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A. M. Rutkowski
Federal Communications Commission

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Integrated Services Digital Network: Issues and Options for the World's Future Communications Systems

A. M. Rutkowski*

INTRODUCTION

The term "integrated services digital network" (ISDN) describes the kind of advanced information services system that will be implemented during the next two decades. Electronics technology at every level, from small components to large networks, now appears to be evolving into the complete interconnection and interoperability of nearly all computer and telecommunication systems into an interconnected global network. These systems will provide universal and complete services for capturing, storing, processing, and transporting most information which society desires to retain or communicate.

In this integrated environment, the primary role of ISDN will be to provide information transport, *i.e.*, a common "digital pipe" network for conveying information among all users and facilities.[1] In addition, an ISDN can potentially include all other information services, including telephone, teletext, picturephone, television, broadcasting, and remote meter reading. These services could be provided exclusively through a monolithic ISDN, multiple interconnected ISDNs or specialized service vendors, depending upon the communication policies of nations.[2]

Until very recently, these matters were regarded as futuristic and not deserving of significant attention. This view changed in November of 1980 when the major international body for devising telecommunication arrangements, the Plenary Assembly of the International Telecommunication Union's (ITU) Consultative Committee on Telegraph and Telephone (CCITT) took three bold initiatives: it recognized as a global imperative the

* The author is a staff advisor at the Federal Communications Commission, Washington, D.C.; adjunct professor at New York Law School; and author of many works in the field of international communication. "The views expressed are those of the author and not necessarily the views of the Commission." [Pursuant to 47 C.F.R. § 19.735-203(c).]

need to devise common world principles, strategies, and standards for an ISDN; identified numerous key issues; and restructured its internal organization based on those issues.[3] The effort was jointly undertaken with the primary international body for information standards, the International Organization for Standardization (ISO), which also initiated extensive restructuring and work on the master information standards model known as "open systems interconnection" (OSI).[4]

The action of the ITU and ISO appears to have galvanized the giants of the international telecommunication and information community, including most major governments, operators, users, manufacturers, associations and regional organizations. In the past two years, the number of documents and articles discussing ISDN has grown from almost none to thousands, and the number of ISDN-related meetings now average several per month.[5] Most importantly, major system operators and manufacturers are apparently committing billions of dollars over the next decade to ISDN implementation.

Despite the magnitude of these developments, there has been virtually no public discussion of the significant public policy issues raised because of the intimidating nature of network engineering which forms the basis for nearly all the current dialogue.[6] This paper discusses current ISDN developments, and sets forth an analytical framework within which these issues may be discussed.

WHAT IS THE ISDN?

The term ISDN is frequently used by different people to mean different things. To clarify the matter, it is useful to subdivide the subject and discuss it at three levels: ISDN as a concept; ISDN as a design emerging from international forms; and ISDN as concrete networks being devised by system operators. Each level requires a different kind of analysis and involves time-frames and different degrees of abstractness; for example, the concept level is somewhat abstract and long-term, while the operator networks are concrete and near-term.

The ISDN Concept

At the conceptual level, an ISDN is a network with two fundamental characteristics—it is "universal" and "intelligent." It is universal because a user can potentially go anywhere in the world, with virtually any electronic terminal, and connect to the ISDN to obtain any information service desired. This capability could encompass almost every electronic storage, processing, transmission, and information device/service in existence. This presumes, of course, that virtually all facilities will eventually be interconnected and interoperate through ISDN-like networks.

ISDN "intelligence" means that sufficient processing, storage, and software will exist within the network to allow an extremely sophisticated dialogue to occur between the user and the network, as well as among networks, concerning the desired communication services. In addition, the network intelligence will itself be able to provide a range of diverse information services beyond the transmission of information. This last capability is highly significant and likely to vary from nation to nation depending on domestic regulatory policy.

Figures 1 and 2 depict the ISDN concept from the perspective of both facilities functions.[7] From a facilities perspective, an ISDN consists of just two major components—nodes and transmission links. The entire globe will be covered with an architecture constructed of nodes and links and look much like a gigantic Tinker Toy set. The links are employed to interconnect network nodes and to provide a local interface with user facilities.

More specifically, user facilities can be subdivided into two distinct types—single and multiple. The difference is that a multiple user facility has its own internal node which allows an ISDN capability to be shared. Examples include a private branch exchange (PABX) or a local distribution system (LAN, CATV, etc.). Transmission links in an ISDN are essentially passive, fungible pipes. One can be readily substituted for another with similar characteristics. Some, however, may prove undesirable where rapid two-way (duplex) transmissions are desired and long time delays occur—such as with satellite radiocommunication. The nodes internally consist of switching, processing, and storage components all managed by imbedded software.

This superficial description masks, however, the extreme complexity of local, national, and international architectures, and does not refer to boundaries which discern ownership or control. Nonetheless, for purposes of issue analysis, it is often possible to return to this basic facilities model of simply interconnected nodes and links. Indeed, this model was recently adopted, in one of the few United States Administrative contributions to the CCITT, to depict a domestic architecture preference.[8]

Although the functional model is useful, indeed necessary, for many applications, it is only the functional perspective which reveals all the ISDN attributes and their interrelationship (fig. 2). Here we see the facility resources (processing, storage, transmission links, and imbedded software in the form of programs and information) being dynamically aggregated by the ISDN, whether they belong to the networks, users or outside vendors.[9] This means that the ISDN will call upon these resources and allow them to operate in concert. If specific resources are not identified by the user, the network would be free to decide for itself which to utilize. It may also substitute similar resources from microsecond to microsecond to achieve maximum network efficiency. This "dynamic aggregation" process creates ISDN functional elements (virtual transport paths, intelligence, information, and storage) which in turn provide the user with any desired communication or information service.[10] It also allows services to be custom tailored to the user. The user would even have the capability to alter the parameters of the service during the course of its provision by the network.[11] The nature of the services could vary from a simple phone call to the bulk transmission of data, electronic mail, or high resolution television.[12]

These ISDN developments will be occurring during a period of remarkable evolution in user terminal capabilities. One can easily envision fifth generation terminals using voice recognition and synthesis capabilities to carry on a plain language dialogue with a human user, serving as a buffer in dealing with the ISDN intelligence.[13] Already, such terminal capabilities are being marketed by L.M. Ericsson to perform simple telephone calling functions.[14] Such terminals will both enhance the utility of an ISDN and make it easier for users to interact with ISDN intelligence.

Obviously, at the conceptual level, an ISDN is an idealized mechanism for the provision of all conceivable electronic communication and information. As such it represents a goal toward which all human society is striving, and realizable only in the distant future. However, the exponentially changing technology and related component fabrication processes may bring that future sooner than expected.

These technological and facilities developments will not occur in a vacuum, and can be expected to transform dramatically all aspects of our society. One commentator has characterized ISDN as the future "economic engine."[15] Any attempt to divine the effects, however, is highly speculative, and will not be attempted in this article.

ISDN As A CCITT/ISO Design

If an ISDN were merely an abstract ideal, it would be relegated to philosophic discussion in academic environments; however, it is not. Network planners are working hard in dozens of international, regional, national, corporate, and trade association forums to define the precise principles, strategies, and standards to implement the ISDN during the next two decades. Their goal is to reach a sufficiently definitive international consensus on these matters during the next two years to allow massive capital investments.

The international forums for the ISDN dialogue are provided by the ISO and ITU. The former is devising the basic framework of network software, referred to as the "open systems interconnection model" or OSI, and the latter is developing the remainder. At the regional and national levels, numerous additional organizations and committees also provide forums for reaching a consensus on regional and local positions and policies.[16]

The work of the ITU is predominently conducted by nearly a dozen CCITT study groups, each possessing an infrastructure of working parties devoted to the examination of a particular question.[17] In addition, each question has its own rapporteur. Most of the ISDN questions are concentrated in three study groups,[18] although nearly all of them have some ISDN responsibilities.[19] Formal liaisons exist for communicating among the study groups.[20] However, the participating individuals are largely the same in all the CCITT and ISO forums. The ISO has a similar but less extensive structure, and work is concentrated in Technical Committee 97 and its subordinate subcommittees and working groups.

