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International Telecommunication Standards: Issues and Implications for the '80's
A Summary Record of a July 1982 Workshop

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15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

International telecommunication standards and their effects on the U.S. telecommunication industry were considered at a 2-day workshop entitled "International Standards--Issues and Implications for the '80's." This report summarizes the 30 papers presented at the conference. The speakers addressed the importance of standards, the international organizations responsible for their development (including U.S. participation in that process), and the standards-building process itself.

The report highlights two major efforts in international standards development--the Integrated Services Digital Network (ISDN) and the Open Systems Interconnection (OSI) Reference Model. The status of other standards work, including videotex and Signalling System No. 7, is also reviewed.

16. Key Words *(Alphabetical order, separated by semicolons)*

ANSI; CCITT; IEC; international telecommunications standards; ISDN; ISO; ITU; OSI; Signalling System No. 7; telematic services; X.25

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FOREWORD

On July 21 and 22, 1982, more than 100 government and industry representatives gathered in Boulder, Colorado, for an informal workshop on "International Standards--Issues and Implications for the '80's." The workshop was hosted by the Institute for Telecommunication Sciences (ITS), the research and engineering arm of the National Telecommunications and Information Administration in the U.S. Department of Commerce.

Thirty informal papers were presented at the workshop. Although no written record of the workshop was originally planned, the information was of such value that the organizers concluded that it should be made permanently available, both to the workshop attendees and to others with an interest in international telecommunication standards development. For brevity, it was decided to summarize the presentations in report form rather than in a formal conference proceedings. This approach also made it possible, in general, to indicate the diversity of views expressed without attributing "positions" on specific issues to individual participants.

Increasingly, the U.S. telecommunication industry is experiencing substantial impacts from decisions made in international standards committees. The material presented at the workshop, representing views from many segments of the telecommunication industry, should help readers understand those impacts and plan for the standards of tomorrow.

The Institute for Telecommunication Sciences, the workshop attendees, and the entire telecommunication community owe a debt of gratitude to the workshop speakers and to their organizations. It was their generous investment in time, talent, and resources that ultimately made the workshop a success.

Ted de Haas, ITS
Workshop Director
Boulder, Colorado
March 1983

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INTERNATIONAL TELECOMMUNICATION STANDARDS: ISSUES AND IMPLICATIONS FOR THE '80's
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D. M. Cerni and E. M. Gray*

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Key words: ANSI; CCITT; IEC; international telecommunication standards; ISDN; ISO; ITU; OSI; Signalling System No. 7; telematic services; X.25

1. INTRODUCTION

The development of international telecommunication standards is increasingly important to the U.S. telecommunication industry. Two reasons for this importance are particularly addressed in this report: the rapid growth of digital technology and the accompanying development of the two global standards efforts called the Integrated Services Digital Network (ISDN) and the Open Systems Interconnection (OSI) Reference Model. Because of the merging of telecommunication and computer technologies, the international organizations responsible for the development of international standards are finding it imperative to cooperate to an extent unrealized in the past.

1.1 Scope and Purpose of Report

This report collects and summarizes information from 30 papers presented at the July 1982 workshop on "International Standards--Issues and Implications for the '80's," sponsored by the Institute for Telecommunication Sciences and

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held in Boulder, Colorado. The workshop, primarily intended for industry and government standards representatives, focused on current and future international standards activities and their impact on common carriers, telecommunication users, and equipment manufacturers. The workshop speakers addressed the above issues by providing an overview of international telecommunication standards activity from both the organizational and standards-development points of view. A particular stress in the workshop was the importance of the user's participation in the standards-building process.

The main purpose of this summary is to provide an avenue for understanding international standards work, and to indicate ways in which interested persons can become involved. It is not the goal of this report to draw conclusions.

In summarizing the workshop material, the authors have attempted to be as complete as possible. However, material that was not presented at the workshop itself has not been added from the literature. Sources of further information on the topics discussed are identified in the References.

Each speaker has cleared the summary of his or her topic for publication. All illustrations selected for inclusion in this report are derived from viewgraphs presented at the conference and are used with permission of the speakers. Illustrations are attributed to particular speakers where appropriate.

The views expressed are not necessarily those of the U.S. Department of Commerce, the National Telecommunications and Information Administration, or any other Federal agency. A list of the speakers is provided in Section 1.2.

1.2 Report Structure

Introductory workshop comments by Dr. William Utlaut, Director of ITS in Boulder, and by Ted de Haas of ITS, workshop director, have been incorporated into this report where appropriate. The names of the other speakers are listed in the relevant section summary below.

1.2.1 Working Methods of Standards Organizations

Section 2 addresses the history, structure, and working methods of the international (and U.S.-related) telecommunication standards organizations. The two international organizations stressed in this section are the CCITT (International Telegraph and Telephone Consultative Committee) and the ISO (International Organization for Standardization). Included in this discussion is the effect of nonstandards groups on the standardization process.

Section 2 includes material from talks by Ted de Haas (ITS), Edward Lohse (Burroughs), Richard Holleman (IBM), Paul Polishuk (Information Gatekeepers), Earl Barbely of the Federal Communications Commission (FCC), Roy Andres (Western Union International), and Hank Marchese (AT&T).

1.2.2 Impact of International Standards

Section 3 analyzes the meaning and nature of standards, the advantages and disadvantages of standards, and the implications of standards implementation. Recommendation X.25 of the CCITT is explored as a recent "successful" standard. The speakers whose material is included are Joseph Hull (ITS), Hank Marchese (AT&T), Robert Bledsoe (Racal-Milgo, Inc.), Philip Black (Tekelec, Inc.), and Paul Polishuk (Information Gatekeepers).

1.2.3 An International Systems-Architecture Standard: The Open Systems Interconnection (OSI) Reference Model

Section 4 considers the Open Systems Interconnection (OSI) Reference Model developed by the ISO. Each of the seven layers of the model is described and the related protocols and primitives are reviewed. A scenario of OSI use is given, and efforts in the standardization of the model are discussed. The OSI model is presented in relation to other standards, particularly those of the CCITT. Speakers whose material is included are Richard DesJardins (Computer Technology Assoc.), Harold Folts (Omnicom), and Christine Ware of GTE-Business Communication Systems (BCS).

1.2.4 An International Systems-Planning Standard: The Integrated Services Digital Network (ISDN)

Section 5 of this report discusses the ISDN as it is being studied by the CCITT. Included is an overview of the ISDN; a discussion of related issues and problems in the United States and in the international arena (seen from the speakers' points of view); a summary of three 1982 ISDN Draft Recommendations; a summary of worldwide views and plans for ISDN service; and ISDN implications as seen by the telephone carrier, the data carrier, the information systems planner, and the user. The roles of the FCC and of U.S. carriers, in relation to the ISDN, are also discussed. The contributing speakers were: Ted de Haas (ITS), Hank Marchese (AT&T), Demos Kostas (GTE Service Corp.), Eric Scace (GTE-BCS), Richard Holleman (IBM), Mark Wall (Chase Manhattan Bank), and Earl Barbely (FCC).

1.2.5 New Services--Teletex, Videotex, and Facsimile

Section 6 of the report discusses teletex, videotex, and facsimile as studied in the CCITT. Each service is described, and a summary of standardization progress is provided. Material in this section is drawn from talks by Roy Andres (Western Union International), Joe Wetherington (AT&T), and Forrest Smith (IBM).

1.2.6 The Message Handling Systems (MHS)

Section 7 describes the efforts of the CCITT in preparing Recommendations dealing with the MHS, a network support activity for the user's interaction with the nonvoice services. The material in this section was presented by Christine Ware (GTE-BCS).

1.2.7 CCITT Signalling Systems: A 50-year Saga

Section 8 of the report is devoted to a discussion of CCITT signalling systems, with an emphasis on Signalling System No. 7--its development, its structure, and its relationship with Signalling System No. 6. The workshop speakers for this topic were Robert Linfield (ITS), Gerhard Hoffman (ITT World Headquarters), and Doug Donohoe (Bell Laboratories).

2. WORKING METHODS OF STANDARDS ORGANIZATIONS

International, regional, and national standards organizations are numerous throughout the world. Of the many international organizations, only one is dedicated exclusively to the development of telecommunication standards: The International Telecommunication Union (ITU). This report stresses the work of the ITU, particularly that done in one of its principal groups, the CCITT.

Two other major international organizations that deal with telecommunications in some capacity are the International Organization for Standardization and the International Electrotechnical Commission (IEC).

2.1 Introduction

Section 2 includes a general discussion of these three organizations. The growing cooperation among all three of the above-named organizations is highlighted in Sections 2.2.4 and 4.3.3.

Of particular interest to the U.S. reading audience is the nature of U.S. participation in these international organizations. Section 2.3 outlines, in some detail, the U.S. preparatory (or advisory) structures for the ITU, the ISO, and the IEC.

Section 2 of the report concludes with a brief discussion of other groups that are directly or indirectly involved in the standards-making process. The major regional standards group considered in Section 2.4 is the European Conference of Posts and Telecommunications (CEPT). Other types of groups mentioned include user groups and international (nonstandards) organizations.

2.2 International Standards Organizations

The three international standards organizations described in this report--the ITU, the ISO, and the IEC--are depicted in Table 2.1. This table compares selected pertinent features that are expanded below.

2.2.1 The International Telecommunication Union (ITU)

The ITU is a specialized agency of the United Nations (since 1948), and is an international treaty organization. It traces its formal beginnings to 1865, and now consists of 157 member nations. Member nations sign the ITU Convention, which is updated at each Plenipotentiary Conference (every 5 to 9 years). The most recent Plenipotentiary occurred in Nairobi, Kenya, in late 1982.

The Seven ITU Organizations

There are seven main organs through which the ITU functions. These are the Plenipotentiary Conference, the Administrative Council, the Administrative Conferences, and the four permanent organs: the General Secretariat, the International Frequency Registration Board (IFRB), the International Radio Consultative Committee (CCIR), and the CCITT.

As indicated above, the Plenipotentiary Conference determines the ITU Charter, the Articles of the Convention, and the main objectives of the ITU. The Articles of this large gathering are signed formally by all member nations.

The members of the Administrative Council are elected by the Plenipotentiary Conference with due regard for representation from all parts of the world. The Council meets annually to decide on financial, administrative and organizational matters.

The ITU Administrative Conferences are either World (general or specific) or Regional in nature. Administrative Conferences are held on the request of the member countries for the purpose of revising Administrative Regulations on

Table 2.1 Comparison of the ITU, the ISO, and the IEC

	ITU	ISO	IEC
Year of Founding	1865	1946	1906
Headquarters	Geneva	Geneva	Geneva
Type of Administration	Central-ized	Non-central-ized	Largely Centralized
United Nations Status	Treaty	Non-treaty	Non-treaty
Number of Member Nations	157	72 (+18 Associates)	44
Main Unit of Working	Study Group	Technical Committee	Technical Committee
U.S. Representative	US CCITT/ US CCIR	ANSI/USNC	ANSI
Expertise	Telecom-munica-tions	Very broad, including information processing	Electro-technical

ANSI: American National Standards Institute
USNC: U.S. National Committee

Telegraph, Telephone, or Radio. World Administrative Radio Conferences (WARC's) decide on the allocation of the radio spectrum to different services.

The four permanent groups in the ITU comprise some 600 staff members. Of these, the General Secretariat, headed by the Secretary General of the ITU, fulfills a number of administrative functions, including technical help to developing nations.

The duties of the second permanent group, the IFRB, concern radio spectrum allocation and organization.

The last two permanent organs, the consultative committees, have responsibility for most of the standards-related work done in the ITU. These two committees are generally self-determining in their work methods. Although the ITU is a single organization, the CCI's were originally independent organizations and have retained a large degree of that independence.. A brief presentation of the two consultative committees--the CCIR and the CCITT--is given below.

The CCIR and the CCITT

Participation in the work of the CCI's is a responsibility of each of the 157 ITU member governments (or administrations). Consequently, in the United States, the membership of individual U.S. telecommunication organizations in the CCI's is handled through the Department of State, Office of International Communication Policy. In general, any U.S. organization that has legitimate interest in participating in the work of the CCI's can become a member of the international group.

The standards work of both CCI's takes place in technical study groups (the CCITT has 15 and the CCIR has 11), and is performed during a 3-to-4-year study period. The plenary assembly held at the end of the study period reviews work done, formally adopts Recommendations, sets the work schedule for the next study period by adopting and assigning questions, discusses and proposes organizational matters, and discusses and proposes administrative arrangements. The proceedings of the plenary assembly are published in books, which are an ongoing, updated record of the work accomplished. The principal components of these books are the Recommendations. The CCIR books are always green; the CCITT books rotate in color, with the most recent (1980) being yellow.

Both of the CCI's conduct their work through formal study group meetings (ideally only two per study group per study period) as well as working party meetings and special rapporteur meetings. The study group topics for the CCITT (the organization most relevant to this reading audience) are given in Table 2.2. The largest of these groups at present are Study Groups VII, VIII, XVII, and XVIII.

The meetings, themselves, make progress by means of contributions from participating members. None of the technical work is actually done in the CCIR or the CCITT. The contributions are considered by the meeting participants and may be combined, edited, or just noted. Eventually, this process of analysis and development yields a Recommendation which is acceptable to all. The process by which contributions from the United States reach the study groups is discussed below in Section 2.3.

The work program for each study group is determined by the questions that are assigned to it by the plenary assembly. As the work progresses in the CCIR, these questions generate reports, and finally a Recommendation may be developed. These reports tend to have a fairly long life, often giving the history of the ongoing work on a Recommendation. In some cases, the Recommendation is never formally adopted because either the subject changes too rapidly or agreement is never reached; the report, then, is all that remains as partial answer to the particular questions.

The CCITT work is similar, although it does not include reports, per se. Relevant material can be annexed to the study group meeting summary, or to the question if it continues from one study period to another. In addition, CCITT books contain a small number of "supplements."

The official U.S. participation in the formal CCI study group meetings differs somewhat in the CCIR and the CCITT. The CCIR has always had strong U.S. Government involvement because the radio spectrum is considered public property. Consequently, the U.S. participants in the CCIR meetings are, with few exceptions, limited to members of the U.S. delegation determined by the Department of State.

The CCITT, on the other hand, has always had little government involvement. The services discussed in CCITT deliberations are provided in the United States by private common carriers, and the representatives of these private organizations have assumed the bulk of the responsibility in representing the United States, both as members of the official delegation and as

Table 2.2. Titles Designated to the 15 CCITT Study Groups for the 1981-1984 Study Period

Designated Group No.	Title
Study Group I	Definition and operational aspects of telegraph and telematic* services (facsimile, teletex, videotex, etc.)
Study Group II	Telephone operation and quality of service
Study Group III	General tariff principles
Study Group IV	Transmission maintenance of international lines, circuits and chains of circuits; maintenance of automatic and semi-automatic networks
Study Group V	Protection against dangers and disturbances of electromagnetic origin
Study Group VI	Protection and specifications of cable sheaths and poles
Study Group VII	Data communication networks
Study Group VIII (and XIV)	Terminal equipment for telematic* services (facsimile, teletex, videotex, etc.)
Study Group IX (and X)	Telegraph networks and terminal equipment
Study Group XI	Telephone switching and signalling
Study Group XII	Telephone transmission performance and local telephone networks
Study Group XV	Transmission systems
Study Group XVI	Telephone circuits
Study Group XVII	Data communication over the telephone network
Study Group XVIII	Digital networks

*"Telematic" is used provisionally.

individuals. Present Government involvement centers on coordinating activities of the many U.S. organizations that may have interests in a particular study group. Frequently, this coordination is easier for a Government representative than for a representative of industry. In regulatory issues, the U.S. Government has been active through representatives from the FCC.

CCITT Membership

Membership in the CCITT is of four classes: administrations; common carriers, called Recognized Private Operating Agencies (RPOA's) in the CCITT; scientific or industrial organizations (SIO's); and the international organizations. The basic membership belongs to the administration, and if voting occurs (a rare procedure because CCITT activities are largely consensus oriented) there is but one vote per administration. The RPOA's, although they do not have voting privileges, have full membership in the CCITT because the CCITT is, in essence, an organization of telecommunication providers. Any telecommunication SIO that is approved by its respective government can participate in the work of the CCITT. Although these organizations are not invited to attend the plenary assemblies, they are looked upon as being a valuable group of experts and in many cases they actually determine the Recommendations to a substantial degree. Those in the final class of membership, the international organizations, attend essentially to keep abreast of the activity. These latter organizations--currently 32 in number--include standards organizations (e.g., ISO), and organizations that do not develop standards (e.g., International Air Transport Association--IATA).

2.2.2 The International Organization for Standardization (ISO)

The second international standards organization to be considered is ISO. The ISO traces its beginnings to World War II. The U.S. allies needed interface characteristics among several aspects of information systems as well as in certain other technical domains, and these characteristics were not covered by existing IEC (Section 2.2.3) standards. As a result, an ad hoc standardization effort was begun, and this was upgraded in 1946 into the ISO. The ISO is a nontreaty agency of the United Nations.

Scope of Studies

The scope of studies in ISO is broad and includes such topics as agriculture, nuclear systems, fabrics, documents used in commerce, library science, computer systems, and computer communications. The latter two are of interest in this report. The ISO contains both fundamental and highly complicated topics in its collective programs, all of which are user oriented.

Organizational Structure

The ISO has, at present 72 "member bodies," or member nations; the United States, through the American National Standards Institute (ANSI), is one of them. There are also about 18 developing nations that have an associate relationship in ISO. Upon request, each of these 18 developing nations receives full documentation of the ISO technical committee activity. Not all of these developing countries are obliged to pay membership dues, nor are they obliged to participate in ISO activities. They do not enjoy voting privileges on administrative or standards-related matters.

Each member country has a designated national agency which represents that country to the ISO. These national agencies are of two types. In the first case, the national agency (e.g., ANSI) is private, voluntary, and member supported. Some members may be government representatives. In the second case, the member body is a government agency, and may have some private sector participation.

The ISO members meet in plenary session about every 3 years, usually in a different host country. Interim management is held by the Central Secretariat, which is located in Geneva. In addition, each ISO technical committee (TC), as well as each subcommittee (SC) and each working group (WG), has its own secretariat located in the country of the member body that has accepted responsibility for that particular committee. For instance, the United States is the secretariat for TC-97 and also for 8 of its 17 SC's (see Figure 2.1). The ISO, then, is a generally decentralized type of standardizing body, where the Central Secretariat coordinates the work of the various technical secretariats located around the world.

The majority of the work in ISO is handled in the TC's and in the various subunits. The TC is primarily a management, policy, and review body and it is assisted by a secretariat advisory group (SAG). Although each TC conducts its business under the broad direction of ISO, it also has its own more specific rules appropriate to its particular work. These rules affect the degree of substructure, the time between meetings, and the number of active projects.

International Organization for Standardization

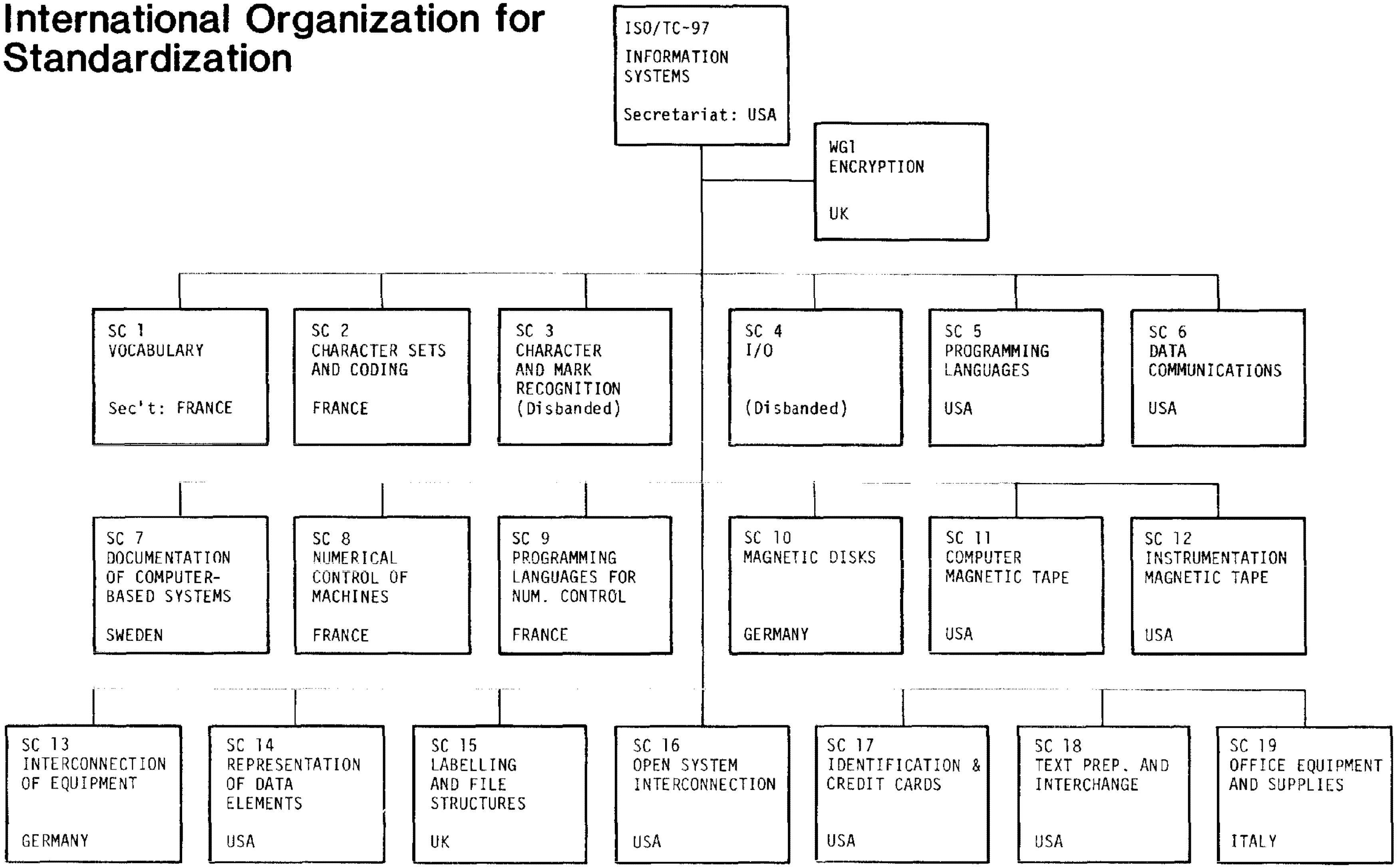


Figure 2.1. International Organization for Standardization

The TC's of most active interest at present include TC-46 (Automation and Library Science), TC-68 (Banking), TC-154 (Documents Used in Commerce and Industry), and TC-97 (Information Systems). Technical Committee 97 is discussed below, both for the relevancy of its studies and for its structure, which is illustrative of the ISO TC organization.

Technical Committee 97

Technical Committee 97 was born at a Paris roundtable in 1960 and eventually absorbed TC-95 (Office Machines). The scope of TC-97 is the standardization (including terminology) of information processing systems from the standpoint of free-standing computer systems, office machinery, and data communication implementation. In June 1982, there were 44 countries involved in TC-97 in some capacity, and more than 30 of these nations were actively involved.

The structure of the SC's and the WG's of TC-97 is shown in Table 2.3. These SC's are responsible for the technical accuracy of the information industry standards created by TC-97. From the present viewpoint, the two most relevant U.S. SC's of TC-97 are SC-6, Data Communication, and SC-16, Open System Interconnection. It is expected that the recently formed SC-18, dealing with text preparation, will also be relevant.

The SC members are of two types--voting, "P" (primary) members, and non-voting, "O" (observing) members. Approximately 10 to 20 member bodies have active voting participants in any particular SC. About 25% additional numbers of members send observer delegations to the SC (or lower level) meetings. These "O" members may also make comments on ballots, and their contributions are valued.

The SC's are divided, as needed, into working groups, expert groups, ad hoc groups, and rapporteur groups. The latter groups generally work on short-term assignments. In most cases, the specific standards writing is assigned to the working group. For the TC, SC, or WG meetings, each member sends a delegation and a head of delegation, with appropriate instructions from the member body, including the degree of freedom permitted to the delegation. The positions and contributions are cleared through the member body, flowing up (in the United States, for example) from the individual contributor to the senior U.S. representative.

Most decisions are made through written ballot. This process takes between 4 and 5 months. In its ongoing process of updating, ISO requires a 5-year review of all ISO standards.

Table 2.3. Titles and Secretariats of ISO/TC-97 Subcommittees

SC	WG	TITLE	SECRETARIAT OR CONVENOR
	WG 1	Data Encryption	UK
SC 1	WG 1	Maintenance	France
	WG 2	Editing	France
	WG 3	Methodology	France
SC 2	WG 1	Code Extension Techniques	UK
	WG 4	Coded Character Set for Text Communication	Netherlands
	WG 5	Coding for MICR and OCR	Germany
	WG 6	Additional Control Functions	USA
		Registration Authority	France
		Registration Advisory Group	France
	WG 7	Revision of ISO 646	Canada
		Registration Advisory Group	Switzerland
SC 5	WG 1	Prog. Languages for the Control of Industrial Processes (PLIP)	Germany
	WG 2	Graphics	Netherlands
	WG 3	Data Base Management Systems (DBMS)	USA
	WG 4	PASCAL	UK
	WG 5	DBMS Coordination	France
	WG 6	APL	France
	EG	COBOL	USA
	EG	FORTRAN	USA
	EG	ALGOL	Netherlands
	EG	PL/1	USA
	EG	Computer Language for Processing of Text (CLPT)	USA
	EG	BASIC	ECMA
	EG	Ada	USA
	EG	DBMS/DDL	USA
SC 6	WG 1	Data Communications Control Procedures	USA
	WG 2	Public Data Networks	UK
	WG 3	Physical Interface Characteristics	Germany
SC 7	WG 1	Symbols, Charts, and Diagrams	UK
	WG 2	Items for Documentation	UK
	WG 3	Program Design	Canada
	WG 4	Decision Tables	France
SC 9	WG 1	Input Language	UK
	WG 2	CLDATA	France
	WG 3	Technological Description	UK
	WG 4	Language Subdivision	USA
SC 13	WG 1	Process Interfaces for Computer Systems	Germany
	WG 2	Interface Standards Administration	UK
	WG 3	Lower Level Interface Functional Requirements & L-L Interfaces	Germany
SC 14	WG 1	Standard'n Guidelines for the Representation of Data Elements	UK
	WG 2	Check Character Algorithms	UK
SC 15	WG 1	Flexible Disks	UK
	WG 3	Interchangeable IRV-Coded Data Files	USA
SC 16	WG 1	OSI Reference Model	France
	WG 4	OSI Application and System Management	Japan
	WG 5	OSI Application and Presentation Layers	UK
	WG 6	OSI Session and Transport Layers	USA
SC 17	WG 1	Physical Characteristics and Test Methods for ID Cards	Germany
	WG 3	Passport Cards	Sweden
	WG 4	Integrated Circuit Cards	France
	WG 5	Registration Advisory Group	USA
	WG 6	Magnetic Stripes on Savings Books	USA
	WG 7	Data Content, Tracks 1 and 2	Sweden
SC 18	WG 1	User Requirements	Italy
	WG 2	Symbols and Terminology	Japan
	WG 3	Text Structure	UK
	WG 4	Procedures for Text Interchange	France
	WG 5	Text Preparation and Presentation	Canada
SC 19	WG 1	Monochrome Test Chart for Document Copying Machines	UK
	WG 2	Duplicating and Document Copying Machines	UK
	WG 3	Keyboards for Office Machines and Data Processing Equipment	Italy
	WG 4	Mail Processing Machines	Germany

The TC-97 plenary meeting occurs about every 2 to 2½ years; the latest was held in Paris in 1981. The subunits meet at the discretion of the chairman or secretariat, as the case may be.

