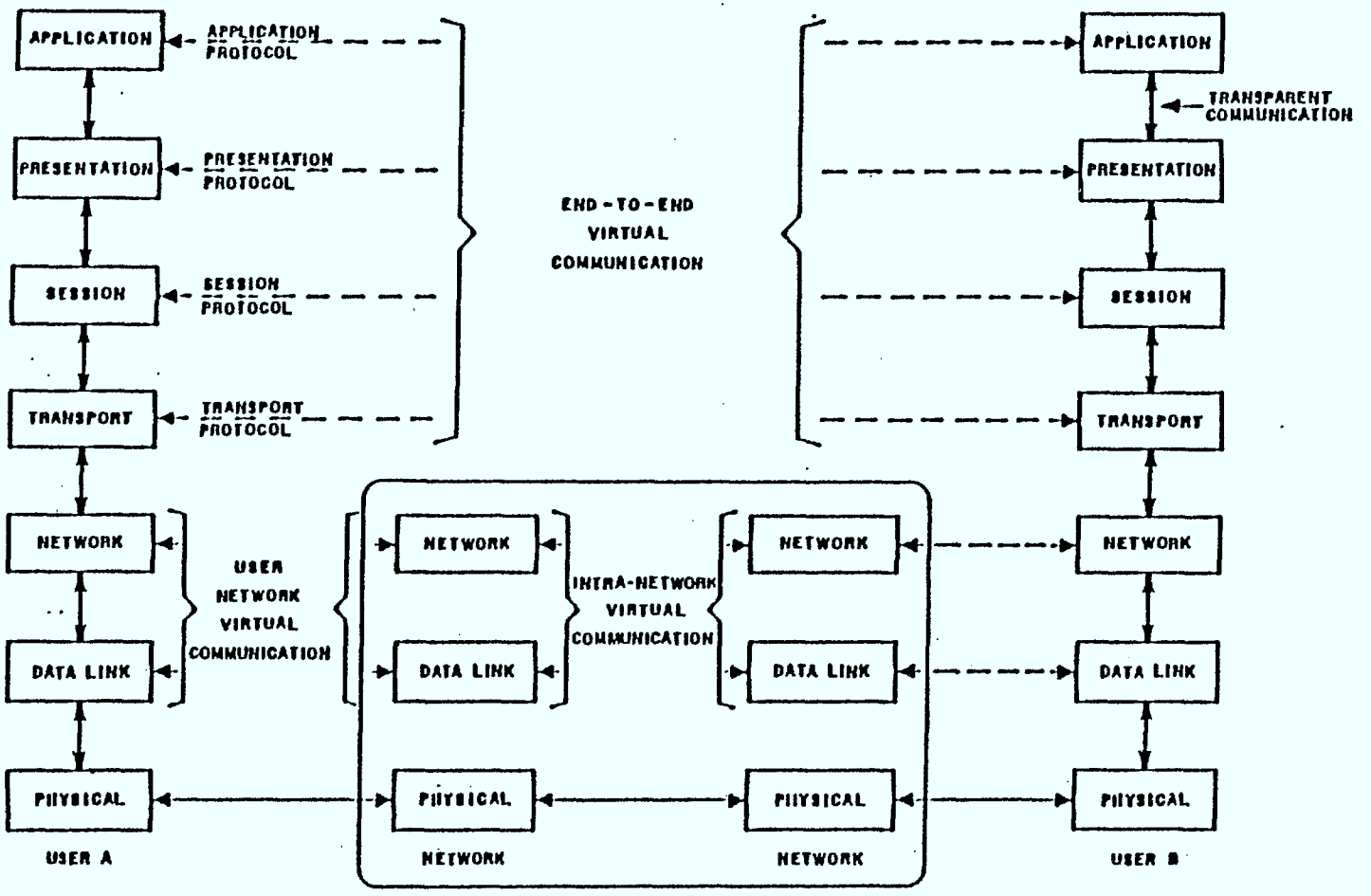
Communications networks can be represented by "functional groupings" interconnected by suitable linking arrangements. These groupings may or may not equate to specific items of equipment. A grouping only shows necessary functions and relationships. A typical example is the Functional Model of ISDN (Figure 1.5(i) refers) which identifies functional groups such as terminal equipment, integrated access, local switching nodes, connection types between nodes and common channel signalling facilities.

ii) Procedural Model: Open Systems Interconnection (OSI)

The Open Systems Interconnection (OSI) Reference Model was proposed by the International Standards Organization (ISO) in the mid-70s and a modified version has been adopted by the CCITT as a basis for ISDN protocol design. The model was introduced to help in the standardization of software protocols used to establish connection between terminals or terminals and ports.

The ISO model consists of seven layers descending from the top-most application layer, which is job-oriented, down to the bottom layer where the physical interfaces to the network are defined.

Thus, from the user's viewpoint, the top three layers are concerned with the user and his task and the bottom three, with the equipment and the connections required to make it work. The middle layer four called the transport layer,



OSI Reference Model

FIGURE 1.5(ii)

bridges user and network aspects. It is through this layer that the user conveys his choice of the functions and characteristics of the network that he thinks appropriate for his task.

This model attempts to classify standards into a vertical scale of defined functions and protocols against which existing "standards" can be compared and the measure of their compliance or variance from the prescribed norm can be recognized.

Note: This seven-layered model has been used by CCITT to draw a distinction between "bearer services" and "teleservices" with the former spanning the lower three layers only, and the latter spanning all seven. However, it should be noted that the CCITT never intended this distinction as a definition of what should be provided by (regulated) telecommunication carriers, and what should not. That is, the distinction between bearer and teleservices is not a regulatory tool, unlike the distinction drawn by the U.S. Federal Communications Commission between "basic" and "enhanced" services (see Chapter 6). The OSI model is simply a reference model and like most models, has proved somewhat inflexible in specific applications.*

* Because of this inflexibility CCITT Recommendation I.320 ("ISDN Protocol Reference Model") and X.200 ("Reference Model of Open Systems Interconnection for CCITT Applications") have been produced to resolve some of the difficulties particularly in the design of the CCS7 and D Channel protocols.

		EXISTING NETWORK	ISDN
RESIDENTIAL	Voice Only (N=1)	Single Analog Pair	No Equivalent
	Alternate Voice/Data (N=1)	Single Analog Pair	Hybrid Analog + Digital (A+D) (Single Pair)
	Simultaneous Voice/Data (N Small)	N Analog Pairs	Hybrid A+D or Basic Digital Access (2B+D) (Single Pair)
BUSINESS	Multiple (Voice/Data) Lines (N Large)	N Analog Pairs	Primary Rate Digital Access (23B+D) (1 T1 Line)

FIGURE 2

(Sections 2.1 and 2.2 refer)

LIKELY EVOLUTION OF USERS IN AN ISDN

2. IMPACT OF ISDN ON CANADIAN PARTICIPANTS

Canadian participants in ISDN will include:

- Users of telephones and data terminals, both residential and business (Figure 2 refers).
- Carriers and Specialized carriers
- Value-Added Networks (VANs)
- Suppliers

At any one point in time, a given company or agency could be all four of the above. The following describes possible characteristics of these future ISDN participants.

2.1 Residential Subscribers

While the residential subscriber is becoming steadily more sophisticated, it can be expected that for the next decade a majority of these telecommunication users will be satisfied with POTS (Plain Old Telephone Service) and CATV. Thus they will not look for ISDN services and will not be customers for the digital access.

However, a significant number, including those who are owners of personal Computers (PCs) may already be using low speed modems (300 baud) to interwork with friends, their place of business or some information source. This activity cannot be measured by the telecommunications carriers since the user is just making another telephone call. Only a survey could determine the level of this activity.

The ability to down-load programs to personal computers may generate a new industry, providing up-to-date versions of programs to suit any of the major PC operating systems. However, these can be dispatched over the existing telephones at low speed. The CATV network can provide higher speed access to programs, but the selection process is less flexible due to the unidirectional nature of existing systems. Videotext may eventually take-off especially if it can be accessed by the existing PCs.

The more sophisticated subscriber may eventually find that alternate use of his line with low speed data is unacceptable and will look for simultaneous operation of voice and data and for reliable higher speed data operation. The use of ISDN access technology and other network features may then be considered economically viable by this class of residential subscriber. In addition, as a low level user of ISDN services, the subscriber may welcome the introduction of measured service (Usage Sensitive Pricing or USP) if the tariff is renewed.

2.2 Business Users

Since the business users have a more obvious need for integrated services they will most likely be given priority in accessing ISDN and they are more likely to provide immediate revenues for telecommunication Administrators.

The professional, small and medium-sized business users today are graduating from using a single analog line, with alternate voice and data, to multiple analog lines allowing simultaneous voice and data. With ISDN, a similar graduation will be open to these users. They will require only a single wire pair, however, to obtain simultaneous voice and data.

It has been estimated that in the U.K.* about 250,000 business customers may want less than a PABX and may therefore be well suited with ISDN access. Perhaps a figure of 150,000 similar small businesses may be expected in Canada, although this figure may be rather high. There has been greater exposure to a wide variety of data processing equipment in Canada, one person in every 100 owns or has access to a computer**; and the vast distances in Canada might make ISDN electronic mail systems, for example, more obviously necessary than in the U.K.

Large users are expected to remain with their private-line and PABX equipment rather than use the ISDN network, either for reasons of security or simply to avoid disruption of their business activities. Insistence on the continuance of private-line provisioning is the main thrust of U.S. policy, but the reasons cited by the Federal Communications Commission (FCC)*** for their retention would also be valid (technically) for large businesses in Canada.

The business user may accept lower quality voice service if this will produce savings, i.e. voice digitization at less than 64 kbit/s. However, such systems will only be possible on private-line PABX systems unless, or until, the entire network's switching and transmission system is made compatible with a less than 64 kbit/s rate.

The business user will expect the cost of long distance calls to be "contained", if not reduced, because of a reduction in the cross-subsidization of local revenues with long-distance revenues. This reduction in cross-subsidies could happen if some form of measured service (USP) is introduced.

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* Integrated Digital Communication Telematics Report Series, U.K., 1983. (page 33)

** Canadian Computer Census, 1982.

*** First Report on ISDN. FCC General Docket 83-841 Paragraph 55, April 1983.

ISDN may also help persuade the business user to relocate his work place. This could happen with increased use of "extended area" pair-gain systems installed to relieve congestion on the downtown central offices and to provide service to the "industrial estates" that now lie on the periphery of many metropolitan areas.

2.3 Carriers and Specialized Carriers

Telephone operating companies are enthusiastic about ISDN because of the economies to be realized by digitizing the network and by the greater control they will have over it with better tools for measuring traffic flow and traffic growth. They will also expect that the extension of the network to the customer via a digitized subscriber loop will promise immediate revenues to help defray the cost of these loops.

USP may be introduced to help spread the costs of proprietary services, many of which will be network-embedded and involve the intelligent telephone. With the telephone, the carriers have an (almost) captive market, for while intelligent telephones and terminals (i.e. customer premises equipment) may not always be purchased from these carriers, the services to exploit their intelligence will be under their control. For example, all services processed by the signalling system will be network-embedded and many will be handled at the central office.

Despite the operating companies control over their own networks, however, they have become increasingly aware of the competition offered by alternative networks and specialized carriers, and the "bypass threat"* they represent. These alternatives include private line systems, interactive cable distribution systems, satellite networks, and to a lesser degree, cellular mobile radio systems.

2.4 Value-Added Networks (VANs)

These are expected to provide more "application" oriented services. In European countries the more visible of these services will be emphasized, such as teletex, facsimile and videotex. Some network services will ultimately be integrated into ISDN. Some will not. They will be replaced by improved services integrated with the ISDN network.

Because VANs can provide more "user" oriented services than the regulated carriers they may seek not to duplicate but to diversify their offerings. To the extent that they diversify, they

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* "The Bypass Threat and What to do About It" B. Netschert, Telephony, July 18, 1983. cf "Bypass Countermeasures", Illinois Bell Telephone Company, Telephony, April 30, 1984.

will not be competitive with the regulated carriers; however, their potential for competition may cause some relaxation of the restrictions that now apply to the regulated carriers.

Note: The term "value-added" network (VAN) is used loosely here, in preference to the term "enhanced". VAN has never been defined, whereas "enhanced" has lost its (semantic) innocence since an attempt was made to do so.

2.5 Service Providers and Suppliers

These can be classified into two groups. The first supplies services that enhance the network; the second provides customer premises equipment (CPE).

There are about 65 suppliers of telecommunications goods and services who are members of the Canadian Advanced Technology Association (CATA).* Of these, about 25 provide services or systems that enhance network services, such as telemetry, signal processing, speech processing, PABX and local area network extensions. These suppliers might be seen as suppliers to suppliers, i.e. to telecommunication operating companies. The second class of supplier includes 35 companies manufacturing OEM components, telephone equipment, office products and earth station systems.

Suppliers and designers of network-enhancing services will see ISDN as an opportunity to press their cause by demanding "joint ventures" with the operating companies to supply such services as signal processing, data and voice messaging services and (subscriber-related) database systems. Included in this group will be off-network providers of EDP services and information databanks. Of those service providers who supply CPE, several will face obsolescence. Like the modem manufacturers who sought from the U.S. FCC the right to provide "customer premises equipment" (CPE) interfaces to ISDN networks to compensate for the obsolescence of their products, so too will Canadian members of this group be expected to plead their case with vigour before the Canadian Radio-Television and Telecommunications Commission (CRTC), the Restricitve Trade Practices Commission (RTPC) and other federal or provincial agencies. Greater opportunities will fall to suppliers of terminal equipment for the office. Equipment which is not compatible with the basic ISDN 64 kbit/s channel speed will need to be enhanced with storage buffers and multiplexers to reconcile its speed with that of the ISDN subscriber loop.

Some small companies may disappear as standardization of terminal and interface equipment spreads and they lose the chance to pro-

* The CATAlog Canadian Advanced Technology Association, April, 1984.

duce innovative, but non-conforming products. The larger businesses will certainly increase their market, thereby speeding up and extending the process of standardization.

2.6 New Service Offerings

The operating companies have not been very successful in their offerings hitherto, e.g. Picturephone, teleconferencing and videotex. The reason may be the carriers distance from the market place for other than telephone-related products and the bigger reason that they have not been allowed to provide other than common carrier services. No major telecommunications carrier is "starry-eyed" about new ISDN services that supposedly will flood the market. GTE* in its response to the FCC's Notice of Inquiry which asked what services and benefits are unique to ISDN, simply pointed to the fact that ISDN was the only plan that provided for the integration of voice, data and (unspecified) multiple services. Though new service offerings will be spurred on because of low risk implementation, GTE does not specify any. Other carriers may be equally cautious in their estimate of ISDN's potential market.