The CCITT's first task was to produce a formal definition of an ISDN.[21] Even here, the dialogue is evolving so rapidly that the definition adopted in November 1980 was discarded eight months later in June of 1981 in favor of a more generalized approach.[22] This new approach took special note of the importance of interfaces, which was a concession to the U.S. regulatory environment.[23] The new CCITT definition of integrated services digital network (ISDN) is a "network evolved from the telephone IDN [Integrated Digital Network] that provides end-to-end connectivity to support a wide range of services, including voice and non-voice services, to which users have access by a limited set of standard multipurpose customer interfaces."[24] However, proposals have already been put forth for the February 1983 CCITT Experts meeting at Kyoto to change the definition still further.[25]

Although there now appears to be some international and domestic agreement on this rapidly evolving definition, the dimensions of the concept remain flexible. The charter under which the international work is proceeding contains several "conceptual principles." Some of the policy-oriented provisions, as recently amended, are:[26]

> 1) The ISDN will be based on and evolve from the telephone IDN by progressively incorporating additional functions and network features including those of any other dedicated networks, such as data packet switching, so as to provide for existing and new services. The main feature of the ISDN is the support of voice and non-voice services in the same network. A key element of service integration for the ISDN is to provide a limited set of standard multipurpose user interface arrangements. . . .
>
> 3) The transition from the existing networks to a comprehensive ISDN may require a period of time extending over one or two decades. In the evolution towards the ISDN, digital end-to-end connectivity may be obtained via

plants and equipment used in existing networks, such as space division switching.

4) During the transition period arrangements must be developed for the interworking of services on ISDNs and services on other networks.

5) The ISDN will contain intelligence for the purpose of providing service features, maintenance and network management functions.

6) A layered functional set of protocols appears desirable for the various access arrangements to the ISDN. Access from the customer to ISDN resources may vary depending upon the service required and on the status of evolution of national ISDNs.

In light of this charter, the CCITT wants to achieve an international consensus on principles and standards in seven key areas during the 1981-84 study period: "a) systematic approach to service types and network features to support them; b) information types; c) channel types; d) access types; e) reference models for customer access configurations; g) principles on interfaces; f) reference models for network structures of the ISDN."[27]

To create ISDN on a global scale, achieving international agreements on these matters is critical, and in order to maximize the global efficiency of ISDN a common model is being devised for all nations.[28] This effort will determine the nature and structure of future information transport systems for the entire world on both domestic and international levels. The arrangements will have to allow considerable implementation flexibility, which is necessary to accomodate the different regulatory environments existing among nations. It may be difficult and potentially costly, however, for users or networks to deviate significantly from the basic provisions.[29] The initial product of this massive international effort is a sufficient consensus on as many ISDN features in as great detail as possible. This consensus will them be formally embodied in Reports and Recommendations of the CCITT in 1984.[30]

In February 1982 at Munich, the European Conference of Post and Telecommunications Administrations (CEPT) countries had reached a preliminary agreement on certain basic ISDN features, and embodied them in three Recommendations.[31] They sought formal approval for CCITT Study Group XVIII in June 1982 under a special acceleration procedure.[32] Other nations, principly the United States, felt, however, that such approval was premature and that further work was necessary.[33] The approval was therefore not granted.[34] During the past year, considerably more work has been done, and an elaborate outline for an entire "I-series" of ISDN recommendations has been prepared, and articulated in considerable detail.[35] The 1982 scenario will likely be repeated in meetings at Kyoto in February, and at Geneva in June 1983.[36]

Nascent ISDN Facilities

In most of the major industrialized nations, the principal communication and information system operators are beginning to plan and implement ISDN-like capabilities. It is difficult, however, to obtain details of these efforts due to the proprietary nature of the work, and the rapidity of these developments. In addition, in the United States, the effects of recent regulatory decisions concerning the provision of information services by American Telephone and Telegraph (AT&T) (known as the Computer II decision), and that company's divestiture of its local operating companies, have served to compound the confusion.[37]

Nonetheless, occasional details emerge. For example, at a recent seminar on ISDN at the Massachusetts Institute of Technology, the principal AT&T spokesman closed his presentation with the bold comment that "the future of AT&T is ISDN."[38] AT&T has taken a commanding lead in shaping ISDN in the United States. Its spokesmen have provided most of the general comments and most of the United States' written contributions to and participation in CCITT forums are by its employees.[39] Recently the new AT&T unregulated subsidiary, American Bell, has begun to introduce NET 1000, a fledgling ISDN.[40] At the same time, American Bell has revealed advanced work on systems incorporating additional ISDN features. A similar situation exists in other industrialized countries, where communications spokesmen are making general statements concerning ISDN in a variety of periodicals and conference symposia, and announcing the implementation of new network capabilities.[41] It is evident that the ISDN race is on. Around the world, billions of dollars are being reserved for investment during the next decade to make the ISDN concept and the CCITT/ISO designs a reality.[42]

ISDN ISSUES

The emergence of an ISDN environment raises a panoply of issues. While some are fairly abstract or long-term, others are concrete and apply to current controversies. It is difficult to separate these matters into neat categories because the near-term decisions frequently have long-term consequences. Similarly, today's regulatory policies may have little applicability of an ISDN environment still largely being planned, but their subsequent effects may be substantial. The following discussion attempts to strike a balance between short and long term issues by using a generic communication issues framework and applying it to current ISDN developments. The details discussed below may appear to be arcane and of interest only to network engineers. While much of the ongoing dialogue does indeed fall into this category, these are important matters with substantial public interest or economic consequences which I have selected for discussion.

Domestic Regulatory Response

The emergence of an ISDN environment presents each nation with some fundamental decisions regarding methods to be employed for implementing and operating information networks. For most countries, which perform these tasks through a government monopoly, there are relatively few procedural problems. Existing decision-making mechanisms are simply used to balance national interest considerations, user demands, and prevailing economics.[43] Even in these countries, however, there may be some concern about the extent to which a monopoly should assume control over all telecommunication and information for the nation. The creation of information is highly dependent on motivated, innovative individuals in a society with the necessary inducements to maintain their creativity.

In other countries such as the United States, where the nation's communication and information services are largely provided by the private sector, the ISDN environment produces substantial procedural dilemmas. Here the means for divining the national interest and regulating the private sector become very complex. The matter is compounded by government processes which are extremely cumbersome and slow, and by the lack of official expertise and resources to make satisfactory judgments.[44] The international momentum toward reaching universal ISDN agreements, on the other hand, is fast and strong. Government decisions capable of being developed only after years of comment, reflection, and adjudication may be of little use in such an environment.

The United States Congress established a goal in 1934 "to make available, so far as possible, to all the people of the United States a rapid, efficient, Nation-wide, and world-wide wire and radio communication service with adequate and reasonable charges."[45] The Federal Communications Commission was established to achieve that goal through regulation of private sector communication facilities. Rather than devising a concept for a national communications architecture, however, it is contemporary policy to achieve this goal largely through private sector competition.[46] Although such a policy has many merits, it may nonetheless present considerable additional complexities to the design and implementation of domestic and international ISDN components. Many of the more significant ISDN issues relate to architectural configurations. The inability of government to address these matters directly means it can only indirectly control the results. In addition, the prospect of information being routed through a large number of facilities under independent ownership and management with no national mechanism for operational coordination and standards setting looms as a serious problem in assuring satisfactory operation of the national communication system.[47]

The Japanese telecommunications entity, NTT, has recently done some very innovative analysis of ISDN regulatory issues. It has taken the Open Systems Interconnection (OSI) model presently used for devising ISDN design details, and is considering its utility as a regulatory framework.[48] Thus applied, the several bottom OSI layers which deal with basic information transport would be reserved for government monopoly, the middle layers dealing with virtual networks would be open to some private sector competition, and the highest layer dealing with the actual provision of information services would be almost exclusively provided by the private sector. This kind of highly sophisticated regulatory approach indicates a Japanese desire to blend the best features of the world's divergent political-economic methodologies. As discussed at the International Institute of Communication's (IIC) Washington Symposium on Communications and International Trade in December 1981, transborder data flow issues also appear to be usefully analyzed through the same OSI model approach.[49] Indeed, it is only through such a structured model that many issues related to "virtual" information services can be meaningfully explored.

External Interfaces

External interfaces are among the most important issues for ISDN as they define the phsical, functional, and electrical characteristics at the boundary between the network and all users. They were recognized as a priority by the CCITT nearly two years ago, and they continue to consume most of the energies devoted to reaching ISDN agreements.[50] AT&T in particular has focused its attention almost exclusively on the subject, and even succeeded in amending the ITU terms of reference for ISDN studies to emphasize user/network interface issues.[51]

This emphasis is certainly technologically appropriate. In classic engineering methodology it is the interface specifications which establish most of the basic characteristics of the system. In practice, they are imperative in establishing boundaries for separate ownership and control of different segments of the overall network. This is a particularly significant matter in the United States, where the regulatory environment mandates several such divisions—terminal equipment separated from the local network, local network separated from the long-haul network, and, for dominant networks such as that of AT&T, "basic" facilities separated from "enhanced" facilities.[52]

Before discussing the intricacies of the user/network interface, it should be mentioned that the question of interfaces has not been studied rigorously. The threshold question of what interfaces should exist, and for whom, has hardly been raised. Even the interface among networks has received only the most cursory treatment, with principal focus on the appropriateness of existing inter-network protocols.[53] The network/network interface becomes even more complex when the networks are those of different countries or involve an international organizations operator such as INTELSAT. Issues related to transborder data flow arise here as well, and questions relating to encryption and the extent of foreign interoperability and control become highly significant. To date, however, there has been little discussion of these subjects.[54]

There may well be a need for other kinds of network interfaces. For example, a "network/local distribution" or "network/information services facility" interface may be desirable. Both are important in light of United States domestic regulatory developments relating to the Computer II basic/enhanced decision, the promotion of competition in providing services, and the AT&T divestiture of local distribution systems. Presently, they have not even been raised in ISDN forums.