2.2.3 The International Electrotechnical Commission (IEC)

The IEC was initiated in 1904-1906 to facilitate the coordination and unification of various national electrotechnical standards. It predates ISO, to which it is historically related, by 40 years. Although affiliated, the IEC and ISO operate as autonomous bodies.

The IEC's roots are operational and technical, as are those of the CCITT. Besides components measurements, the IEC is concerned with information processing systems and with the safety of data processing and office machine devices, including the electrical connector itself. These interests continue to broaden.

Each of the 44 member nations of the IEC has a "national committee" which represents the full spectrum of IEC interests within the country. The American National Standards Institute (ANSI) has oversight for the U.S. National Committee (USNC) for IEC in the United States (see Section 2.3.4). Although official delegates to IEC meetings are approved by the USNC, other non-ANSI individuals may serve as expert members on working groups.

The IEC plenary occurs each year, and the General Secretariat (Geneva) provides central management in the interim between plenaries.

The IEC work is divided into the following six divisions or groups:

1. Basic standards
2. Materials
3. Electrical equipment and installations
4. Industrial equipment
5. Power generation, transmission, and distribution
6. Electronic components, devices, instruments, and systems

Although all six groups have some interest in information systems and telecommunications, this interest is particularly centered in Division 6.

To support the work of the 6 groups, IEC has 82 technical committees and 5 subcommittees of the International Special Committee on Radio Interference (CISPR). The TC's deal with fundamentals of electrical parameters, measurements, components, and rules of practice, etc.

The technical committees and their subcommittees related to telecommunications are listed in Table 2.4. The IEC TC-46 is of particular current interest because it deals with cables, wires, and waveguides.

2.2.4 Cooperation Among the International Organizations

The three international standards organizations discussed here--ITU/CCITT, ISO, and IEC--have developed different administrative and operating structures in order to deal best with their particular areas of responsibility. However, as telecommunication and information processing technologies have accelerated, as the demand for the resultant services has increased, as certain of their studies have overlapped, and as the monetary problems faced by each organization have multipled, the need for coordination and cooperation among them has been magnified.

Each organization has formulated--and is continuing to formulate through dialo--policies of cooperation at the General Secretariat level. Each organization's policy endorses cooperation with the other two (and with other organizations not considered in this report), while retaining commitments to its own membership. Agreements stipulate that there should be no duplication of effort and that common programs should be mutually reviewed so as not to waste the limited human resources available for standards development. Joint meetings have achieved significant agreement on the technical content of standards as well.

Liaison efforts among these organizations are extensive. The following two examples indicate the kinds of cooperation that exist.

The ISO and IEC

In addition to interaction and communication at the General Secretariat and TC levels, specific work allocations have been made to avoid duplication. Some examples are:

1. As early as 1968, the decision was made to fold IEC TC-53 into ISO TC-97. This work included, particularly, the data communication studies of IEC SC-53B.
2. It was mutually agreed to conduct all product safety work on information systems in IEC TC-74, and to disband work then underway in ISO TC-97 and TC-95.
3. It was mutually agreed to put all the work on radio interference (of importance to ISO) into IEC CISPR, rather than to start a competitive project in ISO.

Table 2.4. IEC Technical Committees and Subcommittees Related to Telecommunications

TC/SC No.	Committee Title
TC-1	Terminology
TC-12	Radiocommunications
SC-12A	Radio Receiving Equipment
SC-12C	Radio Transmitting Equipment
SC-12D	Aerials (Antennas)
SC-12E	Microwave Systems
SC-12F	Equipment Used in Mobile Services
SC-12G	Cabled Distribution Systems
SC-12H	Written Message & Graphic Systems Primarily Intended for Use on Television Terminals
TC-13	Electrical Measuring Equipment
TC-18	Electrical Installations in Ships
SC-18A	Cables and Cable Installations
TC-46	Cables, Wires, and Waveguides for Telecommunication Equipment
SC-46A	Radio Frequency Cables
SC-46B	Waveguides and Their Accessories
SC-46C	Low Frequency Cables and Wires
SC-46D	Connectors for Radio Frequency Cables
TC-47	Semiconductor Devices and Integrated Circuits
TC-48	Electromechanical Components for Electronic Equipment
SC-48B	Connectors
TC-57	Telecontrol, Teleprotection, and Associated Telecommunications for Electrical Power Systems
TC-60	Recording
SC-60C	Systems of Audio-visual and Electronic Technology (for Information and Communication)
TC-65	Industrial-Process Measurement and Control
SC-65A	System Considerations
SC-65C	Digital Data Communication for Industrial-Process Measurement and Control Systems
TC-66	Electronic Measuring Equipment
TC-74	Safety of Data Processing Equipment and Office Machines
TC-76	Laser Equipment
TC-77	Electromagnetic Compatibility between Electrical Equipment Including Networks
CISPR	International Special Committee on Radio Interference
ACET	Advisory Committee on Electronics and Telecommunications

The ISO and CCITT

These two organizations establish liaison wherever appropriate at all levels of structure. These interactions are working very smoothly. Indicative of this ongoing effort are the categories concerning the CCITT which are to be found on every ISO project. Three such categories are labelled "Requirements for Liaison/Cooperative Development," "Related CCITT Questions," and "ISO/CCITT Category." There is much interaction at the national levels (e.g., ANSI/U.S. CCITT) as the proper entities in each country prepare for their international meetings.

When it became apparent in the 1970's that data processing equipment and terminals (ISO) could be effectively connected by telecommunication facilities (CCITT), it became obvious that the standardization of the boundary (interface) was needed. By the use of common personnel, and by joint meetings and exchange of draft documents, ISO and CCITT have been able to achieve such standards. The specific interrelationships of these two organizations in the work on the OSI Reference Model is discussed in Section 4.3.3.

2.2.5 Some Problems Currently Experienced by International Standards Organizations

In addition to concerns about the growing cost of international standards organizations, there are other cost-related problems that demand resolution. One such problem in the ITU is a growing conflict between the need to address the telecommunication requirements of the developing countries (technology, information, personnel assistance, etc.) and a need to continue the rapid development of international standards required by the industrialized nations. Another problem, shared by all these organizations, is the need to speed up the standards-making process. More is said about this problem elsewhere in this report. A closely associated problem is the need to speed up the publication of approved standards. A fourth problem is the relatively long time it takes to reach standards decisions--whether by consensus or by vote. Some questions being asked in this regard are "How much agreement assures support?" and "How far do we push this agreement?"

In an attempt to resolve these problems, both the ITU and ISO (TC-97) are considering ways to "practice what they preach" by using telecommunications and information processing to facilitate standards development. Some specific proposals are:

1. to automate the draft standard data bases,

2. to update them electronically via data communications to all member bodies, and

3. to make maximum use of automated text preparation.

Unless these organizations are able to achieve more cost-effective operation, the expenses will increase faster than the technical results. Many members of these organizations believe that if changes are not implemented soon, a restructuring and rebuilding of these organizations is likely in the near future.

2.3 U.S. Standards Organizations

Although there are many active U.S. standards organizations, this section focuses on those that are most directly related to the three international organizations already discussed. The U.S. CCIR and U.S. CCITT are the U.S. preparatory groups for ITU affairs, while ANSI functions as the U.S. member body for both ISO and IEC.

2.3.1 U.S. CCIR--Organization and Contribution Process

The U.S. CCIR (Figure 2.2) is headed by the National Committee, which is directed by Gordon Huffcutt (Richard Schrum, 1983) of the State Department's Office of International Communication Policy. The 11 U.S. CCIR study groups operate on a one-to-one basis with the 11 international CCIR study groups. Each U.S. study group conducts its own meetings, establishes ad hoc groups as needed, and develops U.S. contributions in preparation for CCIR meetings.

After a contribution (worked on in an ad hoc group) is approved by the study group, it is distributed to all the members of the National Committee (a large number). A specified deadline is set for comments, and if no response to this contribution is received by the deadline, consent is implied. Before the contribution can be sent to Geneva, it must have the approval of the National Committee (See Figure 2.3). Under urgent conditions, the contribution may be approved by the study group and the National Committee simultaneously, rather than progressively, but still it must have the approval of both.

2.3.2 U.S. CCITT--Organization and Contribution Process

Figure 2.4 shows the U.S. CCITT organization. The National Committee is headed by William Lowell (Dexter Anderson, 1983) of the U.S. Department of

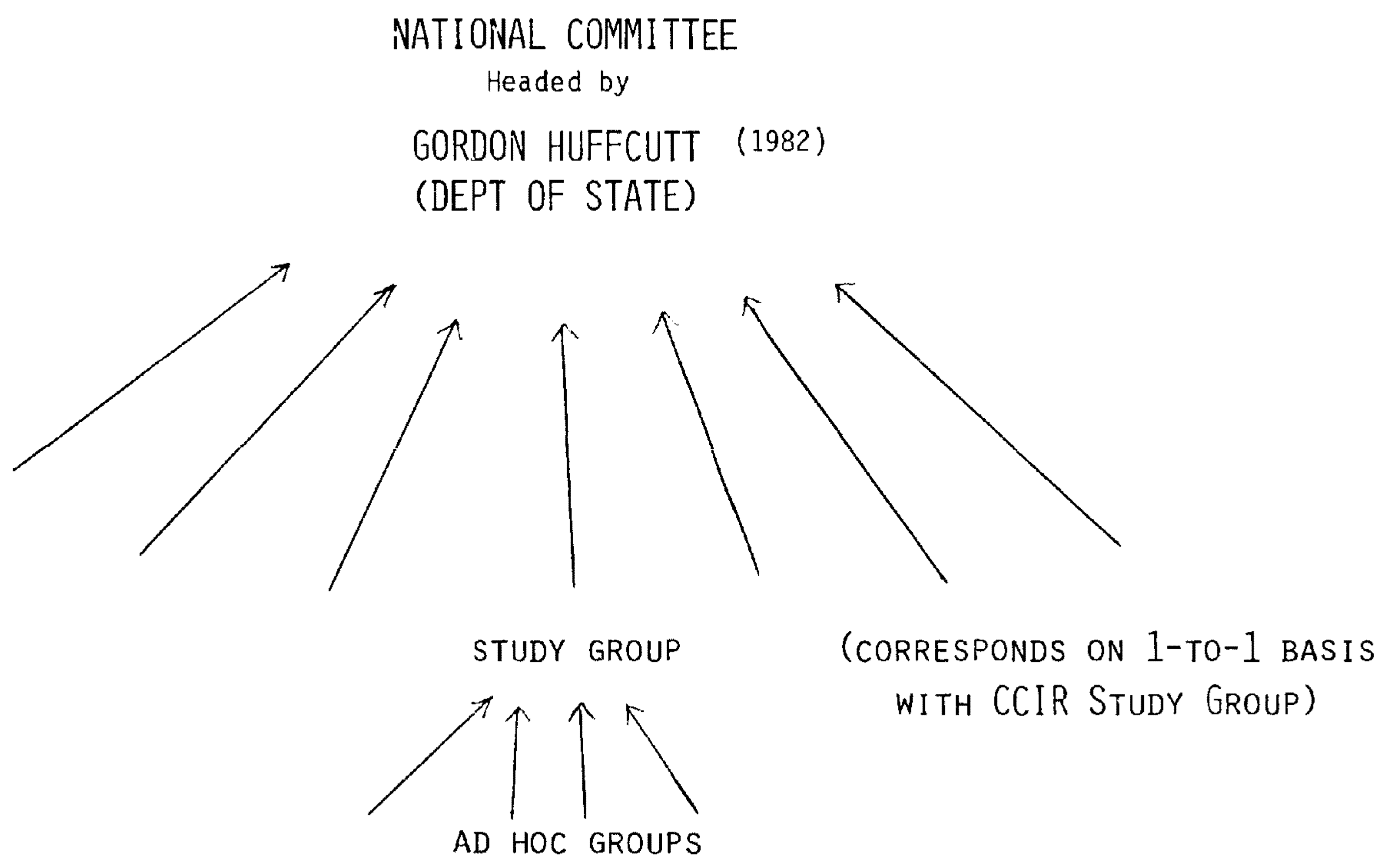


Figure 2.2. Organization of the U.S. CCIR.

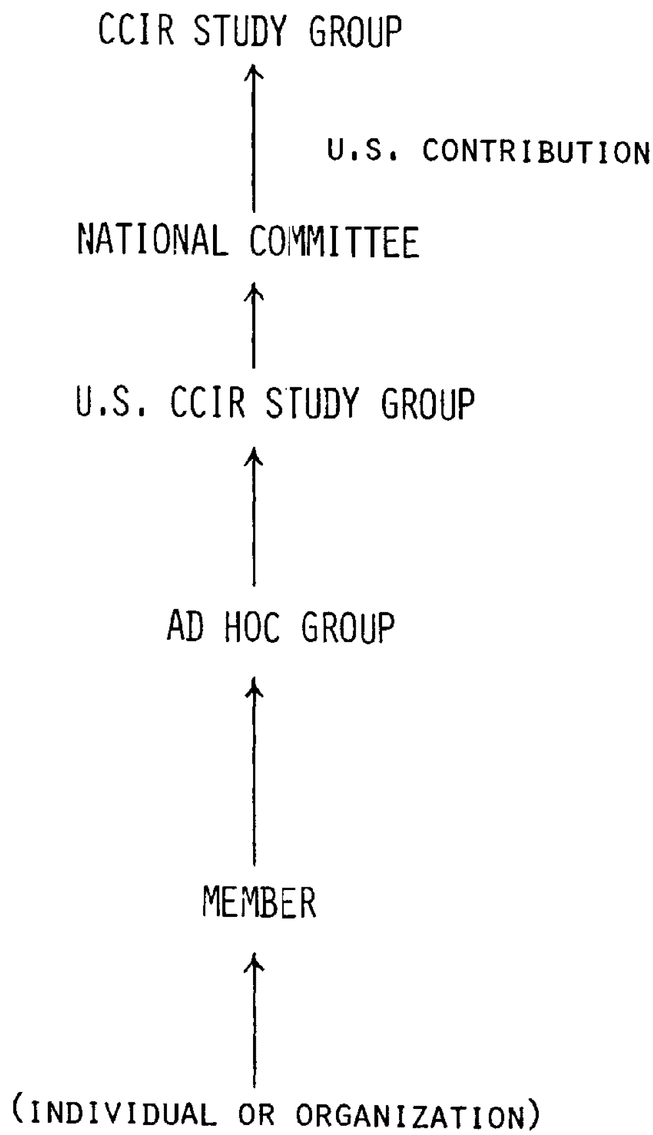


Figure 2.3. Approval chain for contributions from the United States to the CCIR.

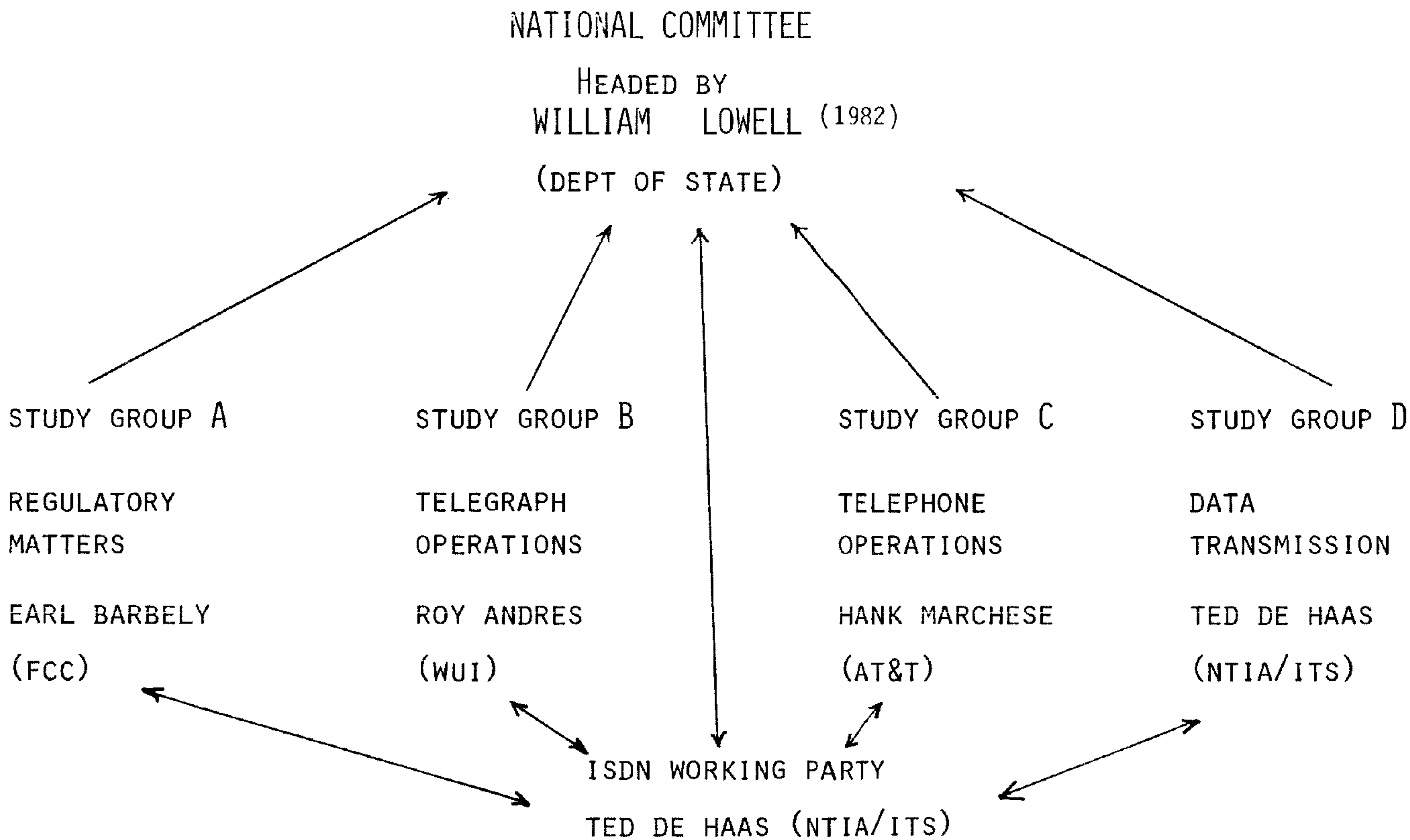


Figure 2.4. Organization of the U.S. CCITT.

State. Instead of having the one-to-one study-group relationship that exists between the U.S. CCIR and the international CCIR, the U.S. CCITT has divided the subject matter into groups as follows:

1. Study Group A: Regulatory Matters
2. Study Group B: Telegraph Operations
3. Study Group C: Telephone Operations
4. Study Group D: Data Transmission, and
5. The ISDN Working Party.

Section 2.3.3 describes the purview of each of these five U.S. CCITT groups, relative to the international CCITT.

There are two types of contributions that go to the CCITT from the United States: U.S. contributions and individual member contributions. Figures 2.5 and 2.6 illustrate the approval process for each type.

U.S. Contributions

The U.S. contributions (Figure 2.5) can be approved only through the appropriate U.S. CCITT study group. They are generated by either individual members or by national groups (e.g., ANSI, EIA [Electronics Industry Association], government groups), or by ad hoc groups that are specially established as part of the U.S. CCITT study groups, (e.g., the Modem Working Party and the Message Handling Systems Working Party of U.S. CCITT Study Group D).

Upon approval by the U.S. CCITT study group, these contributions are sent to the appropriate CCITT study group in Geneva. This process occurs via the U.S. Department of State because that department is the official submitter. They are not, however, distributed for approval to the National Committee.

Individual Contributions

Contributions from individual organizations (Figure 2.6) generally obtain approval through the entire study group process outlined above, and this is the preferred method. However, in the exceptional case described below, the chairman assumes the responsibility for approval.

There are circumstances that make it impossible for a contribution to be processed before the due date in Geneva. The contribution may simply fail to be ready in time, or internal review by the individual organization may cause delays. In these cases, the contributor is requested to coordinate with the chairman of the particular U.S. CCITT study group before sending the document to Geneva. The chairman reviews the document, and if he judges it to be potentially controversial or objectionable to other U.S. CCITT organizations, either

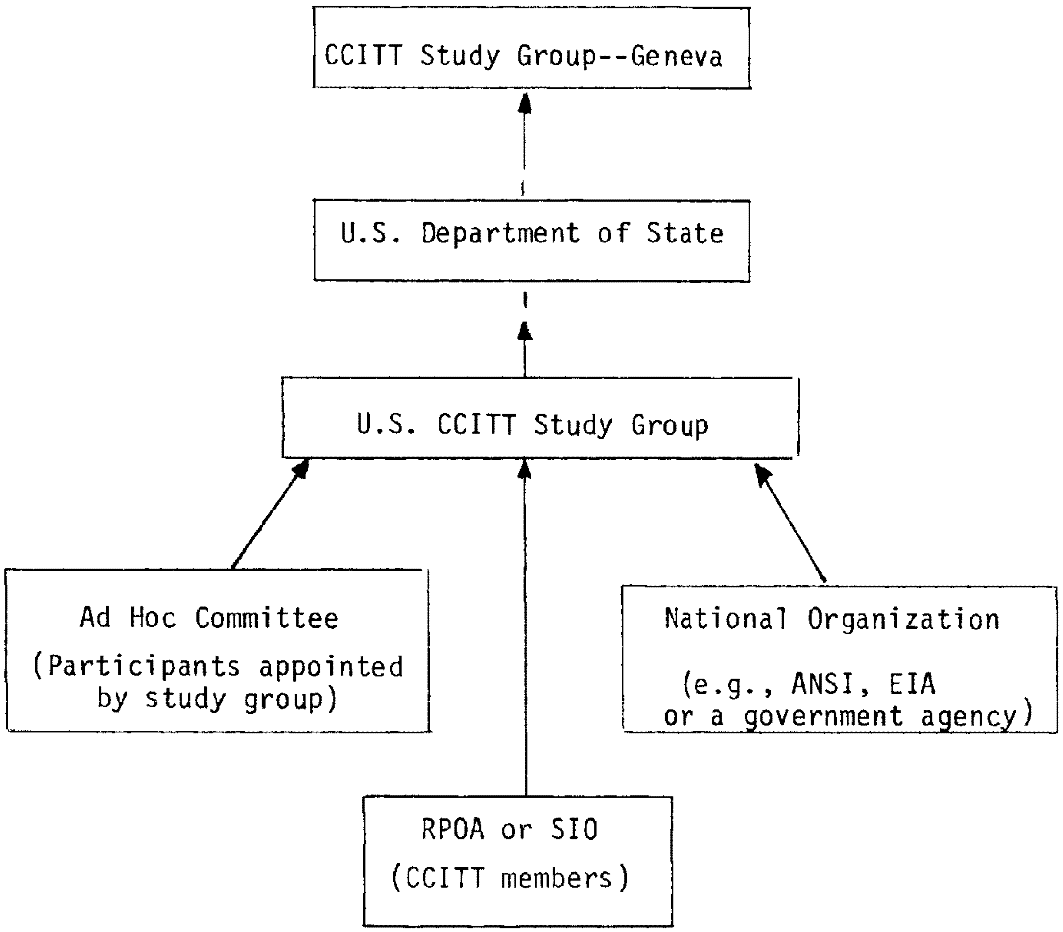


Figure 2.5. Typical approval chain for "U.S." contributions to the CCITT.

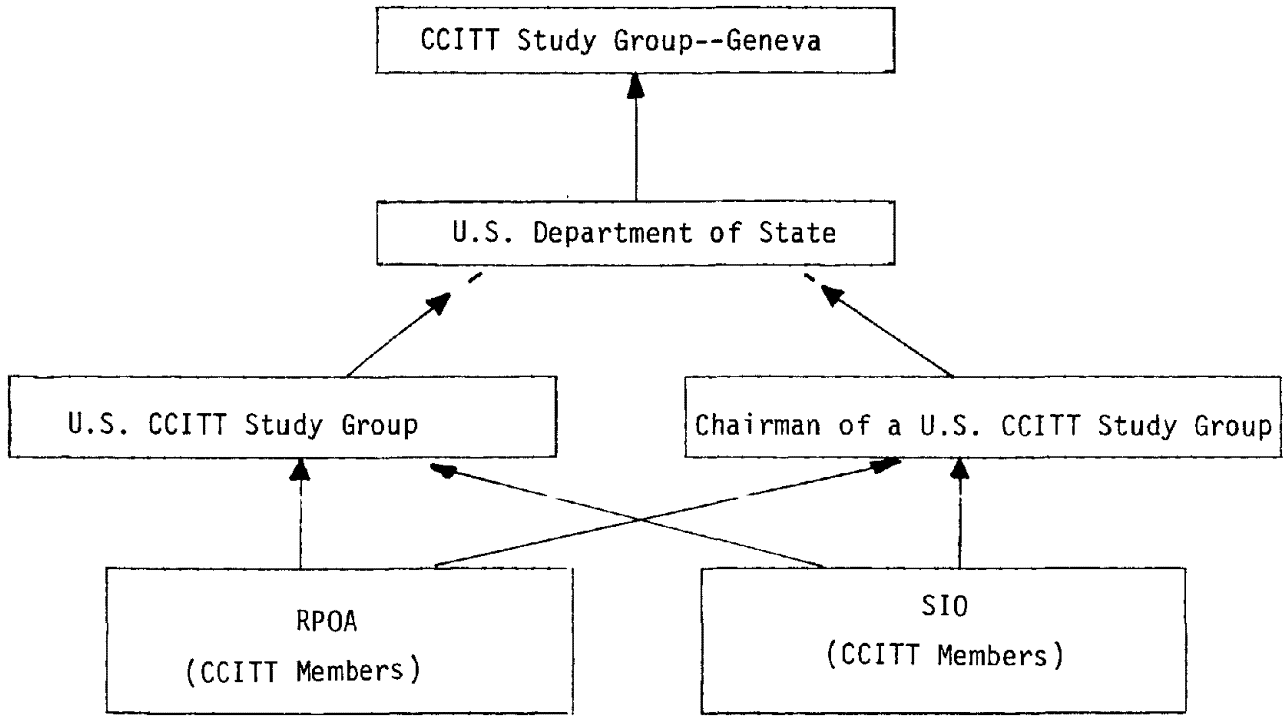


Figure 2.6. Typical approval chain for "individual member" contributions to the CCITT.

he will suggest sending it to members of the U.S. study group, or he will personally make the necessary consultations. This process is intended--as are all the processes mentioned here--to establish a unified U.S. position at the international meetings.