As regards services that the user may expect when he obtains access to ISDN and not withstanding CCITT's attempt to define ISDN in terms of these services, certain participants in CCITT groups refuse to be prematurely enthusiastic.

A member** of the Conference Europeenne des Administrations des Postes et des Telecommunications (CEPT) has the following view:

- The demand for a definition of services that may be suitable for integration in an ISDN at the end of the 1980's is very difficult to determine now ... It is, therefore, not productive to attempt to optimize the design of ISDN solely on the analysis of service requirements. A pragmatic approach is to identify a constant set of network capabilities, providing flexibility and allowing types of service of interest to be supported.

2.7 Government Guidance to Participants

The Government can assist in the process of preparing for ISDN in the following ways:

i) Conduct an Analysis of Services that will be supported by ISDN:

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* GTE Response to Notice of Inquiry, Section V, Comment C. October, 1983.

** Evolution of ISDN in Europe. L. Ackzell, Issls 1982.

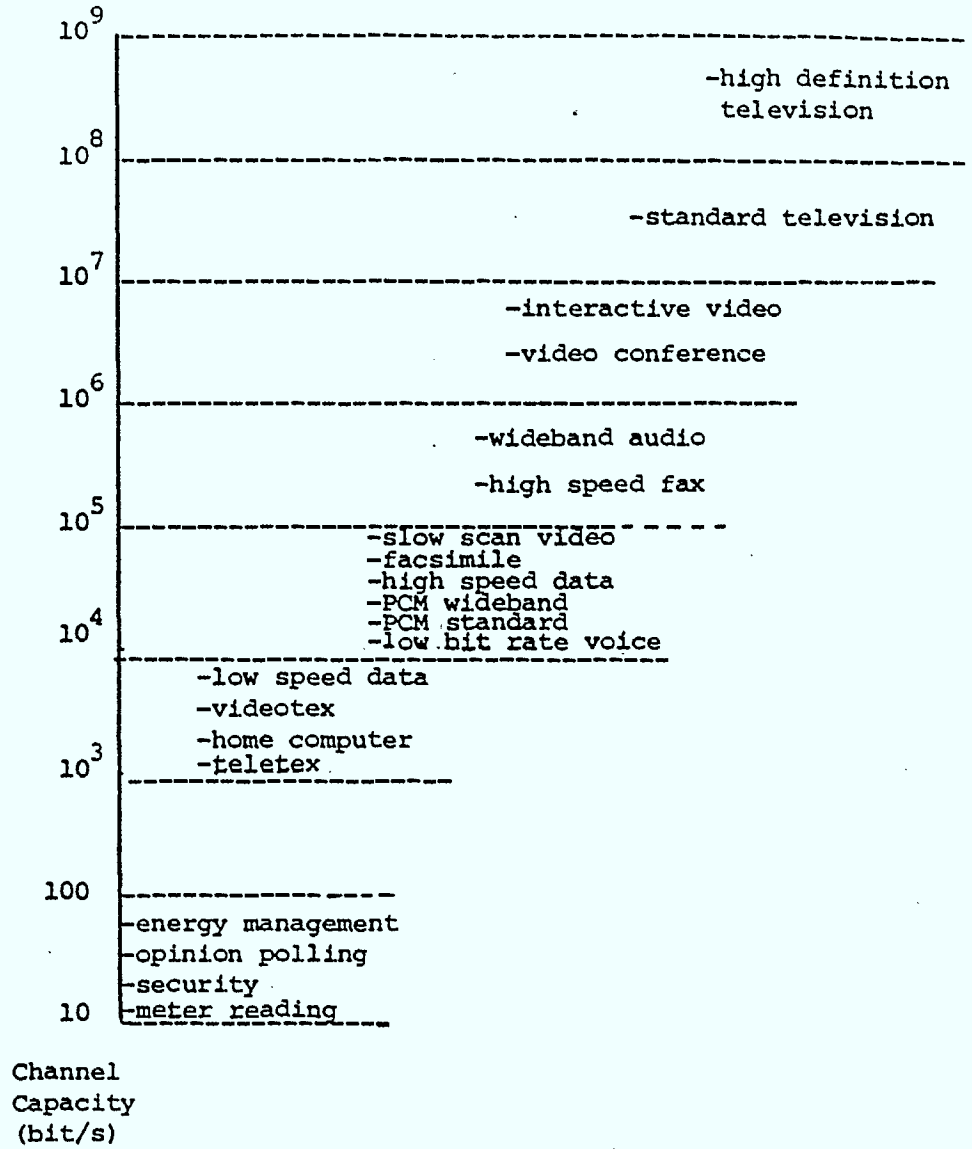

FIGURE 2.7

POTENTIAL ISDN SERVICE OFFERINGS BY BANDWIDTH

That is, an analysis of services ISDN could provide - rather than the identification of potential customers. The result of a "services analysis" should be a catalogue of services that, short-term, will ensure that some, at least, of ISDN's features will be available.

I.130 provides a framework for categorizing ISDN services in terms of their characteristic attributes. These attributes, for which values have to be assigned, include the desired transmission mode (circuit-switched or packet-switched) bandwidth, mode of establishing and maintaining connection with the network (switched, permanent), signalling and access protocols and quality of service. The list of attributes is provisional but will be extended as OAM, interworking and multimedia attributes are defined. (See Figure 2.7 as an example of the classification of ISDN service by bandwidth.)

Once these service categories have been listed, then a subset of them could be drawn up in order to determine which of the services listed would suit a majority of the four classes of business users referred to above.

ii) Provide Guidance to Ensure Terminal/Wiring Compatibility:

Both the user and the supplier must know what attributes are required in terminal equipment that will protect the network, ensure integrity of transmission and ease of user access.

The CSA "Steering Committee on Telecommunications" (SCOT) has, as its mandate, to set national standards covering "definable characteristics of terminal equipment attachment to the telecommunication networks, network protection and interfacing of networks"; further to ensure "that national standards setting is undertaken at an appropriate time." An appropriate time to anticipate ISDN is now, considering the progress being made towards the digitization of the Canadian telephone network. The timing of the subsequent digitization of the user-access to this network should be borne in mind by the Committee when selecting its priorities.

iii) Facilitate Joint Ventures:

The risks and costs of providing ISDN services will shrink. Suppliers of enhanced services will be able to build on the bearer services provided by the carriers. To encourage them to provide new services, the government should encourage joint ventures between suppliers and the carriers in order

to tap the resources and the innovative talents of each. Government should foster collaboration between the two because of the economic and technical complexity of the user-network access path.* Sponsorship of trials of equipment and services should include those that help adapt users' existing equipment to the ISDN.

iv) Establish User-Carrier Responsibilities:

This can be done if the T** interface is confirmed as the user-network boundary and by confirming the responsibility of the carrier to install and maintain Network Channel Termination Equipment (NCTE).

The principal reason for confirming the T interface rather than the U (loop) interface as the boundary, between user and network is the need to have a "stabilized" interface. On the network side of the T interface, new transmission technologies are currently under investigation; on the user's side of the interface, ISDN-compatible terminals are being marketed. Given a "stabilized" interface these activities, insulated from each other, can proceed at their own pace. The user can therefore graduate to higher bit rates on the loop or to a more sophisticated CPE without the one affecting the other.

Who should be responsible for installing and maintaining (though not necessarily providing) the NCTE is another issue. There is no overall economic advantage to be gained in splitting the revenues from the provisioning of NCTE between independent suppliers and carrier-affiliated suppliers. However, from the user's point of view it might be preferable for the carrier to provide all equipment from the central office to the T interface. The carrier has both the resources and the responsibility for doing so. Independent suppliers do not.

Evidence for this assumption, that the user would prefer to deal with a "single vendor" for both NCTE and loop might be found in users' past experience and present attitude towards carrier-supplied, TAP-certified and non-TAP certified equipment.

v) Recognize Carriers' Priorities:

Regulated carriers are required to provide telephone service when requested, with all reasonable dispatch. ISDN offers

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* Section 3.1 refers.

** T and U interfaces are described in Section 3.1(ii). The T versus U interface controversy is also referred to in Sections 5.5 and 6.3.2.

both voice and data service, but will not be offered at first to those requiring only telephony. The carriers will wish to give priority to business users requesting a mix of both telephony and data communications. This priority should be recognized by the government and its position, vis a vis "integrated services" (i.e. telephony and datacom) clarified.

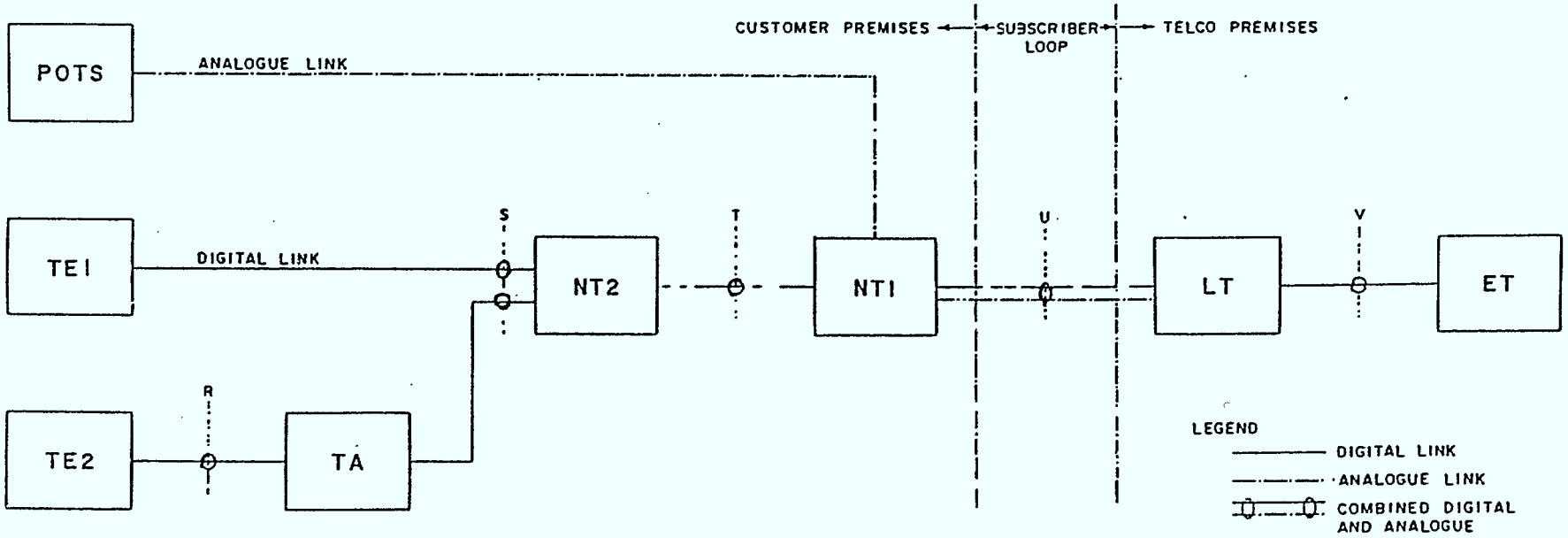


FIGURE 3.1(ii)

USER-NETWORK ACCESS MODEL FOR ISDN

3. USER-NETWORK AND NETWORK-NETWORK INTERWORKING

User-network interworking is characterized by three features: the services available to the user at his port with the network, the characteristics of the interfaces along his access path to the network and the possible configurations that his CPE can assume. The user's power of choice is three-dimensional, however, CCITT has attempted to reduce the number of interfaces to a minimum to increase portability and decrease cost to the user.

Network-network interworking involves the provision of interfaces between individual networks which form part of the national network or between national networks. These networks may be large or small. They may be designed to ISDN principles or be service dedicated networks. In each case, interface standards must be provided together withcompatible levels of service or quality for interworking to be effective.

The ISDN concept is designed to establish within a country (or a region having a strong community of interest):

a) A single homogeneous network.
b) A collection of networks capable of working together to provide the user with the perception of one network.

3.1 User-Network Interworking

CCITT Approach

The CCITT approach is to describe user-network interworking in terms of the three dimensions of choice open to the user:

i) Services: The ISDN user-network interfaces defined by CCITT have physical and procedural characteristics designed to provide access to a range of current and future services. While the new loop facilities will permit the user to access all current switched services and some private line capabilities, his access to any new service may require significant network enhancement. The level of services provided to a specific user may depend on the degree of penetration of appropriate network capabilities. Therefore for effective exploitation of the ISDN potential it may require stimulation of the provision of network features.

ii) Interfaces: CCITT has identified 3 locations between the user's terminal and the local switching office at which the user may interface to the network. These are the R, S and T points. See Figure 3.1(ii)

The R point is intended for existing non-ISDN compatible terminal equipment, Terminal Equipment 2 (TE2) and requires a Terminal Adapter (TA) to permit conversion to the standard ISDN interfaces. The S interface is suitable for ISDN

compatible terminals, Terminal Equipment 1 (TE1). S and T interfaces are essentially equivalent, but the S location is physically separated from the T location by the Network Termination 2 (NT2). (The NT2 provides a number of functions including those of a PBX.) Two further reference points have been identified for functional definition of access components, however, the U.S. Federal Communications Commission has proposed a user-network interface at the U reference point (adjacent to the Network Termination 1 or NT1). Thus, in the U.S. a user would have 4 points (3 physically and procedurally different) to which his equipment could be connected. Increasing the number of alternative points increases the variability of terminal devices and tends to lead to increased cost and confusion for the user.