Even beyond the United States and its regulatory approaches, many nations might want the flexibility of allowing some competition among those providing information and communication services. It seems, however, that the present trend to emphasize only one kind of interface (one basically designed for small-scale users) predisposes the network to exist as a monopoly.

The User/Network Interface

Thousands of pages of material have been generated over the past two years in an attempt to wrestle with the details of the basic user/network interface.[55] Much of this material does not raise significant issues, but only requires agreement on such fundamental questions as the number and size of pins on the universal connector for attaching to an ISDN. These decisions are important, however, because they will substantially determine the manner in which all of us will communicate by electronic means. Also, virtually every decision will have some significant effect on costs, and the extent of our communication capabilities and options.

There is a broad class of issues concerned with user/network interface alternatives. Agreements need to be reached of sufficient detail to allow the design of equipment, yet not so detailed and inflexible as to prevent innovative or alternative approaches. This is no easy task when the technology is changing rapidly, but it is nonetheless a critical threshold step which must be taken if an ISDN is ever to become a reality within this decade.

The first of these choices involves certain assumptions regarding the type of local transmission medium. Virtually all the work to date on the so-called Universal Physical Interface between the user and network has proceeded on the assumption that the transmission link from the network is a standard copper wire pair.[56] This may have the effect, however, of impeding the rapid implementation of alternative media, such as radio or optical fibres, at this interface. Admittedly, it makes considerable sense to maximize the use of the local transmission medium most pervasive globally—the telephone pair terminating at homes and offices—but the exclusivity of the focus appears inappropriate.

Another basic choice involves the precise placement of the interface in terms of functions provided by the user terminal and those provided by the network. Because of the differing regulatory environments of countries, this is a particularly difficult matter, and it has been necessary to recognize two different kinds of user/network interfaces. In ISDN jargon these are known as the "NT1" and "NT2" interfaces.[57] The NT1 interface is a relatively dumb one, while the NT2 is considerably smarter, providing such functions as local subdistribution to a number of users, or code and protocol conversions. In some countries such as the United States, there is considerable controversy concerning exactly what will be provided at these interfaces.[58] It is a highly intricate, high stakes game among network and non-network providers of terminal equipment; hundreds of millions of dollars in potential market opportunities may ride on the placement of a line.

A related question is whether to allow a "passive bus" to be provided by the network.[59] Such a scheme would allow a small number of users, perhaps up to several score, to share a single user/network link on a random, ad hoc basis. Considerable cost savings could result for certain user classes. However, the need, technical feasibility and competitive effects have only begun to be analyzed.

Functional alternatives at the interface raise considerations of national public interest. One issue involves the controls exercised by the network over terminal use under various conditions. This question includes such matters as the activation/deactivation of terminals by the network for remote sensing, for non-payment, or in times of emergency when orders of priority of use might need to be established.[60] Interwoven with the question of priority use is the provision of emergency power by the network.[61] Although sophisticated terminals clearly require more electrical power than can be provided easily by the network, it seems that some minimal amount of power should be available from the network for ordinary telephone service. This is the general situation today in nearly all countries, and it allows people to use the phone when local electrical power fails—a particularly important matter in times of emergency. Presumably most nations would want to mandate a similar capacity for the ISDN. The matter becomes more tricky, however, if optical fibres are used for local service, but in recent demonstrations sufficient light energy was provided from the network to allow the powering of basic telephone service at the terminal end.[62]

Another issue with public interest ramifications is the matter of "hybrid access."[63] Here the question is whether it might not be more economical and appropriate for some large class of users to refrain from acquiring a fully digital, high capacity interface. Digital capabilities would simply be "piggybacked" on top of existing analog voice telephone service. One side in this debate argues that in the near future, many users, particularly in developing countries, would have little use for the full array of ISDN services. The hybrid access option would allow the partial and selective implementation of some services using mostly existing equipment. The other side argues, however, that the costs of providing fully digital service are plummeting, and that the use of an intermediate hybrid arrangement might result in greater long-term costs and delay implementation of standard ISDN features.[64]

Standards-Making

In the ISDN dialogue, it is remarkable how the shifting sands of technology can complicate the standards-making process. One of the best examples involves the basic ISDN channel structure. Fairly early, a consensus was achieved that "standard" service would consist of two "basic" or B channels with 64 kilobits per second (kbps) duplex capacity, and one 16 kbps D channel for a dialogue between the user and network intelligence.[65] The D channel would also be used for low bit-rate data collection and control services such as remote meter reading or electrical load control.[66] The choice of the 64 kbps rate was largely based on the need, two years ago, to use that rate for reasonably good quality digital voice communication. Today, technology has advanced to allow the same quality to be provided with only 32 kbps with the possibility of 16 looming in the near future.[67] Because of this, some people have questioned the efficacy of the original channel scheme.[68] The original plan will probably be retained because of the need to adopt some kind of uniform approach, but the technical rationale has disappeared somewhat.

As different, wider bandwidth transmission links to the user become available, there are plans to offer multiples of the B channel capacities all the way up to 140 Mbps.[69] This would encompass, for example, the provision of high resolution video programs. Although the implementation of this magnitude of digital capacity to individual users remains largely unstudied, the recent availability of low-cost Very Large Scale Integration (VLSI) digital television packages operating at 6 Mbps may stir the CCITT to action.[70]

These developments pose few profound regulatory issues for nations, with the possible exception of the United States. The Computer II basic/enhanced dichotomy may need clarification to recognize a distinction between basic communication services and those provided incidental to the user/network dialogue over the D channel.

How Much User Control?

The most far-reaching user/network interface issues concern the user options, *i.e.*, the degree of control a user will have in shaping and determining the nature of the functional elements and services available at the interface.[71] There is a fundamental tension in this area between the desire of the network to enhance network efficiency and market opportunities, and the desire of the user to minimize costs and maximize flexibility. An ISDN will make available an array of options far beyond that offered in today's networks. These choices will include a myriad of different characteristics, including such things as bandwidth (actually bit-rate), error rates, and time delay.[72] But what it may or may not include, depending on the current ISDN dialogue or subsequent national regulatory option, is a choice of alternative providers of transmission links, storage and processing facilities, or software and information. These highly important matters involving all sorts of national and international considerations, have only been addressed tangentially, mostly under the veil of technical options.

Perhaps the most controversial of the user control issues involves the availability of so-called leased lines.[73] These are simply a fixed transmission capacity between two points for which the user pays a flat rate independent of actual use. In recent years, both communications entrepeneurs and large or specialized users of communications have found it attractive to lease such lines and create their own network.[74] In some cases this is done to provide high degrees of priority and reliability for their communication. In other cases it is done to compete directly with the lessor, attempting to siphon off its business. In the latter case, particularly where the lessor is a government monopoly, the matter has become very contentious.[75] Indeed, several D-series CCITT Recommendations rather explicitly describe the circumstances under which this can be done, and additional restrictions find their way into contractual agreements.[76]

The controversial subject of leased lines necessarily arises in ISDN discussions. Some large users of existing leased circuits fear that ISDN is a device to limit the future availability of such circuits.[77] For example, the current ISDN reference model being developed by the CCITT does not explicitly depict such circuits, and considerable work is presently being undertaken on "virtual" leased circuits.[78] While the possibility of future restrictions exists, they are unlikely. What seems to be lacking, however, is significant user participation in developing standards for a virtual leased circuit.

The lack of user participation at ISDN forums goes beyond circuit matters. It has been a matter of some concern in all the discussions. There is little effective representation of user interests.[79] As noted, an intrinsic tension frequently exists between desires of users and networks. Countless decisions must be made that balance these divergent interests in a mutually acceptable way. However, there are few, if any, effective advocates for the user side. There is thus a danger that the resultant arrangements may tip rather decidedly in favor of network interests.

Network Model and Architecture

The network model and architecture are of less interest to the user and of greater interest to network operators and (in those countries where the network operator is not a PTT-type government monopoly) national regulatory authorities. Network operators have an interest in operating an economically efficient network capable of satisfying user demand. The regulatory authorities, including PTTs, impose a variety of restrictions on the network based on public interest and national security determinations. These requirements have the effect of altering the model and architecture.