More information on U.S. participation in CCITT matters and contributions can be found in Cerni (1982a and 1982b).

2.3.3 U.S. CCITT Study Groups

The five U.S. CCITT study groups, or preparatory groups, (Figure 2.4) are composed of individuals with or without formal affiliation with an official CCITT member organization.

Broad-based participation in these study groups is encouraged by the Department of State. Individuals represent user's groups and national standards groups as well as the technical telecommunication industry. The U.S. CCITT meetings are generally open to the public. Telecommunication organizations can request to be put on the mailing list for a specific study group by writing to the chairman of that group on company letterhead stationery.

The sections below outline the specific CCITT issues that are dealt with in each of the U.S. groups (see Table 2.5). The emphasis in this report is on the 15 technical study groups of the CCITT (Table 2.2). In effect, this portion of the report provides a detailed overview of the CCITT itself. The general descriptive material on the technical issues dealt with by the CCITT study groups is offered for the reader who is interested in CCITT involvement. More detailed, and more complete information is to be found in CCITT documentation.

Study Group A (Regulatory Issues)

Study Group A is essentially concerned with service issues in CCITT Study Group I and tariff policy in Study Group III, from a regulatory point of view. Study Group A is also concerned with studies relating to the International Monetary Unit (UMI) in Study Group III, which involves, for example, the international interexchange of money. The work of the CCITT/CCIR Joint Working Party SMM (Mobile Maritime services) is also of interest to Study Group A. These studies involve regulatory issues relating to radio services to ships at sea, including satellite services.

Table 2.5 U.S. CCITT Study Groups and their CCITT Reference Groups

U.S. CCITT Study Group	CCITT Study Group *
Study Group A	I, III, SMM
Study Group B	VIII, IX
Study Group C	II, IV, V, VI, XI, XI, XII, XV, XVI, XVIII, LTG, CMBD, GAS 3, 4, 5, 7, 8, 9
Study Group D	VII, XVII
ISDN Working Party	XVIII (and III, VII, VIII, XI, XVII)

Special Groups Dealing with Specific Technical Issues:

SMM:	Mobile Maritime Services
LTG:	Use of telephone-type lines for purposes other than telephony
CMBD:	Circuit Noise and Availability
GAS:	Special Autonomous Groups that prepare general manuals and handbooks useful to developing nations, for example.

*The words "Study Group" refer also to some of the other CCITT groups besides the technical study groups that deal with special issues.

The developing interest in these issues can be measured by the statistics: in 1974 there were about 12 persons (mostly from the common carriers) in Study Group A; in 1982 there were about 40 to 60 persons, ranging from representatives of academia to users. There are 6 to 7 Study Group A meetings per year. The activities include tracking international meetings, providing the forum for contribution preparation, sharing views, examining contributions from other international organizations and other administrations, and deciding on overall positions for CCITT meetings.

Study Group I: Study Group I defines the operational aspects of all telematic (facsimile, teletex, videotex, etc.) and telegraph services. Study Group I has five working parties. These are listed below, and some issues relevant to Study Group A are indicated.

1. Telex and Related Services

   One of the key concerns is store-and-forward telex, which will permit a subscriber to reroute telex messages to one or several addresses. Related issues such as privacy, message loss, etc., are critical. Study Groups I and IX have formed a joint working party to study store-and-forward telex.

2. Telegram and Message Switching Services

   Study Group VII is also concerned with these topics. Record services have been traditionally handled through public switched networks. Many private companies (e.g., airlines) are now looking at the possibility of their own switching systems. The effect of the ISDN on these services is also of interest.

3. Teletex Service

   Questions related to this topic include: "How will teletex be interworked with telex?" What facilities will be used for overseas transmission?" "How will the service be charged to the network?" Study Group III is concerned with these questions as well.

4. Facsimile and Telewriting Services

   One main issue concerns electronic mail services. Involved groups include the Universal Postal Union, CEPT, and the FCC. The electronic mail service appears to be replacing what some of the international record carriers call a letter telegram or the international overnight telegram.

5. Videotex Services

   Study Group A's concern is the definition of the service from the public's point of view.

Study Group III: Study Group III has four working parties. These are:

1. Private Leased International Circuits

   Of concern to Study Group A is the "resale" issue, as well as the possible elimination of subspeed circuits. Of the 3500 circuits in the United States, 1600 are subspeed (12½ and 25 baud), involving many small users. Europeans are interested in eliminating these circuits. Another issue, interruption provisions, is in process of being resolved--from a 3-hour to 1-hour minimum outage for credit-back. Other concerns are the M1020 conditioning charge, the pricing of digital-circuit services, and ISDN-related problems.

2. Tariff and Accounting Principles to be Applied in Public International Data Networks

   The issues include reverse charging facilities and charging for public data networks (e.g., should there be an international multi-tier pricing structure?)

3. Tariffs and Accounting in the International Telegram Services and in New International Services

   Of concern to this working party are such questions as, "How should teletex be charged, especially if a telex machine (and circuit) are used?" "How are the networks interconnected?" "How is store-and-forward telex charged?"

4. Tariffs and Accounting in the International Telephone Service and in International Sound and Television Programme Transmissions

   The interests of this working party can be summed up in the question, "As international television establishes expensive, full-scale, full-time leased channels, what kind of charging procedures should be established?"

The international issues involved in the purview of Study Group A, as can be seen, are of high interest to user groups worldwide. Also, when issues of rates and remuneration abound, so does national opinion. The members of this study group are actively searching for the user's point of view so that the U.S. public interest can be genuinely served in the CCITT.

Study Group B (Telegraph Operations)

Study Group B is concerned with two CCITT study groups--VIII and IX. Study Group VIII covers terminal equipment standards for all telematic (telegraphy-related) services. Study Group IX covers switching, signalling, numbering plans, etc., for the telex and message services.

In 1980, the seventh Plenary Assembly of the CCITT reassigned certain questions, and aspects of questions, causing U.S. Study Groups A and B to have regions of overlap in their studies. A major example of this is the study of "services"--especially videotex. The definition of services, i.e., how a service will operate, is assigned to Study Group I (the domain of U.S. Study Group A), but the technical, operational standards of the related equipment, switching, network, etc., is studied in Study Group VIII (the domain of U.S.

Study Group B). Therefore, Study Groups A and B have been compelled to hold joint meetings during the current study period when considering these topics.

Study Group C (Telephone Operations)

The U.S. CCITT Study Group C relates to the following CCITT groups involved with telephone network subject: Study Groups II, IV, V, VI, XI, XII, XV, XVI, and XVIII (excluding the ISDN [moved to the ISDN Working Party]), LTG, CMBD, and the GAS groups (see Table 2.5). Although the related topics have not created a great deal of conflict over the years, the character of the industry is now changing. Therefore, there is much more interest on the part of a variety of industry members and government, so that the character of the effort in Study Group C will no doubt change with time.

Two of the most important tasks of the chairman are to act in a Secretariat function for all the above-named groups and as liaison between U.S. members and the State Department. The first role involves the distribution of each U.S. CCITT contribution (from whatever source) to all members of Study Group C. This requires very careful updating of the lists of members on a per-CCITT-study-group basis.

In the second case (liaison) the chairman acts as a coordinator for special balloting, whenever the State Department decides to develop a U.S. response instead of allowing individual member responses to an opinion query.

The scope of Study Group C is extensive, and the following paragraphs label the subject matter and some issues.

Study Group II: Study Group II covers a host of issues including network management and numbering plans. The world routing plan is of major concern at present. The CCITT members are interested in good service quality, efficient use of transmission and switching facilities, and the avoidance of circular routing. There is a conflict between the structured approach and flexibility. Another major issue for the United States is the international telephone credit card validity check letter which is changed every year, and must have a worldwide agreement. The expense incurred (about $11 M each year) would be reduced if the validity period could be extended (say, to 5 years).

Study Group IV: Standards for maintenance on current and emerging international systems, including circuits and devices, need to be timely. Studies are continuing at present on the maintenance of 56 kb/s services and the equivalent mixed analog/digital systems and circuits.

Some recent accomplishments in Study Group IV include maintenance arrangements for both maritime satellite systems (COMSAT has done a great deal of the ongoing work) and Signalling System No. 5; functional categorization of maintenance organizations, which permits each administration to identify persons responsible for specific aspects of the system (e.g., switching, multi-frequency tones related to signalling); leased circuit maintenance requirements; measuring standards for longitudinal balance; and measuring-equipment standards. This latter is a particular challenge, because the work cannot be done isolated from the needs of "user" groups in other study groups. This concept of "user" includes the designers in Study Groups XI and XV, and technical people in Study Groups XVII and XVIII. In all cases, the challenge is in ascertaining that the requirement permits everyone either to develop or to purchase test equipment to the stated specifications. In addition, the impairments (e.g., gain and phase hits, dropouts) needing measurement standards are in process of definition, and it is difficult to get agreement. There has been significant achievement in the development of measuring sets such as low frequency phase jitter, primary multiplex, digital phase jitter, code violation monitoring, and digital error measuring.

Study Group XI: The six working parties of Study Group XI, and certain key topics, are listed below. All these topics relate to telephone switching and signalling.

1. Interworking, satellite, operating system specifications
2. Signalling System No. 7

   Two major subjects dealt with are: a) architectural layering and, b) the PBX user part. (See Section 8.2 for a discussion of Signalling System No. 7.)
3. Programming languages for SPC (Stored Program Control)

   Study Group XI has worked for years on three such languages:

   a) SDL (Specification and Description Language) to allow a common language in which administrations can specify functions, and manufacturers can describe the process.

   b) CHILL (CCITT High Level Language) for SPC systems and associated systems.

   c) MML (Man-Machine Language) being developed to facilitate the operation, maintenance, installation, and worldwide testing of switching machines. (National maintenance arrangements are often complex.)
4. Digital Switching

   Some of the active study items include switching aspects of the ISDN at the local exchange; the definition of "exchange interface" for various operations in maintenance mechanisms; the definition of "overload standard"; the availability performance of the exchange and its components; the definition of the exchange measurements; and the definition and measurement of the "loss" at the interfaces.

5. National Switching

6. Digital Subscriber Line Signalling

   This is the newest working party (1980) and it has technical responsibility for signalling for digital access to digital local exchanges (i.e., B and D channels). This working party interacts with Study Groups VII, XVII, and XVIII. Although some Recommendations are expected in 1984, the next study period will require a great deal of detailed work.

Study Group XV: Transmission systems issues, dealt with in Study Group XV, are moving very fast, and it is difficult for the standards bodies to keep up with them. One major accomplishment of Study Group XV has been the compendium of available information on the developing optical fiber systems, presented in the ITU publication, the Telecommunication Journal (1981, 1982). This material will be the basis for a CCITT handbook on the subject. Another concern of Study Group XV is the deployment of echo cancellers and compandors (in cooperation with Study Groups IV, XII, and XVI).

Study Group XVIII: The work of this study group is of major concern to Study Group C. The five working parties are:

1. ISDN
2. Speech Processing
3. Network Performance Objectives
4. Digital Equipment
5. Switching and Signalling

Of the numerous important issues, two are of particular interest: encoding methods other than 64 kb/s PCM (Pulse Code Modulation) and network performance objectives.

In the first case, a single Recommendation is hoped for by 1984 which will cover 32 kb/s adaptive differential PCM methods for voice and voice-band signals. This will require cooperation with Study Groups XII and XVI.

In the second case, the active study items include the definition of error-free intervals (there may be a redefinition from 1 second to 1/10 second); the allocation of end-to-end performance objectives, particularly a 2-level provisional allocation based on the size of the country; the interworking between 1.544 and 2.048 Mb/s systems at a hybrid multiplex level; and alternate voice-data transparency without disabling mu/A equipment.

Special Autonomous Groups (GAS): These six GAS groups prepare handbooks for use by developing nations, and there are several U.S. participants in these efforts. The topics are:

- GAS 3 Economic and Technical Aspects of the Choice of Transmission Systems
- GAS 4 Primary Sources of Energy
- GAS 5 Economic and Social Problems Relating to Telecommunication Development
- GAS 7 Rural Telecommunications
- GAS 8 Economic and Technical Impact of Implementing a Regional Satellite Network
- GAS 9 Economic and Technical Aspects of Transition From an Analog to a Digital Telecommunication Network.

The number of GAS groups doubled during the last plenary assembly. The work in these groups is done on a voluntary basis (with review) and as such is not subject to approval by the plenary assembly. This escalating work of the ITU was referred to in Section 2.2.5.

Study Group D (Data Transmission)

United States CCITT Study Group D covers essentially two CCITT Study Groups--VII, Data Communication Networks (X-series Recommendations), and XVII, Data Transmission on the Public Analog Telephone Network (V-series Recommendations).

Study Group VII has a broad purview, covering all aspects of the data network except for tariffing principles. The uniqueness of Study Group VII, in this respect, developed because of the original need to pull together the expertise of all the different disciplines involved in data networks. The VIIIth Plenary Assembly (1984) will likely reassign some of the work of Study Group VII to other appropriate study groups.

Study Group XVII is much smaller than Study Group VII. It deals primarily with modems, DTE (Data Terminal Equipment) interfaces, error control, and transmission quality and maintenance.

Study Group VII: This study group is composed of five working parties:

1. Network Service Classes and Facilities

   Working Party VII/1 specifies the kinds of signals (operating modes and data signalling rates) and the facilities (essential and added) that should be available to users of data networks. These specifications are contained in Recommendations X.1 and X.2, and are being extended to adapt to a future ISDN. Some other concerns of WP 1 are packet assembly/disassembly facility (X.3), and the interworking requirements among public data networks, as well as those between public data networks and other networks (telex, telephone, ISDN, etc.).

2. Network Access Interfaces

Working Party VII/2 deals largely with the physical characteristics and call control procedures of the interface between the DTE and the data network (X.21 and X.25). Of considerable importance is the development of a multipurpose interface that can be used in the data network and in the ISDN. These studies are made in conjunction with Study Groups XI, XVII, and XVIII.

3. Network Interworking, Switching and Signalling for Data Networks

Working Party VII/3 is concerned with the data user part of Signalling System No. 7, in addition to interworking between packet switched networks (X.75) and the layered reference model for signalling systems--all in conjunction with Study Group XI. Working Party 3 also studies the formal description technique and system description language as it applies to signalling Recommendations.

4. Network Transmission and Maintenance of Service

Working Party VII/4 deals with test loops for DTE's and DCE's (Data Circuit Terminating Equipment) used in part to get fault isolation (e.g., X.150). Working Party 4 also deals with quality of performance parameters, including the effects of long delays (such as those encountered with satellites) and error recovery. The quality of performance is viewed from both the network's and the user's point of view. The user's view is a relatively new study and is just being introduced to the CCITT.

5. Network Aspects

Working Party VII/5 deals with some difficult and fundamental problems. These include the numbering plan (X.121), subaddressing, routing principles, Message Handling Systems (see Section 7), the OSI Reference Model (see Section 4), and system description language for X-series Recommendations.

Although Recommendation X.121 does define a numbering plan, the attendant problems related to subaddressing and routing must be studied. In the case of subaddressing (for any kind of private networks that may be attached to the public network), two-stage dialing is to be avoided if possible. Similar problems emerge with routing principles for calls to be routed over a network that interconnects at different points.

Study Group XVII: One of the most important topics being studied in Study Group XVII is the question of 2.4-kb/s duplex modems on the analog circuit. These modems are intended to be used with some of the new services (e.g., videotex and teletex). Two new draft Recommendations deal with the two competing techniques: FDM (frequency division multiplexing) and the echo cancelling method.

Studies are progressing in Study Group XVII (as they are in Study Group VII) on a universal physical interface. These studies and other ISDN considerations (e.g., ISDN compatible modems, and adaption of modems to ISDN transmission rates) are also of major importance to Study Group D.

The ISDN Working Party

The U.S. ISDN Working Party is concerned with the ISDN aspects within Study Group XVIII. Study Group XVIII (Working Party 1) is responsible for general ISDN aspects in the CCITT, and has been assigned the role of coordination of ISDN studies in Study Groups II[illegible], VII, VIII, XI, and XVII.

To meet this responsibility, Working Party XVIII/1 set up a group of experts on ISDN matters who have divided their work among the following six ad hoc groups:

1. Customer access
2. Basic access, Level I characteristics
3. Services
4. Network
5. Signalling
6. Switching

The work done so far has been limited to preliminary, basic discussions of the principles involved, the scope of study, etc.

The work of most urgency has been in ad hoc 1, and three draft Recommendations have been developed (see Section 5.4). Of greatest importance has been the agreement reached so far on a standard customer interface (the electrical and physical interface for access to the ISDN) because it allows terminal manufacturers to proceed with initial designs of ISDN terminals.

The topic next in priority is basic access as being considered in ad hoc 2. Some "tentative" principles have been developed that

1. favor an interface with not more than four wires (one path in each direction);
2. favor coupling to the terminal equipment that allows power feed and isolation (e.g., transformer); and
3. are concerned with contention resolution to resolve the problem of simultaneous attempts to communicate by different terminals all having the same customer number.

Ad hoc 3 has, so far, made two elementary services distinctions. One distinction is between transport services (e.g., a 64-kb/s circuit switched transport available to the customer to be used as desired) and connection services (e.g., voice, data, facsimile) in which the application needs to be specified as well as the transport. The other elementary distinction is between services that are an entity in themselves (e.g., transport or connection services) and services that are supplementary enhancements (e.g., call forwarding, closed user groups, etc.).

Little work has been done by ad hoc groups 4, 5, and 6 so far. There have been initial discussions in each group, specifying certain problems. Some items to be studied in each group are listed below.

Ad hoc 4: Network

1. numbering plan
2. terminal identification
3. subaddressing
4. hypothetical reference model
5. protocol reference model

Ad hoc 5: Signalling

1. end-to-end signalling over D channel
2. D channel contention resolution
3. signalling in hybrid access arrangements
4. PABX signalling
5. application of Signalling System No. 7

Ad hoc 6: Switching

1. integration of packet switched and circuit switched functions in the same network
2. switching aspects of issues arising from the other ad hoc groups.

2.3.4 American National Standards Institute (ANSI)

The leaders in the development of U.S. standards in data communications are primarily ANSI Committee X3 (Information Systems), IEEE-802 (Local Area Networks), and EIA TR-30 (Modems). Although all three of these organizations, as well as several others, contribute significantly to the national and international standardization efforts, only the first mentioned, ANSI, is discussed in this report.

Overview

The American National Standards Institute, ANSI, administers and coordinates those national organizations that develop U.S. standards. The ANSI, itself, is not a standards-writing organization, but the manager of the American National Standards (ANS) process. The ANSI's main role, which may be considered an "umbrella service," is that of the accreditation and supervision of the U.S. standards groups in the preparation, processing, approval, and distribution of proposed American National Standards. These organizations, under the auspices of ANSI, use the procedures that ANSI has established to ensure balanced representation in working committees, consensus in decision making, and fair hearing for appeals of the approved standard in question.

The ANSI organization is depicted in Figure 2.7. The governing and policy-making body, the Board of Directors, has 9 members. These directors, under the leadership of an executive vice-president, administer the following groups:

1. Technical Affairs
2. Government Liaison
3. Certification/Accreditation
4. Development
5. Standards Programs
6. Standards Audit, Accreditation, and Review
7. International Operations
8. Administrative Services
9. Communications

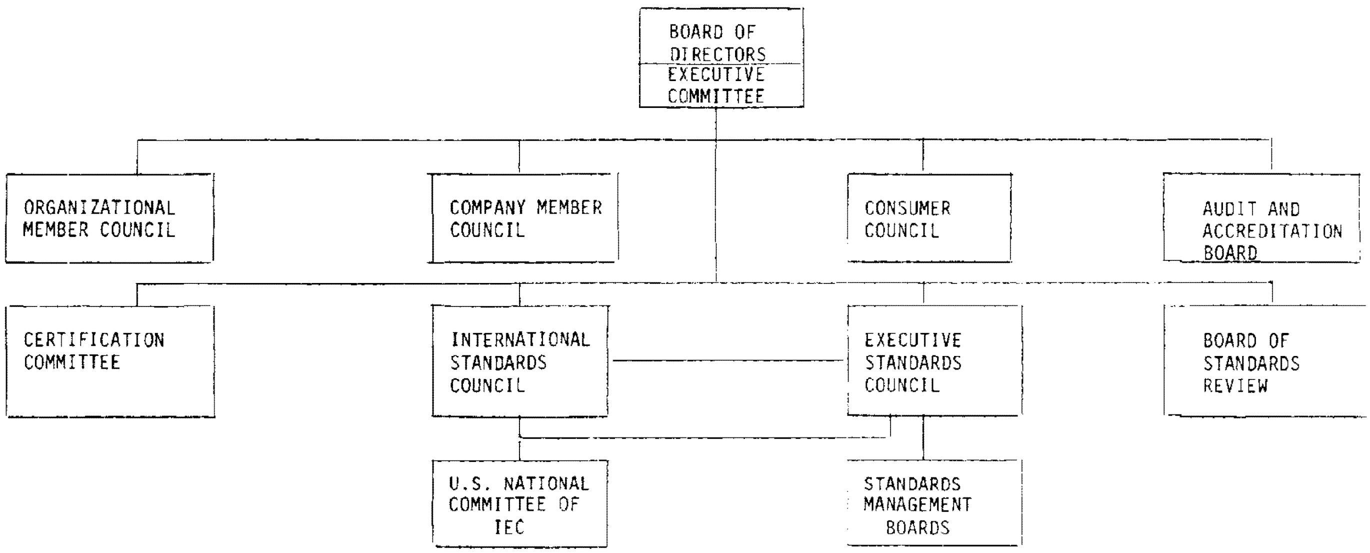
The other ANSI organizational units are briefly discussed in Figure 2.7.

The ANSI oversees both national and international standards-making activities on the part of U.S. groups. The ANSI acts as the U.S. member body for ISO, IEC, and several other nontreaty organizations as well. Much of ANSI activity deals with the international version of U.S. national programs. Over 25% of the 1981 budget ($5.7 M) was used for international standards activities while 14% of the budget was spent on national standards activities. The international expenditure was almost evenly divided between the running of the secretariats which the United States has assumed in ISO and IEC, and the paying of dues to these two bodies on behalf of the United States. Most of the national standards expenditure is spent on national standards coordination. The money is largely from two sources: sale of standards publications (50% of 1981 income), and member dues (37%).

Development of American National Standards (ANS)

There are three processes used by ANSI in the development of an American National Standard, as depicted in Figure 2.8. Standards may be developed by:

1. an accredited organization, such as the IEEE, that has agreed to follow the ANSI procedures;
2. an American National Standards Committee (ANSC), often erroneously called an ANSI committee (e.g., ANSC X3, X9, and X12); and



Board of Directors: The governing and policymaking body of the Institute.

Executive Committee: Acts for the Board of Directors between meetings of the Board and maintains a continuing review of the financial affairs of the Institute and makes appropriate recommendations to the Board.

Organizational Member & Company Member Council: Ensure participation of their members in ANSI programs and provide a communication channel between their members and constituents and ANSI's Board on programs and policies of the Institute; help determine standards needs.

Consumer Council: Responsible for consumer input to standards programs; ensures that standards meet the needs of consumers by reviewing and rating all applicable standards during approval process; conducts consumer information programs.

Audit and Accreditation Board: Administers audits of the methods and procedures used by standards developing groups in preparing and processing proposed American National Standards; also accredits standards developing organizations under the Accredited Organization Method.

Certification Committee: Develops and operates programs leading to national accreditation of certification programs.

International Standards Council: Responsible for administrative policies for ANSI's international activities.

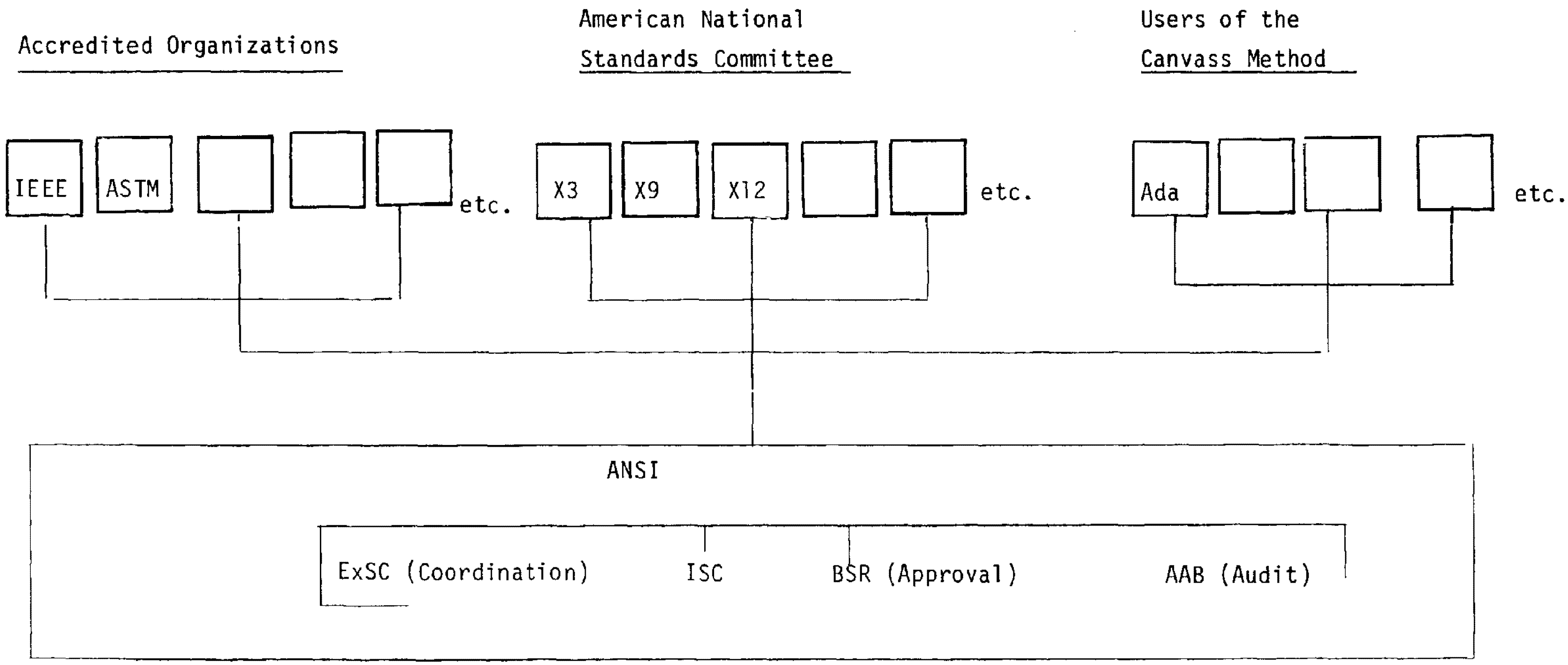
Executive Standards Council: Manages the standardization activities coordinated by ANSI--promulgates operating procedures; initiates standards projects; stimulates expeditious completion of standards work; also coordinates U.S. participation in technical work of international organizations.