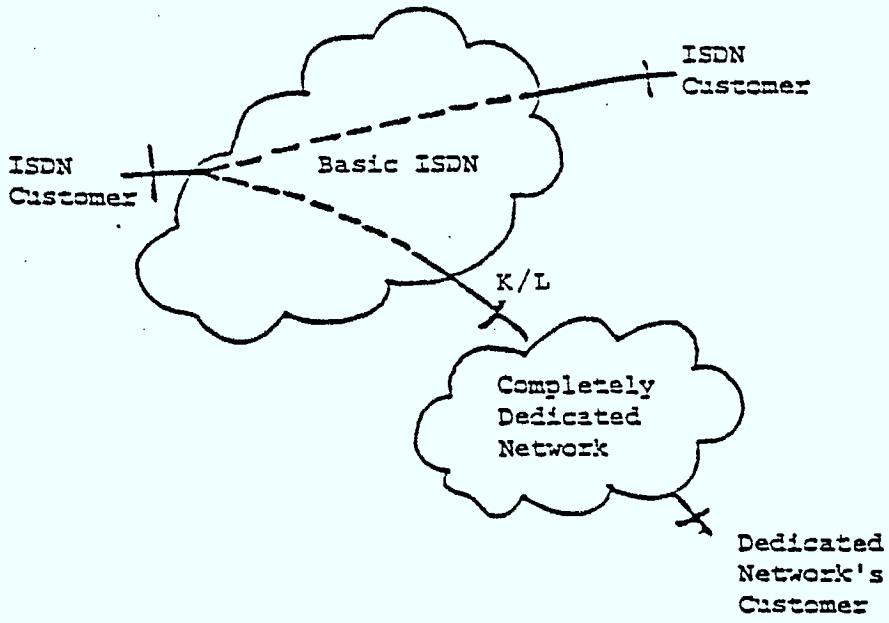
iii) Customer Premise Equipment and Wiring:

a) The design of the Basic T interface is directed at the user requiring not more than eight terminals of various types as a design objective. These terminals may be served by a passive bus from the NT1 or in a star configuration by adding an NT2. The electrical models on which the interface is based are given in I.430, but there is no limit to the variations which may ultimately be possible. It will be necessary to provide guidelines to the user regarding the application of terminals to the ISDN.

A second application for the basic T interface will be the integrated work station (containing data, image and voice terminal equipment). In this case the transmission capabilities of the basic access may be utilized by one terminal device leading to a much simpler wiring configuration.

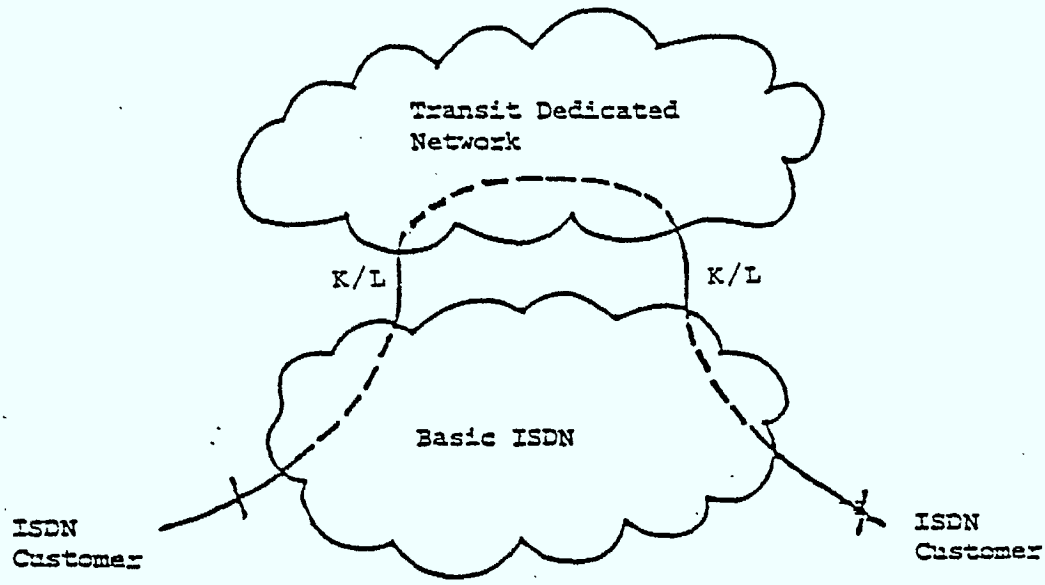
b) For customers requiring more capability than provided by a single basic access, two choices exist at this time. One may choose either multiple basic access N(2B+D) or a primary rate access (23B+D) where D equals 64 kbit/s. (See Section 5.2.2 for a description of the access options specified to date.) In either case, an NT2 device is likely to be needed for optimum utilization of the access capacity (PBX, Keyset).

c) To cater for the small subscriber who wishes to have data capability added to his current voice circuit(s) and finds the alternate voice/data arrangement inconvenient, a Hybrid access has been proposed. This will provide up to 16 kbit/s of data above the voice channel. The user in this case can continue to use his existing equipment (telephones) over the voice path while operating his data equipment into the digital part of his network termination (NT1) equipment.



Network services provided by Dedicated Network, as well as by ISDN.

FIGURE 3.2(i)



Network Services provided solely by Transit Dedicated Network

FIGURE 3.2(ii)

d) ISDN terminal equipment will provide its signals to the network in digital form. A standard set of procedures called the "D" channel protocol has been designed. To cater for simple terminal devices the protocol contains a stimulus signalling capability which requires a series of interactive prompts between the terminal and the network. For intelligent terminals the protocol contains functional signalling messages which provide faster and more efficient interaction between terminal and network.

e) Because the new access can cater for many more terminal devices it is considered that there may no longer be justification for provision of power by the telephone company to subscribers using an ISDN access. Suggestions for feeding emergency power only, or turning equipment on and off to reduce power consumption are under consideration. In the U.S. it has been proposed that technology for customer provided emergency powering is economically available.

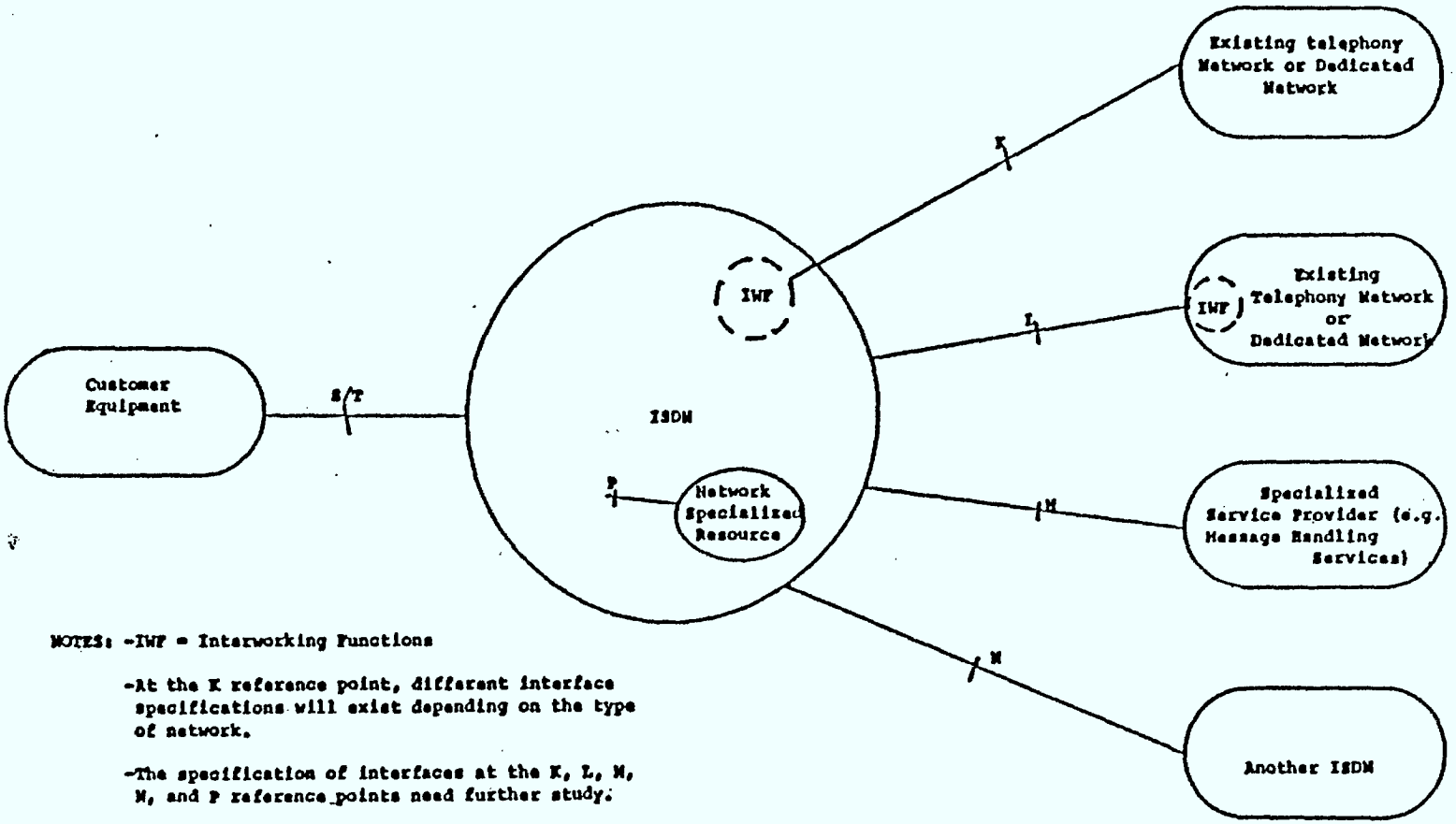
3.2 Network-Network Interworking

Dedicated Networks - Because dedicated networks have been optimized for specific purposes (i.e. for either voice or data) and because they cannot be rapidly withdrawn without hardship and disruption to users, arrangements must be made for them to interwork in the meantime. Further, there may always be a need, economic or technical, for the continuance of some specialized networks. Two kinds of dedicated networks have been identified (Figure 3.2 refers):

i) Dedicated networks offering services that will eventually be provided within the ISDN. For these to interwork, arrangements must be made for a user connected to an ISDN to interwork with a user connected to a dedicated network. As dedicated networks are gradually absorbed into ISDN, it is expected that users will migrate from one to the other, if tariffs are adjusted to induce them to do so.* (Note: An example of this is the CEPT expectation that, for example, Telex will evolve into a more enhanced teletex service provided by ISDN.)

ii) Dedicated networks offering specialized services which the ISDN will not provide. Connections between two terminals connected to the ISDN will be routed through such dedicated networks which will act as transit networks. This category of network will remain separate from ISDN for economic or technical reasons such as the specific requirements for a given quality of service.

* CEPT DOC T/CCH (82) 30 Stockholm Nov. 1982. Chapter 4.2 on the Interrelationships between ISDN and other networks.



NOTES: -IWF = Interworking Functions

-At the K reference point, different interface specifications will exist depending on the type of network.

-The specification of interfaces at the K, L, M, N, and P reference points need further study.

REFERENCE POINTS ASSOCIATED WITH THE INTERCONNECTION OF CUSTOMER EQUIPMENT AND OTHER NETWORKS TO AN ISDN

FIGURE 3.2(iii)

Network-Network Interfaces - These network-network interfaces have not been specified to the degree that user-network access options have. The gateways or interfaces between networks have merely been enumerated. They have not been defined. Work will continue on network interworking in the next Study Period.

Five hypothetical reference points have been recognized, K, L, M, N and P. These reference points (see Figure 3.2 iii) refer to interfaces between ISDN and:

i) An existing telephony network or a dedicated network where the interworking function is performed in the ISDN (K) or in the non-ISDN (L).

ii) Another ISDN (N).

iii) A specialized resource within the ISDN (P), or outside it (M), that answers a service request such as optional features relating to a telephone ensemble, ISDN network appeal to a data base (billing functions, credit checking, routing selection and other OAM functions.)

The principal functions that these interfaces must include are:

i) Physical and electrical conversion (i.e. media conversion).

ii) Numbering conversion between, for example, a national telephony numbering plan as proposed in the E.16X Series and a data network numbering plan (X.121).

iii) Bit rate adaptation between countries from and to 64 kbit/s and 56 kbit/s.

iv) Reconciliation between two networks as regards conversion from a message based common channel signalling protocol and in-slot signalling.

v) A to mu Law coding conversion.

vi) The plesiochronous junction between two networks.

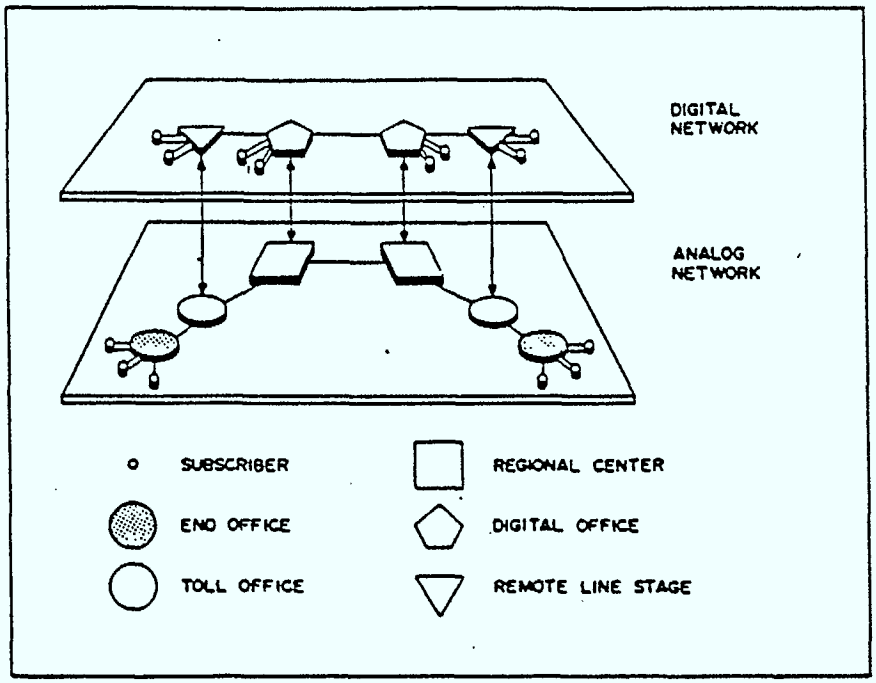
vii) Tariff application.

3.3 Interworking Issues

3.3.1 A CEPT Viewpoint

In its introduction of ISDN, CEPT* proposes special nodes for centralized network-provided service capabilities in cases where this solution costs less than the full distribution of the

* Report on ISDN Studies. CEPT COC T/CCH (82) 30, Section 3.2.5 and 4.2.3. Stockholm, Nov. 1982.



OVERLAY NETWORK STRUCTURE

FIGURE 3.3.1

capabilities in the network. These nodes will give access to a variety of dedicated networks, each providing a specific type of communication.