Preferential Configurations

In most countries, the architecture is established by the government authority that owns and operates the nation's telecommunication system. Straightforward engineering decisions based on user demand, cost and national topography are modified to accommodate public interest considerations such as cross-subsidization for certain segments of the populace, enhancing the reliability of government circuits, promoting the use of domestic facilities, and assuming control over the network during national emergency.[80] Even countries, such as the United States, which are departing from a national telecommunication monopoly environment, significantly manipulate the architecture. There may be less consideration given to cross-subsidizations, but that is replaced by encouraging competitive, redundant local and long-haul facilities and services through a variety of government regulatory devices.

One of the most recent and important of these devices is the Computer II basic/enhanced dichotomy.[81] The effect of this regulatory mandate on ISDN architecture in the United States is, among other things, to require AT&T to create physically separate nodes, owned and operated by a fully-separated subsidiary known as American Bell, for the provision of anything more than information transport.[82] Aside from the regulatory motivation for this result, it may also serve a technologically useful purpose by optimizing transport node facilities for maximum transport efficiency rather than for all sorts of general purpose information services. Whether this would be sufficient to offset the transmission and protocol penalties incurred as a result of the separation is unclear. Thus, other nations might profitably emulate the dichotomy, although different distinctions between "basic" and "enhanced" information services, or a different connotation of "separation," should be considered.

There are other important examples of preferred architectural configurations. One which remains a source of considerable controversy relates to the transit time of different transmission links. The delays which are intrinsically part of space satellite links are highly undesirable in some applications.[83] This led the CCITT to adopt a preliminary restriction on the use of such links in international ISDN communications. An optimal transit rate, in addition to other attractive features, seems to have spurred an increased commitment to optical fibre links for interexchange transmission in an ISDN environment. It would appear ISDN architecture is destined to be a largely terrestrial, switched, distributed configuration for most industrialized nations.

There are many situations, however, where a more centralized facility based on space radiocommunications will provide an attractive ISDN configuration. Large nations, where the implementation of terrestrial routes are difficult, could benefit from this.[84] Even for developed countries, with dense populations, space facilities should remain an important means of long-haul mobile communication, or of effecting multipoint distribution.

Similarly, national interests in a reliable network in times of national emergency may dictate particular architectures. Generally, these will be the switched distributed configuration, with satellite backup.[85] Just as there may be preferences for certain configurations based on national interest considerations, other architectures may be undesirable. Some people have begun to worry that the procompetitive fragmentation of both local and long-haul communication facilities in the United States may produce sizable independent private networks, with detrimental effects on the public networks. This phenomenon is also referred to as "network bypass."[86] The problem is not new. Indeed, in the early days of telephone in the United States, the difficulties posed by multiple independent private networks led to AT&T's designation as a regulated monopoly. However, it is not clear that the problems are as grave, nor that they outweigh the benefits of competition.

Interface and Interoperability Among Networks

The most interesting and potentially most contentious issues arise in conjunction with the interface and interoperation among networks. "Interface" refers to the points at which networks physically, electrically, and functionally interconnect. "Interoperation" refers to the ability of one network intelligence to give instructions to another, in other words, to direct a foreign network to provide resources or services. From the first international telecommunications conference in 1865 to today, the arrangements for accomplishing these tasks have been the most fundamental part of creating a global communications capability.[87] At the domestic level in the United States, questions relating to interface and interoperability among networks have become very significant as the nation's communication and information providers have grown more fragmented in the quest to promote competition.

The tremendous new flexibilities available in terms of interface and interoperability options have resulted in a concomitant ability to skew the availability of particular network resources for competitive advantage. For example, at the interface level, a question arises regarding the extent to which encrypted public communications will be allowed to circulate among nations. Devices to accomplish encryption are becoming increasingly inexpensive and sophisticated, and users have an increasing incentive to use them, if nothing else, to protect a copyright interest.[88] A dialogue is just beginning to emerge in CCITT on encryption and the efficacy of the network itself providing this service.

A more difficult interface question involves international gateways. The ISDN environment and the procompetitive policies being fostered in some countries will tend to promote a proliferation of gateways. Other nations which do not share those views, and which wish to avoid the associated technical and operational complexities, or perhaps which prefer a particular gateway because of a cable investment, seem reluctant to see such a proliferation.[89] Even international organization providers of telecommunication service like INTELSAT, INMARSAT, and INTERSPUTNIK have obvious substantial interests in the outcome of such arrangements. Looking into the future, the matter could become even more complex if INTELSAT, for example, introduced switching, processing, and storage capabilities on board its satellites, and thus became an ISDN node interposed among national systems. Already, TAT-8, the new transatlantic optical fibre cable which is in the process of being designed, is causing controversy concerning the manner in which it will be split among European countries.[90]

The interoperability issues will continue to vex network operators around the globe. Indeed, it is these issues to which the ITU's 1988 World

Administrative Telegraph and Telephone Conference (WATTC) may be dedicated.[91] These issues are an extension of those posted at the user/network interface. At that interface it was noted that many key questions dealt with the extent of control a user would have over the network resources and services being provided. For example, could alternative providers of those resources and services be specified, could a user specify which particular transmission paths, could dedicated or leased circuits be specified and assembled by the user (even to compete with services offered by the network) and could levels of priority or reliability be requested and assured.[92]

These matters can become complex and highly contentious. Take, for example, the situation where the networks are those of different countries, one of which restricts, for economic or policy reasons, the availability of certain user options. To what extent can the more restrictive national network now allow foreign users or networks to obtain resources or services unavailable to its citizens? If it does institute two operational standards, what is to prevent a citizen from establishing a circuit to a foreign network and requesting from that foreign network the services and resources unavailable from his native country's network? This area of extraterritorial activities of citizens and foreign entities through information networks is virtually bereft of guidelines or international law.[93] It is an important matter to resolve because the current condition may result in the imposition of the policies of the most restrictive nation. This is not a welcome result for those who value freedoms of inquiry and communication among nations and people.

Another highly important interoperability question concerns the basis for making resource utilization decisions when they are not specified, or allowed to be specified, by a user or foreign network. The problem discussed above was concerned with what will occur when an explicit request is made, where here the question is what will occur when that request is not explicit. The problem applies not only to the international transit facilities, but also to situations like the United States' competitive network configuration. If, for example, a user in the United Kingdom wishes to communicate with someone in San Francisco, and that user either does not specify the routing or is not allowed to do so, the United Kingdom telecommunications authority must decide regarding the choice of long-haul path from the gateway location to San Francisco, and finally choose a local path within San Francisco to reach the ultimate addressee. This is not an entirely new problem. However, both the extreme interoperability flexibilities of ISDN and the competitive fragmentation of information transport resources in countries such as the United States pose very significant problems which must be satisfactorily addressed in devising the standards and operating principles for the ISDN.

A third interesting and significant interoperability issue relates to the matter of addressing end terminal portability.[94] It is particularly interesting because of the intertwined privacy concerns that are raised. Basically, the controversy is centered on the meaning of terminal address. Does that address connote a real person or a location? Although existing communication network schemes generally use the latter, the technology now exists to adopt the former. For example, if A dials B's phone number, A is not really dialing B, but a fixed network terminal where A expects B to be. It is now possible, however, to associate permanently a numerical identity with a person, and have the network communicate directly with that person regardless of location: so-called numerical portability.

There are many benefits to such portability. The network can be made highly efficient in communicating with a mobile population, is very attractive for billing purposes, and allows each of us to communicate without the necessity of forwarding calls every time we leave a fixed location. Indeed, this is the attractiveness of mobile telephones now coming into extensive use through cellular radio systems.[95] It also means, however, that a highly efficient electronic system will potentially be aware of everyone's geographical location and movements through time. Lest any paranoid readers be left with ominous impressions, the obvious answer to inhibiting such tracking is simply to leave one's terminal at home or to turn it off. The price paid, however, is the inability to communicate.

The above discussion of interoperability issues is not exhaustive. One of a more technical nature relates to the synchronization of networks.[96] The entire network must adhere to a synchronization agreement if errors in transmission and processing are to be minimized. If a centralized timing reference is utilized, it should be available to all participants in an ISDN in a nondiscriminatory fashion.[97] A continuous, close operating environment among all providers of transport service is important in a network which embraces nearly everyone.

There are also issues involving the management functions carried out by the intelligence within and among networks. The responsibilities of the intelligence would include control of all resources available to the network in response to general or specific directions by customers. It is not clear how these responsibilities are to be shared. There are significant national security considerations associated with such control in times of emergency. Depending upon the nature of the emergency, different management criteria may apply.