Board of Standards Review: Approves standards as American National Standarcs and acts on withdrawal and reaffirmation when it finds that a consensus exists among those substantially concerned with the scope and provisions of the standards under consideration.

U.S. National Committee of IEC: Responsible for effective participation ir the work of IEC and for operation of the technical advisory groups that develop the U.S. position on international electrotechnical standards.

Standards Management Boards: Assist the Executive Standards Council in carrying out its management and coordination functions for standards development in the discipline or homogeneous technical sphere in which the particular SMB operates.

Figure 2.7. Organization of ANSI.



ExSC: Executive Standards Council; ISC: International Standards Council; BSR: Board of Standards Review; AAB: Audit and Accreditation Board; ASTM American Society for Testing Materials.

Figure 2.8. Organization chart for the development of American National Standards.

3. a general interest group. Examples of work achieved by general interest groups include the high-level language, Ada, which was developed by the U.S. Department of Defense, and the industry application called MUMPS, which deals with hospital system data processing.

In the first case, the accredited organization follows its own procedures of approval. In the second case, the draft standard, prepared in a subcommittee, must first have review and approval by the parent committee (see below). The third case, the "canvass method," involves almost total user participation and self-organization. The interest group, not a formal organization, becomes sufficiently involved to draft a standard and says, in effect, "We think that we have a requirement for an ANS in this area that is not being addressed through either the accredited organization method or the ANSC method, but we think that there is a need in the United States for such a standard."

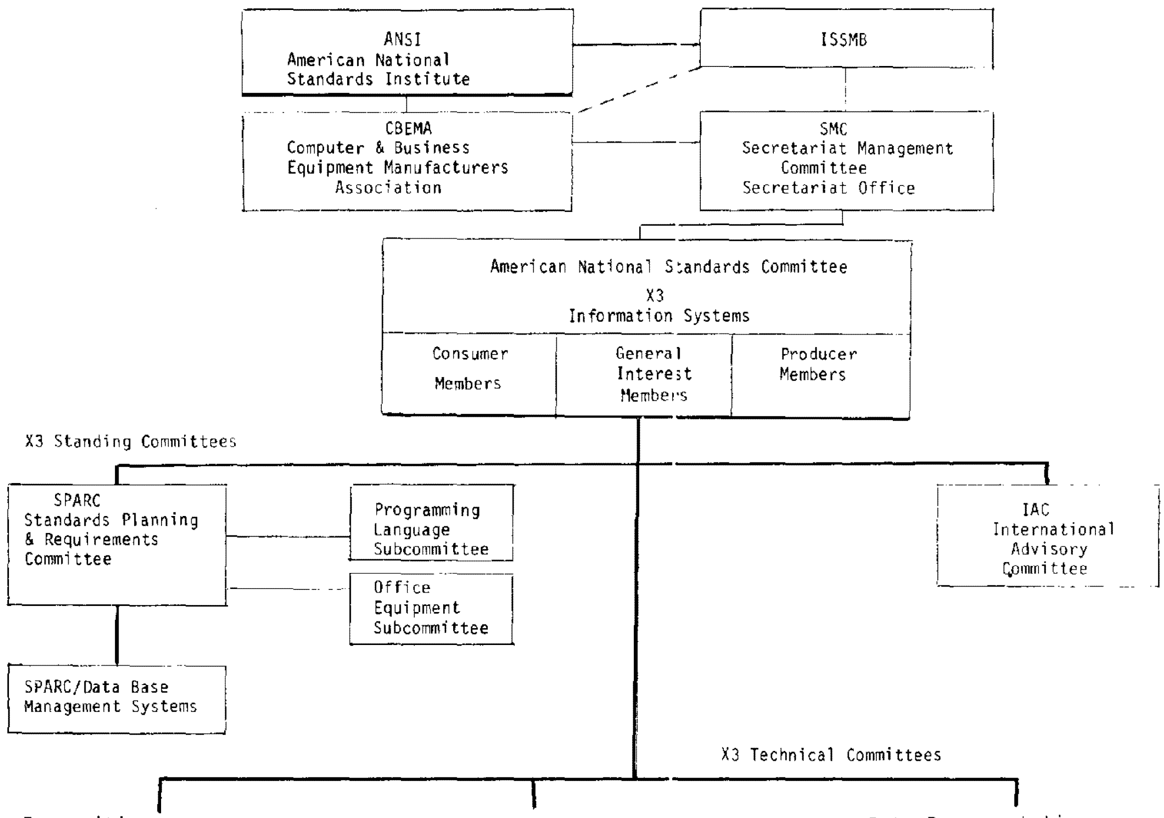
Upon receipt of the draft standard, the appropriate ANSI group distributes it in an extensive mailing (to over 20,000 persons) for a 4-month period of review and comment. Return comments must be resolved in the originating committee to ensure that the consensus process is as complete as possible. After formal review and approval by the ANSI Board of Standards Review, the standard is officially numbered.

American National Standards Committees (ANSC)

The basic structure of an American National Standards Committee includes both standing administrative committees and technical committees and subcommittees. The overall membership of the committee includes three kinds of members--consumer, general interest, and producer. Although ANSI requires a balance among these three types of members, it has been difficult to get user involvement. Consequently, the user interests have frequently been inadequately and only indirectly represented. However, even at the expense of balance, anyone with a substantial interest in the work of an ANSC must be considered for participation.

These various committees meet from two to six times a year, depending upon the nature and the urgency of their work. A meeting might be as short as a day or as long as a week.

American National Standards Committee X3: This discussion of the structure of ANSC X3 (Information Systems)--hereafter called X3--is presented as illustrative of basic ANSC operations. Figure 2.9 offers the schematic structure of X3. At present, X3 has about 43 member organizations. The two main standing committees are the Standards Planning and Requirements Committee (SPARC),



Recognition

X3A1	OCR
X3A1.1	Font Design
X3A1.2	OCR Supplies and forms
X3A1.3	Image Def. Measurement
X3A7	MICR

B-Media

X3B1	Magnetic Tape
X3B2*	Perforated Media
X3B3*	Punched Cards
X3B5	Mag Tape Cassettes
X3B6	Instrumentation Tape
X3B7	Magnetic Disks
X3B8	Flexible Disks
X3B9	Paper Forms/Layouts
X3B10	Credit/ID Cards

H & J - Languages

X3H1	OP Sys Cmd & Resp Language
X3H2	Data Definition Language
X3H3	Computer Graphics
X3H3.1	Core Graphics System
X3h3.2	Reference Models
X3H3.3	Virtual Device Interface
X3H3.4	Conformance & Binding
X3H4	Information Resource & Dictionary System
X3J1	PL/1
X3J1.3	PL/1 Gen. Purpose Subset
X3J1.4	PL/1 Real Time Subset
X3J2	BASIC
X3J3	FORTRAN
X3J4	COBOL
X3J4.2	COBOL Data Base
X3J5	COMPACT/ACTION/SPLIT
X3J6	Text Processing
X3J7	APT
X3J9	PASCAL
X3J10	APL

K - Documentation

X3K1	Project Documentation
X3K2*	Flowchart Symbols
X3K5*	Vocabulary
X3K7	Program Abstracts

L - Data Representation

X3L2	Codes & Character Sets
X3L2.1	Labels & File Structure
X3L8	Data Representation
X3L8.3	Indiv. & Bus. Identification
X3L8.4	Geographical Units

S - Communication

X3S3	Data Communication
X3S3.1	Comm. Stds. Planning
X3S3.2	Comm. Vocabulary
X3S3.3	Data Comm. Formats
X3S3.4	Control Procedures
X3S3.5	Comm. System Performance
X3S3.6	Transmission Speeds
X3S3.7	Public Data Networks

T & V - Systems Technology

X3T1	Data Encryption
X3T1.1	Data Link Encryption
X3T5	Open Systems Interconnection
X3T5.1	Architecture
X3T5.5	Application & Pres. Layers
X3T5.6	Session & Trans. Layer
X3T9	I/O Interface
X3T9.2	Lower Level Interface
X3T9.3	Device Level Interfaces
X3T9.4	I/O Operational Specifications
X3T9.5	Loc. Dis. Data Interface
X3V1	Office Systems
X3V1.1	User Requirements
X3V1.2	Symbols & Terminology
X3V1.3	Text Structure
X3V1.4	Procedure for Text Interchange
X3V1.5	Text Preparation & Presentation

*inactive status

Figure 2.9. American National Standards X3 Committees.

which receives all proposals for new standards projects, and the International Advisory Council (IAC). Of the X3 Technical Committees delineated in Figure 2.9, special note is made of two of them--X3S3, Data Communications, and X3T5, Open Systems Interconnection. The seven subcommittees of X3S3 are actively involved with ISO TC-97/SC-6 and CCITT Study Group VII. The three subcommittees of X3T5 exactly parallel ISO TC-97/SC-16.

In addition to its work of studying and developing U.S. standards, X3 determines for ISO the U.S. position on certain topics of new work projects, draft standards, and final approval. The X3S3 acts as the technical advisory group (TAG) to ISO TC-97. This means that contributions to ISO from whatever source (such as IEEE or EIA), must first flow through X3S3.

The members of X3 have identified certain problems that must be addressed in the near future, and these same concerns are voiced often by other standards groups. These concerns include both organizational and participatory issues.

From the organizational point of view, X3 is concerned with general planning; restructuring (e.g., to improve coordination); timeliness and efficiency of standards development; costs and funding; the nature of international representation, including the development of positions, coordination and recognition, and leadership; and the relationship of ANSI with other standards developing groups (e.g., IEEE).

Regarding participation, X3 is greatly concerned with both the quantity and quality of member activity. The user interest is of particular concern, because active involvement includes much more than being a technical expert on an issue. It requires an active tracking of developments, and a willingness to devote time to actual writing. Although observers with a global point of view are helpful, the active user is essential, so that standards can be timely, useful, balanced, and acceptable. (More is said on user's participation in Section 3.6).

2.4 Other Groups Affecting the Development of Standards

There are many groups that influence the standards-making of international (and national) organizations. These groups include voting regional groups, user groups and user sections, international organizations, political organizations, professional organizations, individual carriers and manufacturers, and individual administrations. These are collectively concerned with such (often) nontechnical issues as the effects of standards on domestic and international markets and the related trade questions.

Many persons believe that it is no longer possible to develop standards considering only the technical dimensions. Increasingly, the standards organizations are subject to complicated and interwoven political, trade, economic, and social--as well as technical--environments. As the political and economic questions are brought to bear on the groups and on the individuals making standards, the most acceptable solutions might not be technically optimum, but might be a balanced compromise among a number of these other factors as well.

A prerequisite for acting in the international arena is to know the players and the rules of the game. And these rules are not necessarily--or even essentially--the same as those that apply in the United States. This is true, in large part, because telecommunications, in most countries, is in the hands of the government (often centered in the PTT--Administrations for Postal, Telegraph, and Telephone Services) whereas the United States has only private telecommunication organizations with historically little government involvement (see Sections 3.7 and 6.2).

Although a substantive analysis of the effects of these influences on standards making is yet to surface in the public domain, Section 3.7 of this report does present the effects of some nontechnical considerations on the implementation of CCITT Recommendation X.25.

The following paragraphs outline the influences that the groups listed above can exert on standards-making organizations. Of the nine types of groups mentioned, only two are developed at some length--voting regional groups and user groups. The other seven are discussed briefly.

2.4.1 Voting Regional Groups

A "voting regional group" refers to a community of administrations that bring a common viewpoint to an international (say) meeting, and may vote, as individuals, in a "bloc." Regional groups who share problems and positions may often move more quickly toward decision, and may then be ahead of other, more isolated, participants.

CEPT

One example of such a regional community is CEPT, the European Conference of Post and Telecommunications. Founded in Montreaux, France, in 1959, CEPT has a membership of 26 European administrations. Their combined geographical area is approximately equivalent to that of the continental United States. The Permanent Secretariat is located in Berne, Switzerland.

At the yearly plenary assembly, the participants discuss the activities of the various working groups. These assemblies, as well as the committee and working group meetings, are generally closed to all except CEPT members, although expert witnesses and others are sometimes invited to contribute.

The official language of CEPT is French, and this is the language of the formal CEPT standards and publications. These publications, as well as formal proceedings, are generally not available to non-CEPT members.

The CEPT has two major groupings, one dealing with postal affairs, and the other with telecommunications. The Telecommunication Committee structure is depicted in Figure 2.10. This committee works not only through the Permanent Secretariat, but also through a foundation in Holland called the Eurodata Foundation. The established functions of Eurodata are the publication of CEPT materials and consultation for member states. Two available Eurodata publications describe a) CEPT member networks including tariffs and regulations, and b) data communications.

The CEPT telecommunication subcommittees cover the whole spectrum of telecommunication activity, as can be seen in Figure 2.10. These subcommittees develop recommendations for review at the yearly plenary meeting. Those recommendations that are accepted by the Telecommunication Committee are then offered to the member states. If a member state chooses to put a certain recommendation into effect, the individual state then develops its own legislation for enforcement of the recommendation.

Other Regional Groups

Several other regional groups are listed below:

1. ATU: Arab Telecommunication Union.
2. ASEAN: Association of South East Asian Nations.
3. CITEL: Committee for the Inter-American Telecommunications--deals with telecommunication issues in South America.
4. COMTELCA: Technical Commission for Telecommunications in Central America.
5. EBU: European Broadcasting Union--is presently concerned about such issues as direct broadcasting satellites, teletext, and videotex.
6. ECOWAS: Economic Community of West African States--has a telecommunication subcommittee looking at the development of the telecommunication network across West Africa.
7. PATU: Pan-African Telecommunication Union--is a broader umbrella-type organization than ECOWAS. Its deliberations consider the entire African continent.

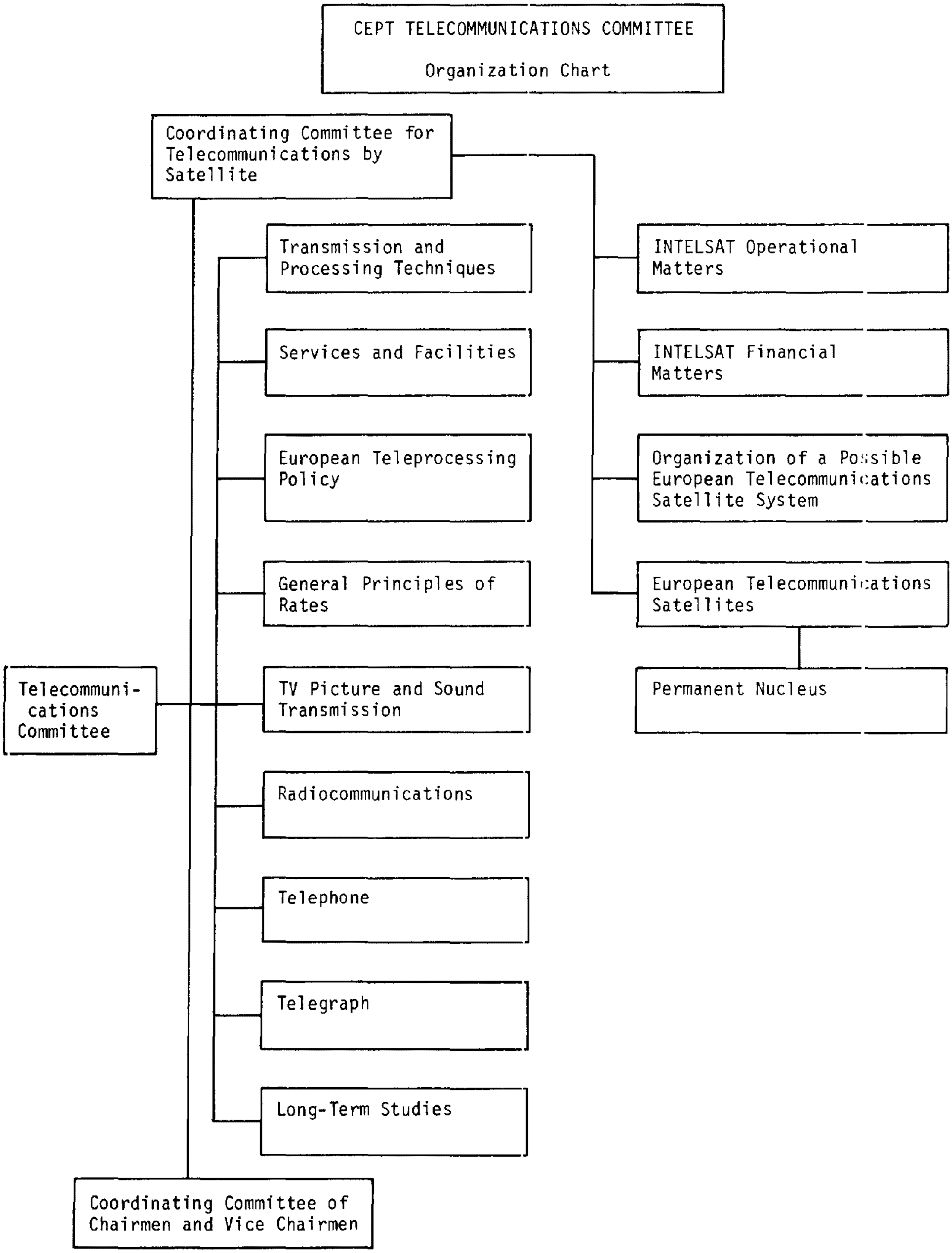


Figure 2.10. Organization chart for CEPT Telecommunications Committee.

8. PBDC: The Pacific Basin Development Council, centered in Honolulu, Hawaii, is concerned with the telecommunication needs of that area.

9. PTC: The Pacific Telecommunication Council is also centered in Honolulu. A regional conference is held each January.

Regional groups such as the above often have to deal with specific regional problems with regard to their own needs for standards. Two examples of these specific needs are 1) the Arab countries have developed telex standards for the transmission of Arabic characters and 2) the African nations must deal with unique problems of temperature and humidity conditions which affect telecommunication service and equipment.

Each of these regional groups may or may not, in fact, be involved in the standards-making process. However, one major importance of these regional groups is that their member states tend to vote the same way in international groups, such as the ITU, which operate under the one-nation, one-vote rule. Consequently the U.S. position on an issue, if disagreed with by one (or more) regional groups, can be easily outvoted by a "bloc" vote.

2.4.2 User Groups

Of increasing importance and significance to standards development are the the user groups. These groups--national, regional, and international--have emerged particularly in the United States, Europe, and Japan. Many of these users, members of multinational corporations, are very international in their approach, and wield economic and political influence. In many cases technology is not their prime consideration, but rather the cost and quality of the service.

One large international user's group is INTUG, the International Telecommunication User's Group, which was founded in 1974 and has its headquarters in London. Within the past few years, INTUG has become actively involved in ITU/CCITT matters. Two of INTUG's objectives are:

1. to foster the development of telecommunication policies, services, and equipment, as well as standards and regulations, all of which are best suited to user needs at prices attractive to the user; and
2. to organize and develop dialog between users and other national and international standards-making bodies, such as ITU, CCITT, CEPT, and the PTT's.

2.4.3 International (Nonstandards) Organizations

The significant international (nonstandards) organizations include such groups as INTELSAT (International Satellite Organization), IMCO (International

Maritime Organization), UNESCO (United Nations Economic and Social Commission), IPTC (International Press and Telecommunications Council), and the GATT's (General Agreements on Tariffs and Trade).

These international organizations play an important role in the overall standards process. Many participate directly in ITU and ISO affairs, largely in an advisory capacity. In addition, their importance stems from two other factors:

1. They wield economic power. This stems not only from large revenues that they have at their disposal, but also from funds contributed to R&D, and the development, in many cases, of their own specialized equipment.
2. They wield political power. This strength accrues from the large economic base.

2.4.4 Other Groups

Other groups which influence the standard-making process include political organizations (national and international), individual carriers and/or manufacturers, and administrations.

Examples of political organizations influencing standards development are EEC (European Economic Community) and OECD (Organization for Economic Cooperative Development). The EEC, for example, is interested in homogenizing standardization in Europe to develop a large market for European manufacturers (see Section 3.8). The OECD, composed mainly of the developed nations, has a working party on information, computers, and communications policy. the OECD members are concerned about transborder data flow issues and the resolution of tensions between privacy and free information flow. Since regulations of data flow have the intrinsic possibility of being used as nontariff trade barriers (i.e., to protect infant computer industries in a particular nation), interest in this topic is high.

Individual carriers and manufacturers, wanting to protect their own new technology and products, are as active as possible in the standards process. The alternative is de facto standards.

Individual administrations, in addition to the above concerns, have national interests, which include national political strategies and national technical needs. They also may have new markets or industries that they wish either to protect or to develop. Therefore, they are interested and involved in the standards-making process.

3. IMPACT OF INTERNATIONAL STANDARDS

This section of the report addresses some of the benefits and risks of implementing international standards. Some advantages of participating in the process of developing these standards are presented from the perspectives of carriers, manufacturers, and users. A study of the implementation of a recent international standard (CCITT data-network Recommendation X.25) is described, and the effects of standards on international trade is indicated.

3.1 Introduction

The U.S. telecommunication market currently represents about 50% of the total world market. The world markets outside the United States are growing much faster than the U.S. market. United States telecommunication exports, however, represent only about 5% of U.S. production. In telecommunication transmission and switching equipment, Bell System practices dominate the U.S. standards. When international standards do not agree with these practices, a double standard is created that forces U.S. manufacturers to produce two product lines--one for U.S. consumption, and another for CCITT-related systems--if they wish to export. In some cases the CCITT adopts two or more standards to allow for the differences recommended by the participating administrations. Multinational corporations now exist in part to respond to the different national standards.

Developing countries often use CCITT Recommendations as procurement specifications when buying equipment. European countries do not allow other than CCITT line signals on their networks. This requires appropriate conversions at gateways to bring about the necessary compatibilities. Thus, U.S. manufacturers are faced with the problem of considering other than U.S. standards of practice in order to compete in export markets where only a small percentage of their production may be shipped. Because of the large size of the U.S. market, foreign suppliers find it profitable to produce equipment conforming to a U.S. (non-CCITT) standard, and thus target sales to the United States. (See Section 3.8.)

The major consideration of any U.S. company in deciding whether to participate in the international standards-making organizations (committees), such as those discussed in Section 2, is the cost in man-hours and travel necessary to support their technical interests. The number of committees, frequency of meetings, and locations of meetings effectively preclude participation by any one company in all organizations and committees relevant to its interest.

3.2 Reasons for U.S. Involvement in International Telecommunication Standards

The impact of international standards on the U.S. telecommunication industry, and the resultant need for broader U.S. involvement in the process of standards-building, can be traced to several issues. Specific issues affecting U.S. involvement in international standards development are a) a growing international market and a changing domestic market; b) the increasing trend toward "proactive" (rather than "reactive") international standards; and c) the internal changes occurring within the international organizations.

3.2.1 Telecommunication Markets

The impact of standards on both the operational capacity of telecommunications and the potential marketing of services and equipment is becoming widely recognized in the United States. About 50% of the world market is in the United States, and that market is increasingly being challenged by foreign suppliers who have developed distribution and maintenance capabilities in this country.

The U.S. represents a large, uniform, relatively open telecommunication market. Even if the relevant U.S. standard is not an international one, it is often profitable for foreign suppliers to build for this market. By contrast, foreign markets are typically smaller, more fragmented, and less accessible to outside competition. Properly structured international standards may serve to minimize these barriers.

3.2.2 Proactive Standards

The history of U.S. involvement in international telecommunication standards work has been largely in terms of "reactive" standards. Such standards evolve when, after an extensive system is already in place, the need arises to communicate outside of the national system. The tendency has been in those cases to negotiate whatever interfaces would be required to assure compatibility and interconnection.

However, several factors are encouraging involvement in the development of "proactive" standards. This type of standard is developed along with new products, systems, and services. This process involves tremendous planning with regard to systems that do not as yet exist and may not exist for some time. The Europeans have generally favored this approach to standards development. The proactive type of standard, with the potential for providing optimum results, also carries definite, recognizable risks (see 3.5 below).

One major factor (among many others) that is influencing the attitude of the telecommunication community toward proactive standards development is the accelerated pace of telecommunication technology development. This is especially true in consideration of the implications of such ambitious, worldwide standards development projects as ISDN and the OSI Reference Model. There is an increasing reluctance on the part of the U.S. industry (and users) to invest heavily in the development of expensive new products and systems (to replace functional existing plant) if there is the likelihood that forthcoming international standards will exclude these new products (and resulting services) from international connections. This latter consideration also helps to account for the growing interest in the U.S. participation in standards work.

3.2.3 Changes Within the International Organizations

Membership in international standards organizations is expanding each year. Interest is particularly strong among the developing countries, who look to organizations like the ITU for assistance in building their national telecommunication networks. The ITU is spending increasing amounts of time and money in providing such assistance, and in consequence, there is a growing tendency within developing countries to use CCITT Recommendations as both design and procurement specifications. The effect has been to expand the impact of CCITT Recommendations to include some potentially large new markets, and this has made U.S. participation in the development of such Recommendations much more important.

3.3 The Nature of Standards

A telecommunication standard provides, fundamentally, compatibility and interoperability. Building equipment to widely accepted standards eliminates costly incompatibilities that may show up later, and ensures interoperability with a large set of similar equipment. The retrofitting required for the interworking of noncompatible systems is always costly and generally nonproductive.

The kind of standard being considered in this report is basically the voluntary agreement that benefits most--and in some cases, all--of the concerned parties. The following are examples of types of telecommunication standards (some worldwide and some not).

1. Numbering Plans: these agreements, at present, provide a unique identification of every telephone in the world. Present work is aimed at providing similar international identification for every data terminal.
2. Maritime Satellite: there is a unique identification of the vehicles.
3. Interface Protocols and Characteristics: these include such widely accepted standards as X.25 (CCITT) and RS-232C (EIA).
4. Signalling Systems: there are numerous international signalling systems in operation to ensure compatibility among the different signalling arrangements in various parts of the world. (For example, calls are set up differently in the United States and in Europe).
5. Circuit Noise Limits: it is essential to establish worldwide standards to avoid chaos in the allocation of degradation.
6. Voice Coding: this is an example of an effort that did not achieve worldwide unanimity.
7. Commercial AC Power: the standards in the United States differ from those in Europe and those in Japan.