Three points of interest arise from this concept of interworking between networks dedicated to different services:

i) It gives a different dimension of meaning to the "island" and "overlay" methods of implementation. The island approach envisions areas that are converted to integrated digital networks with eventual interconnection between the islands. An overlay approach demands the structure of a network across a country which works in parallel with the existing national telephone network. Either approach will create different points of interconnection between ISDN and the analog telephone network. The topology of ISDN, its routing and its numbering may therefore cease to reflect the geographical structure of the existing analog network, and cease to observe territorial (i.e. jurisdictional) boundaries.

ii) Further, if special service nodes are implemented then customers not connected directly to these nodes will have to be connected to the nearest ISDN node, by a special digital path. This may cause problems with numbering and charging plans for subscribers who are more "remote" from these nodes than others clustered near to them.

iii) This idea, if implemented in CEPT countries, would not be as bothersome as it would be in North America. The CEPT countries intend to provide ISDN services to business users first and most of these will be clustered in metropolitan areas provided with local digital exchanges where specialized nodes will allow access to specialized networks. However, for North American Administrations, where all customers are supposed to be served equally, a service once provided to one type of customer, must be made available (within reason) to all others.

3.3.2 Interworking Issues for Canada

In the Canadian network, large strides have been made in creating a digital backbone network and digital switching offices and packet nodes appear in most major centres. Because of this, the overlay concept espoused by CEPT and to some extent the U.S.A., is not necessary. The dedicated data networks currently utilize these digital facilities and closer integration at the circuit switching and packet nodes can be expected to follow.

Interworking between networks of different carriers within Canada and with U.S. ISDN and dedicated networks will, however, be a major Canadian concern.

Interworking between Canadian and U.S. networks would permit the following:

i) A Canadian user, would be able to choose a U.S. carrier when placing a call to the U.S. and be able to choose a Canadian carrier for en route carriage to the U.S.

ii) A Canadian user would be able to place double-hop calls to the U.S.*

iii) A Canadian user would be able to bypass his own national or overseas network by making a detour through another country.

The above will be technically possible with ISDN. The question arises as to whether choice of carrier should be left to the user, negotiated by the common carriers or determined by appropriate, tariff-setting bodies.

Establishing groundrules for international interworking is important at this point in time, while it is still possible to build into the design of an ISDN any features in signalling, interworking and numbering plans, that can help achieve national policy objectives at an international level.

3.3.3 CCITT Agenda for Interworking

For the 1985-1988 session three Questions have been proposed which deal with interworking and access:

i) Question G/XVIII is concerned with the interworking of ISDN networks with non-ISDN networks. The motive for the Question is to enable the migration of users existing applications and terminals from dedicated networks to ISDN networks.

ii) Question F/XVIII is concerned solely with ISDN-ISDN interworking. It assumes the existence of multiple ISDNs within some countries; and the need to pass operational, administrative and maintenance information from one to the other.

iii) Question N/XVIII is a new Question which will deal with the Testing and Maintenance of the interface between ISDN Digital Subscriber Lines and Subscriber Equipment. It was supported by six annexes, only one of which came from the U.S. Administration although it described a problem more acutely felt in the North American environment than in the CEPT domaine, namely terminal attachment. Thus:

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* cf Report on Offerings of Longnet Telecommunications and Camnet Communications of Vancouver, B.C. Maclean's, May 28 1984. cf CRTC Telecommunications Bulletin June 1984, Vol 8 No.6.

"Trouble isolation within a network has always been difficult because of lack of coordination between equipment provided by the network and equipment provided by the network user. Even when each equipment could perform some type of testing within itself, there was always a degree of uncertainty regarding that small part of each equipment that was left untested by normal internal testing procedures. This uncertainty could be eliminated by having the capability of establishing non-simultaneous test loops that overlap, so that all equipment is tested by either or both the overlapping test loops."

The overlapping of these test loops is significant because both the user and the network owner will be testing each others equipment. The mutual dependence on each other to initiate these tests suggests a new approach to terminal attachment problems. If mutual dependence between user and network can be designed into an on-line testing procedure, then the need for certification of terminal equipment may diminish.

4. ISDN NUMBERING PLAN

To be ISDN user-friendly a numbering plan should: have a uniform and understandable structure; allow a subscriber to call another subscriber locally, nationally and internationally at the same station address; be expandable, i.e. able to accommodate not only all present and future telephone users but also all public (and perhaps private) data networks; allow interworking between more than one ISDN (at both the national and international level) and between an ISDN and other public networks.

4.1 CCITTs Telephone and Data Network Plans

Two of the numbering plans recommended by the CCITT concern the International Telephone Service and International Public Data Networks. However, SG XVIII is now concerned only with the former. "The ISDN numbering plan will be based on and evolve from the existing numbering plans applicable to national and international public telephone networks."

The numbering plan designed for International Public Data Networks (X.121)* will not be a model for an ISDN one. It is expected that networks using this plan will be connected to an ISDN via a gateway which will provide a conversion from one numbering system to the other.

4.2 International Telephone Numbering Plan**

The International Telephone Numbering plan structure consists of three components:

i) Country Code (CC): Here, "country" refers to a geographical area with an integrated telephone numbering plan, such as the countries of North America which, with the exception of Mexico, share the same country code. The allocation of country codes is the responsibility of the CCITT. Eighty-seven spare codes remain to be allocated; these are considered to be adequate up to the year 2000 A.D.

ii) Trunk Code or National Destination Code (NDC): This code indicates the called numbering area within a country and is to be dialled before the subscriber number where calling and called subscriber are in different numbering areas. In the U.S. and Canada it is known as a Numbering Plan Area code (NPA) or more commonly, an area code.

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* X.121, Yellow Book, Vol. VIII, Fascicle VIII, 3, Geneva Nov. 1980. Seven world zones are proposed; each country having a single or a series of 3-digit "country codes" to identify its Data networks.

** E.160 and E.163 Vol. VIII, Fascicle II, 2 refer.

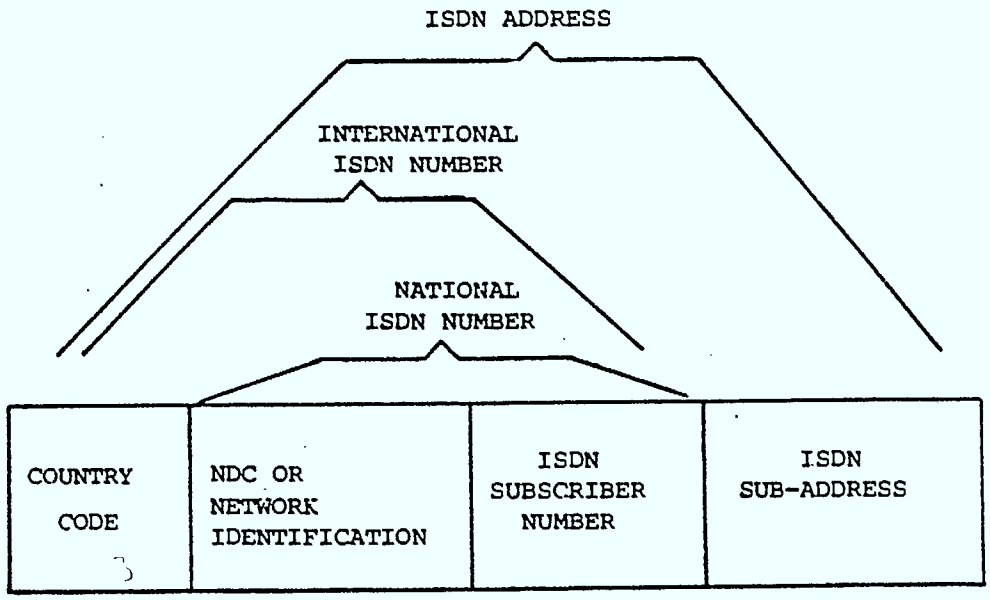

FIGURE 4.3

FORMAT OF ISDN ADDRESS

iii) Subscriber Number (SN): The subscriber's number is to be dialled to call a subscriber in the same numbering area. In the North American numbering area it consists of a three digit central office code (COC) and a four digit station number. The NDC and the SN combined constitute the National Significant Number (NSN). An International subscriber's number for a resident in Canada consists, therefore of:

CC + NDC + COC + Station

CC + NDC + [SN]

CC + [(NSN)]

[International number]

Thus in North America NPA subscribers make and receive international calls according to a closed ten digit numbering plan and receive calls according to a closed eleven digit numbering plan.

The allocation of area codes has, hitherto, been the responsibility of AT&T. Only 21 codes remain to be allocated out of a maximum of 152 and it is believed that these will be exhausted by 1990. Some solutions to this problem have been proposed, (see below).

4.3 ISDN Numbering Plan*

An ISDN Numbering Plan will observe the same structure as the International Telephone Numbering Plan. The three components of the number consist of CC, NDC and SN. The ten digit decimal character set 0-9 is used in all components. The maximum number of digits for an international ISDN number is 15.

Country Code: "The ISDN numbering plan shall include an unambiguous identification of a particular country and it shall retain the integrity of the telephone country code as defined in Recommendations E.160 and E.163." That is, a "country code" will remain as a one, two or three digit number.

This system of one, two or three digits for the country code has to be retained for international calls coming from countries overseas with step-by-step exchanges. No one or two digit country code may be repeated in the leading digit(s) of another country code for if there were a country code "35", all calls for countries numbered 350 to 359 would be diverted to country "35". Similarly, as the North American area has been assigned country code "1", no other country code may appear in the series 10 to 19

* E.164 The Numbering Plan for the ISDN era. Geneva, April 1984. cf I.330 The ISDN Numbering and Addressing Principles and TD 131-E (amendments).

or 100 to 199. Any new country code assigned by the CCITT will be a 3-digit code as all 1 and 2-digit codes have already been assigned. If Canada requests its own (Canadian) country code, it will be a 3-digit, not a 1-digit one.

National Destination Code (NDC): As in the telephone numbering plan, the NDC has a trunk code selection function to route the call over the network to the called area. However, an NDC may also be assigned to a network or network service (e.g. as for the TWX series, 800 or 900). Therefore, where a country has more than one network the NDC must include the means to select one of them.

Network Selection: E.164 proposes three ways to select a network:

- NDCs specially assigned for interworking purposes.
- A special prefix consisting of one or more digits.
- A non-numerical address qualifier, i.e. an escape code which indicates that subsequent digits are not to be interpreted in the conventional way.*

Two of these qualifiers recognized by the CCITT correspond to asterisk and cross hatch. The use of either of these two would allow the reuse of the whole range of telephone numbers for non-voice purposes (e.g. data or images).

Two other methods of interworking between ISDN and other dedicated public networks are described by CCITT. Neither forms part of the official ISDN numbering plan. Both consist of information which is passed transparently through the network and is not processed by it. Both will be the subject of subsequent Recommendations in the next CCITT Study Period. These methods are:

Service Selection: This method envisages some kind of intelligence preprogrammed in the calling party's terminal equipment which will automatically pass service-related information to the network via the D channel when the call is signalled.

Network Address Extension (Sub-Addressing): This is another method for transferring information across the network. The sub-address is envisaged as a means of identifying a specific terminal within a cluster of terminals at the destination. An address extension may consist of a maximum of 32 decimal digits. This suffix is not processed by the network. It is a formula agreed on by the calling and called parties and its interpretation will be determined by the configuration of their terminal equipment.

* CCITT Recommendation Q.763 refers.

4.4 A New North American Numbering Plan

The CCITT is anxious to retain existing telephone numbering systems because of the widespread use of the telephone and the users familiarity with it.

The ten digit North American Telephone Numbering Plan* has a clear and simple structure. It is also, at ten digits, within the maximum recommended by the CCITT. However, because of its three digit NPA, three digit COC and four digit station number it cannot easily register demographic changes despite the fact that ten digits can enumerate a population thirty times that of the North American continent. The creation of multiple networks in North America and the appropriation of NPAs to denote network services has (almost) exhausted the NPAs available. Circa 1995 AT&T will resort to using "Interchangeable Codes" whereby both NPAs and COCs will be assigned codes from the same range of digits. NPAs and COCs will then become identical, causing a seven/ten digit ambiguity. The user may not easily know whether a local call is a toll call or not.

One solution has been the proposed introduction (later this year in Pennsylvania) of an additional network selection code, a 10XXX prefix to the 10-digit North American telephone number to permit selection of 999 networks. Furthermore, by September 1984 each BOC plans to install at least one digital exchange to provide "equal access" to all interexchange carriers, that is, to recognize this network selection prefix and switch accordingly**.

It is understood that at this point in time about 400 networks have applied for a number. It is doubtful whether allowance for only 999 networks will be sufficient for North America. Of more significance is the fact that the network selection code is a de facto North American standard.

Another solution proposed by Telecom Canada*** is to scrutinize the four digit subscriber numbers in order to recapture some of the slack. It proposes the installation of digital switching systems equipped with Remote Switching Unit (RSU) capabilities. These RSUs, ranging from 96 to 4,500 lines would act as extensions of the central office, sharing its COC but differentiated from it in its range of subscriber numbers. Thus, small communities with fewer than a central office's maximum of 9,999 lines could share this maximum with the central office.

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* Notes on the Network, Section 2, AT&T, 1980.

** "One Manufacturer's Ideas on Providing Equal Access", H. Nothhaft, Telephony, May 14 1984. cf Bell Communications Research (Network Planning) Internal Memorandum, April 1984. re: Feature Group D.

*** Digital Network Notes, Chapter 10. Telecom Canada, 1983.

This solution will solve the problem of providing for ISDN subscriber terminal numbers (as distinct from ISDN network numbers). A natural growth in ISDN subscribers can be expected, but it will also be gradual. An ISDN subscriber will only require as many ISDN numbers for his CPE as he requires telephone numbers now, for his non-ISDN CPE.

5. TECHNICAL AND ECONOMIC CONSIDERATIONS

5.1 Technological Trends

The exercise of designing an ISDN has concentrated attention internationally on two aspects of it; the digitization of all traffic, voice, data and image, that flows through the network, and the need to make do with existing copper loops for a period of one or two decades. Consequently, current research is being directed towards improving or removing any limitations imposed by these two elements. For example, the basic ISDN access rate (2B+D) has been set because a line rate of 192 kbit/s is considered the transmission limit that can be obtained from the majority of wire-loops. Therefore, recent research has concentrated on evaluating time compression multiplexing (TCM) and echo cancellation hybrid (ECH) techniques in order to extract this capacity from the loop.

Voice and Image Digitization: The main feature of ISDN is the support of voice, images and data on the one network. The basic PCM coding algorithm for voice, used around the world, requires a 64 kbit/s channel. This is now considered efficient with the development of new encoding algorithms and 32 kbit/s encoding has been found adequate for voice and voice-band data. Work on lower bit rates is proceeding based on modulo 64 kbit/s. This should hasten the implementation of common channel signalling in order to obtain 64 kbit/s clear channel capacity and also, the modification of central office equipment to permit the switching of bit streams of less than 64 kbit/s.