Finally, there are significant legal issues, including complex questions of liability. Information might potentially be transported through dozens of different, independently owned and operated functional elements. In many, if not most, instances the user might be unaware whose facilities were being utilized. In our emerging information societies, great costs might be associated with the loss, delay, or distortion of information. The law must eventually provide answers in the apportionment of liability.

Rate Regulation

In one way or another, ISDN users will pay for the available information services. In some cases this will be done through direct arrangements between user and provider. In others it will be determined on the basis of national or international tariffs. Regardless of the mechanism, the problem of assessing costs must be resolved, presumably in a manner which reflects costs incurred in providing the services.[98]

The problems of rate setting are as old as communication networks. The difference in an ISDN environment lies in the extreme flexibilities and options associated with each provision of service. The relevant factors include transmission quality, transport distance, routing complexity, short and long term information quantities, degree of dissemination, burstiness (the instantaneous rate of change of information flow), priority, bit-rates, or social/political/economic characteristics of the sender or recipient of the information. This area may present special problems for the United States because of the tendency of other nations to devise tariffs for international transport based on criteria unrelated to transport alone, or to establish tariffs for non-transport information services.

Trade

Because the essence of ISDN involves global standardization and interoperability, significant foreign trade issues arise with respect to equipment and the provision of transborder information services. A major concern involves the extent that any one nation may depart from the rest of the world in devising different domestic standards, and the impact of that action on foreign trade. For example, a governmental regulatory decision designed to further domestic competition may result in domestic equipment which is at a competitive disadvantage internationally. Although less likely, the ability of foreign users of national information services to access those services efficiently could similarly be made less attractive by domestic ISDN regulatory decisions. In an ISDN environment, considerable interdependence will exist between domestic and international effects.

The provision of transborder information services raises many new issues of a political and economic nature. A foreign entity will have the potential technical capability not only to gather and furnish information, but also to provide a considerable range of information services within any given nation. Concerns relating to foreign competition and alien activities are already scuttling the old platitudes such as "free flow," and leading to a thorough scrutiny from national scrutiny and foreign trade perspectives. For example, a London-based group recently noted the increasing United States restrictions on Soviet-bloc user access to publicly available data bases.[99] Similarly, Congress is now contemplating a new "reciprocity" law which would place this entire area in a foreign trade framework.[100]

Spectrum Management

An ancillary issue to central ISDN questions is the matter of allocating and allotting radio frequency bands and channels. In the integrated transport environment implied by an ISDN, most means of radiocommunication would be operating in concert under the direction of network intelligence to provide inter-nodal or termination services.[101] The plethora of existing, content-oriented radio "services" such as broadcasting, maritime mobile, aeronautical mobile, land mobile, fixed, etc., can be expected largely to devolve into two: inter-nodal and termination. The government's traditional methods for deciding among competing services and applicants for frequency bands and channels will be significantly affected. Some new basic scheme will probably become necessary for managing the public's radio resource.

CONCLUSION

In summary, ISDN represents the implementation of new technology to provide a universal, intelligent information network. Beginning in early 1981 and continuing over the next two decades, massive efforts involving manufacturers, users, national administrations, and international organizations will take place to establish the principles, strategies, and standards for ISDN necessary to provide a stable foundation for the commitment of the substantial capital required.

These developments present a broad range of technical and national policy questions. The answers will explicitly and profoundly shape the nature of future domestic and global communication.

NOTES

[1] In the integrated information environment, the term "information transport," as a species of generic information services, seems more appropriate and is increasingly being used as a replacement for the term "telecommunication." *See* Report on the Meeting of the Group of Experts on ISDN Matters, Doc. No. COM XVIII-No. R8, at 51-54 (CCITT Mar. 1982) [hereinafter cited as Munich Report]. The term "digital pipe" appears to have been coined by Irwin Dorros, vice president for network planning at AT&T. *See* I. Dorros, Keynote

Address to the IEEE Communications Society, Integrated Services Digital Network Symposium (Jan. 7, 1981), *printed in* Dorros, *Challenge and Opportunities of the 1980's: The ISDN*, TELEPHONY, Jan 26, 1981, at 43 (as amended in the Feb. 23, 1981 issue at 28).

[2] *See* Munich Report, *supra* note 1, at 53-54.

[3] *See* Proposals for the Organization of CCITT Work on the ISDN and New Services, Temp. Doc. No. 60-E/PLEN (CCITT Nov. 1980); Final Report to the VIIth Plenary Assembly (Part IV), Doc. No. AP VII-No. 103 (CCITT Sept. 1980); Questions Allocated to Study Group XVIII for the Period 1981-1984, Doc. No. COM XVIII-No. 1 (CCITT Feb. 1981) [hereinafter cited as Study Group Questions]. The ITU is an international organisation located in Geneva, Switzerland, which serves as an umbrella for the nations of the world to gather and fashion international arrangements for telecommunication and information systems. It consists of numerous bodies, one of which is the CCITT. Participants in the CCITT's work include not only representatives from member States (largely the Post, Telegraph and Telephone ministeries or PTT), but also delegates representing Recognized Private Operating Agencies (RPOAs), such as AT&T, and Scientific and Industrial Organizations (SIOs), such as IBM. Together they fashion the CCITT Recommendations, which consist of hundreds of principles, standards, and tariffs for operating the world's telecommunication and information systems. *See* G.A. CODDING & A.M. RUTKOWSKI, THE INTERNATIONAL TELECOMMUNICATIONS UNION IN A CHANGING WORLD at ch. 10 (1982).

[4] *See* Data Processing—Open Systems Interconnection—Basic Reference Model, Doc. No. OSI/TC97/SC161N719 (Int'l Org. for Standardization 1981).

[5] FCC—Off. of Science & Technology, *Bibliography of Documents on the Integrated Services Digital Network (ISDN)*, BULL. No. 57 (Aug. 1982) [hereinafter cited as *ISDN Bibliography*].

[6] *See, e.g.*, Rutkowski & Marcus, *The Integrated Services Digital Network: Developments and Regulatory Issues*, COMPUTER COM. REV., July-Oct. 1982, at 68; Panel Transcript of A.B.A. Sec. of Science and Technology (Aug. 7, 1981) (entitled: "Policies for the Integrated Communications Environment of the Future"); R. EWARD, INTEGRATED SERVICES DIGITAL NETWORKS: IMPACT & INDUSTRY (undated) (prepared under the auspices of Mortech Strategies); STRUCTURAL ISSUES IN GLOBAL COMMUNICATIONS 23-26 (undated) (prepared under the auspices of the Tobin Foundation).

[7] The distinction is important because the facilities perspective fails to reveal two of the most significant ISDN resources—software and the information imbedded in storage facilities.

[8] *See* Philosophy and Concept of ISDN, Doc. No. COM XVIII-No. 130 (CCITT Sept. 1982).

[9] *See* Munich Report *supra* note 1, at 51-53.

[10] *See id.* at 53-57.

[11] *See id.* at 51-52. The utilization of a separate signalling channel (referred to as the "D Channel") inherently allows user/network dialogue during the course of providing any service. *Id.* at 22.

[12] *See id.* at 54. "Type U3" information encompasses bit rates of up to 140 Mbit/s, well within that necessary to encompass high resolution television. *Id.* at 59.

[13] The term "fifth-generation computer" connotes the existence of information systems possessing sufficient intelligence to learn from a dialogue with a human or other machine or sensory device. *See* JAPAN INFORMATION PROCESSING DEVELOPMENT CENTER, PRELIMINARY REPORT ON STUDY AND RESEARCH ON FIFTH GENERATION COMPUTERS (1981).

[14] Isaksson, *L.M. Ericson Introduces Phone With Voice-Activated Dial*, Berlingske Tictende (Den.), July 29, 1982, at Sec. II, 6, *reprinted in* JOINT PUBLICATIONS RESEARCH SERVICE [JPRS] No. 82083 at 106-107 (Oct. 26, 1982); Lars Porne, *More Details Revealed on Experimental Voice-Activated Phone*, Svenska Dagbladet (Swed.), Sept. 27, 1982, at 1, *reprinted in* JPRS No. 82267 at 36 (Nov. 18, 1982).

[15] Kenedi, *Plotting a Strategy for the Emerging ISDN*, TELEPHONY, June 22, 1981, at 22.

[16] In addition to the ISO and the ITU's CCITT, the CCIR (Consultative Committee on

Radio), and the International Federation of Information Processing also provide international forums. On the regional level, the European Computer Manufacturers Association (ECMA) and the European Conference of Post and Telecommunication Administrations (CEPT) provide forums. At the U.S. domestic level, the U.S. Organization for CCITT (a Dept. of State public advisory committee), the Institute of Electrical and Electronic Engineers (IEEE), the Federal Telecommunication Standards Committee, the American National Standards Institute, and the Electronic Industries Association also provide forums.