The very nature of standards, as depicted above, is to have both advantages and disadvantages; this concept is developed below. Particularly in a multiple-supplier environment like the one in the United States, the business of making standards is an imperfect art and a complicated process. Many of these complications are tied to the timing of the standard. It is imperative for the standards makers to be sensitive to several things including: the user's point of view; the advantages and disadvantages of standards; and the life expectancy of a given standard, including the possible inadvisability of offering a given standard, if its predicted life expectancy is too short.

In broad perspective, the abundance of voluntary telecommunication standards, both national and international, is a tribute to the work that has already been accomplished in reaching such agreements.

3.4 Some Advantages of Standards

There are general advantages of standards for all groups within the telecommunication community, including manufacturers, users, and providers. This section considers some of these advantages.

3.4.1 To the Manufacturer

One main advantage to the manufacturer, of having clearly defined standards, is that building to a broadly accepted standard can provide a larger (if more competitive) market for a given product. This is especially true if the specified framework of a standard is flexible, providing the possibility of optimizing the options within it. For this reason, standards should not be--or attempt to be--design specifications, but rather should be function or performance oriented.

The manufacturer reduces the proprietary nature of specific equipment and services when building to standards. This tradeoff between the larger market and presentation of proprietary rights must be seen as advantageous, and these advantages are ultimately user related.

3.4.2 To the User

The benefits to the user are not limited to those of a competitive telecommunication market. The user of telecommunications at all levels is becoming more sophisticated and knowledgeable. This growth is largely the result of wide availability of numerous kinds of data equipment and the resultant interface and communications problems that have emerged. The user does not choose to be either locked into one kind of generally incompatible proprietary equipment--whether leased or purchased--or forced to change equipment within short periods of time.

The advantages for the user of standards that will permit new equipment to offer broad interconnection of existing noncompatible systems are almost self-evident. With the interconnection of different kinds of materials and equipment assured--whether tapes for a tape recorder, RS-232 interfaces on data terminals, or X.25 networking--the user is freer to choose the machines, systems, and networks exactly suited to the need of the moment.

Intrinsic to the use of equipment is the use of services. It is not advantageous to subscribe to expensive new services that might or might not become widely available. Service-related standards however, help to ensure and to encourage such wide use. Once the user can be certain that a given service will be widely implemented (and therefore less costly), then everyone benefits--the manufacturer, the user, and the provider.

3.4.3 To the Provider

Service providers have been subjected to the "chicken and egg" syndrome for the past decade. The services that the carriers wanted to provide were real enough, but often there were not enough subscribers to make it profitable. For a brief time, in the recent past, there was but one choice for the sending of data--the telephone line. The established standards of the telephone carriers were widely known. Using these lines for data affected the carrier systems minimally, because the voice-grade service provided was adequate for carrying data. Today, however, the network providers (telephone and data) must make a significant investment to provide, for example, an X.25 network. A major investment in hardware and software is necessary. Without the assurance of a "guaranteed" user market, the provider will be reluctant to make this investment. However, with the advent of standards that are amenable to both users and manufacturers, the providers are willing to develop the required network(s).

3.5 Some Disadvantages of Standards

There are distinct possible disadvantages of standards. Some of these disadvantages are listed here. Section 5 on the ISDN includes further reflections.

In the general case, once a standard is set and widely implemented, freedom of choice is necessarily restricted. The acceptance of a standard may also inhibit other (perhaps superior) solutions and may stifle innovation. And, depending on the type and scope of the standard, existing equipment may become prematurely obsolete.

Proactive standards bear an added risk. The standards may be approved before extensive experience develops, as was true with X.25. Consequently, there have been numerous revisions to X.25, and in some cases (e.g., Canada and France) the early installation of the standard has prohibited revision, and so these countries have two versions of X.25 protocols running concurrently--at a major expense.

Another problem relates to the different interpretations of a standard's specifications. For example, among the numerous operative X.25 networks worldwide, no two have implemented the CCITT specifications in exactly the same way. Each country interprets the specifications differently, and most administrations rewrite them to suit their own needs. The CCITT options only partly absorb the differences, and the resultant CCITT revisions of Recommendations X.25 have attempted to deal with the ambiguities.

For all of the above reasons, there is a real need to keep the standards directed toward functional (not design) specifications and definitions. This approach allows the maximum freedom for implementation.

3.6 Participation in Standards Work

The advantages to the participant in the process of standards development are numerous--to the manufacturer, to the provider, and increasingly to the user. The nature of participation is broadly the same for all. The first step in this process is focusing one's interest and selecting the appropriate standards committee. Although the tendency is to branch out from this area, it is productive to keep one's focus centered, not spreading one's involvement into related standards work elsewhere.

3.6.1 Nature of Participation

Although the number and variety of standards organizations cause inevitable topic overlap and some competition, the variety does guarantee a freedom to pursue self interests. This freedom is precious to Americans and should be encouraged. The idea of a single, worldwide standards organization, where each voice is subject to the approval or disapproval of the particular head of the organization, is not attractive here.

The cost of participation is high in terms of effort, time, and money. Most estimates indicate that it takes about a year for a new member to become fully aware and participative in a standards organization. The effort necessary for active involvement requires genuine dedication. The kind of serious participation really needed by standards groups is time intensive. Standards committees need strong, dedicated committee members willing to abstract themselves from personal interests. Since the number of persons who hack out the details of standards are few, a productive individual's burden can be great. (See, particularly, Section 4.3.3).

Involvement can be less intense and still valuable. Some groups, such as ANSI, permit both active and observer members. Observer status permits participants to watch the process, track it, and keep abreast of trends. The ITU does not have this distinction in its membership. In all cases, the only sure way to receive the contributions distributed at working meetings is to attend the meetings.

Typically, the standards working committees and groups meet about four times a year. The period of work can extend from 1 day to a week. The larger groups, such as the CCITT study groups or the ISO technical committees, meet about once a year for as long as 3 weeks. The amount of time spent developing and/or studying contributions for these meetings can be substantial.

The financial cost of membership in a standards organization is sizeable. The CCITT, for example, requires an $8,000 annual fee from any U.S. scientific or industrial organization that becomes an official member (there is no fee for individuals who join the U.S. CCITT groups, however).

3.6.2 Advantages of Participation

Active participation in the standards-building process minimizes the risks associated with the individual interpretation of any standard. It is inevitable, especially in the initial writing of a standard, that certain points will be misinterpreted by the reader. Developers of standards have found it impossible completely to overcome this aspect of standards writing, even with the improvements of later refinements and amendments.

This can be illustrated by an incident (albeit an extreme and unusual example) concerning CCITT Signalling System No. 5bis. Shortly after the CCITT approved No. 5bis, one PTT developed a new signalling system following the new Recommendation, according to their understanding of it. However, the finished product was unsatisfactory. The problem in this particular case was that this PTT had not participated in the CCITT meetings in which the No. 5bis Recommendation was developed, and therefore was unaware of subtleties in the interpretation of the new Recommendation which were apparent to the participants. Although standards developers always seek to prevent such misunderstandings, development of completely unambiguous standards is regrettably often an iterative process. (See Sections 5.3, 5.4, and Appendices A-F for specific efforts in this regard on the ISDN Recommendations.)

Telecommunication users have a golden opportunity at present. The users are not only welcome at standards meetings, they are essential for the standards community to do what must be done. The users must voice their needs and their opinions, so that the suppliers know what is wanted and needed (see Section 3.2). If the users do not enter the standards developing process early, it can be a very long time before they are able to get what they really want. User interest that is too little, and/or too late, can and has both delayed the good aspects of standards and permitted inadequate (from the user point of view) standards to be developed. User involvement permits timely and efficient standards development. Intrinsic to the involvement is balance. If the user requirements are too high, too costly, or unrealistic, the implementors on the committee will be there to modify the request.

The manufacturer's involvement in the standards process is geared to concerns about the cost of equipment and the timing of production. Manufacturers need to influence relevant standards development to ensure that the standard is actually tenable, yielding equipment that customers can afford. Their participation in the actual process also gives them first-hand knowledge of the timeliness of standards implementation as well as a basic insight into the potential permanence of the standard. The manufacturers basically have two choices: they can hurry into production to be ready as soon as possible, chancing the need for early changes, or they can delay production, waiting until the market is mature. The maximum risk involved in the first case is somewhat reduced when they have participated in the standards process, have knowledge of the user's needs, and are somewhat certain of customers.

Users and manufacturers must get together with network suppliers early in the process to agree on what is needed, what can be done, and what is economical. Once this is all defined, it becomes possible to justify the development cost, which gives the low price that everyone wants. One sees, then, that a better definition means fewer false starts. Fewer false starts mean lower risk.

3.7 An Example of a Recent International Standard: Recommendation X.25

The United States has an unusual position in its stance on telecommunication standards. It has neither government control of its telecommunications, nor formal (nor informal) national strategies (see Section 6.2). As a result, those countries with a strong, central PTT often approach the development and implementation of standards with a different perspective from that of the United States, whose history includes competition and lack of government involvement. It is necessary for those participating in international organizations to understand these differences, in both approach and point of view, in order to function well in the international arena.

The history and implementation of X.25 is presented as an example of the development and the consequences of a recent international standard. In this discussion, the measure of the "success" of a standard refers more to the user dollars spent on the standard's implementation than to acceptance by nations and organizations. The concept of "user" has been stretched to include intermediate users (as well as end users) and so includes common carrier networks and value-added networks.

3.7.1 Overview of X.25

The CCITT Recommendation X.25 (Geneva, 1976; amended, 1980) is entitled "Interface Between Data Terminal Equipment (DTE) and Data Circuit Terminating Equipment (DCE) for Terminals Operating in the Packet Mode on Public Data Networks." Often, this standard interface between the user equipment and the packet switched network is misconstrued to mean a medium for transmitting data. Figure 3.1 indicates a typical packet switched network and illustrates some X.25 links.

Benefits of X.25

The DTE's that can be connected to the network include computers and other intelligent devices. Basically, by accessing the network, they are interconnected and thus can talk to each other. The X.25 network permits such value-added services as call setup, error recovery, flow control, network maintenance, and message accounting.

Other benefits that are now perceived in an X.25 network include: a) an international service through gateways between X.25 networks; b) cost-effective technology for low to intermediate traffic volume; and c) the support of many logical connections by a single physical link.

The History of X.25

Recommendation X.25 had its beginning in 1962 when the packet switching concepts emerged. The ARPANET (U.S. Department of Defense) in 1969, and the work of the United Kingdom's National Physical Laboratories were predecessors to X.25. Between 1970 and 1975 major packet switched networks were developed in Canada (DATAPAC), France (TRANSPAC), Japan (NTT), Spain, the United Kingdom (PSS), and the United States.

During its 1972-1976 Study Period, the CCITT studied questions on packet switched data networks, and in 1976 Recommendation X.25 was published in the Orange Book. In a very real sense, this was an extraordinary event. For several defined (and other as yet undefined) reasons, tremendous interest and activity developed worldwide in this work of Study Group VII. The Special Rapporteur meetings held on this topic were both better attended and held more

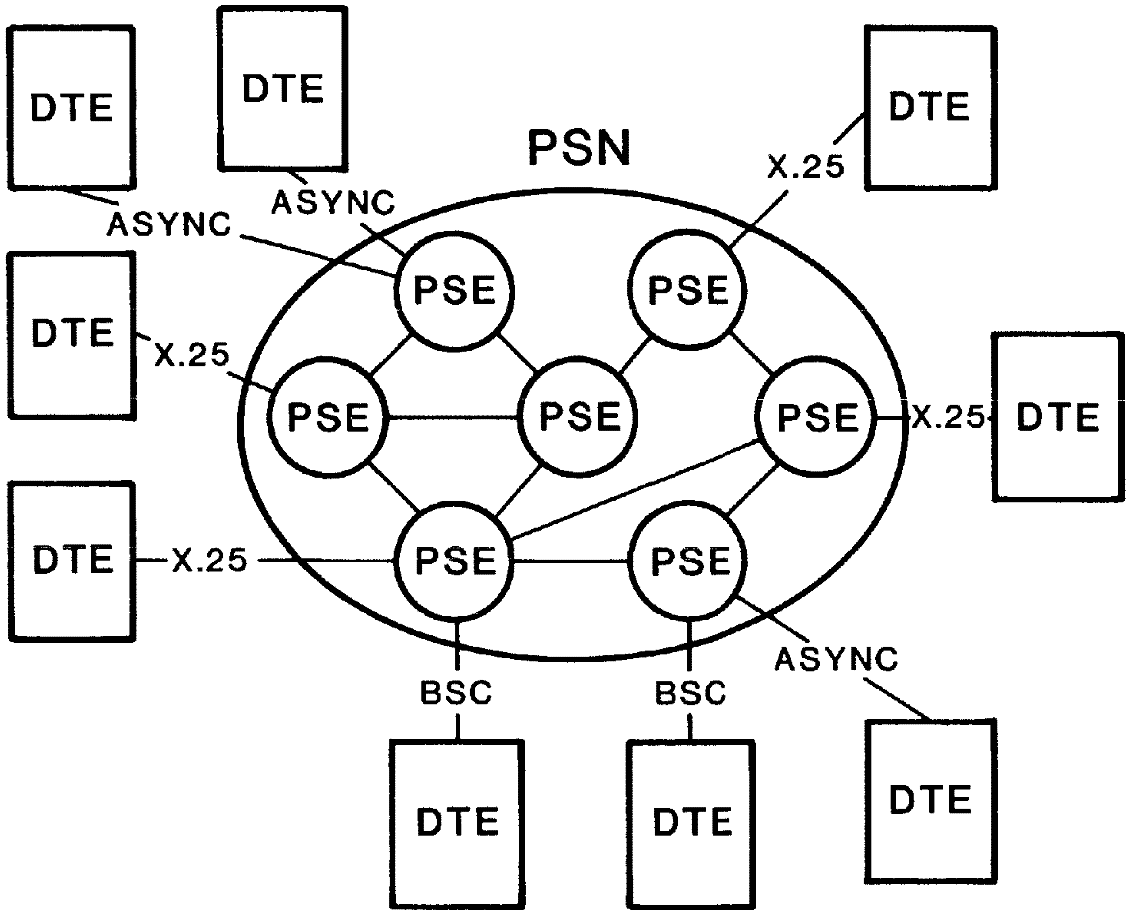


Figure 3.1. A typical packet switched network (courtesy P. Black, 1982).

often than the study group meetings themselves. Tremendous pressure was exerted on the CCITT to produce its Recommendations. (The CCITT is faced with almost the same situation today concerning the ISDN. This is discussed in Section 5.) A revision of X.25 appeared in the 1980 Yellow Book. About 18 countries have public packet switched networks today.

The implementation of X.25 in the United States is growing. Public packet switched X.25 networks, in addition to the ARPANET, include Telenet (GTE), Tymnet (Tymeshare), Graphnet, Uninet (United Telephone), Cylix, and FFCS 80 (Federal Reserve Bank).[1] The AT&T has recently announced specifications for interfaces to a new Bell packet switched network, which is planned for a 1983-1985 phase-in. This proposed network is called BPSS (Bell Packet Switched Service). In addition to these public networks, there are many private U.S. networks that have implemented X.25.

3.7.2 Implementation of X.25

The acceptance and consequences of the implementation of a standard are not based uniquely on its technology, as was discussed in Section 2.4.1. Although the technology is certainly a major factor, the commercial, political, and "fashionable" aspects, as well as the publicity surrounding the standard, are also important. (However, the broad publicity received by X.25 has made it so widely known that one is surprised to find how little money has actually been invested in this by the end user, worldwide.)

National Strategy and Implementation

The following discussion on the differences in the implementation of X.25 in France and in Germany (Federal Republic) illustrates the importance of a nontechnological factor--government strategy--in a nation's implementation of a standard.

France's network, TRANSPAC, has a capacity of 11,100 ports, and by mid-1982 already had 6,500 X.25 subscribers. This system is a success because

[1]Certain commercial services and equipment are identified in this report to clarify or illustrate technical conclusions. In no case does such identification imply recommendation or endorsement by the National Telecommunications and Information Administration, nor does it imply that the service or equipment identified is necessarily the best available for the purpose.

people have been persuaded to put money into X.25 and into compatible and end-user equipment.

Germany, on the other hand, has had a very different set of results with basically the same standard. DATEX-P, which was started in 1980, had only 140 subscribers by mid-1982.

The key reason for the differences in these statistics may be the reduction of risk-taking perceived by the industrialists in France. France has a strong, unified national policy that promotes the implementation of data communications. The national data communication strategy, coupled with the French industry's confidence in their government strategy, has encouraged industry to put money into a network envisioned to have permanence. Germany, however, does not have a government strategy in this regard, although it does have a powerful standards organization (DIN), and is accustomed to having definite telecommunication strategies. Germany has two other older national networks--DATEX-D (circuit switched, based on X.21), and DATEX-L (leased line). With no government strategy to encourage industry to select X.25 rather than the other networks, industry is hardly willing to risk choosing. Basically, there are too many options.

In response to this uncertainty, the German Bundespost is applying the use of X.22 to the problem. Recommendation X.22 offers a multiplexed arrangement by which any of the three above-mentioned networks can be accessed by the same on-site plant.

Essentially, France represents the position that chooses to risk implementing only one kind of standard (or, in this case, network) thereby reducing the dilution of R&D funds in parallel studies, and offering to its budding engineers a clear direction for study. In addition, a strong, unified national strategy assures independence, reducing the possibility of becoming totally dependent upon a single manufacturer.

Germany is representative of those nations that do not have, or have decided not to have, a national strategy (in this case relative to a national data network). Instead, Germany has implemented more than one standard (and, so, more than one network).

There are issues unrelated to profit and loss that must be addressed by those who implement a given standard. The question needs to be asked, "What are the defined goals for the implementation of this particular standard?" Such assessment of X.25, for example, indicates that a network is being built that will effectively be, in about 15 years, one giant computer with one giant data base.

It is essential to understand what the goals are. Standards meetings are not the places for this discussion. In effect, those countries that promulgate a national strategy are saying, "Here are our goals and these standards are the means to implement them." All nations who implement far-reaching standards, with or without a national strategy, need to ask, "What is the goal of this standard, in a gobal sense?"

Consequences of Implementation

Some consequences of the implementation of X.25 concern the balance of pressures between the PTT's (and/or the common carriers) and the computer industry. Recommendation X.25 has helped create the interest in computers within the telephone companies. There are the de facto standards of the manufacturers, and universal standards such as X.25; who will win in the long term? The only realistic answer will come from the money being spent by the end users--not the publicity given to the standard, or even the number of people who attend standards organization meetings.

Another consequence of standards implementation is the accumulation of statistics. As data on use and on outage/performance of X.25 networks become available, the tariffs can be tuned for efficiency and profitability.

3.7.3 Alternatives to X.25

This issue involves technical alternatives less than the fact that the word "alternative" has different meanings for different people, depending largely upon one's position--in the data industry, or in standards development. Is it an alternative solution to a particular need, or is it an alternative protocol? These questions assume significance depending upon whether one is an end user or a standards developer.

The person in the computer industry might consider an alternative to X.25 to be a de facto standard which was developed by the computer manufacturer, permitting computer/computer communication. This de facto standard is really a product offering, not necessarily another standard. It is accepted for nontechnical, practical reasons even though it is not the standard accepted by standards organizations around the world.

Another shape that an alternative can take is the acceptance of a different standard, not necessarily similar, but capable of getting the job done.

An example of this is the use of X.21 (CCITT Circuit Switched Network Interface in place of X.25.

3.8 Standards and International Trade

Two examples are offered here to illustrate the role that standards may play in international trade.

3.8.1 Homogenization of Standards

The first example deals directly with international trade from the perspective of Anton Philips, a director of Philips' Telecommunicatie Industrie in Holland. At Communications '82, he issued a plea to the EEC and PTT's telecommunication industry to "face reality." The following paragraph is a summary of his perspective:

The U.S.A. and Canada have a population roughly equivalent to that of the EEC (280 million) with just short of 200 million telephones (120 million in Europe). There are five manufacturers to serve this market. In Europe, there are 12 manufacturers and the EEC is not a uniform market: there are eight different sets of standards and requirements. Thus, because the home market cannot meet development costs, the manufacturer finds himself in a weak competitive position in the export market.

Thus, according to Mr. Philips, the EEC needs to become a homogeneous market, and the governments and PTT's should aim at this end. His further comments called for standardizing specifications, and harmonizing certification requirements for terminal equipment. He also called for the removal of barriers to trade across national borders (within the EEC) for all telecommunication equipment.

3.8.2 Optical Fiber Standards

The second example is drawn from the rapid advances in fiber optics technology. New fiber optics technology can be considered to have a half-life of about 6 months! How can a standards group keep up with this kind of motion? At present, each administration that is desirous of using fiber optics for transmission is developing its own ad hoc standards (e.g., AT&T, Nippon Telegraph and Telephone, the PTT's). Concurrently, the military is also developing its own standards.

However, the other industries, such as those in computer process control, are moving more slowly, perhaps because of the lack of any standards. This may be where the international groups can be of assistance. And even so, the questions is left: How do all these standards, then, become homogenized, and who does it?

The situation in the United Kingdom may be considered a particular case in point. Since the British Post Office is now allowing a separate long-haul network (Mercury), the three major European suppliers--GEC (General Electric Co.), Plessey, and STC (Standard Telephones and Cables)--are thrashing out, in their respective technical committees, a series of fiber optic standards that will allow their equipment to be connected to Britain's telephone system (British Telecom).

The specifications would ensure, for instance, that fiber made by GEC could receive telecommunication signals from STC's solid state lasers. The completed standard will enable British Telecom to order equipment from all three suppliers knowing that equipment from each will fit into the network. As can be readily deduced, the use of large quantities of optical fiber equipment purchased from these three companies may effectively preempt competition from privately owned telecommunication networks.

4. AN INTERNATIONAL SYSTEMS-ARCHITECTURE STANDARD: THE OPEN SYSTEMS INTERCONNECTION (OSI) REFERENCE MODEL

Data communications standards, which started in the early 60's with the physical interfaces (such as RS-232), had developed by 1976 into those standards (such as X.25) permitting public packet switched networks. However, none of these standards ensured complete communications between the ever-growing numbers of heterogeneous end-user systems.

Telecommunication transmission media provide the electrical means for interconnecting end-user systems. If the user's equipment and interconnecting systems are all of the same manufacture or design, such communication is easily realized. In today's competitive world, however, these end-user systems often consist of basically incompatible operating equipment of a wide range of designs and implementations.

By the mid 70's, it had become vividly apparent, especially to the users, that their "closed" homogeneous system environments, well able to communicate internally, would have to become "opened," able to communicate externally with other closed, but different, homogeneous environments. A structure was envisioned upon which to base future standardization efforts for the next generation of information systems.

The ISO was first to set work on establishing some standards that would provide this open systems environment. In 1977, TC-97 established SC-16, which is called "Open Systems Interconnection." The goal of SC-16 was to define an architectural model that would tie together, in an organized way, the multitude of terminals, systems, computers, etc., capable of performing information transfer. The structure had to be universally logical, capable of relating to all applications, and as general as possible.

The Open Systems Interconnection (OSI) Reference Model, a draft international standard, was formally accepted by ISO TC-97/SC-16 in March 1982. The OSI Reference Model, as defined in ISO Document DP 7498, represents the first time that a broad systems view of information processing standards has appeared in the international arena. This reference model provides a framework, or an architecture, for the standardization of the rules governing the interactions between interconnected heterogeneous systems.

Since 1978, work on the OSI has taken place both in ISO TC-97/SC-16 and in CCITT Study Group VII, which works in cooperation with SC-16. This cooperative venture is detailed in Section 4.3.3 of this report.

4.1 The OSI Reference Model--Overview

The developing OSI environment being planned by ISO (and by CCITT) employs a standard architecture with associated interfaces and protocols, to provide the widest possible range of applications with the flexibility required for communication in an effective and economical manner.

Throughout this discussion, the term "user" refers to an Application Process (AP). An AP task can vary from a simple keyboard program to a complex data base operation.

The functions required for communication between data systems can be organized into a continuum, one function depending on the next. The decision to divide this continuum of functions into seven layers (or sets) evolved from considerations that a) each layer should not be so big that any individual layer would become too complicated; b) there should not be so many layers that the structure itself would become a complex entity; and c) the agreed upon structure would need international approval. These layers group those functions that are most logically related to each other, providing efficient and effective handling.

According to the ISO standard, the OSI Basic Reference Model will:

1. provide a universally applicable structure;
2. serve as a reference to position existing standards and compare requirements;
3. facilitate compatible interconnections for communicating AP's; and
4. enable an evolution of advancing technology into the future

4.1.1 The Seven OSI Layers

The seven layers are depicted in Figure 4.1. The first four layers, which provide the transport service, deal with the movement of the data between end-user systems. The three upper layers are concerned with the users of the transport service. Therefore, these upper layers deal with the processes that ensure the cooperation of the systems and of the activities that support the cooperating AP's. Each of these seven layers is described briefly below.

1. The Physical Layer

   This layer constitutes the boundary between the physical communication medium (such as a telephone line) that is outside the OSI environment, and the data link layer. This layer, concerned with the movement of bits over the physical media, provides the functional and procedural characteristics for it.

2. The Data Link Layer

   This layer provides essentially error-free movement of the information, link-by-link, between the communicating end systems.

3. The Network Layer

   This layer is involved with the switching, routing, and relaying functions of the particular network used for communication between the end systems.

4. The Transport Layer

   This layer ensures end-to-end integrity of the information that is being passed between heterogeneous end-user systems through the telecommunication network. Communicating AP's must have a certain quality of service, which is dependent upon the task being accomplished. This layer attempts to provide the necessary quality by making up for any deficiencies that might exist.

5. The Session Layer

   This layer sets up and terminates the logical relationship--called a session--between the two AP's (from the two end users). This layer also manages any dialog involved.