As neither voice nor image traffic needs to be of exceptionally high quality for average use, there will be a thrust to seek new compression techniques to reduce the volume of voice and image bit streams and thus, reduce the problem of trunking congestion at the central office.

Image encoding require from 1 megabit/s to 100 megabit/s channel capacity depending on whether frame-freeze or high definition TV quality is required. The scope for compression of image bit streams is perhaps greater than that for voice, for the detection of movement is what has to be extracted. However, the nature and quality of the data that the human eye can do without has not been as closely investigated (by the telecommunications industry) as has the human ear. Until fibre optic cables, with their ability to provide high bit rate transmission at low cost, become generally available, it is expected that compression techniques for image bit streams will be more actively pursued.

Data Communications: Compression techniques cannot be applied to data traffic without jeopardizing its integrity. Instead, any spare capacity of the digital channel can be used to enhance its reliability and security using redundancy techniques. These techniques include parallel transmission (i.e. duplicate or

triplicate data streams) with orthogonal error detection and correction.

Here the thrust is not so much to make transmission efficient, but to exploit channel capacity to ensure reliable data traffic.

There will also be a strong thrust to exploit the higher speed of digital transmission facilities. Hitherto, data has either been piggybacked at a low speed over analog lines or separated out onto operationally independent networks with a maximum speed of only 9,600 bit/s. However, over the next decade, it is expected that the average user will demand a marked increase in speed for data retrieval purposes and for data downloading. The effect of ISDN will be to match the available transmission speed to the internal speed of conventional mainframe disc storage systems. Attention will therefore shift to optimising computer retrieval speeds and also that of other terminal equipment. It is expected that the average user's CPE will include faster printing mechansims, more "hands-off" features and features that appeal more to the eye and the ear.

5.2 Utilization of Existing Loops

5.2.1 Pair Gain Loops

The purpose of pair gain loops is to expand the effectiveness of existing copper transmission facilities as a resource shared between subscribers.

In the U.S., 90% of single pair subscriber loops are 20 kft or less in length and thus fall within the short-loop (i.e. non-loaded) population.* Each wire pair is dedicated to a subscriber station. On longer rural loops, wire pairs are shared between subscribers by means of concentration or multiplexing techniques.

Digital pair-gain systems using TDM were introduced for local loops in 1972, following the introduction of the T-carrier system for interoffice trunks in 1962. The Bell System introduced two Subscriber Loop Multiplexers (SLMs). Both systems used delta modulation and operated on single wire pairs up to a distance of 50 miles.

Other subscriber carrier systems have appeared since, which are compatible with the T-carrier PCM mode of transmission and which can therefore be directly interfaced to a digital end-office.

These subscriber carrier systems were originally intended for long, rural loops where the cost of the electronics for digitiza-

* AT&T Bell Laboratories Technical Journal, May-June 1984.

Interface Structure	Information Rate (kbit/s) at U Reference Point
2B+D	144

Access Capability	Information Rate (kbit/s) at U Reference Point
D	16
B+D	80
2B+D	144

BASIC ACCESS TO ISDN

	Primary Rate = 1544 kbit/s	Primary Rate = 2048 kbit/s
B Access Structure:	23B+D	30B+D
	23B+E	30B+E
	24B	31B
HO Access Strusture:	3HO+D	5HO+D
	3HO+E	5HO+E
	4HO	5HO
H1 Access Structure:	H11	H12

PRIMARY ACCESS TO ISDN

A+D	16
A+B+D	80
A+2B+D	144

HYBRID ACCESS TO ISDN

FIGURE 5.2.2

tion and for multiplexing were offset by savings in copper wire. However, though they were intended for rural use, these local loop systems are now held to be equally as useful as urban carrier systems.*

The technology involved has proved to be less significant than its application to the predicaments that pair-gain loops can solve.

For example**, about a year ago a pair gain loop was installed in Long Island to serve an area four miles away from its central office. The area served was an industrial park, a concentration of commercial and industrial firms. The pair gain loop was a FOTs extension to the locality where a small "sub" end office was able to provide these firms with the special data services they demanded. These industrial parks are a phenomenon in North America and it can be expected that their occupants will be among the first to require ISDN services.

The application of electronics in pair gain systems indicates how savings in money and time can be realized. In effect, this has anticipated the application of ISDN access. It demonstrates that expenditures on these loops can be deferred until demand for them actually occurs. This permits flexibility in planning for ISDN. Questions such as who are possible subscribers and where are they located, become less critical.

5.2.2 Access Options

Basic Digital Access: The basic digital access is a pair gain system designed to provide simultaneous paths between the customers premises and the local office. Two capacities have been proposed, a (2B+D) and a (B+D) structure, where B = 64 kbit/s continuous circuit and D = 16 kbit/s for packet operation. The D channel carries signalling for the B channels and interleaved packet data. Two directions of transmission can be carried on one physical pair by using appropriate transmission schemes. One method being studied is known as the burst mode (TCM) where the information is transmitted in alternate bursts from each direction in turn. The overall transmission rate is in excess of

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* "A Digital Subscriber Carrier System for the Evolving Subscriber Loop Network" A. Karia, Northern Telecom, S. Rodi, Bell Canada. Issls Sept. 1982 The authors present the case for the DMS-1 Urban.

** "Modern Technology, Ingenuity join to meet Subscriber Loop Demand" DeMarco, McGarvey, Ryan. Telephony, July 4 1983. Note: Seven of the subscriber carrier systems used in this installation can now be multiplexed over a single pair of fibres to provide 672 phone conversations or their equivalent. "Record" AT&T Bell Laboratories. Vol. 62, no.5, 1984.

twice the information capacity in one direction. The other method uses an Echo Canceller Hybrid (ECH) at each end to prevent reflections, thus permitting signals in both directions to be transmitted simultaneously. The transmission rate of ECH is half that of TCM and thus permits operation over a significantly greater distance (up to 18 kft). The pressure of FCC to define a unique U interface could result in a decision for selection of one technique and a fixing of the format of the line signal. This will limit any further advances in loop transmission technology.

Primary Rate Access: A decision was made to select the hierarchical primary rate (1.544 Mbit/s in the North American case) as the access transmission standard for the next higher capacity system. The channel structure chosen was 23B+D where the D channel has a 64 kbit/s capacity and caters to the signalling of all 23 message channels. Two other structures were also identified, 3HO+D, where HO is 384 kbit/s (suitable for high quality audio) and H11 (1.536 Mbit/s) for video. The transmission technique is already an industry standard. Two metallic pairs are required, one for each direction of transmission. At this point in time, a fibre optics interface for higher rate transmission has not been considered.

Hybrid Access or Data Over Voice: For the user who requires only limited data capability a complete conversion to digital capability is not necessary. It has been shown that it is possible to achieve up to 16 kbit/s of data in each direction in the band above voice on a VF pair for the majority of subscriber loops. For short loops, even higher digital capacities are achievable, however, it is likely that the advantages of standardization would prevent a multitude of different structures being designed.

The Hybrid access has the advantage of being very suitable for working with an analog switch (voice in an analog mode with signalling in-band) in addition to its compatibility with existing terminal types.

Choice of Access Transmission Schemes: It appears that each of the three access methods is suited to a different field of application. The fully digital (basic and primary) systems depend on the availability of suitable digital equipment for the customers premises, but are more economic for the more sophisticated applications. An economic cut over point will exist between multiple basic versus a primary rate facility. A hybrid access will support the initial introduction of higher speed data services in less highly populated centres.

In both cases, the costs of provisioning must be weighed against the costs of existing techniques for accessing voice plus data services to the network.

5.3 Rating Schemes for ISDN

The cost of basic telephony should not be affected by ISDN, since basic telephone subscribers will continue to use a voice frequency access. The widespread introduction of personal computers may encourage some subscribers to explore ISDN; for example, to have simultaneous use of domestic telephone and high speed data retrieval or interaction. However, for the vast majority of residential telephone subscribers ISDN rating will not be a concern. Potential criteria which should be taken into account when establishing a basis for an ISDN service rate are discussed in the following paragraph.

5.3.1 Access Charge

The subscriber who does require access to ISDN will receive both telephony and data services. Any ISDN access charge should therefore include a basic telephone charge. It has been suggested that ISDN basic access (2B+D) is the equivalent of two voice channels plus a data channel and should be charged for on this basis. This basis for comparison is somewhat arbitrary; however, it does serve to maintain some equivalence between ISDN and non-ISDN users.

5.3.2 Flat Rate per Channel Bandwidth (Access)

This might be a monthly charge based on the "channel" capacity presented by the user's NT1. This could be classed as hybrid (A+D), basic (1B+D or 2B+D), primary (23B+D) or broadband and the NT1 rate charged for whether the bandwidth is used or not.

This class of charge would be most suited for any interim or trial period, say six months, for each customer new to ISDN. It would provide him with a chance to become aware of ISDN's potential as well as his own needs. It might also help the carriers (as well as other service providers) to ascertain demand for proprietary "teleservices" before committing themselves to maintaining support for them.

Objections could be raised however, to this scheme. As the telecommunication carriers may not have control over the user's NT1, if FCC thinking prevails in North America, they will need to monitor the user's bandwidth allocation at the central office. There will also be a problem in setting rates for bandwidths less than the potential that the NT1 permits. This problem will arise in cases of bit rate adaptation, where, for example, a user's terminal equipment is not capable of operating at 64 kbit/s and his data has to be padded to conform to it.

Account would have to be taken of this built in redundancy until the end office can recognize and deal with these subrate channels. Very few items of computer equipment can utilize a 64 kbit/s channel. Although a service bureau quality line printer

could exploit a 32 kbit/s channel, dumb, smart or intelligent terminals (or for that matter, most electromechanical equipment with paper flow facilities) would have to be clustered in groups of about 45 to 48 to exploit 64 kbit/s capacity. Such numbers would be found among large business users of computer equipment who could multiplex and transmit their data across an ISDN network (providing they were transmitting end-to-end from PABX-to-PABX and would do their own demultiplexing at the destination PABX.) However, large business users tend to lease private lines and would be paying a flat rate charge anyway.

Certain features of ISDN service other than access charge, can be clearly identified as cost components. However, for bearer service there seems no one easy measurement of use. An algorithm for rate setting will need to consider the following possibilities.

5.3.3 Bit Count Rate

As ISDN will be totally digitized, all transmission can be measured in terms of bits transmitted. Therefore, the bit capacity used is a significant component of any tariff. In fact, CEPT members have stated "...the charge for a 64 kbit/s circuit-switched bearer service should not vary depending upon the type of information (i.e. voice or data) transferred over it."*. However, the greatest objection to a bit-count rate is the essential difference in information that can be carried by voice or data. It is also likely that processing techniques will alter the required bit rate for any specific information from time to time.

Closely associated with a bit-count measurement is the transaction frequency (that is, call set up, call disconnect, etc.) in short, all use made of the switch. Transaction frequency is not proportionate to bits transmitted and therefore has to be a separate (and measurable) cost component.

A quality of service component (error recovery processing) is proportionate to bits transmitted. Here, because different levels of performance could be provided as a service to different users, this cost component must be separate from the bit count and used as a multiplier or weighting factor.

5.3.4 Weighting or Value Factor

The three major media, voice, data and images are not comparable as regards the information content of their bit rate. This is especially so with standard encoded voice bit streams which require at least eight times the bandwidth of the current analog voice train. One seconds worth of coded voice even at 32 kbit/s voice would scarcely be enough to catch a breath, whereas a seconds worth of data will provide one to two pages of text. The

* Section 1.3 DOC T/CCH (82) 30. CEPT Stockholm, 1982.

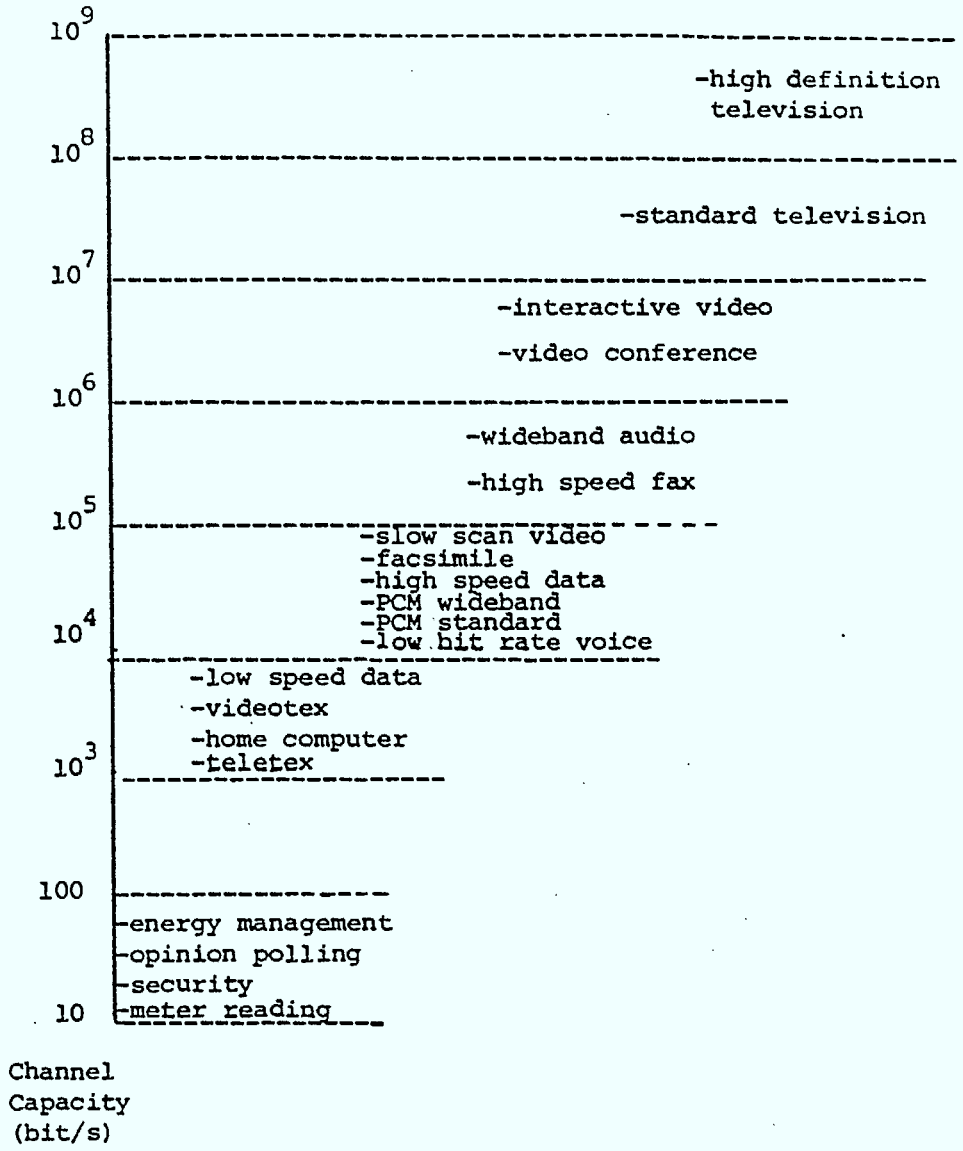


FIGURE 5.3.4

POTENTIAL ISDN SERVICE OFFERINGS BY BANDWIDTH

transmission "cost" of images could be 200 to 2000 times the "cost" of text depending on their resolution. Figure 5.3.4 illustrates the bandwidth required for data, voice and images.