17 *See, e.g.*, Questions Allocated to Study Group XVIII for the Period 1981-1984, *supra* note 3.

18 Study Groups VII, XI, and XVIII.

19 CCITT, *Report by Committee A on ISDN Working Methods*, in STUDY OF ISDN 128 (1981) [hereinafter cited as YELLOW BOOK].

20 The persons conducting such liaison are referred to as rapporteurs for the other study groups. These representatives may convey ad hoc questions and answers between groups, or introduce relevant documents from the represented group.

21 *See* Final Report to the VIIth Plenary Assembly, Vocabulary of Pulse Code Modulator and Digital Transmission Terms at Rec. G. 702, Doc. AP VII-No. 102-E, at 24 (CCITT 1980); Minutes of the VIIth Plenary Meeting, Temp. Doc. No. 83-E PLEN (CCITT 1980).

22 *See* Report of the Meeting of Working Party XVIII/1 (ISDN), Doc. No. COM XVIII-No. R3, at 5 (CCITT July 1981) [hereinafter cited as Working Party Report].

23 *See* Definition of Integrated Services Digital Networks (ISDN), Doc. No. COM XVIII-No. 31 (CCITT Apr. 1981) (contribution of AT&T) [hereinafter cited as ISDN Definition].

24 *See supra* note 20.

25 *See* Proposals for ISDN Terms and Definitions, Doc. No. COM XVIII-No. 139, at 3 (CCITT Nov. 1982). If favorably acted upon, the new definition would read: "An integrated digital network that uses common digital links and digital switching equipments to set up digital connections in order to provide a range of different services." *Id.*

26 *See* Working Party Report, *supra* note 20, at 5.

27 *Id.* at 4.

28 *See* YELLOW BOOK, *supra* note 17, fascicle III.3 at 65 ("The CCITT [considers] the need for a common basis for the future studies necessary for the evolution towards an ISDN . . ."); Study Group Questions, *supra* note 3, at 7 ("[M]any countries wish to adopt a common strategy for [ISDN] . . .").

29 Non-conforming networks would at most be required to fashion special interfaces; or at least be precluded from interconnecting with an ISDN, depending on the nature of the deviation. A user would incur a similar penalty.

30 *See* CODDING & RUTKOWSKI, *supra* note 3, at ch. 10; *see also Recommendations on the Organization and Work of the CCITT*, in *Yellow Book*, *supra* note 17, at 233-49.

31 *See* Munich Report, *supra* note 1, at 34-37, 13-20, and 21-25. The three Recommendations were designated I.XXW, I.XXX, and I.XXY.

32 *See* Comments on the Results of the ISDN Experts Meeting, Doc. No. COM XVIII-No. 101 (CCITT Apr. 1982).

33 *See* Summary Minutes of the U.S. CCITT ISDN Working Party (Dep't of State, Off. of Com. Pol'y Apr. 18, 1982) [hereinafter cited as U.S. ISDN Working Party].

34 Report on the Geneva Meeting, Doc. No. COM XVIII-No. 129, at 4 (CCITT June 1982).

35 *See* Study Group XVIII Group of Experts on ISDN Matters, Temp. Doc. No. 33 (CCITT Feb. 1983) (proposed layout of the I-series Recommendations) [hereinafter referred to as the Kyoto Meeting].

36 *See* Report of the Kyoto Meeting, Doc. No. XVIII-No. R_____ (CCITT—1983).

37 *See In re* Amendment of Section 64.702 of the Commission's Rules and Regulations, 77 F.C.C.2d 384 (1980) [hereinafter cited as *Second Computer Inquiry—Final Decision*]; *In re* Amend-

ment of Section 64.702 of the Commission's Rules and Regulations, 84 F.C.C.2d 50 (1980) [hereinafter cited as *Second Computer Inquiry - Memorandum Opinion and Order*]; *In re* Amendment of Section 64.702 of the Commission's Rules and Regulations, 88 F.C.C.2d 512 (1981), *aff'd sub nom.*, Computer and Communications Industry Ass. (CCIA) v. FCC, 693 F.2d 198 (D.C. Cir. 1982) [hereinafter cited as *Second Computer Inquiry - Further Reconsideration*]; *see also* United States v. American Telephone and Telegraph Co., 532 F. Supp. 131 (D.D.C. 1982) (modification of final judgment); Bell Operating Companies, No. 83-71 (FCC Mar. 4, 1983).

[38] *See* MIT Research Program on Communications Policy, Minutes of Seminar on ISDN (Oct. 7, 1982).

[39] *See, e.g.*, U.S. ISDN Working Party, *supra* note 31; Munich Report, *supra* note 1, at 113 (list of participants).

The following statements are illustrative.

[W]hat is the ISDN? It is a public end-to-end digital telecommunications network providing a wide range of user applications.

[The challenge of] network planners is to fulfill the ISDN's potential as much as possible. As usual when vision and reality meet, there is a crucial period of challenge when basic decisions must be made. Now is such a time, a time when standards are being set, large amounts of capital are being committed, and new industry structures are being mandated not just in Washington, D.C., but in other capitals around the world.

The main motivation for the ISDN is the economies and flexibilities which the integrated nature of the network would foster. The economies occur because many of the emerging new services are digital and can be combined with existing services to use an integrated transport capability at a significantly lower overall cost than it would take for each service to use a spearate transport capability.

Most people will agree with the general architecture. Where we may have different perspectives is in such issues as: first, the details under this scheme; second, interface specifications; third, how to go about making this happen; fourth, what should motivate the evolution; fifth, how rapidly it will evolve; and sixth, what will be the services driving the evolution process. Dorros, *supra* note 1.

[40] *See American Bell*, AN INTRODUCTION TO AIS/NET 1 SERVICE (undated); Hindin, *What American Bell Offers*, ELECTRONICS, June 30, 1982, at 28.

[41] *See ISDN Bibliography*, *supra* note 5, at 25-28.

[42] *See, e.g.*, Haag, *Telecommunications War: Ericsson Goes Its Own Way*, Stockholm Veckans Affarer (Swed.), Feb. 3, 1983, at 40, *reprinted in* JPRS No. L/11204 at 6 (Mar. 21, 1983); *View of Ministry of Posts and Telecommunications*, Tokyo Sentaku (Jap.), May, 1982, at 72, *reprinted in* JPRS L/10697 at 16 (July 29, 1982) (noting 20-year plan for investment of 20 trillion yen in ISDN); Krojnc, *One Hundred Twenty-Five Million for the World Center*, Paris Zero on Informatique Hebato (Fr.), Dec. 20, 1982, at 7, *reprinted in* JPRS 82869 at 48 (Feb. 16, 1983).

[43] *See* CCITT, ECONOMIC AND TECHNICAL ASPECTS OF THE CHOICE OF SWITCHING SYSTEMS at ch. III (1981).

[44] General Accounting Office, Report to Congress on Legislative and Regulatory Actions Needed to Deal With a Changing Domestic Telecommunications Industry, GAO Rep. No. CED-81-136 (1981).

[45] Communications Act of 1934, Sec. 1, as amended, 47 U.S.C. § 155 *et seq.* (1976).

[46] *Second Computer Inquiry—Further Reconsiderations*, 693 F.2d 198; MCI Telecommunications Corp. v. FCC, 580 F.2d 590 (1978), *cert. denied* 439 U.S. 980; *In re* Establishment of Policies and Procedures for Consideration of Application to Provide Specialized Common Carrier Services in the Domestic Public Point-to-Point Microwave Radio Service and Proposed Amendments to Parts 21, 43, and 61 of the Commission's Rules, 29 F.C.C.2d 870 (1971), *aff'd sub nom*, Washington Utilities and Transport Comm'n v. FCC, 513 F.2d 1142 (9th Cir. 1975), *cert. denied*, 423 U.S. 836; *In re* Policy and Rules Concerning Rates for Competitive Common Carrier

Services and Facilities Authorizations Therefor, 91 F.C.C.2d 59 (1982), *recon. denied*, — F.C.C.2d — (1983); *In re* Authorized User Modification, 90 F.C.C.2d 1394 (1982); *Second Computer Inquiry—Memorandum Opinion and Order*, 84 F.C.C.2d 50; *In re* Regulatory Powers Concerning Resale and Shared Use of Common Carrier Domestic Public Switched Network Services, 83 F.C.C.2d 187 (1980); *Second Computer Inquiry—Final Decision*, 77 F.C.C.2d 384; *In re* Regulatory Policies Concerning Resale and Shared Use of Common Carrier Services and Facilities, 60 F.C.C.2d 261 (1976); *In re* Establishment of Domestic Communications-Satellite Facilities by Non-Governmental Entities, 35 F.C.C.2d 844 (1972) (Second Report and Order); *In re* Use of the Carterfone Device in Message Toll Telephone Service and *In re* Thomas F. Carter and Carter Electronics Corp., Dallas, Tex. v. American Telephone and Telegraph Co., Associated Bell System Companies, Southwestern Bell Telephone Co. and General Telephone Co. of the Southwest, 13 F.C.C.2d 420 (1968); *In re* Authorized Entities and Authorized Users under the Communications Satellite Act of 1962, 4 F.C.C.2d 421 (1966).