6. The Presentation Layer

   This layer selects the correct data information format, or provides the necessary conversions, to ensure that both end-user systems are

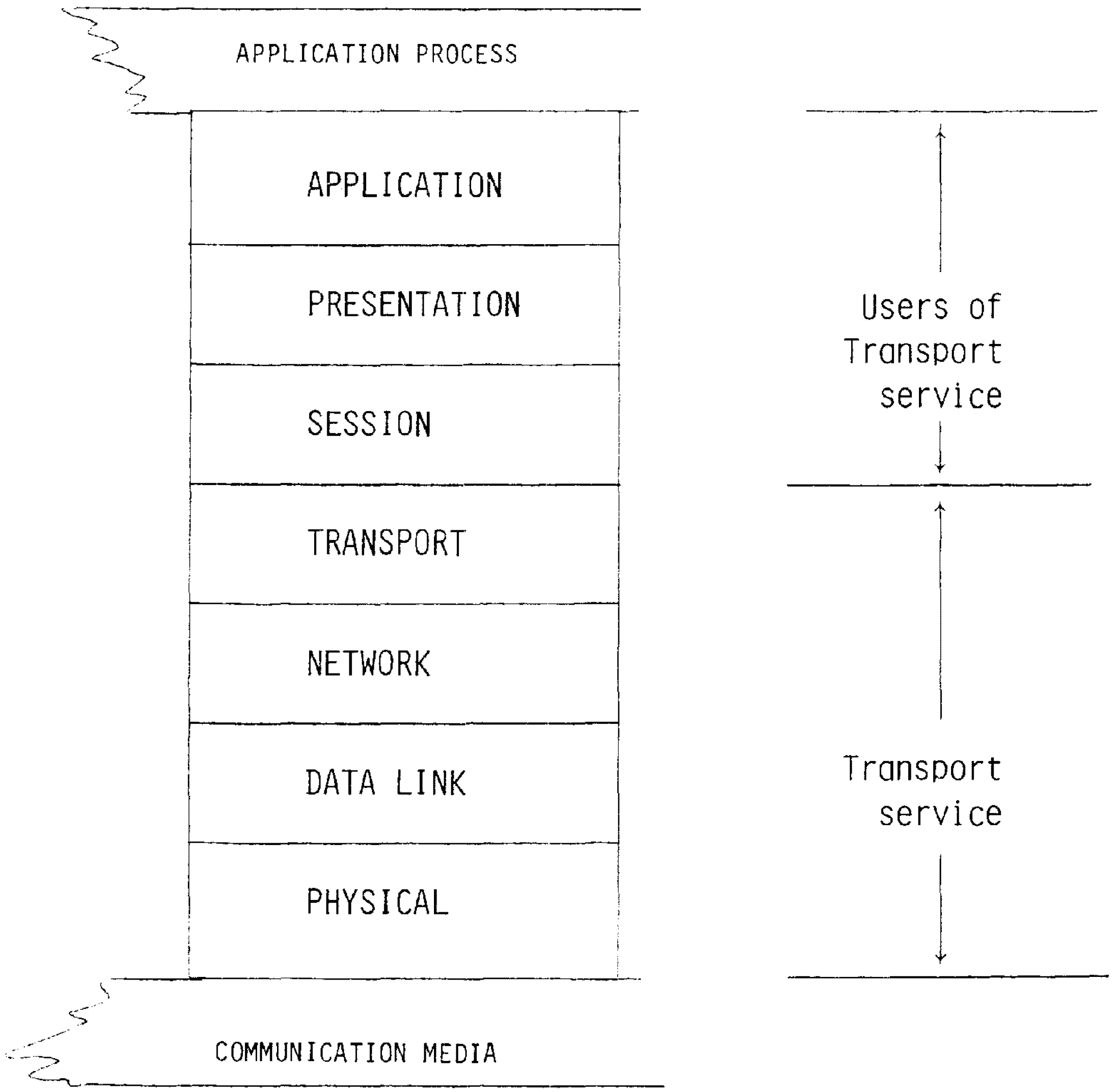


Figure 4.1. Layers of the OSI Reference Model.

"speaking the same language." If both are speaking the same language--and using the same format--the presentation layer becomes essentially inactive. (Just how inactive is under debate.)

7. The Application Layer

   This layer offers the access between the AP and OSI environment. It provides the management and control of the resources and of the communication. Since this is the only layer that provides services directly to the AP, all of the OSI services are also channeled through this layer.

4.1.2 Protocols and Primitives Connecting These Layers

There are two main points to be made about relations of the layers to each other. In the first place, the functional entities within the respective layer in each end system need to communicate. Each layer actually spans the full interconnection between end systems. The rules, or necessary procedures for the exchange of information between the equivalent layers, are called peer protocols. Figure 4.2, which depicts the interconnection of two local-system environments (end users) through an OSI environment, indicates these peer protocols. The concept of a layer is illustrated in Figure 4.3.

End-user X in system A, switching to communicate with end-user Y in system B, must first "knock on the door" of its application layer to establish communications. The peer protocols established between the same functional layers communicate between the two end systems (e.g., A_A to A_B, P_A to P_B, etc.) This way, layer by layer, communications between X and Y are assured. These peer protocols between the similar layers in the communicating systems are the main areas of standardization in the OSI Reference Model.

The second point involves the need for the seven adjacent layers within each end-user system to communicate with each other. Essentially, each layer is connected to the layers below and above. The rules that have been established for these interactions are called primitives. These are the connections over which the communication logically flows between the AP's.

Under development, as a follow-on effort to the OSI Reference Model, are the Layer Service Definitions. There will be one for each layer (call it N) that details the services that are provided to the next upper layer (the N+1 layer) together with the associated interaction primitives and parameters. The draft that is currently most advanced is for the Network Layer Service Definition.

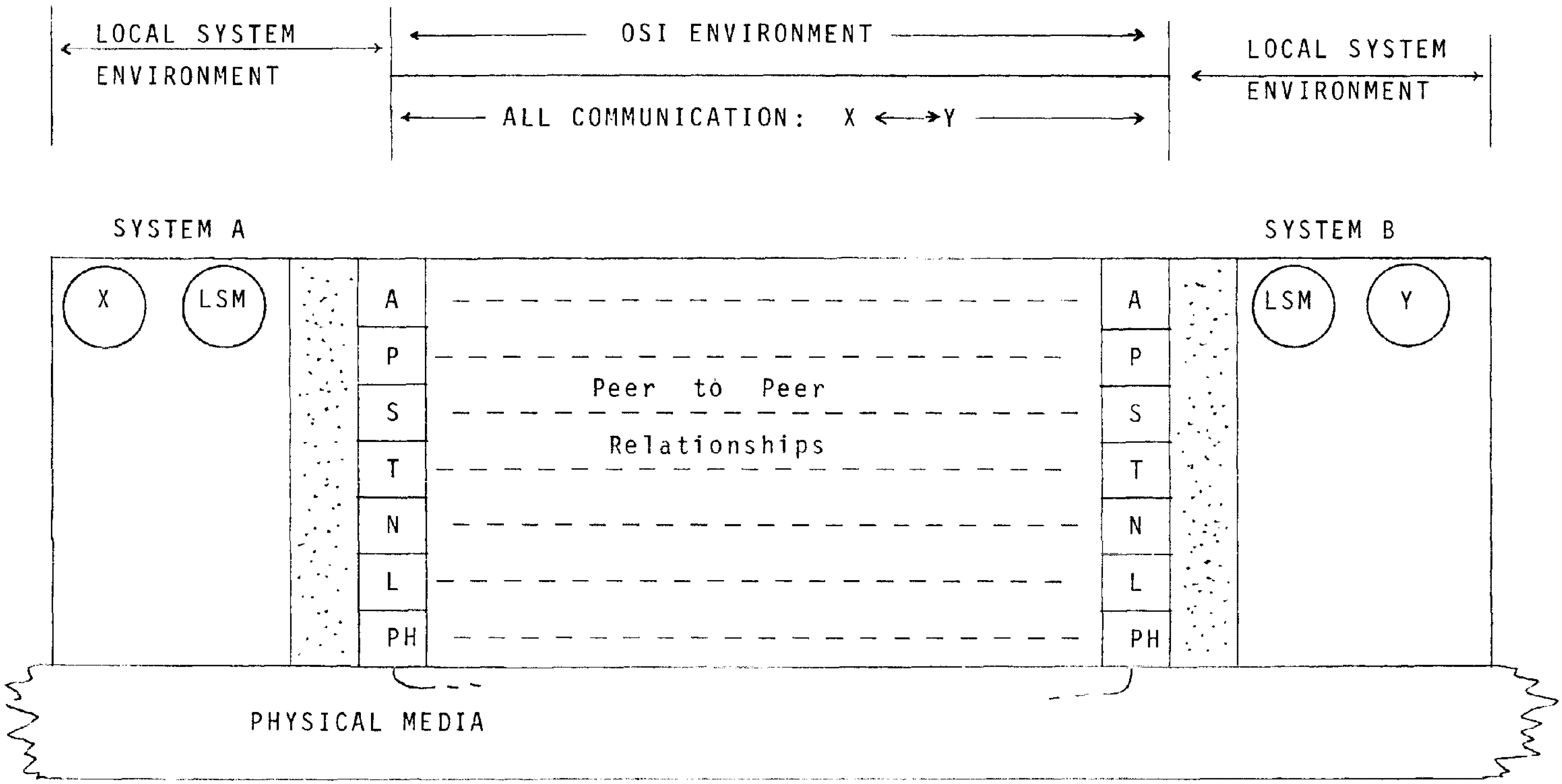


Figure 4.2. Interconnection of two local system end users through an OSI environment.

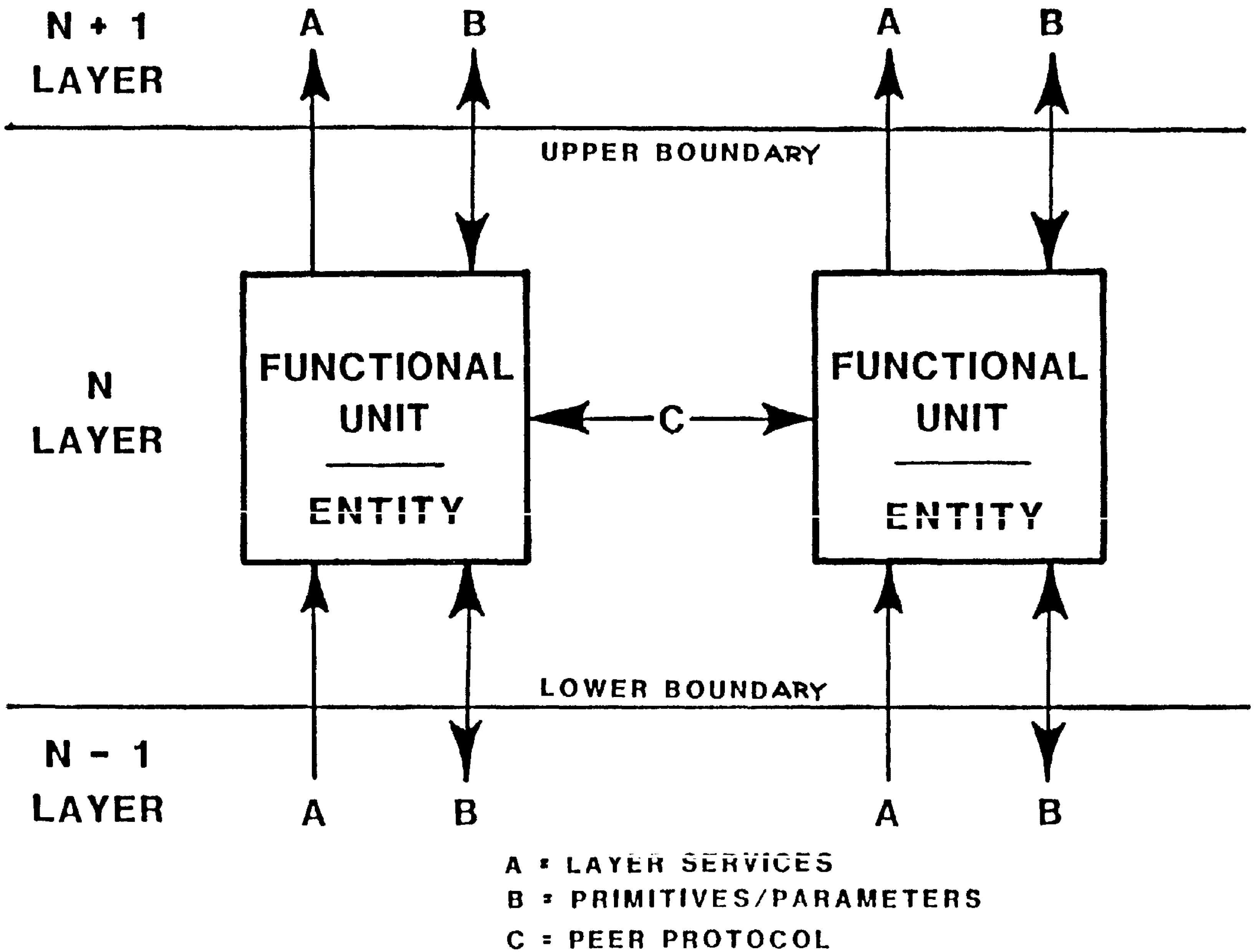


Figure 4.3 A pictorial representation of an OSI layer.

4.2 Scenario of OSI Use

The following scenario, based on Figure 4.4, gives an idea of how an OSI communication might work. Ordinarily, there would be several end-user systems involved in the interconnection, with several intermediate nodes along the way for network switching and relay. (Relay functions are identified for each of the lower three layers at the present time, but upper layers could also be useful for specific applications.) Figure 4.4 indicates only two end users and does not include any nodes.

As illustrated in Figure 4.4, X wishes to originate communication with Y; X asks the application layer to set up the connection. The application layer checks to see that the OSI resources are available, and then proceeds.

The overall process can be described as follows. The information flow will occur vertically downward from X, through the layers, to the physical transmission media. After switching, modem conversion, relay, etc., the information is transmitted vertically upward to Y, which completes the end-to-end transmission.

A detailed view indicates the activation of the layers, one by one. As the data units are passed through each layer, starting with the originating application layer, the peer protocols of layer operation (12 separate operations) are processed. The diagram illustrates each protocol header that is appended to the data by a given layer before passing the data and attached header (the combination now called a data unit) down to the next layer. These headers convey the peer-to-peer control information within a layer to facilitate the communication itself.

As the data unit flows from the transmission medium to the receiver Y, the functional unit of each layer removes the header--its peer control information--processes it, and passes the information up to the next layer where similar operation occurs. Eventually the information is received by Y.

The OSI designers intend that only the functions required for a specific information transfer from one AP to another need to be used. The total amount of functionality is offered to provide communications where there are large differences between the systems that are trying to communicate.

4.3 Efforts in the Standardization of the OSI Reference Model

It took 4 years, from March 1978 to March 1982, to achieve an agreed-upon draft international standard for the reference model. The schedules for OSI standardization work develop with an awareness of the relative importance of

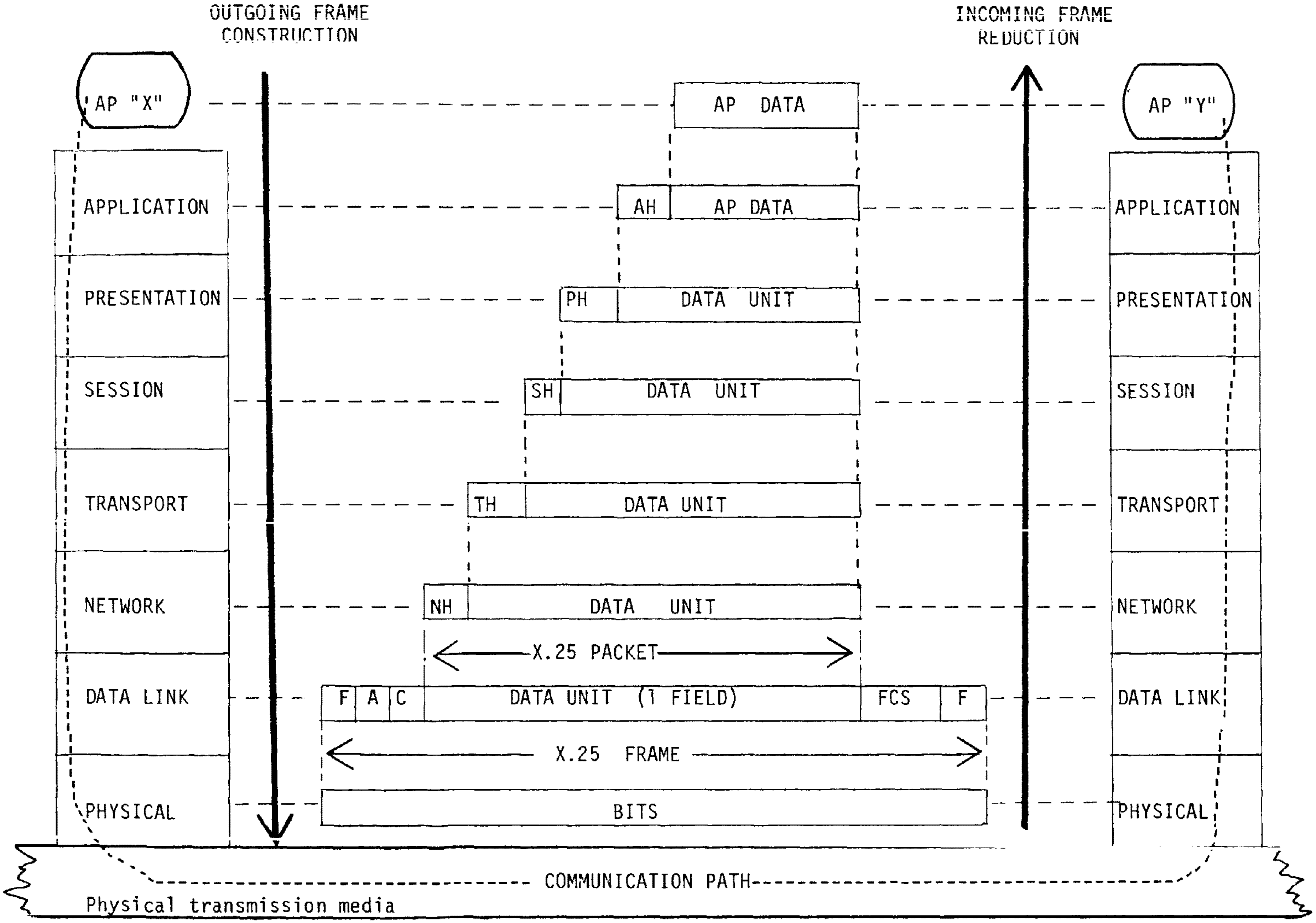


Figure 4.4. An example of how an OSI communication might work.
(Courtesy H. Folts, 1982)

the various aspects of the model. Everything is not of equal significance. The major effort, to date, has been on the user's need to have a single worldwide transport-layer standard. Attention has now turned to the session layer. The following illustration is offered to indicate the importance of the transport-layer protocol.

The OSI architecture can be likened to a wine glass. The broad base is composed of the many different technologies for implementing connections in physical arrangements, such as LAN's (local area networks), metro networks, cellular radio, etc. The top of the glass is constituted of many different application protocols appropriate for moving different kinds of data and presenting them in different ways. The stem of the glass represents the middle of the OSI Reference Model architecture by which reliable, bottom-to-top (end-to-end) transfer of bits can be achieved. There must be only one world standard for this transport, applicable to any network used.

4.3.1 Overview

The aim, at present, is to achieve a complete set of OSI protocols by 1984. Definite and encouraging progress in the transport studies has been made. On June 1, 1982, in Tokyo, SC-16 voted to accept the transport layer service and protocol standards as Draft Proposals (DPs). This was an extremely significant step because it is the first time--since agreeing on the reference model principles themselves--that both ISO and CCITT reached consensus on an OSI standard. The 2-year effort to reach this goal and the success of the challenging cooperative venture has provided momentum to apply the newly developed mechanisms and procedures to continuing work.

The present plans of SC-16 aim at achieving a single world session standard by early spring of 1983. This standard will offer the definition and control of the "pipes" transporting the bits. The application of both standards, transport and session, provides the desired variety of uses of these pipes across all the different networks. When this is achieved, OSI will become really useful in the sense that equipment can be plugged in anywhere to achieve end-to-end connections for any purpose.

There is a similarity between these goals of the OSI and the goals of the ISDN. The designers of ISDN standards are also aiming at one, universal interface. There can be many ISDN's, many services, etc., but the fundamental objective is to take any piece of equipment, "plug it into a socket," and achieve services across that interface.

4.3.2 Proposed Schedule for OSI Studies in TC-97/SC-16

Figure 4.5 is the SC-16 schedule adopted in Tokyo in June 1982. Although this 4-year plan has not yet been fully integrated with the schedules of other groups working on OSI, it does represent the first extended schedule of SC-16, based on the work already accomplished. Figure 4.5 represents the following project goals:

1. Reference Model (Project No. 1 in the figure): The draft international standard (DIS in the figure) was achieved in March 1982, and the international standard (IS) is expected to be accepted in early 1983.

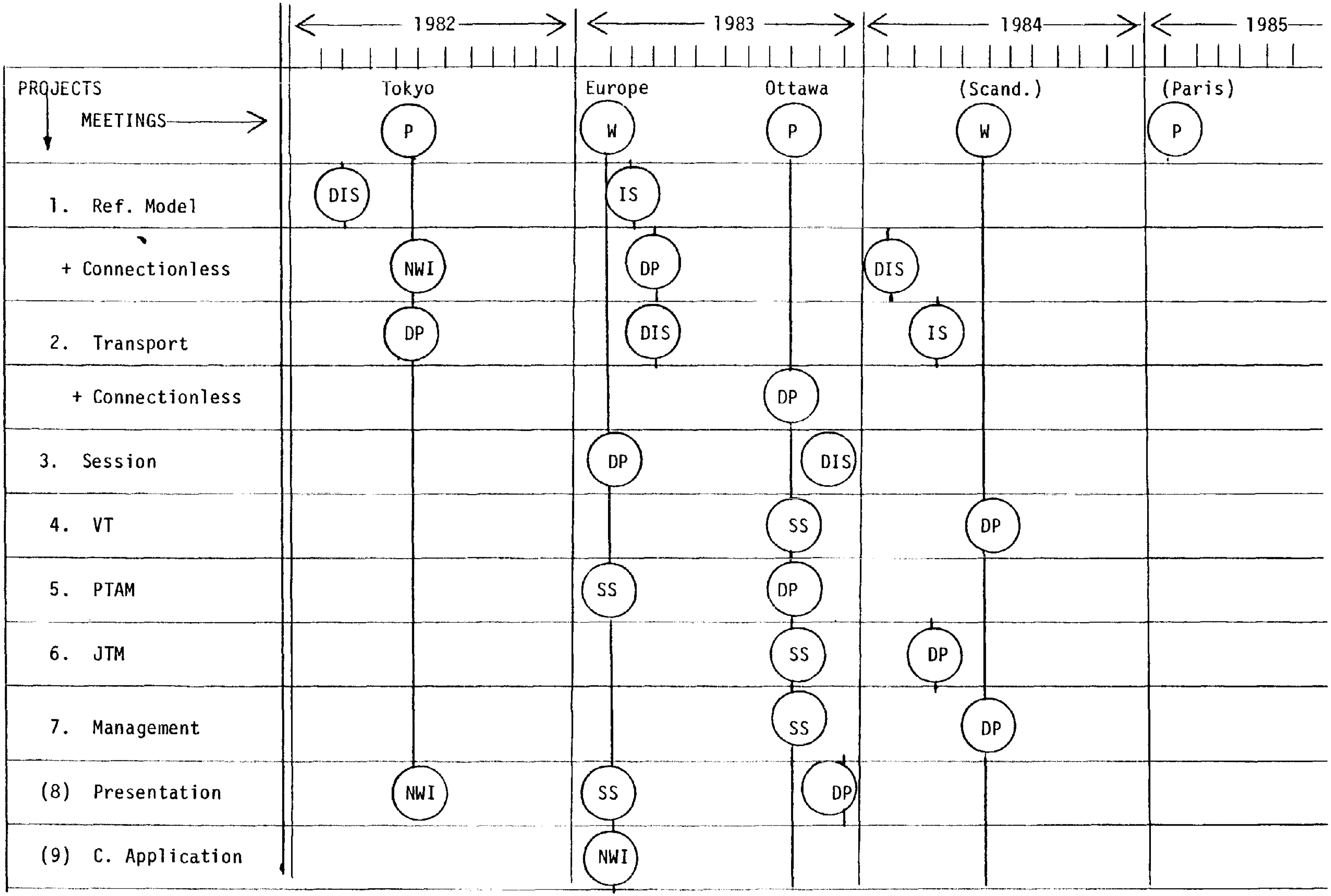
   The basic reference model is connection oriented and, as such, it fits the X.25 virtual circuit nicely. But there has been some disagreement concerning its adaptation to the connectionless (no return from the recipients) mode of interconnection. This has been studied for a year and a half under the instigation of the United States, and SC-16 added it as a new work item (NWI) in June 1982. The goal is to add a connectionless addendum to the reference model indicating that the connectionless mode does fit the OSI. A draft international standard is hoped for by 1984.

2. Transport Layer (Project No. 2): The accepted draft proposal (DP) of the transport layer is the second landmark so far achieved in SC-16. An interim terminal standard is expected in 1984. In keeping with the new work item (NWI) in the connectionless mode, studies in a connectionless transport addendum could be added by late 1983. (See Figure 4.6 for a pictorial, somewhat tongue-in-cheek history of the transport protocol agreement).

3. Session Layer (Project No. 3): ISO, as well as CCITT, is working diligently to have a draft proposal ready for 1983, and a DIS by late 1983. As the session-protocol work is progressing, stable service definitions are being developed for two important upper layer protocols--presentation and application.

4. Project Nos. 4 to 8: Work on the presentation layer (in the Tokyo meeting) forged agreement that all of the different applications (e.g., virtual terminal [VT], virtual files and messages) required a common representation of the syntax transformation. This common representation would assimilate the many different representations, the number dependent upon the "n" different applications used. This NWI, generated in Tokyo in 1982, is a formalization of agreements already reached on the presentation service, and so a stable service definition should be reached by early 1983.

   Achieving a stable service definition for the file transfer access manipulation (FTAM) should be reached at the same time (February 1983). October 1983 should see presentation and FTAM draft proposals. This same meeting is expected to achieve stable service definitions for the other principal application services, namely, the virtual terminal services (Project No. 4), the job transfer manipulation (JTM) service (Project No. 6), and the management service (Project No. 7).



DIS: Draft International Standard; IS: International Standard; DP: Draft Proposal; NWI: New Work Item;
P: WG/Plenary Meetings; SS: Stable Service Definition; W: WG Meetings Only.

Figure 4.5. SC-16 4-year plan.