Hence, one could consider applying a different weight attached to those three modes of transmission which when multiplied by the bits used would provide a cost that the user will accept as reasonable.

An objection to such a weighting of a bit-count rating scheme is that any large difference in price between voice and data would encourage the user to use a "voice" tariff for transmission of data and thus be subsidized by those subscribing to a "data" tariff. The present plan for D channel signalling should, however, prevent this tactic for it is designed to check the type of receiver (telephone or terminal) at the destination.

5.3.5 Basic Plus Premium Rate

This envisions a basic rate for "bearer services", i.e. telephony, circuit and packet-switching data services with additional charges for teleservices.

Teleservices will be clearly premium services to the user and will include data network services which during the transition stage will be carried on a "dedicated network" with which ISDN will interwork. Such services include telex, TWX, teletex, facsimile, videotex and services involving storage and forwarding of voice and data messages and information retrieval. These may be provided by Service Providers, VANs and carriers acting as service providers, i.e. at arms length from regulated affiliates or parent carriers.

As these are clearly premium services and will be seen to be so by the user, charges for these can be "unbundled" from the basic bearer services that support them and can be charged according to what the market will bear.

5.3.6 Unbundling and User Choice

Under the heading of bearer services, to be covered by a basic charge, are certain services which fall into the CCITT category of "Additional Lower Layer Functions". These include network control, administrative and management functions such as billing, transaction services which generate messages as a consequence of the users placing a call (such as credit call card checking) and those functions which will interpret and process new techniques in placing a call (e.g. call forwarding).

As these functions are an extension of the basic signalling function, they will be provided by the carrier. As they cannot be easily unbundled, charges may have to be built into the basic rate and spread or shared by all users.

This is not to say that extra fees cannot be charged for some of the above. For example, a yearly or monthly fee could be charged for the use of a credit call card. Where some of the processing performed by the network is occasioned by use of "intelligent" telephones which are not supplied by the carrier, then the carrier will not be able to "unbundle" the costs of the processing by attaching these costs to the price of the telephone. Thus, in the area of these "additional lower level functions" it is not clear what a "basic rate" should include. It may depend on how much processing the carrier is prepared to build into the network in order to allocate charges more precisely to those who actually incur them.

5.3.7 Urgent Further Study

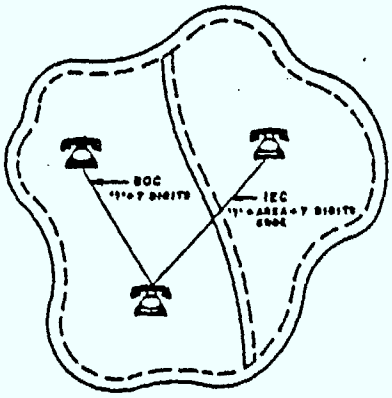
The several cost components mentioned above must be taken into account in setting a rate for ISDN bearer service. These include the access charge, bit count, transaction frequency, quality of transmission - and also distance - multiplied by a weight or value factor.

Some of these cost components are more critical in toll traffic (e.g. bit count, quality and distance) but they will affect ISDN toll traffic costs in essentially the same way they affect today's toll traffic costs. Other cost components have significance primarily for local traffic. (These include bit count, distance, access and transaction charges.) These will demand closer analysis in rate setting, since they are to some extent usage sensitive in the ISDN environment.

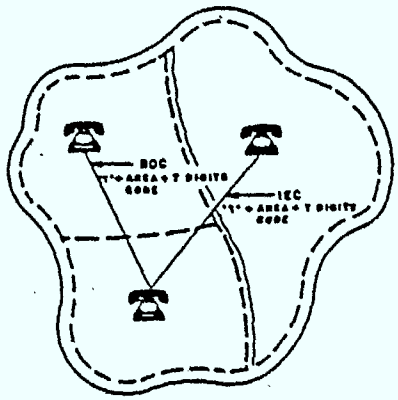
In the next Study Period, three events will take place that may focus on the issue of rate setting.

First, setting rates for telecommunications services is a national matter and not a direct concern of the CCITT. Nevertheless, Study Group III will address, under the general heading of "Tariff Guidelines" the concepts of "service definition criteria" and "charging parameters".

Secondly, work will continue on the Study Group XI Draft Recommendation Q.931 (I.451), the ISDN User-Network Interface Layer 3 Protocol. This protocol includes provision for sending information across the network. This information permits the expression of the user's choice of network service, bit rate, quality of service and other performance characteristics and options such as closed user group. As some of these parameters are cost-related, the study of these information elements may bring to light the relationship between these elements and the rates that can be set for them.

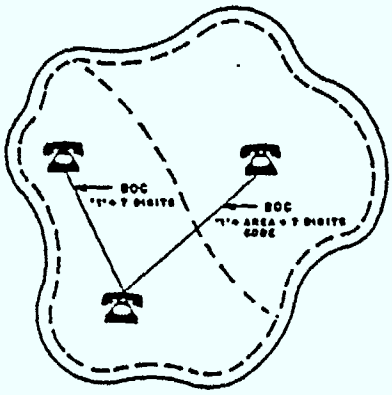


LATA Boundaries Coincide With NPA Boundaries

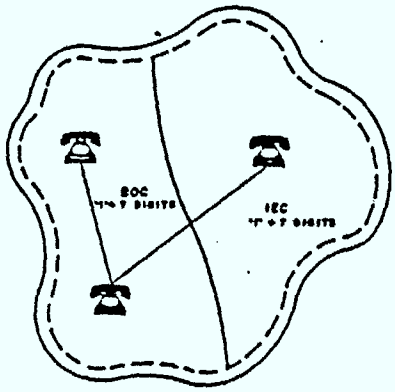


Multiple LATAs/Multiple NPAs

CUSTOMER PREMISES
LATA BOUNDARY
NPA BOUNDARY



Single LATA Containing Multiple NPAs



Multiple LATAs/Single NPA

FIGURE 5.4

Thirdly, another aid to the business of clarifying pricing considerations for ISDN will be the Draft Transport Layer Protocol being prepared jointly between CCITT and ISO.* The Transport Layer selects the appropriate network service out of several which a given network may offer, each with different service qualities. The user's power to choose is expressed by means of the Transport Layer Protocol, though the categorization of the choices open to the user is not yet complete.

However, the exercise of categorizing these options may help focus attention on the methods and principles of charging for them.

5.4 Economic Consequences of U.S. Industry Reorganization

Events occurring since the divestiture of AT&T and its seven RBOCs can be seen as a pre-ISDN experiment in internetworking. From the technical aspect the methods of interconnection are of interest to all countries who are planning an ISDN, but from the economic point of view it is peculiarly a North American problem, with consequences for Canada.

AT&T gave to the RBOCs approximately 70% of its assets and 65% of its employees. It became an interexchange carrier on the same footing as other carriers not subject to the anti-trust consent decree - save that the "interconnection access" fee it is required to pay the RBOC's is 12.75% return on revenue. All other interexchange carriers pay only 55% of the AT&T rate. It was hoped that AT&T and its RBOC's would each have 50% of future revenues. Local Access and Transport Areas (LATAs) were formed within which the RBOC's could claim local and toll charges. Inter-LATA traffic revenues would go to the interexchange carriers.

For fair and equal access for non-AT&T carriers, the user either presubscribes, i.e. registers his choice of carrier at his local office, or as occasion demands, he may override this choice by prefixing his number with 10XXX, where XXX denotes the carrier of choice (10XXX + Area Code + seven digit subscriber number).

Two unfortunate consequences are:

i) Confusion for the subscriber in being able to exercise his choice. This is caused by the fact that some LATAs are coterminous with a Numbering Plan Area (NPA), some include several NPAs within them, whereby the RBOCs collect toll revenues and some NPAs are split between LATAs.

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* "The Data Communications Transport Service and Protocols" Paul A Kirton. Telecommunication Journal of Australia, Vol 33, No.3 1983.

Thus, an easy distinction cannot always be drawn between an Inter-LATA call requiring no area code and an Intra-LATA call requiring one. Hence, a subscriber cannot be aware that he can exercise his choice of Inter-LATA carriers unless he is able to "map" an area code plan against a LATA plan, (Figure 5.4 refers).

ii) The second consequence is that some LATAs will have smaller long distance revenues than others to subsidize their local revenues. For this reason, the FCC proposed the "subscriber access fee" of two dollars and six dollars per month for a residential and single-line business user respectively. The aim was to create a Universal Service Fund which would help those RBOCs who bore a heavier expense than others by reason of the more dispersed and remotely situated subscribers that they had to service.

This idea met with vigorous protest from Members of Congress and the idea has been shelved until 1985. However, the idea represents the recognition of the need for overcoming cross-subsidization of local revenues by toll revenues and a mechanism for implementing it.

5.5 Technical and Economic Concerns for Canada

The technological and economic trends outlined above suggest the following:

i) That basic research should be conducted in the following areas:

- Compression techniques for image traffic in the basic-to-primary access range.
- Error correction techniques for different signal applications and at different levels of performance.
- Improved device technology to speed signal processing within the network.

ii) Recognition that the T interface rather than the U interface be defined as the user-network boundary following an assessment of the technical and economic consequences of choosing between T and U.

iii) Anticipation of the need to specify a fibre optics interface for beyond H11 bandwidth.

iv) Case studies of the impact that ISDN standard access rates (hybrid, basic and primary) will have on a user's operations. (The kind of study proposed might examine the effects on a typical Government headquarters computer centre which distributes data to its regional offices across Canada

in time zone sequence.) The objective would be to understand the impact on the scheduling of data transmissions at ISDN-standard transmission speeds (rather than current 2.4 to 9.6 kbit/s), the possibilities for improving the thruput of the computer centre and the impact of such a conversion on the work habits of those responsible for operating the centre. The purpose of such a study would be to provide information and some direction to prospective users of ISDN and to help them identify their bandwidth requirements.

v) The economies of ISDN suggest that that an access charge must be levied for access to an ISDN network, but recognition that such an access charge is solely compensation for conventional service provided by the carriers and borne by the subscriber. That is, it is in no way an access charge such as proposed by the FCC for subscribers in the U.S.A., a charge which has a different objective (cross subsidization).

The Consent Decree attempted, purposefully, to return some long distance revenues to the RBOCs (via LATAs) after their divestiture from AT&T. It is suggested that ISDN may achieve a similar redistribution of revenues, in time and inadvertently. However, evidence that this could be the case can only be gained by studying the topology of a Canadian ISDN and estimating its effect on future revenues.

New ISDN services, those primarily concerned with data rather than voice traffic, will tend to attract revenues to metropolitan centres and thus increase local service revenues rather than long-distance ones. However, the extent to which this flow of data traffic will be intracity rather than intercity cannot easily be assessed. Some expectations of its growth (35% of all traffic) are more optimistic than others.

6. INTERNATIONAL PARTICIPANTS

6.1 FCC: U.S. Federal Communications Commission

6.1.1 Notice of Inquiry and First Report*

In August 1983, the FCC released a Notice of Inquiry (NOI) on ISDN. Its subsequent Report, "The First Report", of April 1984 concludes that the inquiry should not be terminated. It should be a continuing process. Further that the FCC should continue to address matters arising out of the ISDN process that are "material to our policy concerns and are significant". To this end the FCC will participate actively in the standardization process.

The FCC's decision to continue the inquiry and to participate in an "informal or advisory" capacity, in the activities of the USCCITT organization, the ISDN Joint Working Party, the ANSI/T1 ISDN Subcommittee and to participate in CCITT delegations was made as a consequence of the NOI. The FCC asked for views on an appropriate role for itself in ISDN matters. Its own tentative view was that its job was to ensure that U.S. policies were understood by all participants in the ISDN process.

The response to this invitation was that virtually all parties to the NOI endorsed an FCC role of identifying the policy implications in ISDN matters. Their motives were mixed. AT&T urged FCC participation in preference to FCC proceedings. The RBOCs also urged the FCC to continue its participation in the Joint Working Party as this latter served as a "funnel" coordinating all U.S. ISDN contributions. Other parties saw the FCC as a counterweight to the dominance by AT&T and other carriers of the USCCITT organization.

Hence the FCC's decision to participate in CCITT delegations and general ISDN activities in order to provide an adequate opportunity for those in the private sector and their foreign counter parts to be "sensitized to our policy concerns". The FCC will continue the inquiry "because of the benefits already realized. Through the posing of specific questions to elicit policy-focused comment the Notice served as a vehicle for the crystallization of U.S. policy views on ISDN, which were then presented to and to some extent accommodated by, the CCITT ISDN planning groups".