47 The Commission's pro-competitive regulatory policies now allow a user to obtain information services by using alternative local, inter-exchange and enhanced service facilities. Formerly, the national network was governed by AT&T specifications. *See* AT&T, BELL SYSTEM PRACTICES (undated). The Commission currently has no regulations to govern the manner in which the new telecommunication network configurations should operate. *See* Rules and Regulations of the FCC, 47 C.F.R. pts. 63, 64 & 68 (1981) (whole list of regulations silent on this point).

48 The author received this (unofficial) information from a representative of the Nippon Telephone & Telegraph Public Corp.

49 *See* Rutkowski, *Emerging International Information Transport Barriers*, in PROCEEDINGS OF THE INTERNATIONAL INSTITUTE OF COMMUNICATIONS (1981) (Symposium on Communications and International Trade).

50 *See* Report of the Geneva Meeting, Doc. No. COM XVIII-No. R2 (CCITT July 1981).

51 *See* ISDN Definition, *supra* note 21.

52 *See Second Computer Inquiry—Final Decision*, 77 F.C.C.2d 384, 418-21; *Second Computer Inquiry—Memorandum Opinion* and Order, 84 F.C.C.2d 50, 53-54.

53 *See* Munich Report, *supra* note 1, at 99-100.

54 *See id.*

55 *See* ISDN Bibliography, *supra* note 5.

56 *See* Munich Report, *supra* note 1, at 38-47.

57 *See id.*

58 *See* FCC Intra-Agency Committee on ISDN Regulatory Issues, Minutes of Meeting, Attachment 1 (March 1, 1982) (notes of IBM representatives presented to the committee).

59 *See* Summary Report of the Joint Meeting of U.S. CCITT Study Group D and the ISDN Working Party, U.S. Nat'l Comm. Doc. No. 276 (Feb. 3, 1983).

60 *See* AT&T Draft Study Group XVIII, Considerations for Activation and Deactivation of Network Termination Equipment (Jan. 1983) (document submitted to U.S. Organization for CCITT).

61 *See* AT&T Draft Study Group XVIII, The Non-Provision of Exchange Originated Power to T1 or NT2 (Jan. 1983) (document submitted to U.S. Organization for CCITT).

62 *See Laser Powers Phone Via One Optical Fiber*, ELECTRONICS, July 14, 1982, at 92.

63 *See* Munich Report, *supra* note 1, at 25.

64 *See* A. Rutkowski, Notes from Meeting of U.S. Organization for CCITT ISDN Working Party Technical Working Group Meeting in Washington, D.C. (Jan. 18-21, 1983).

65 *See* Munich Report, *supra* note 1, at 12.

66 *See id.* at 22.

67 *See* Rutkowski, *supra* note 3.

68 *See id.*

69 *See* Munich Report, *supra* note 1, at 59.

70 *See Digital TV VLSI Goes Into Mass Production*, ELECTRONICS, April 7, 1983, at 86.

71 *See* Munich Report, *supra* note 1, at 48-59.

72 *See id.* at 56; *see also* AT&T Draft Study Group XVIII, Framework for Describing ISDN Services (Jan. 1983) (document submitted to U.S. Organization for CCITT).

73 *See* AT&T Draft Study Group XVIII, Definition of 64 KBls Leased Circuit Capability (Jan. 1983) (document submitted to U.S. Organization for CCITT).

74 *See id.*

75 *See* Sanger, *Waging a Trade War Over Data*, N.Y. Times, Mar. 13, 1983, at F26.

76 *See* General Principles for the Lease of Intercontinental Private Leased Telecommunication Circuits at Rec. D.1, in YELLOW BOOK, *supra* note 17.

77 *See* FCC Intra-Agency Committee on ISDN Regulatory Issues, Minutes of Meeting, Attachment 1, *supra* note 57.

78 *See* Munich Report, *supra* note 1, at 92.

79 *See* Special Session on the International Implications of Changing Market Structures in Telecommunication Services, Doc. No. ICCP (83) 1, at 11-12 (Jan. 1983).

80 *See, e.g., Economic and Technical Aspects of the Choice of Telephone Switching Systems*, CCITT GAS & HANDBOOK (1981); PROC. OF THE SECOND CCITT INTERDISCIPLINARY COLLOQUIUM ON TELEFORMATICS (1980).

81 *See, e.g., Session on National Security*, PROC. OF THE SYMP. ON INT'L TELECOMMUNICATIONS AND INFORMATION POL'Y (1983); Stine, *Relationship of ISDN to Future DCS Architectures*, ISDN SYMPOSIUM (1982).

82 *See Second Computer Inquiry-Final Decision*, 77 F.C.C.2d 384, 418-21; *Second Computer Inquiry - Memorandum Opinion and Order*, 84 F.C.C.2d 50, 53-54.

83 *See* Rutkowski, *The Role of Radiocommunication in ISDN*, TELECOM., June 1983, at —.

84 *See id.* (references cited therein).

85 *See* Stine, *supra* note 80; *see also* Ross, *Military/Government Digital Switching Systems*, 21 IEEE COMMUNICATIONS 18 (1983).

86 *See* Third Report and Order, No. 82-579 (F.C.C. Dec. 22, 1982).

87 *See* CODDING & RUTKOWSKI, *supra* note 3.

88 *See* Pool & Solomon, *Intellectual Property and Transborder Data Flows*, 16 STAN. J. INT'L L. 113 (1981); Solomon, New Technological Impacts on Copyright, Doc. No. DSTI/ICCP/81.15 (OECD May 1981).

89 *See* Letter from Hans Wurtzen, Chairman of NORDTEL, to various U.S. common carriers (June 30, 1982).

90 *See* Italian Interest in TAT-8 Transatlantic Fiber Optic Cable Landing in Sicily, Rome Telegram No. 28598 (Dep't of State Dec. 23, 1982).

91 *See* WORLD ADMINISTRATIVE TELEGRAPH AND TELEPHONE CONFERENCE, FINAL ACTS OF THE PLENIPOTENTIARY CONFERENCE at Res. No. PLA/1 (Nairobi) (1982).

92 *See* AT&T Draft Study Group XVIII, Framework for Describing ISDN Services (Jan. 1983) (document submitted to U.S. Organization for CCITT).

93 *See* Chandler & Smiddy, *Contract and Tort Liability in Transnational Data Transfer*, SCI. TECH. SEC., A.B.A. PROJECT ON INT'L DATA NETWORKS (1983); *see also* Bing, Forsberg & Nygard, Legal Issues Related to Transborder Data Flows, Doc. No. DSTI/ICCP/81.9 (OECD 1981).

94 *See* Munich Report, *supra* note 1, at 35, 66-67.

95 *See, e.g.,* Williams, *Capacity Dynamics in Cellular Mobile Telephone Systems*, 17 TELECOM. 32 (1983).

96 *See* Report of Working Party XVIII/4 (Switching and Signalling), Doc. No. COM. XVIII No. R12 (CCITT June 1982); Abate, Cooper, *Switched Digital Network Synchronization*, 199 TELEPHONY 33 (1980).