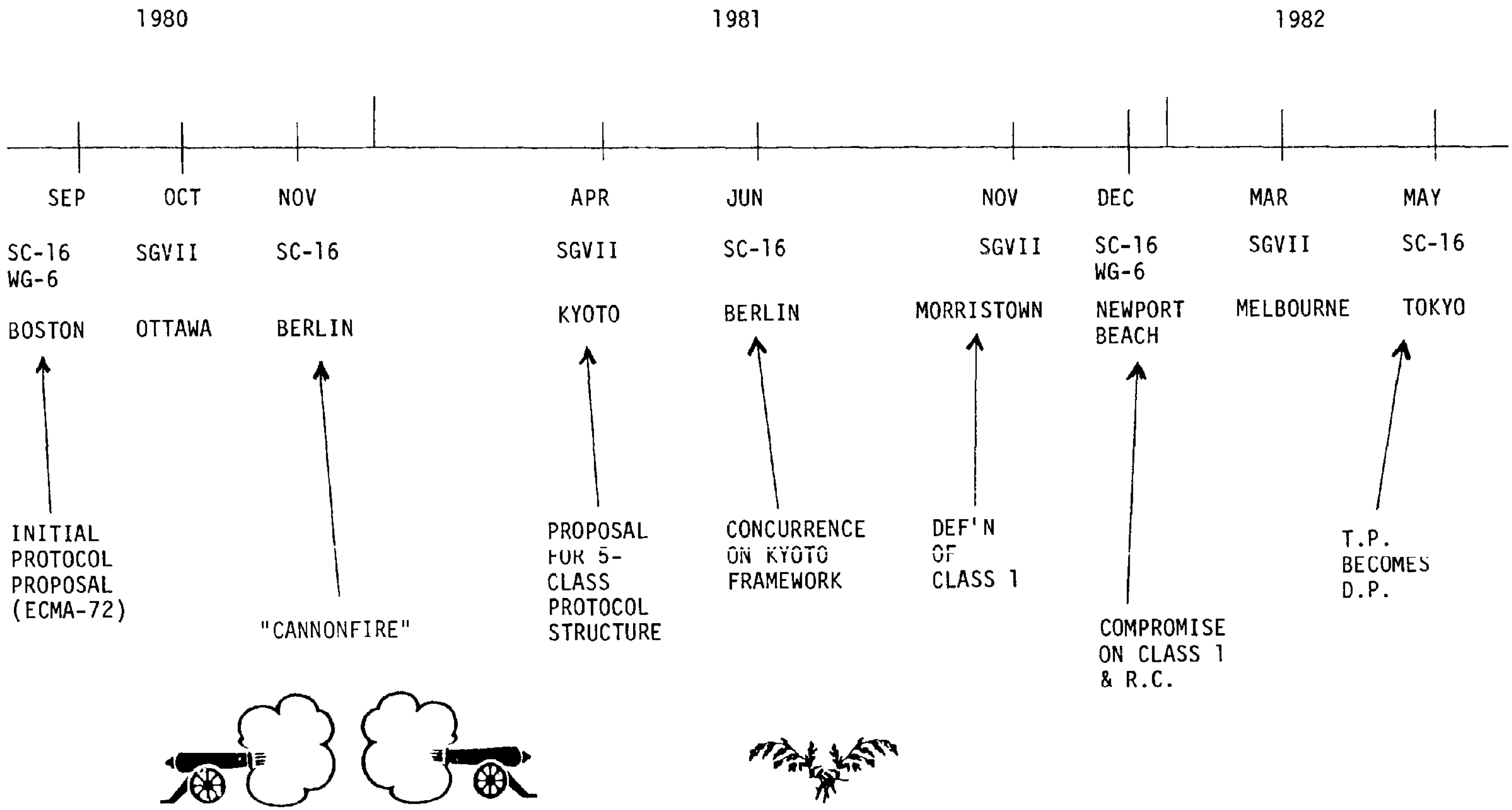


Figure 4.6. Chronology of transport protocol agreement.

5. Common Application Layer (Project No. 9): In addition to this work, there is still some definition to be achieved in the application layer. This is the other major topic being studied before the February 1983 meeting. The achievement of a common application layer definition and its actual partitions is expected. The CCITT OSI model differs from that of the ISO in that the CCITT has identified three types of applications entities--the common entity, the user entity, and the application specific entity. The SC-16 will be looking at that particular type of partitioning for the application layer within ISO. If this architecture is decided upon, then the other application services will have a stable common application base upon which to build.

4.3.3 CCITT/OSI Liaison in OSI Development

The OSI Reference Model is truly an international standard in that both CCITT and ISO have been, and are, deeply involved in its development, even though it is usually referred to as an ISO standard.

Different Perspectives

These organization approach the work from different and changing perspectives. The historical orientation of the CCITT is toward the lower (network-oriented) layers of the model, while the orientation of ISO SC-16 is toward the upper (systems-oriented) layers. In addition, the CCITT has generally had a public focus in the development of its Recommendations which apply to services provided for wide-scale, general use. The standards makers in ISO (largely equipment manufacturers), on the other hand, bring to the standards forum more experience in private user environments, which tend to be more deterministic and driven by a more specific scope of requirements. Both organizations are now moving into each other's historical territory, so to speak: the carriers (in CCITT) are now very interested in supplying services, which are really systems applications, and as such, require user input, and the manufacturers (in ISO) are now very interested in manufacturing and supplying networks.

The difficulty of bringing together these different, and dynamic, perspectives to a point of agreement on a common set of standards to allow every system in the world to communicate is easily seen. One factor contributing to the difficulty of this cooperative venture between the CCITT and the ISO is the already existing structural complexity in both organizations. Fortunately, both organizations have committed themselves to the goal of developing a single set of OSI standards.

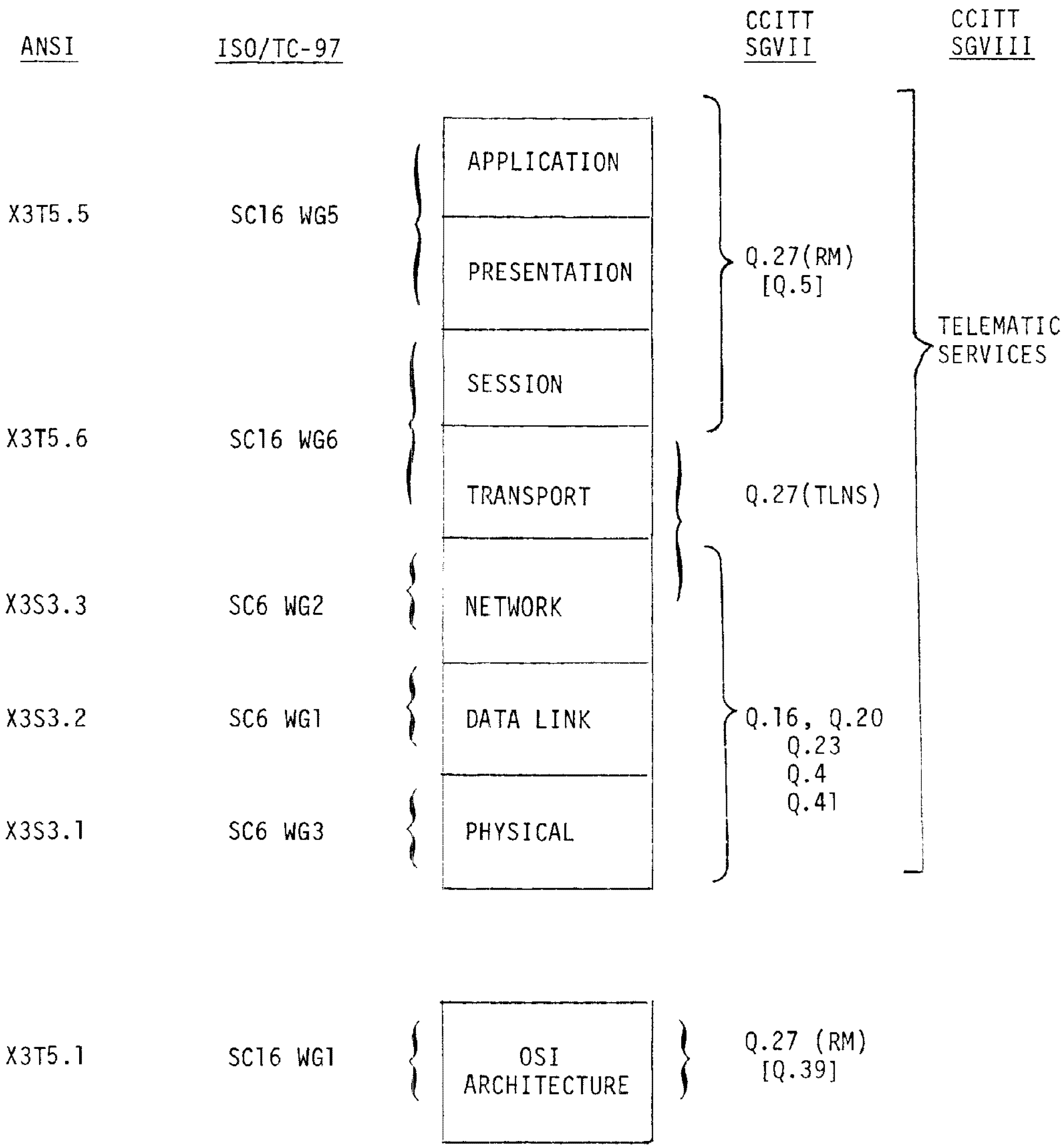
Organization of Work

Figure 4.7 illustrates the organization of OSI work in both ISO (and ANSI), and the CCITT. The work in ISO is conducted in SC-6 and SC-16. For each WG in ISO, there is the corresponding ANSI TAG in the United States. Corresponding to this structure is CCITT Study Group VII. From an OSI perspective, the most important question in this study group is 27/VII (Q.27 in Figure 4.7), although, as can be seen, at least seven other Study Group VII questions are also relevant. The CCITT Study Group VIII, which studies the technical aspects of the telematic services (see Section 2), is also involved. The CCITT Question 27/VII has been divided into two sections: issues on reference model architecture in general (and the top three layers in particular), and the issues of the transport layer and network services.

In addition to the work of SC-16, indicated in Figure 4.7, TC-97/SC-13 and TC-97/SC-18 are also working on the reference model and OSI protocols. The SC-13 is active in the interior interconnection of the parts of a data processing system. The SC-18, the newly formed group on text processing, is working on such issues as message format and message handling protocols, which will be compatible with the OSI Reference Model. In the future, any kind of information object that could be defined by one of the powerful new languages, for instance, that allow abstract data packing to be represented in the syntax of the language itself, could be transmitted across the OSI environment. This leaves the door open to the applications in the late 80's and 90's of a distributed processing of true remote automation control and interprocesses communication, and synchronization. The OSI will open up the world of the information society in many ways.

The CCITT grapples with several issues related to the OSI, such as the abundant questions on existing public data network technologies, and the effect of newly developing (as well as already developed) CCITT Recommendations on the lower layers of the OSI architecture.

A major point for both ISO and CCITT members is the difficulty of participating in all the groups indicated in Figure 4.7. As an example, to participate in the work of only two OSI layers--transport and network--involvement in the work of atleast 11 groups is required: five ANSI groups, three SC-16 groups, and three CCITT groups. This is an enormous investment in energy, time, and money, and yet the work demands this kind of liaison. The cooperation is at many levels--among manufacturers, among carriers, and among international organizations themselves. This extensive cooperation required in standards work on the OSI spotlights the need for active participants.



RM = Other Reference Models

TLNS = Transparent layer and network service

Figure 4.7. Organization of OSI work.

4.4 The Relation of OSI to Other Technology

The following discussion indicates the relationship of OSI to Recommendation X.25, manufacturers' standards, and to Local Area Networks.

4.4.1 OSI/CCITT Recommendation X.25

The CCITT defined the three levels of Recommendation X.25 in 1976, preceding the draft OSI Reference Model by 6 years. The three X.25 levels--the physical, link, and packet levels--do correspond with the first three layers of the OSI Reference Model. Because of this, Recommendation X.25 is often considered an early OSI protocol.

4.4.2 OSI/Manufacturers' Standards

All operating system development of a distributed nature has internal layering, and the issue becomes, "How does this layering map into OSI?" The ISO has picked the model of the OSI which best matches the needs of the people who participated in its development.

Every major manufacturer of computers in the United States is represented on SC-16. Many of the manufacturers are multinational companies with international operations. Each of these companies is participating in OSI studies precisely so that the OSI model can represent the best possible compromise between the layering inherent in their particular architecture and that of the OSI.

For example, while OSI is being developed to provide an international standard architecture and set of protocols, IBM's Systems Network Architecture (SNA), which is widely implemented, provides somewhat of a de facto industry standard. A migration from SNA to OSI is possible because both have layered architectures. Some of the functionality can be tracked layer by layer. There are differences, also. Some layers of SNA are minimally functional compared to OSI, and some layers of SNA are more finely subdivided than they are in OSI. The general correspondence is shown in Figure 4.8.

4.4.3 OSI/Local Area Networks

The relationship of the OSI to LAN's has been considered in great detail by TC-97/SC-16. This subcommittee has asserted that the fundamentals of the reference model do apply to LAN's, with possibly some extensions to be developed. In fact, both the LAN standardization in IEEE, and the hyperchannel standardization in ANSI provide the dividing of the standards into physical

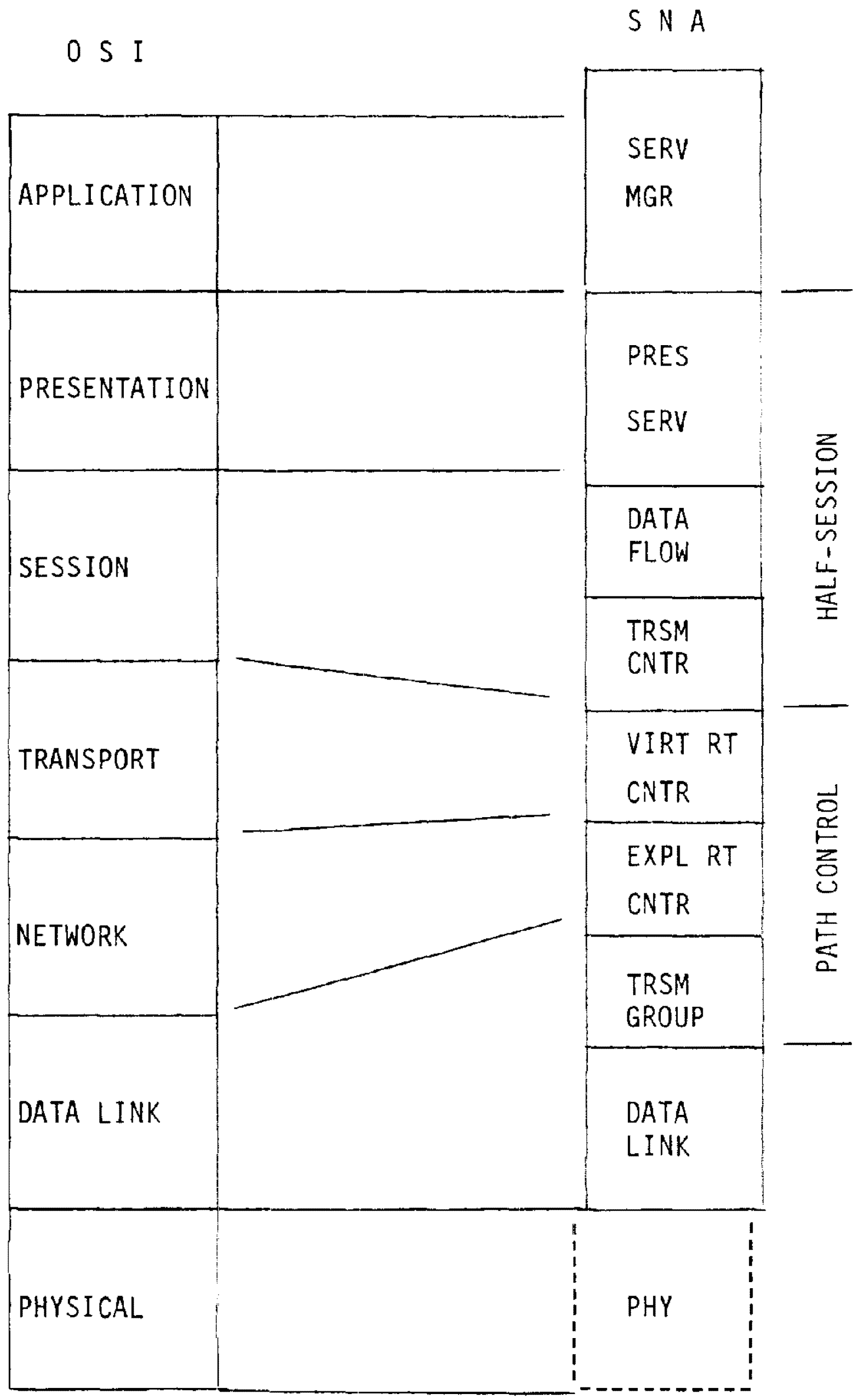


Figure 4.8. General correspondence of the OSI and SNA layers.

and data link layers that are compatible with the reference model. In the layers above the data link layer, the complicated problem exists of interconnecting all networks--LAN's--with each other and these with long-distance and metropolitan area networks. This interworking problem (a current project of TC-97/SC-16) applies to the network layer of the OSI and is fully recognized. Beyond that, the problems associated with the upper layers peer-to-peer connections between the end systems apply, regardless of the networking when heterogeneous data systems attempt to communicate with each other.

4.5 When to Implement OSI

Since the principles are established for OSI, the time to start using it is now. The OSI, which is basically a framework for the standardization of the rules governing the interactions between interconnected systems, will never be "finished." It will be an on-going subject, evolving over the years. By starting to apply OSI now, the system will grow into an OSI system as the standards evolve. Early implementation appears to be the only practical way to gain the benefits that are already offered by this structure.

5. AN INTERNATIONAL SYSTEMS-PLANNING STANDARD: THE INTEGRATED SERVICES DIGITAL NETWORK (ISDN)

The unprecedented interest that was generated worldwide in the CCITT studies on packet data networks in the 70's, as indicated in Section 3.7 (Recommendation X.25), is evident again in the CCITT studies on the ISDN in the 80's. Even though the real implementation of the ISDN is years away, the worldwide interest is resulting in pressure to get the standards now.

This section of the report does four things:

1. It presents an overview of the ISDN. This is complementary to the discussion of the work of CCITT Study Group XVIII in Section 2. Specific issues and problems associated with ISDN concepts in the United States are included.
2. It reviews a preliminary survey (CCITT Study Group III) that attempted to gather views, worldwide, on the ISDN.
3. It presents a summary of the three ISDN draft Recommendations from Study Group XVIII.
4. It offers a perspective on the ISDN from several quarters of the telecommunication community--that of telephone carriers, data carriers, information system planners, and users.

5.1 An Overview of the ISDN

The overall concept upon which the ISDN is based is a simple one, and two technology trends have promoted its development. First, more and more of the telephone network is becoming digital in switching and in transmission. This trend is expected to continue and even to accelerate. Second, the providers of many other services that were originally analog (e.g., facsimile) have found it economically advantageous to go digital, exploiting the rapid advances in integrated circuit technology.

These two trends taken together make it seem very logical to progress by relatively small steps toward a totally digital, end-to-end network that could support almost any kind of communication service, analog or digital. However, it must be recognized that the phasing out of the present telephony analog network will take a long time.

The ISDN concept is defined in very general terms, and is open to different opinions and interpretations. For example, the telephone network is rather central to the concept, although the CCITT definition of the ISDN in Recommendation G.702 (vocabulary) refers to any network that provides more than one service using shared facilities. Thus, a network providing data and facsimile over common digital switches and paths would qualify as an ISDN. However, since the telephone network is the only one that reaches almost everyone and so can provide total connectivity, current concepts in the CCITT (G.705) view the ISDN as "based on and evolving from the telephone network." Our discussions here are based on this approach.

The ISDN seems to mean different things to different people and also stirs varying--and often contradictory--reactions. Some concepts of the ISDN are: the ISDN will be a single, worldwide ISDN; each country will have an ISDN with a high degree of connectivity with other ISDN's; there will be several ISDN's possible in one country, with varying degrees of connectability; the capability of the ISDN to provide all kinds of services will eliminate other telecommunication providers and may actually severely restrict customer-service choices; and the ISDN will enable many new services. Clearly, the beauty (or lack thereof) of the ISDN lies in the eye of the beholder, i.e., in his or her expectations or fears, as the case may be. It is equally clear that, at this time, it is impossible to arrive at a common understanding and agreement on the exact scope and nature of the ISDN.

Objectively, the present telephone network is, to a significant extent, an integrated services network. Via the local loop, one can access such nonvoice services as facsimile, data (via modems), message handling services, data bases, etc. The "U.S. telephone network," which provides access to these services, is one network, although it consists of 1600 telephone companies (including some long-haul competition).

Similarly, it is possible that the United States will one day have a "U.S. ISDN." This ISDN will be made up of many constituent parts and will include competition in different segments of the network. All will be compatible and integrated so that, from the user's side, it will appear to be one network.

From all indications, the continuing and ever expanding use of digital techniques in transmission and switching for economic reasons means that the public telephone network will inexorably evolve into an integrated services digital network. Therefore, it is not the evolution in itself that has made the ISDN a major subject of international importance, but rather the philosophy in the planning and design of the future network and of the subscriber access to that network, including the interconnection of constituent (telephone and nontelephone) networks, and of peripheral networks (e.g., private networks).

5.2 Issues and Problems in the United States

There are many factors in the U.S. environment that must be resolved prior to the implementation of an ISDN. There is a multiplicity of common carriers and a multiplicity of private networks to be connected to the public telephone network, or public ISDN. (There are countries in Europe with this latter problem as well, but not on the same scale as that of the United States.)

The multiplicity of international common carriers presents yet another problem, as does the separation between voice and record carriers. Implementing the ISDN in this environment raises questions, some of which are internal to the U.S. scene.

One of the goals that is unique to the United States is the promotion of competition in telecommunications. This concept of competition exists to some degree in some other countries (e.g., Canada and the United Kingdom) Implementing the ISDN in a competitive environment will result, it is believed, in the best possible service at the lowest possible cost.

In solving these problems, the United States should be aware of the international climate. The United States also should not block efforts toward an international ISDN just because some of those efforts do not fit the U.S. environment.

Two things are certain. The user in the United States is increasingly communicating with countries overseas, and the U.S. user should not be denied the advantages that might accrue from the ISDN. Cooperation in developing standards is therefore essential.

5.2.1 Technical/Economic Issues

One example of a problem that is unique to the U.S. environment concerns 64-kb/s digitized voice. In the United States, the 64-kb/s digitized voice is not economical over the length of trunk circuits used on long-haul communications. It is economical for short-haul circuits as long as perhaps 200 miles (320 km), like the ones found more typically in Europe.

This situation has resulted in a major effort toward using lower bit rate digitized voice. At the moment, 32-kb/s digitized voice is being strongly considered; chances are very good that in the CCITT there will be a Recommendation for 32 kb/s within this study period. In principle, it may be established by next June (1983) when Study Group XVIII meets again (see Section 2.3.3).

What effect will this have eventually on the ISDN? The ISDN is presently based on 64 kb/s. This is not likely to change because most of the established short-haul digital trunks will continue to operate at this rate. The real problem, however, is not transmission but switching. Switching for ISDN is, at present, presumed to be at 64 kb/s, and sub-rate switching is not generally accepted. Another problem is that a long-haul ISDN connection set up for voice might contain 32-kb/s trunk sections and thus not be a "transparent 64-kb/s pipe" (as ISDN connections were originally thought of).

An appreciable part of the local loop plant may not be able to support the full ISDN interface capabilities. Is replacement of that part of the loop plant (or the entire loop plant) justified? These, too, are real questions.

One advantage of a standard interface such as that dealt with in Recommendations I.xxx and I.xxy is that terminal portability will be available. This means, for example, that the terminal used at the office could be taken home and plugged in for operation. This feature will obviously have some effect. Having the interface standard, alone, does not guarantee the portability feature, however. The data rate at home must be the same as that available at the office, or the terminal must be capable of operating at several data rates. It is necessary to examine the related costs, as well as the terminal equipment costs, in this situation.

Hybrid schemes are being discussed which would allow a portion of the present network, during a transition period, to be used in conjunction with the all-digital portion. This feature has some limitations and some consequences for terminal manufacturers. Not all customers will have requirements for all of the services to be available from the ISDN; the ISDN's full capability will not be needed by everyone. Furthermore, for many decades the bulk of transmissions, and the bulk of the revenue, will still be just ordinary voice communications--digitized or analog.

The requirements that are imposed on the network by the different services--by voice communications, by data communications, by high-speed facsimile communications--may be different. Costs must be examined here, and the question must be asked: will all classes of users pay their fair share? Care must be taken to avoid cross subsidization (even unintentional) resulting from building a network to the highest requirement when 80% or 90% of the time that network would be used only for a lower requirement.

5.2.2 Role of the FCC in the ISDN

The FCC has established an intra-agency task force on the ISDN. It is made up, primarily, of persons who were somewhat involved in helping to write Computer II and/or the recent competitive carrier rulings. Obviously, they will try to maximize the understanding of what Computer II means both domestically and internationally.

This task force monitors the domestic activities of the ISDN and evaluates their relationship to the efforts of the CCITT. Anyone--carrier, manufacturer, user--who would care to give input to the work of the task force is encouraged to contact the FCC in this regard. (The chairman of U.S. CCITT Study Group A has volunteered to be the liaison for this information.)

5.3 The International Scene from the U.S. Perspective

How does the international scene look? Is the United States being forced by the Europeans into standards that are mainly responsive to the European view of the ISDN and the PTT environment?

The Europeans are very serious about getting ISDN standards soon--with or without the United States. In other words, if not in CCITT, they will establish standards in CEPT (or otherwise), and they will set European rather than world standards. Europeans do want standards, soon on the whole, because early standards would permit them to put their ISDN-development efforts and money in the direction of least risk.

However, the Europeans have a vivid memory of the multiplex hierarchy standoff of some years ago that resulted in two PCM standards--the North American and the European. Although there were many reasons for the dual standards, no one really enjoyed the process.

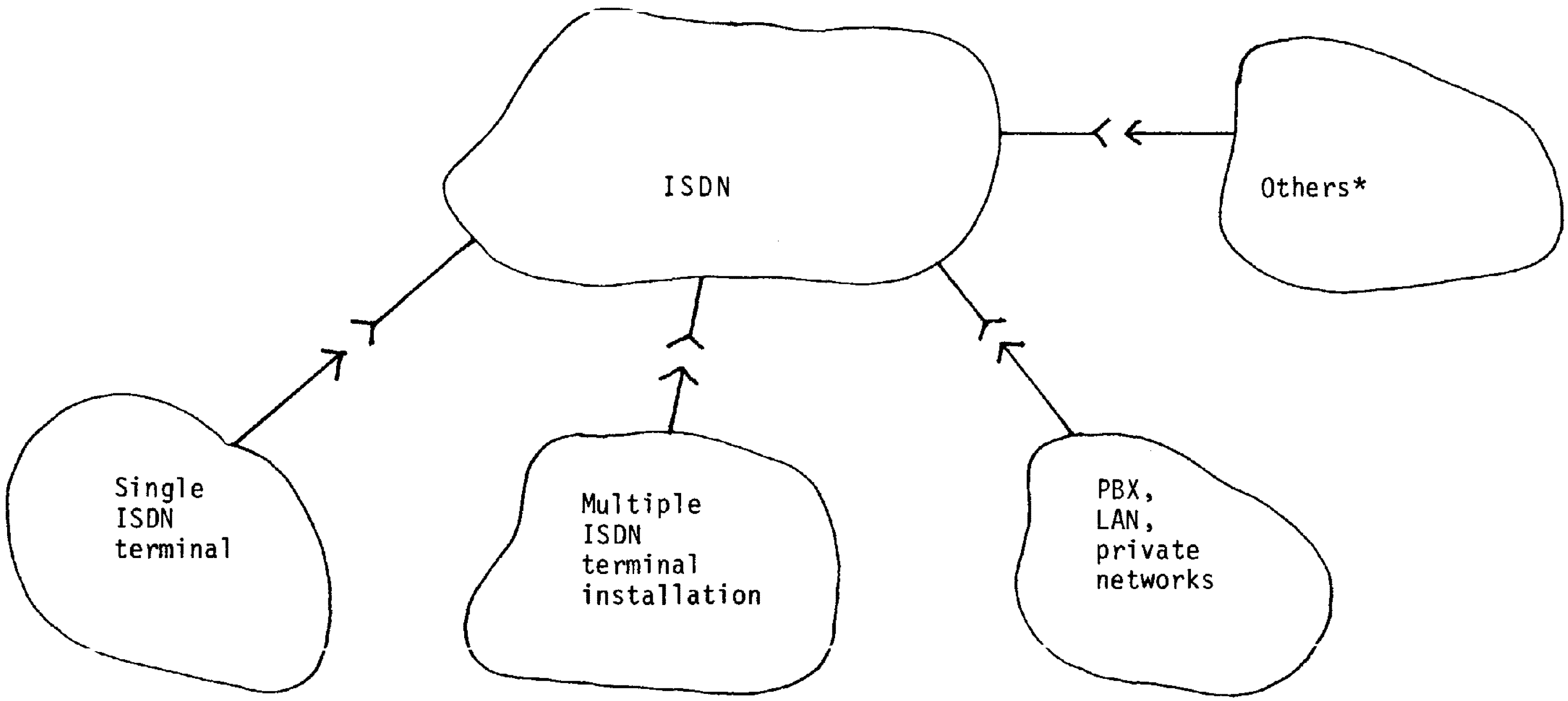
And just as the Europeans are willing to work very hard to avoid a similar occurrence, so is the United States, who also learned a lesson. Everyone is now more receptive and sensitive to the importance and benefits of common standards.