6.1.2 FCC Mandate

The FCC mandate follows from the Communications Act (1934), the FCC's own Computer II (1983), the Modified Final Judgement on the AT&T Consent Decree (CC. Docket No. 78-72 Phase III June 1983),

* Notice of Inquiry re: ISDN, Gen. Docket No. 83-841; FCC 83-83-373, August 1983 and First Report re: ISDN, Gen. Docket No. 83-841 FCC March 1984.

and general U.S. policy on competition which it expresses thus:

> "... to ensure that pro-competitive, multiple-vendor telecommunication policies of the U.S. are made known ... towards the end that the ISDN concept is sufficiently flexible to accommodate these policies."*

It follows from the these mandates that the FCC will demand the following and it has this to say:

Equal Access via a Numbering Plan: "Thus, it would appear that reasonable flexibility could be attained to ensure that the fundamental numbering plan definition does not frustrate the workings of a multiple vendor U.S. market. This will require that efficient coding techniques be incorporated into the numbering plan within the five digit constraint, so that sufficient numbers of alternative vendors are selectable. It would appear that effective U.S. participation in the appropriate CCITT Study Groups ... will be essential."**

Basic Enhanced Dichotomy: "The primary effect of classification of an offering as basic or enhanced is that an enhanced service is not subject to regulation under Title II of the Communications Act... we considered the potential effect of such deregulation on competition... conditions were placed on all common carriers to assure that basic service providers which also offer enhanced services would not gain unfair competitive advantage over enhanced service providers that did not own underlying transmission facilities."***

Unbundling: "Common carriers may offer enhanced services, but only if the costs of their unregulated enhanced service offerings are not borne by subscribers to their basic services; all facilities-owning carriers continue to offer such basic transmission facilities pursuant to tariff and support their own offerings of enhanced services on the same basis as competing enhanced service providers; common carrier tariffs do not offer enhanced services"***.

Private Leased Lines: The FCC will also insist on the availability of private leased lines, in line with their insistence on the availability of basic services.****

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* First Report, Paras 3-5, 14.

** First Report, Para 16. cf CRTC 84-18 "Enhanced Services", July 12, 1984.

*** First Report, Para 33.

**** First Report, Para. 48 et seq., 62.

6.1.3 Role of the FCC in the ISDN Planning Process

On describing the CCITT ISDN planning process, the FCC criticizes it as amorphous and suggests it has exceeded its mandate.* Thus, "ISDN planning recommendations have been drafted to govern not only the interconnection of national ISDNs but seemingly to govern the design of the national ISDNs themselves." CCITT, by implication, has advanced from studying the interworking of networks at the international level to studying the services and facilities to be provided by these networks.

This criticism on the part of FCC does not seem to be entirely valid since:

- It is impossible to develop a network concept without consideration of potential services and facilities required for user-interworking.

- CCITT has for years been involved in the definition of services used in national networks with the support of U.S. delegates and presumably the tacit agreement of the FCC.

In the next Study Period the FCC will address four questions which it considers are matters for its mandate:

i) Pricing and tariff principles.

ii) Numbering and addressing plans.

iii) Access policies. The FCC is concerned with the problems of imposing "interconnection access" and "subscriber flat-rate access" charges.

iv) Interconnection policies. The FCC is concerned with the impact of ISDN on the execution of the Modified Final Judgement (MFJ) as it applies to interconnection between the RBOCs and interexchange carriers.

6.2 Canada vis a vis FCC Positions

6.2.1 Issues for Canada: Basic Enhanced Dichotomy

- Canada could adopt the FCC's definition of "basic services" as a criterion for determining what services should or should not be regulated. Or Canada may prefer to use CCITT's definition of "bearer services", i.e. allow regulated carriers to provide services that include functions at only the lower Layers 1, 2 or 3 of the OSI Reference Model. Or new criteria could be developed.

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* First Report, Para. 63.

The first (FCC) criterion is not generally accepted even in the U.S.*

The second option would not be workable. The CCITT definition is not a regulatory tool and was not meant to be. The "bearer service" definition implies that only a partial service is being provided. The carriers historically have always provided a complete service in the area of telephony and it would be absurd to deny them the right to provide this same service simply because the users in question may be using terminals that extend into the more "intelligent teleservice" layers of the Reference Model.

- Secondly, to provide a partial service is to share responsibility for the proper functioning of the resource in question. This frequently means a dilution of responsibility and diminished effectiveness. The subscriber may want a choice of vendor, but may not want more than one vendor providing functions of the one service.

- In Canada, the expertise required to provide end-to-end connectivity for non-telephone services may be found primarily in Canada's carriers. Canada's computer software industry tends to be applications oriented, not systems software oriented and in the larger area of "intelligent microelectronics" Canadian carriers have led the way.

Therefore, it may be more suitable for carriers in Canada to be given more latitude in the provision of "enhanced" or "teleservices" than is proposed by FCC. To an extent this has happened. Telecom Canada provides a packet switching service as a "bearer service". This service would be considered an enhanced service in the U.S.

Other approaches and criteria, could be considered that might prove more flexible than either the FCC or the CCITT definition of services.

* "The convergence of information - handling products and technologies increasingly means that distinctions between basic or enhanced services are becoming artificial." "Maintaining Excellence in an Open Market", E. B. Fitzgerald, Chairman, Northern Telecom Inc., Telephony, Jan 9 1984.

- One approach in deciding whether a service should be a regulated offering or not might be to use the yardstick of cost effectiveness. In line with the recently proposed Competition Bill, (Bill C-29, April 1984)*, the carriers could justify a service if it helped their networks work better. Some services in the Operating, Administrative and Management (OAM) areas obviously are necessary to make the network work at all. Other services are not so network-oriented or network-embedded. Yet they nevertheless exploit the network's potential. For example, a voice messaging (store and forward) system would be perceived by many as a telephony service which a telephone network should properly provide.

  In the past there tended to be a distinction drawn on the basis of the signal type (i.e. between voice and data). With ISDN and the digitization of all forms of communication, any distinction between different signal types will be obliterated or at least blurred, and with it, the notion of what a regulated carrier should or should not be allowed to provide. Cost effectiveness is a better discriminator because it can be measured, although with some difficulty. Further, the measure of cost effectiveness can be assessed within the time frame that gives rise to it. It must be remembered that ISDN is a decade away. The costs that prevail today will not be those that prevail ten years hence. A regulatory measure that adapts to the times is, for that reason, a flexible one.

- Two other approaches open to Canada that also avoid the need to define or categorize a service as something to be regulated or not (and avoiding definitions and categories helps avoid semantic dogfights) could include:

  i) Endorsement of the idea that where competition exists, regulation should be suspended.

  ii) Encouragement to the carriers to form joint ventures with independent suppliers for the provisioning of "teleservices".

  None of the above approaches may prove satisfactory on its own, nor can any be espoused at this point in time with any assurance of equity since ISDN will take at least a decade to take shape in Canada. While there is much to be said against the FCC position on the basic-enhanced division of services, the FCC approach of maintaining - not just a

* 31.41 (4) "Abuse of dominant position". "No order shall be made under this section where competition has been, is being or is likely to be prevented or lessened substantially in a market as a result of the superior economic efficiency of the person or persons against whom the order is sought."

watching brief - but active participation in the ISDN standardization process as an alternative to rule-making, is something that Canada must consider.

6.2.2 Issues for Canada: An ISDN Numbering Plan

Canada's telephonic "country code" is virtually a "continental code".

If Canada retains the North American numbering plan and the ISDN plan is compatible with this, then all ISDN services in North America will become accessible to Canadians. In this case Canada may want to do the following:

- Reassess the direction of flow for this traffic, given that ISDN is at least a decade away.

- Decide what conditions must obtain for its own service providers to have a fair share of the numbering blocks to be allotted and the right to advertise in any "ISDN Directory" on an equal footing with U.S. companies.

- Some Canadian-U.S. agencies must have the responsibility for establishing and administering the ISDN numbering plan. It is not clear that AT&T would want to assume the task in the light of its changed circumstances. The FCC certainly appears willing to concern itself with a numbering plan for ISDN. However, it cannot do this unilaterally for North America. Unfortunately there is no North American equivalent of the CEPT - a corps of telecommunication administrators that could devise an ISDN plan which has a sound structure, which allows for expansion and which puts all suppliers on an equal footing.

6.2.3 Issues for Canada: The Economics of Access

When AT&T was divested of its 22 operating companies it was hoped that future revenues would be divided 50/50 between AT&T and the RBOCs. That is, between long distance and local revenues.

The FCC proposed the imposition of a subscribers access charge. The purpose of the access charge was to set up a Universal Service Fund to subsidize the higher costs of service to remote communities. In essence the fund was to replace the former cross subsidization of local service by long distance revenues.

The problem of cross-subsidization is also of concern to Canada. Some kind of access charge to ISDN services will have to be imposed in order to defray the costs of ISDN services. However, a flat rate access charge for Canada would probably meet with the same opposition as it has met in the U.S. An ISDN subscriber under existing extended area rules could:

- Create a virtual private network within this area at no additional cost (i.e. tie up trunk facilities).

- Cause congestion at the local switch because of high switching activity.

The only equitable solution to these problems is USP. As an alternative to a flat rate access charge, Canadian carriers wish to introduce some form of USP in advance of ISDN. If a USP system anticipates ISDN, then its implications for ISDN must be taken into account.

6.3 CEPT (Conference Europeenne des Administrations des Postes et des Telecommunications)

6.3.1 CEPT Objectives

In 1959 CEPT was founded to promote cooperation among 26 PTTS. Membership extends beyond membership in the European Community. CEPT includes countries within the Western European land mass which are contiguous with each other and which are not necessarily bound to each other by other than the common need to communicate.

In 1975 the Comite de Coordination de l'Harmonisation (CCH) was formed, as a group within CEPT, because of the general awareness of the need to cooperate in the planning of new national networks. There was a "unique acuity" in Europe of this need for harmonization. For example, the telephone density of the member countries varied widely, from as little as 18 to as many 80 telephones per 100 persons. Different countries also had different attitudes to the supply of subscriber equipment ranging from monopoly, competition with private industry, to disengagement. Furthermore there was an awareness that different Administrations were to a greater or less degree, inclined to protectionism when it came to awarding contracts or R&D support for telecommunications related goods and services.

Objectives - A major thrust at the CEPT is the standardization of customer equipment.

i) First, it wishes to ensure its portability, its upwards compatibility and its quality.
ii) Secondly, the CEPT seeks type approval for it.
iii) Thirdly, the Conference seeks rationalization of the OAM practices of its member PTTs.

The CEPT approach to these objectives is characterized by three priorities. These are uniformity, consciousness of the opportunities for equipment suppliers and user-consciousness.

Uniformity - The CEPT is desirous of promoting innovation, but this is not a priority. Uniformity, rather than diversity is

what is sought. In fact they do not appear to welcome the tendency "particularly influenced by institutions and industries in the U.S." of providing special purpose networks for special subscribers.

Telecom Canada* testifies to this, "A key concern was the rapid growth of specialized service networks ... it appeared that a major strategy would be to develop one unified network capable of handling a wide range of integrated services ...".

Opportunity for Equipment Suppliers - Further, unlike the U.S. where regulated carriers may have their own arms length manufacturing subsidiaries, the PTTs do not, themselves, manufacture telecommunication equipment. If anything, CEPT members tend to be much more insistent on the opportunities that ISDN can offer the manufacturing industry and the encouragement that should be given them.

A comment from a U.K. report underlines this difference in attitudes between the PTTs and U.S. telecommunication carriers when, in referring to the latter, it states, "(they) have come under increased pressure in recent years both from a demand for regulatory changes to reduce the extent of their monopolies, and from an appreciation that increased competition from satellite and cable TV distribution technology means that there is a need for a more direct marketing of their services and the creation of opportunity for others".**

User-Conscious - CEPT members also tend to be more user conscious insofar as they wish to retain existing services with which the user directly interfaces. In accordance with this approach, CEPT recent work has concentrated on subscriber "telematic" services. That is, teletex, telefax and videotex.

The marketing approach adopted by British Telecom underlines this user awareness:- "BT will be marketing IDA - Integrated Digital Access - not ISDN. IDA is the customer's means of access to the ISDN services and is the product we are selling."

6.3.2 The CEPT Stance vis-a-vis North American Positions

The CEPT stance has been revealed during certain discussions on ISDN matters in which they were at variance with stated North American positions.

Jurisdiction - The principal difference between the CEPT and North American Administration is the difference in ownership or jurisdiction of their networks.

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* Digital Networks, 12.5.1

** Integrated Digital Communications. Telematics Report Series, Chapter 1.

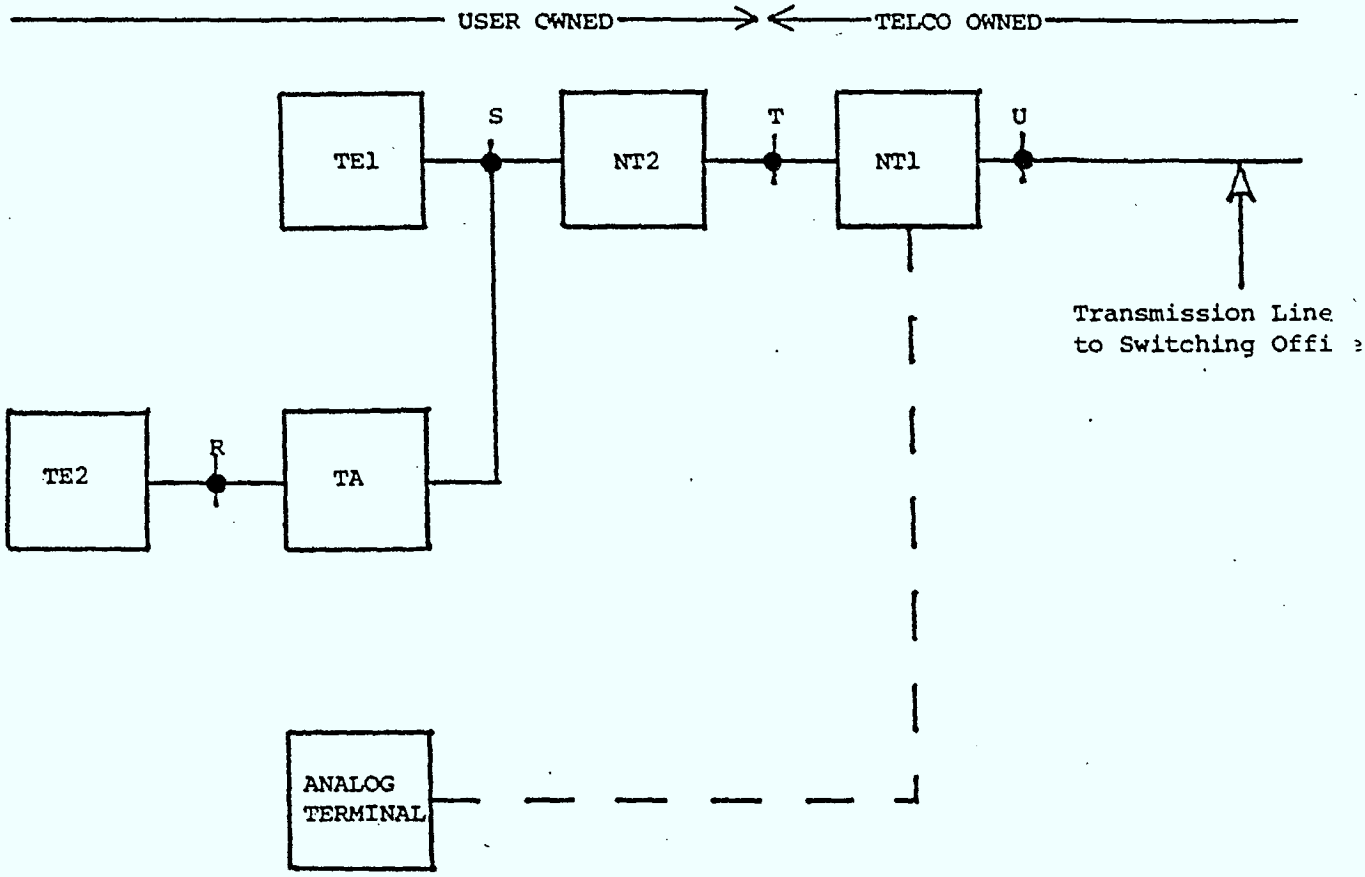

FIGURE 6.3.2

ISDN USER ACCESS MODEL (CUSTOMER PREMISES)

The PTTs own or provide far more of their network apparatus than do the North American Operating Companies.