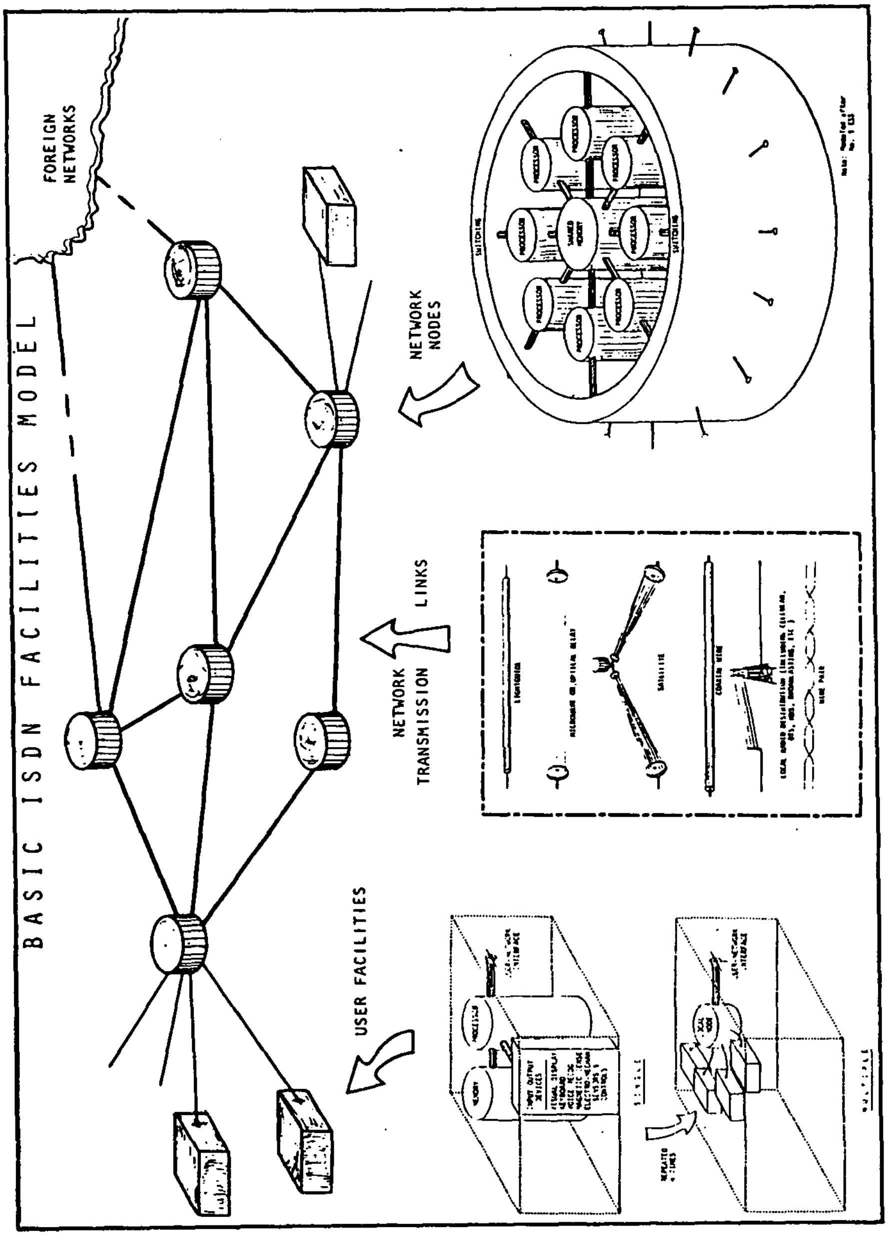
97 *Id.*

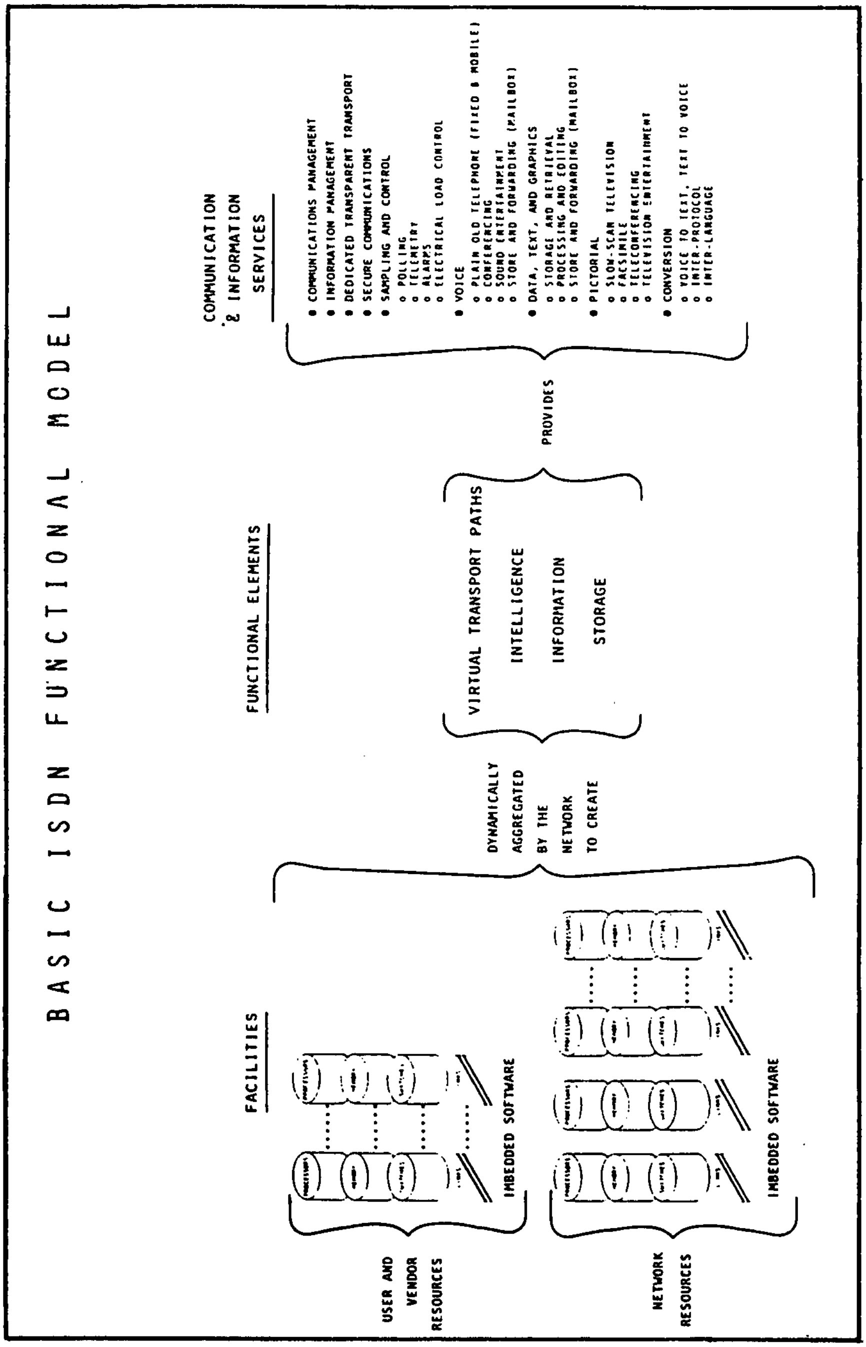
[98] Such matters have begun to be addressed in the context of CCITT Study Group III, Question 21, entitled Tariff Guidelines for Integrated Services Digital Networks. *See* Study Group III, Doc. No. COM. III No. 1 (CCITT Dec. 1980).

[99] *See Freezing Technical Data Flows Called Dangerous,* 5 TRANSNAT'L DATA REP. 232 (1982).

[100] See, e.g., H.R.5158, S.2051, H.R.5205, S.898, S.2904, S.2058, 97th Cong., 2d Sess. (1982); S.999, 98th Cong., 1st Sess. (1983).

[101] *See* ISDN Working Party, ISDN Interoperability with Alternative Local Transport Network Technologies (Aug. 26, 1982) (draft document submitted to the U.S. Organization for CCITT).


BASIC ISDN FACILITIES MODEL
FOREIGN NETWORKS
NETWORK NODES
NETWORK TRANSMISSION LINKS
USER FACILITIES


BASIC ISDN FUNCTIONAL MODEL
FACILITIES
USER AND VENDOR RESOURCES
IMBEDDED SOFTWARE
NETWORK RESOURCES
IMBEDDED SOFTWARE
DYNAMICALLY AGGREGATED BY THE NETWORK TO CREATE
FUNCTIONAL ELEMENTS
VIRTUAL TRANSPORT PATHS
INTELLIGENCE
INFORMATION
STORAGE
PROVIDES
COMMUNICATION & INFORMATION SERVICES
• COMMUNICATIONS MANAGEMENT
• INFORMATION MANAGEMENT
• DEDICATED TRANSPARENT TRANSPORT
• SECURE COMMUNICATIONS
• SAMPLING AND CONTROL
o POLLING
o TELEMETRY
o ALARMS
o ELECTRICAL LOAD CONTROL
• VOICE
o PLAIN OLD TELEPHONE (FIXED & MOBILE)
o CONFERENCING
o SOUND ENTERTAINMENT
o STORE AND FORWARDING (MAILBOX)
• DATA, TEXT, AND GRAPHICS
o STORAGE AND RETRIEVAL
o PROCESSING AND EDITING
o STORE AND FORWARDING (MAILBOX)
• PICTORIAL
o SLOW-SCAN TELEVISION
o FACSIMILE
o TELECONFERENCING
o TELEVISION ENTERTAINMENT
• CONVERSION
o VOICE TO TEXT, TEXT TO VOICE
o INTER-PROTOCOL
o INTER-LANGUAGE