Thus, CEPT members will own or provide Network Termination Equipment (NTE) which, for them includes the functional groups NT1 and NT2. Hence, the interface S between the customer's terminal equipment (TE) and the NTE is what they wanted to see specified.

The North American RPOAs, on the other hand, saw themselves as owning and providing only the NT1. The NT2 and all else on the subscriber's side would be owned by him and constitute his Customer's Premises Equipment (CPE), (Figure 6.3.2 refers).

Altercation ceased when, finally, it was decided that the S and T interfaces could be considered as functionally identical. The solution is specified in Recommendation I.411. However, the specification of these user-network interfaces and the functions to be performed by the equipment that is to be located at what are now two boundaries, the North American boundary and the European boundary, has been unduly delayed.

The FCC has since gone further in defining U.S. policy, pushing the boundary of ownership beyond the T interface and the NT1, onto the U reference point which is at the termination of the metallic subscriber's loop. It has the support of IBM in this, but has met with vigorous objections from the major U.S. Operating Companies.

Nevertheless, it is expected that the FCC will prevail. One or more optional interfaces will therefore need to be specified and will provide the user-network boundary in the U.S. Canadian authorities may wish to distance themselves from the FCC's position on this matter.

Other Issues - A second matter for concern in the development of the electric characteristics of the basic interface arose from the differences in wiring requirements between Europe and North America. In general the requirement for European Customer Premises wiring length were considered to be within 150 metres, with a need for up to eight terminals. The North American requirements involved catering to campus-like environments, the existence of bridge taps and "work station" applications. An overriding CCITT principle was that terminal devices should be portable i.e. should fit any wiring arrangement, and for a passive bus arrangement mixed terminals from various suppliers could be used.

Although a compromise set of characteristics were agreed upon, the validity of these to meet the varied situations must be proven in real applications. Because this has a significant impact on the provision of terminals for the ISDN, each administration must ensure that the specifications are valid for their national requirements.

Other causes for concern have included the CEPT's (and some North American) opposition to "stimulus" switching. This is an interactive signalling protocol whereby each action by the user or by the network would generate a short signalling message indicating the action taken or to be taken. It differed from a prior protocol called the "functional" protocol which proposed the use of a small set of self-contained, structured messages to indicate the required service. The CEPT opposed stimulus switching as it would satisfy only comparatively unintelligent terminal equipment. Current work has produced a signalling protocol which combines both functional and stimulus characteristics. However, it should be recognized that this puts an additional burden upon the network to recognize both forms of signalling message. The CEPT opposition underlines CEPT members' awareness that they are responsible, not just for the network alone but for the terminal equipment with which the user accesses it. The jurisdiction of CEPT members thus extends beyond that of any telecommunications entity in the U.S. and in Canada.

OECD and GATT Fora* - Contention has also arisen outside CCITT circles. One cause of contention was referred to in a speech made by the Chairman of the FCC, Mark S. Fowler, before the Organization of Economic Cooperation and Development (OECD), and concerns the application of the FCC's Computer II rulings to the resale and shared use of international circuits. The Chairman seems to have been at pains to reassure members of the OECD that approval of resale was not de facto, and that the FCC's international resale rulemaking procedure had yet to be resolved.

Similarly, a U.S. study submitted to the General Agreement on Tariffs and Trade (GATT) and reported on in January 1984 proposed world trade rules for the telecommunications industry. This study proposed multilateral agreements on customer equipment to attain a "universal right to plug in". However, other points raised in the study are virtually accusations of the unfair practices of (unspecified) government telecommunications agencies and the restrictions they had placed on "trade" in telecommunication goods and services. Many of the points raised in this GATT study echoed those raised in the FCC's First Report.

6.4 ECSA/ANSI T1 (ISDN) Subcommittee

In January 1983 the idea of the Exchange Carriers Standards Association (ECSA) was conceived by the Washington Legislative Council Of Telecommunication Executives (i.e. the RBOCs). In August 1983 ECSA was incorporated and sought accreditation from American National Standards Institute (ANSI) to sponsor a new Technical Standardization body - the T1 Committee.**

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* As reported in Telephony, January 3 and 9, 1983 resp.

** First Report, Para. 73.

The ECSA established a T1 ISDN Subcommittee to assume the functions of the Technical Working Group, a subgroup of the Joint Working Party, which in turn, was a subgroup of USCCITT, the Advisory Committee on Telecommunications to the U.S. Department of State.

In February 1984 the T1 Committee had 79 members, of which 35 members had exchange carrier, interexchange or reseller interests. Thirty members had manufacturing interests or vendor interests. Fourteen members had general, user group or liaison interests. The Committee's principal asset is said to be the broad representation of its participants; almost all of the major companies and government agencies are members. Observer status is available and participation in the Technical Subcommittees does not require membership in T1. Northern Telecom Inc. is a member and chairs the CPE-Carrier Interfaces Subcommittee. Telecom Canada, as an interexchange carrier is a member and the CSA is a member as having liaison interests.

The six technical subcommittees cover most of the major issues before the CCITT. They appear to be even more extensive than the corresponding subcommittees of the CEPT. They are:

i) ISDN - This is concerned with all aspects of ISDN services including user-to-network, network-to-network interfaces, gateways, numbering plans, administration and maintenance.

ii) CPE/Carrier Interfaces - This deals with non-ISDN network interfaces with telephony users, PABXs, private networks and gateway applications, analog voiceband interfaces and extended framing format for 1.544 Mbit/s.

iii) Carrier-Carrier Interfaces - This subcommittee will concern itself with exchange access interfaces, synchronization, common channel signalling and mid-span connections.

iv) Internetwork OAM - This deals with basic network management, including OAM system interface languages and telemetry, common coding universal billing data interchange formats, automatic transmission measurement systems, telephony network tones and announcements.

v) Performance Objectives - This is concerned with digital and analog data, voice transmission performance, performance of local exchange and interexchange reference connections.

vi) Special Subjects - This subcommittee is concerned with exchange carrier to cellular carrier interfaces, enhanced video services, teleconferencing, voice and speech coding and processing.

It is expected that the T1 Committee will contribute to and interpret CCITT Recommendations in the light of its North

American interests. It is strongly influenced by interexchange carriers, including AT&T and therefore, will deal with the prospect of multiple ISDNs and the need to ensure that they can interwork.

ECSA and the T1 committee will fill a vacuum left by the divestiture by AT&T of what are now the seven RBOCs. There is no single Bell System to set network and interface standards, de facto or otherwise. Nor may AT&T represent its former operating companies before the federal government as the Operating companies had represented AT&T before state governments. Now each must represent itself before both. Such confrontations attended as they have been in the past, with undue delays, may be reduced in the future by virtue of the ECSA role. That is, by providing a forum in which liaison between government agencies and the industry may anticipate or diminish this confrontation.

6.5 Canadian Participants

CNO-CCITT and NSGs: ISDN is an international concept for telecommunication network evolution. The CCITT is developing key interface and structural standards, and these will have an impact on the Canadian and U.S. network.

Canadian participation in the work of CCITT is primarily concentrated in Study Groups XVIII, II, III, VII and XI, through the work done in its National Study Groups (NSGs) under the auspices of the Canadian National Organization (CNO-CCITT). Canadian delegates from a number of agencies have demonstrated their skills in these areas and have presented a Canadian consensus on many aspects of ISDN conceptual and standards work.

CCITT work essentially terminates at the user-network interface and the provision of terminals to match the network has been left to national bodies.

6.6 CSA - SCOT

The establishment of the Steering Committee on Telecommunications (SCOT) under the auspices of the Canadian Standards Association (CSA), took place in January 1983. The SCOT is responsible for coordinating and monitoring the development by voluntary organizations of national standards in four areas:

i) Voice telephone sets and auxiliary equipment.

ii) Voice Key telephone systems and PABX's.

iii) Network protection.

iv) Interfacing networks, (optical fibre, coaxial cable) and Information Technology equipment.

Members of the Committee include Federal and Provincial government representatives, carriers, manufacturers and users. Terms of Reference include the identification of work priorities, the establishment of technical committees and the maintenance of liaison with national and international standards bodies. The thrust is to ensure compatibility and reliable performance of voice and non-voice terminal equipment. The Terminal Attachment Program Advisory Commmittee (TAPAC) of the Department of Communications was designated as the CSA Technical Committee on Network Protection. Related standards and certification activities will be pursued under CSA sponsorship.

7. POLICY APPROACHES FOR CANADA

Canada has concerns at the national, regional (North American) and international level. The concerns at all three levels are interrelated and a coordinated policy approach with appropriate priorities based upon user, service provider and carrier interests should be formulated.

1) National Interest

i) ISDN should help businesses in general to become more efficient by reason of faster, cheaper and more helpful communication services. The process of making the business user aware of ISDN and its potential is perhaps the most difficult task at the current stage of ISDN development. Only if the user is informed can he suggest the kinds of service that would aid him. If there is not a "demand pull" for services, then there is a danger that inadequate service offerings will be proposed and they will not find a market. Furthermore the side effects of the sociological impact and the change in business usage and location cannot be evaluated without input from knowledgable business users.

ii) Canadian suppliers of equipment and of teleservices should obviously be fostered and Canadian-content policies continued. Canada might support the concept of portability of both equipment and services, and push for the classification of both. To this end, a common set of service and equipment standards with the U.S. and the rest of the world (CCITT) will provide an opening into a wider market.

What is at stake here is not only the export market for products designed in Canada, but the export market for ISDN services and for Canadian expertise in network design, installation and management.

iii) CCITT will, in the next Study Period, address questions raised by Study Group III on Pricing and Tariff guidelines. Traditional agreements on tariffs at the International level lack precision and force. Canada's concern will be that with the international interworking between ISDNs, adequate flexibility in pricing approaches are included to meet Canadian national and regional as well as international revenue needs.

iv) Deregulation is now the watchword in the U.S., (though one observer, Fitzgerald of Northern Telecom Inc, predicts there will be demands to move from "regulated competition back to regulated monopoly.")

Canada may choose to follow the American example or it may not. The CRTC proceedings on Interexchange Competition and Related Issues scheduled for the fall of 1984 will provide an insight to the Canadian direction and related issues applicable to ISDN development. It is not appropriate to speculate on the outcome at this time. However, careful analysis of the CRTC decision will be required to assess the impact on the ISDN development in Canada.

2) Regional (North American) Role

Canada and the U.S. have no equivalent to the CEPT, whose members are a consortium of Administrators with jurisdiction over their respective national networks. The ANSI/T1 subcommittee will not serve the purpose. While its meetings are open to the public including Canadian organizations, they are dominated by U.S. interests. Its foci will be the technical and economic concerns of the U.S. telecommunications industry and not the jurisdictional (and sovereignty related) concerns of Canada.

i) An ISDN numbering plan will have to be devised with the U.S./Canada border in mind. A new ISDN numbering plan will be costly whether it is one shared with the U.S. or not. Canada may see the advent of ISDN as an opportunity to acquire a separate "country code" and thereby gain extra capacity for both its telephone subscribers and the ISDN services it offers. However, any new Canadian country code will be a three digit one.

Consideration must be given to whether a new numbering plan will impact the cross-border traffic in ISDN services and whether the flow from north to south will increase, decrease or stay the same. A shared ISDN-numbering plan would make more accessible to Canadians the alternative services that the U.S. interexchange carriers will provide. Where there is a price differential, revenues will flow to the cheaper service.

ii) A more long-term concern is the extent to which Canada wishes to identify with the pro-competitive stance of the U.S.

Canada may take the view that ISDN will benefit more from collaboration than from competition. What is being attempted is the establishment of a single telecommunications network which will be perceived as a national resource.

How this can be achieved within the competitive environments that are developing in the U.S. and possibly Canada and some countries in Europe has yet to be

studied. It is expected that the ISDN from the user's view will ultimately be a simple total telecommunications service irrespective of how providers manage to supply it.

For the above two reasons, Canada should be concerned with all aspects of interworking between networks during the next Study Period, both at the CCITT and by the T1 Subcommittee.

3) International Concerns

Timing of ISDN implementation can be critical. Canada may wish to encourage this implementation as fast as possible or proceed at a more deliberate speed. In the rush to provide new ISDN-type services de facto standards will, almost certainly, be established instead of carefully planned and open-ended ones.

ISDN standards have an international intent, although many aspects of it leave room for national preferences. Canada may want to consider its position vis a vis "North American" standards. That is, whether it should adopt now, a de facto North American standard which may later be adopted internationally or whether, as a matter of policy, it should persevere with the international standardization process.

4) Recommendations for a National Policy on ISDN

The short-term impact that ISDN will have on Canadians may be significant for only certain sectors of Canadian society. The first priority would be the understanding of its potential and then the identification of the sectors to be impacted. Some of these sectors lie outside the telecommunications industry and they are therefore not currently informed on the impact of ISDN. The scope of the impact could well increase as ISDN is implemented. To some supporters of ISDN it is considered to be the key to the new "informatics" environment.

If this view is accepted then there is a need for Government to be active in bringing together the very diverse interests that such an impact on society represents. It may be appropriate for a mechanism similar to the Computer Communications Task Force of the early 70's to be established to give direction to Canadian policy and provide leadership in the broader area of the "informatics society".

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