So far, the visible results in ISDN standards work have been modest, with most of the effort centering on mutual understanding, and building mutual trust. A severe test of this mutual trust was made during the Study Group XVIII meeting in June 1982. The United States delegation did not favor using the accelerated procedures for early approval of the three ISDN draft Recommendations, although the European administrations wanted this. The U.S. delegation successfully conveyed to the study group members that the reasons for its objections were not the principles of the Recommendations, but the ambiguity of the terminology that could result in serious misinterpretation. At present, the three Recommendations are being refined and clarified (see Section 5.4).

The ISDN concept presents opportunities as well as challenges and problems. But the moment is here to move forward and to work at agreement on common standards before individual investments in different countries or different groups have grown so large that agreement would be totally impossible.

5.4 Three ISDN Draft Recommendations (1982)

The three draft Recommendations of CCITT Study Group XVIII, referred to in Section 5.1, are labelled I.xxw, I.xxx, and I.xxy. The following discussion is based on the February 1982 version of these three documents (Appendices A through C). Before this report was printed, a Study Group XVIII drafting group (Geneva, November 1982) editorially refined these drafts for presentation at the June 1983 meeting of ISDN experts (see Section 5.3). These drafts are also included in this report in Appendices D through F. However, in keeping with the report policy detailed in the report Introduction (page 2), the changes have not been incorporated into the following discussion or figures. It is instructive, however, to read Section 5.4 with the revised version in hand.



*Depending on national regulation, this may include:
1) specialized services networks;
2) other carrier networks;
3) specialized information processing centres.

Figure 5.1. ISDN user/network interface examples.

5.4.1 Draft Recommendation I.xxw

Draft Recommendation I.xxw is entitled, "General Aspects and Principles Relating to Recommendations on ISDN User/Network Interfaces." This preliminary draft Recommendation defines the main feature of an ISDN as the support of a wide range of services, including voice and nonvoice services in the same network by offering end-to-end digital connectivity. The goal is a limited set of standard, multipurpose user/network interfaces for the ISDN. Therefore, an ISDN will provide a basic network transport capability for a variety of services, and will be recognized by service characteristics available through user/network interfaces, rather than by its internal architecture. This would permit user evaluation that says, "Yes, this does/does not meet the ISDN Recommendations." Recommendation I.xxw permits the incorporation of information storage and processing, depending on national regulations.

Figure 5.1 is a graphical representation from I.xxw demonstrating that the ISDN should serve at least all of the indicated purposes. The ISDN should relate to a single terminal, a multiple terminal, a more complex terminal arrangement (e.g., a PBX, a LAN), and be able to interconnect and interoperate with private networks and with other networks.

The approach one takes in analyzing these ISDN concepts allows either of the following points of view: an ISDN is one internetwork with many constituent parts, or an ISDN is a multiplicity of ISDN networks that interoperate.

5.4.2 Draft Recommendation I.xxx

Draft Recommendation I.xxx is entitled "ISDN User/Network Interfaces--Reference Configurations." Conceptual configurations are useful in identifying a variety of access arrangements, and they relate to two rather important concepts--the concept of reference points, and the idea that these conceptual reference points divide functional groupings. These reference points and these functional groupings may or may not correspond to physical interfaces, but they are used as a basis for agreement. (The reader interested in the relationship of these functional groupings to the OSI Reference Model is referred to I.xxx, Appendices A and D of this report.)

Figure 5.2 illustrates three basic reference configurations for user/network interfaces to be found in I.xxx. The square boxes represent functional groupings and the intersections marked by one uppercase letter (from the end of the alphabet), indicate the reference points. The letters and the numbers have the following (simplified) significance.

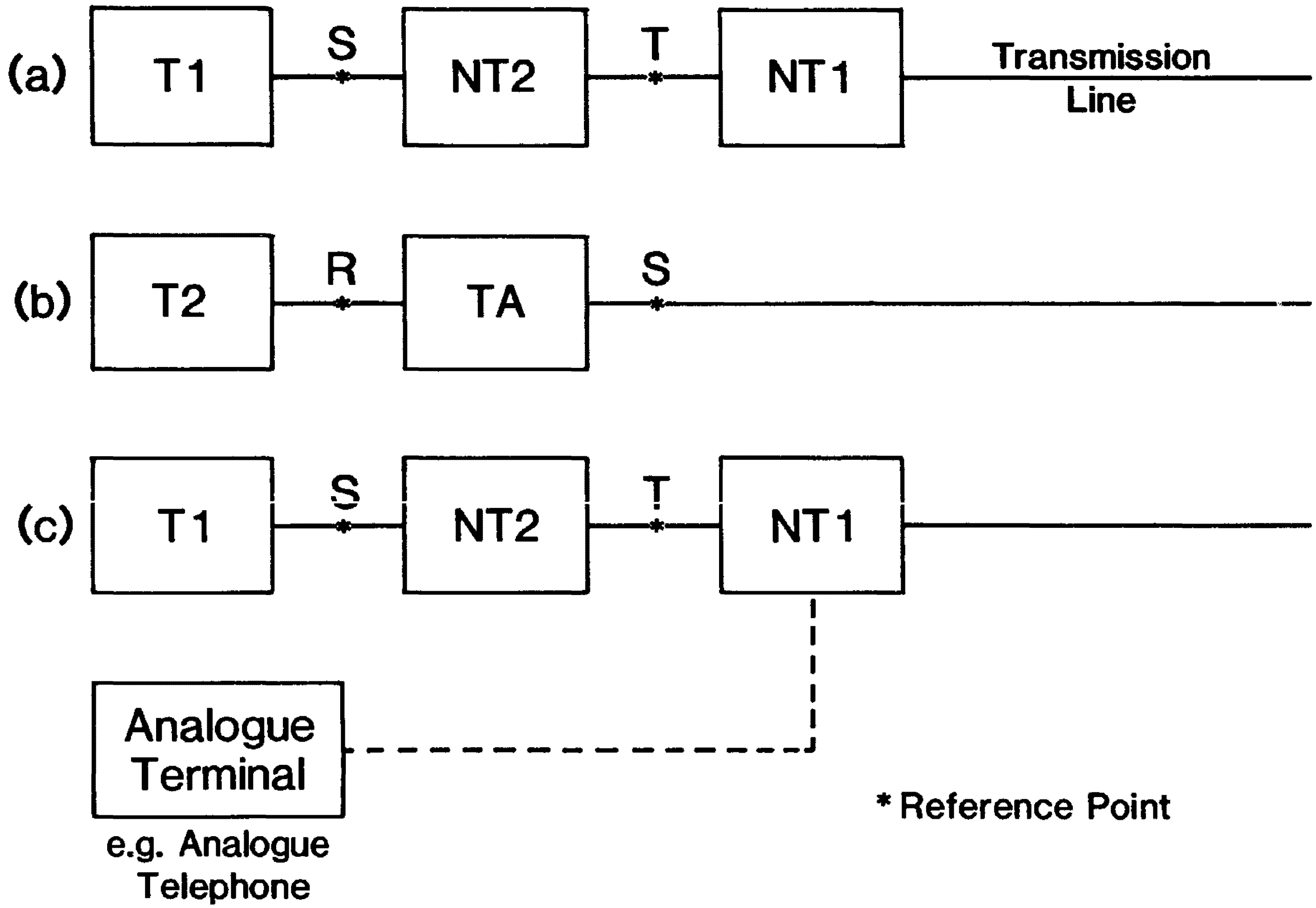


Figure 5.2. Reference configurations for three ISDN user/network interfaces.

Functional Groupings (sets of functions that may be needed in ISDN user access arrangements):

T1: terminal equipment that is ISDN compatible (capable of a direct connection to an ISDN user/network interface channel structure as specified in draft I.xxy)

T2: terminal equipment that is not ISDN compatible

NT1: basic network termination group (e.g., transmission line)

NT2: more complex network termination group (e.g., PABX)

TA: terminal adaptor (for T2's)

Reference Points (conceptual points dividing functional groupings--may also represent a corresponding physical interface):

R: a reference point that is not ISDN compatible (e.g., interfaces complying with other CCITT Recommendations such as X.21, X.25; or other existing interfaces)

S: a reference point that is ISDN compatible (enhanced services)

T: a reference point that is ISDN compatible (nonenhanced services)

Figure 5.2a illustrates the general ISDN configurations. Figure 5.2b shows the connection of a non-ISDN compatible terminal T2. If TA were to be included in T2 (e.g., as a plug-in module), then there might be no physical interface corresponding to R, and T2 + TA would in fact become T2.

Figure 5.2c illustrates a possible configuration for a variety of hybrid access arrangements. This configuration represents a transitional approach, one that involves an analog circuit (i.e., analog telephone) and a low-speed digital circuit.

Figure 5.3, found in I.xxx, offers some examples of user/network arrangements to show the correspondence between ISDN reference points and physical interfaces. In these diagrams, of varying complexity, there are S and T physical interfaces (—>)—) indicated at the reference points (—✳—); see particularly Figure 5.2. They do, in fact, still divide functional groupings and actual physical equipment.

5.4.3 Draft Recommendation I.xxy

The third Draft Recommendation is entitled "ISDN User/Network Interfaces--Channel Structures and Access Capabilities." To minimize the variety of physical interfaces, I.xxy defines a limited set of both channel types and channel

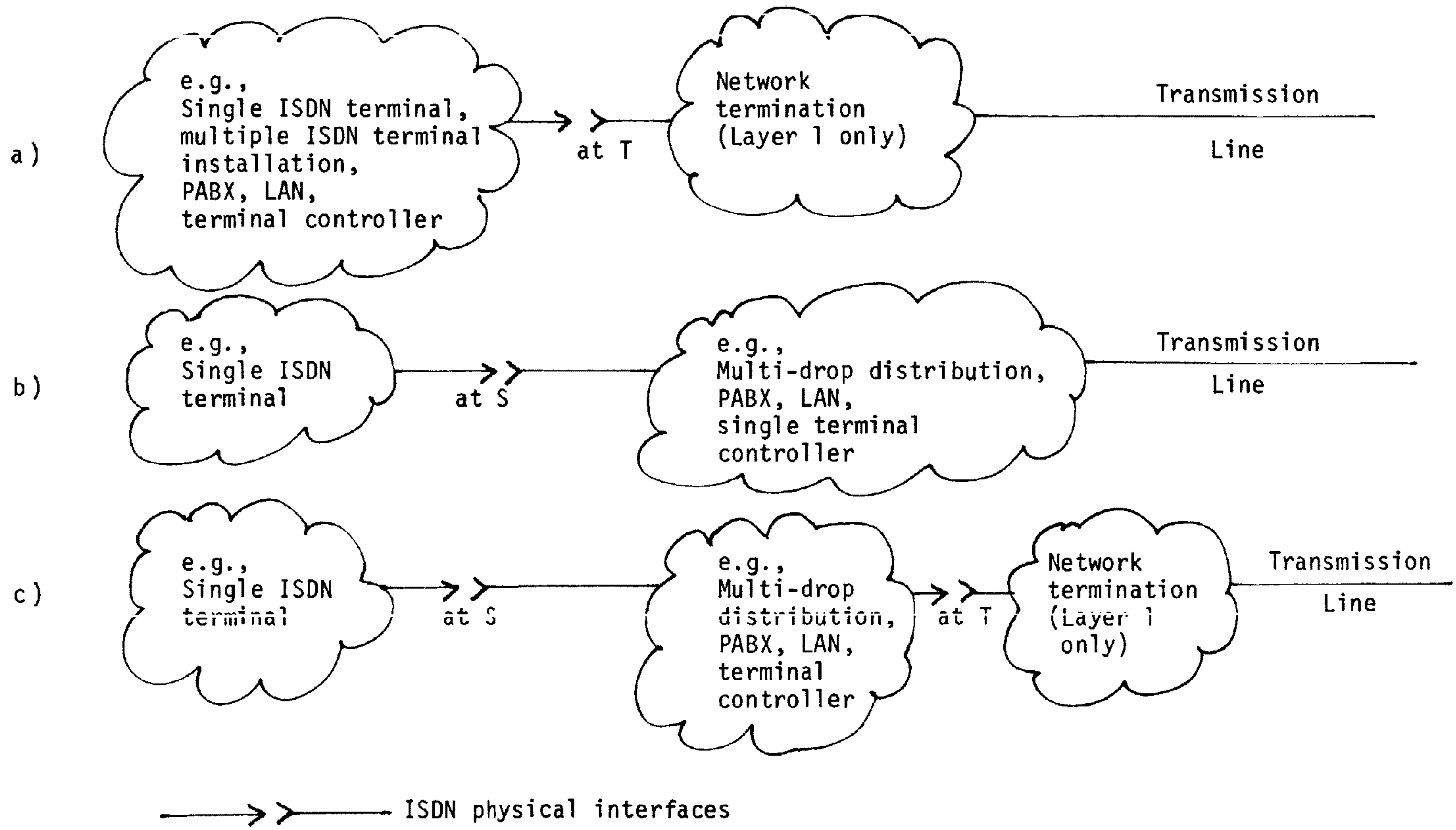


Figure 5.3. Some examples of the correspondence between ISDN reference points and physical interfaces in alternative ISDN user/network arrangements.

structures for such interfaces. Draft Recommendation I.xxy offers the following definitions of these terms.

A channel represents a portion of the information-carrying capacity of the interfaces through which it is carried. Channel types are combined into channel structures. A channel structure defines the total, potential digital information-carrying capacity across a physical interface. Access capability refers only to that portion of the digital capacity of the interface actually supported by the equipment behind it.

Channel Types

Draft Recommendation I.xxy has, so far, defined three channel types: B, D and C channels.

The B channel is a 64-kb/s channel. It should embrace traditional PCM voice at 64 kb/s; data--either at bit rates of 64 kb/s, or rate adapted to 64 kb/s; digital voice encoded at less than 64 kb/s and combined with data, carried at 64 kb/s to the same destination; and high-quality voice encoded at 64 kb/s.

The D channel, operating at 16 kb/s in some structures and at 64 kb/s in others, will carry primarily signalling information for controlling B channels, but may carry packetized data and telemetry as well.

The C channel, operating at either 8 or 16 kb/s, would embrace packetized data, telemetry, and signalling information, and is associated with an analog channel. It allows for the possible use of analog terminals (analog telephones) together with some digital services. (Signalling to control the analog channels may or may not be carried over the C channel.)

Other channels under study include broadband channels and higher rate channels and signalling channels for PABX access arrangements using Signalling System No. 7.

Channel Structures

Three channel access structures are defined in I.xxy: basic access, hybrid access, and primary rate access.

Basic Access: The basic channel access involves two B channels and one D channel (2B+D), and thus operates at 144 kb/s plus the necessary framing and overhead. With the basic access channel structure, two B channels and one D channel are always present at the ISDN user/network physical interface. One or both B channels, however, may not be supported beyond the interface. Therefore, the following three access capabilities are possible: 2B+D, B+D, or D.

Hybrid Access: This refers to the combination of an analog channel and a C-channel.

Primary Rate Access: These structures correspond to the primary multiplexing rates of 1.544 Mb/s (North American) and 2.048 Mb/s (European), consisting respectively of 23B+D and 30B+D channel structures.

Other channel structures under study include:

1. an intermediate access between the basic and primary access (possibly between 500 and 800 kb/s), and
2. a broadband access, which might embrace services that the basic 144+ kb/s cannot handle (e.g., 1.544 Mb/s access capable of handling 1.472 Mb/s + D).

5.5 Worldwide Views/Plans for ISDN Services

Study Group III's working group on Question 21/III (Working Party 1) is interested in the tariff, accounting, and marketing of services within the ISDN. These issues include such policy-related topics as resale, and the interconnection of these channels to telephone networks.

In late 1981, CCITT Study Group III's Working Party 1 distributed a "preliminary survey questionnaire on the plans for developing an ISDN." At the time, many members thought that concern with these issues might be premature; by June 1982 (when the three draft Recommendations were developed) the same members viewed the process as more timely.

The survey polled opinions on issues such as rate structures, the merits of the ISDN, which services might be included in the ISDN, specific tariff and policy problems that might arise when the ISDN is introduced, and the status of ISDN development for each country.

Based on the responses obtained from 14 administrations, the Special Rapporteur of Question 21/III prepared a tentative summary. The major points are presented below.

1. The transition to the ISDN will be lengthy. Also, the process toward implementation of the ISDN will vary among countries.
2. In several countries, the ISDN will be introduced to a limited number of exchanges or routes by 1985.
3. At the initial stage of the ISDN, it is most likely that the packet switched network and wideband transmission network will not be integrated. However, it would eventually be possible to integrate almost all services conceivable in the ISDN.
4. With the advent of the ISDN, maintaining a reasonable balance between the tariffs of diverse services will likely become a major problem.

This will necessitate the gradual modification of the existing tariffs, paying due consideration to a reasonable balance between the charges of different services. Also, rates for new services should be established, taking the advent of the ISDN into account.

5. On the international level, further study is required on accounting rates, differences in charges of international routings, and international coordination of telecommunication facilities and services.

Further information concerning this survey may be found in CCITT Study Group III Temporary Documents, Nos. 501, 502, and 504, all dated June 9, 1982.

5.6 Progress Toward ISDN Implementation

An early pilot ISDN will be Japan's integrated system, to be called INS (Information Network System), and scheduled to be operational in 1984. Nippon Telegraph and Telephone Public Corporation (NTT) plans to construct "a nationwide integrated system combining digital communication networks and computers, to provide diversified communications and information services to the public." For a description of this national ISDN, as well as those being planned in six other countries (Canada, France, Germany, Italy, Sweden, and the United Kingdom), the reader is referred to the work of Glen (1982).

5.7 A U.S. Telephone Carrier's View of the ISDN[2]

The ISDN trend indicates that today's public telecommunication network will evolve into an ISDN to satisfy and stimulate the telecommunication needs of our evolving information society. Telephone carriers see the ISDN evolving from today's network penetration of the IDN (Integrated Digital Network). This existing plant is an asset that is driving the ISDN.

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[2]It became obvious early in the workshop, summarized in this report, that the speakers and the participants represented a broad cross section of attitudes, philosophies, fears, and hopes concerning the ISDN. With this in mind, the following four sections (Sections 5.7 through 5.10) attempt to capture faithfully each individual speaker's contribution on his view of the ISDN. These speakers (see also Section 1) were: Dr. D.J. Kostas, GTE Service Corp. (Section 5.7); Eric Scace, GTE-BCS (Section 5.8); Richard Holleman, IBM (Section 5.9); and Mark Wall, Chase Manhattan Bank (Section 5.10). No effort has been made to synthesize the convergent points of view (necessitating some repetition), nor to compare the divergent points of view. Above all, nothing has been done to evaluate any point of view. It is left to the reader to recognize points of agreement and/or disagreement with the views expressed, and thus to sharpen his/her own focus.

One way to perceive the ISDN is as a shopping center of tomorrow. The success of shopping centers in our society is based on two primary considerations: economies of scale, and the desires of people to have a sole supplier for their services.

5.7.1 Advantages of the ISDN

The ISDN advantages for telephone carriers involve integration and standardization. These advantages are seen as ultimately benefitting not only the carriers, but society as a whole.

Integration Advantage

There are four kinds of integration here: facility, service, operations, and demand.

Facility integration refers to the economical advantages accruing from the minimal facilities that will be needed when all services, reduced to the primitive "1" or "0" content, employ digital transmission.

Services integration describes the "single supplier" shopping center approach to telecommunications. This not only leads to higher efficiency through multiplexing, but will offer synergies among services by supplying them "under one roof." Also as the services grow the "partitions of the shopping center can be moved." This provides timely operation as well as flexibility at low cost.

Operation integration, which makes it easier to use one network, refers to the fact that everything is reduced to a common denominator in terms of operations. The same person can handle voice or data, or maintain and operate the system.

Demand integration gives ready access for new services over the one network. By "moving the partition" the timely introduction of new services may be effected with minimum risk. If it is unsuccessful, the new service will leave the market! Therefore, the introduction of new services will be spurred by that capability. Also, the capabilities of filing for an experimental tariff and turning on the service at low tariff cost will be advantageous.

To summarize, the benefits of the ISDN in terms of integration include: reduction of capital expenses of new plant, reduction of operational expenses, and the spurring of new service offerings through low starting costs/low-risk implementation.

Standardization Advantage

The early identification of basic ISDN features will permit more effective planning for the telephone carrier. This will lead to compatibility and uniformity of services, minimizing of waste associated with unproductive developments, economies of scale resulting from the minimizing of interfaces, and better choices of equipment for the carrier because many manufacturers will be making a more uniform product.

5.7.2 ISDN Specifications

The ISDN specifications are a necessary constraint in today's telecommunication-industry revolution. Although specifications can have a constraint on innovation, innovation and change must sometimes be constrained in order to secure a definitive, new product. But specifications and constraints are directly proportional: the more detailed the specifications, the more confining the constraints.

Specifications for the ISDN need not be--should not be--design instructions. Rather, a balance must be found between giving directions for the ISDN based on the most advanced of today's technology and allowing the inclusion of tomorrow's. Three aspects of ISDN specifications will illustrate this point: standardization, planning, and allocation.

Standardization is an exercise in deliberate constraint of the variations and permutations in which a product or a service may be offered. Such standardization refers to the compatibility and interworking of aspects of the ISDN.

Planning is the constraining of available options suggested to decision makers to attain certain results in the future. The ISDN draft Recommendations (I.xxw, I.xxx, and I.xxy discussed in Section 5.2) are valuable to telephone carriers as planning documents. They are not design specifications, but they are a rough sketch of the ballpark. Although clearer definition of some aspects is still needed, they are valuable because they enable some planning at this time.

Allocation of resources is the consequence of the constraint imposed by the fact that all resources are finite. The ISDN Recommendations permit planning, and the planning is dependent upon allocation of resources.

Specifications on the ISDN are needed more now than specifications were generally needed in the past. The reason lies partly in the new technology that has altered the telecommunication environment.

In the past, the telephone carriers had a well-defined, low-volatility environment. In this country there was a leading standards maker, AT&T, who gave long-lasting specifications that were fine tuned by all the carriers to permit a uniformity of one U.S. telephone network. Standardization of these specifications assured this uniformity.

The future promises a very volatile, uncertain environment for the telephone carrier. There is no longer a leading standards maker, per se. No one knows who the players will be in the new environment. General, functional specifications like the ISDN (and the OSI) are developed with the awareness that tomorrow's services--which will be built on today's standards--are as yet unknown. So, standardization is preceding the implementation instead of vice-versa (see Section 3.2.2). The telephone carrier needs flexibility to adapt in a cost-effective manner. In particular, the ISDN is demanding from the carrier a stored-program controlled network, and digital capability.

5.7.3 Some Objectives of the ISDN

There are three kinds of objectives associated with the implementation of, or conversion to, an ISDN on the part of the telephone carrier. These are planning objectives, access objectives, and design objectives.

Planning Objectives

The ISDN should be planned in such a way that it provides an orderly, economical evolution and growth of the present telephone network. This implies that the process satisfies a multiplicity of demands, including compatibility with existing (and still improving) analog facilities. Every step of the way, the process must optimize the use of the tools at hand and also exploit the new technologies. It is important not to overburden the user in this process; the transition to an ISDN should be smooth, and the highest standards of the telephone network should be maintained in all aspects.

Access Objectives

The ISDN access should enable terminals, subscriber line transmission, and central offices to incorporate technological processes independently, and should facilitate the introduction of new services. An approach to be avoided is, "We'll give everybody cake whether they like it or not." The approach used should not place a heavy burden on telephone services.

Design Objectives

Some major considerations on the design of the ISDN are that it should be an open-ended architecture with a limited set of standard, multipurpose user interfaces. The user flexibility should be maximized. The costs should be kept low through economies of scale. The objective is to prevent undue proliferation of equipment interfaces.

5.8 A. U.S. Data Carrier's View of the ISDN

A data carrier's point of view on the ISDN is partly that of a carrier, and partly that of a user of transmission services. The CCITT questionnaire on the ISDN, discussed in Section 5.5, indicates that the sheer economics of the situation is the most powerful motivating force for the ISDN. This survey also suggests that the possibility of integrating services in the manner described below is probably the second strongest motivating factor. How will this affect the dedicated data network of today and tomorrow?

5.8.1 The Data Environment

Unlike the telephone environment, the data environment has always been a volatile one. There has never been one clear standards maker; there has always been a crying need for standards before implementation; and users have always had to piece together different components to produce "one network." Figure 5.4 illustrates today's world for data users. The multiple interface choices do not exactly encourage direct terminal-to-terminal connections between data terminals. The constant digital-to-analog-to-digital conversions are not very efficient uses of communication resources.

Further, while work is progressing on defining a new interface for the ISDN, questions have yet to be fully studied relating to interworking between those who use the new interfaces and those who, for good, powerful, economic reasons, choose not to throw out all their old equipment. For example, it would be very desirable in areas where ISDN is not immediately available, to take an ISDN terminal, T1, and by some means, be able to carry its signals through the analog network to reach the ISDN-capable network, so that it can communicate with other ISDN terminals.

Similarly, provision is needed for interworking between existing terminals and new terminals, both in the ISDN environment, and in the environment where the ISDN is not available locally. That same kind of interworking is

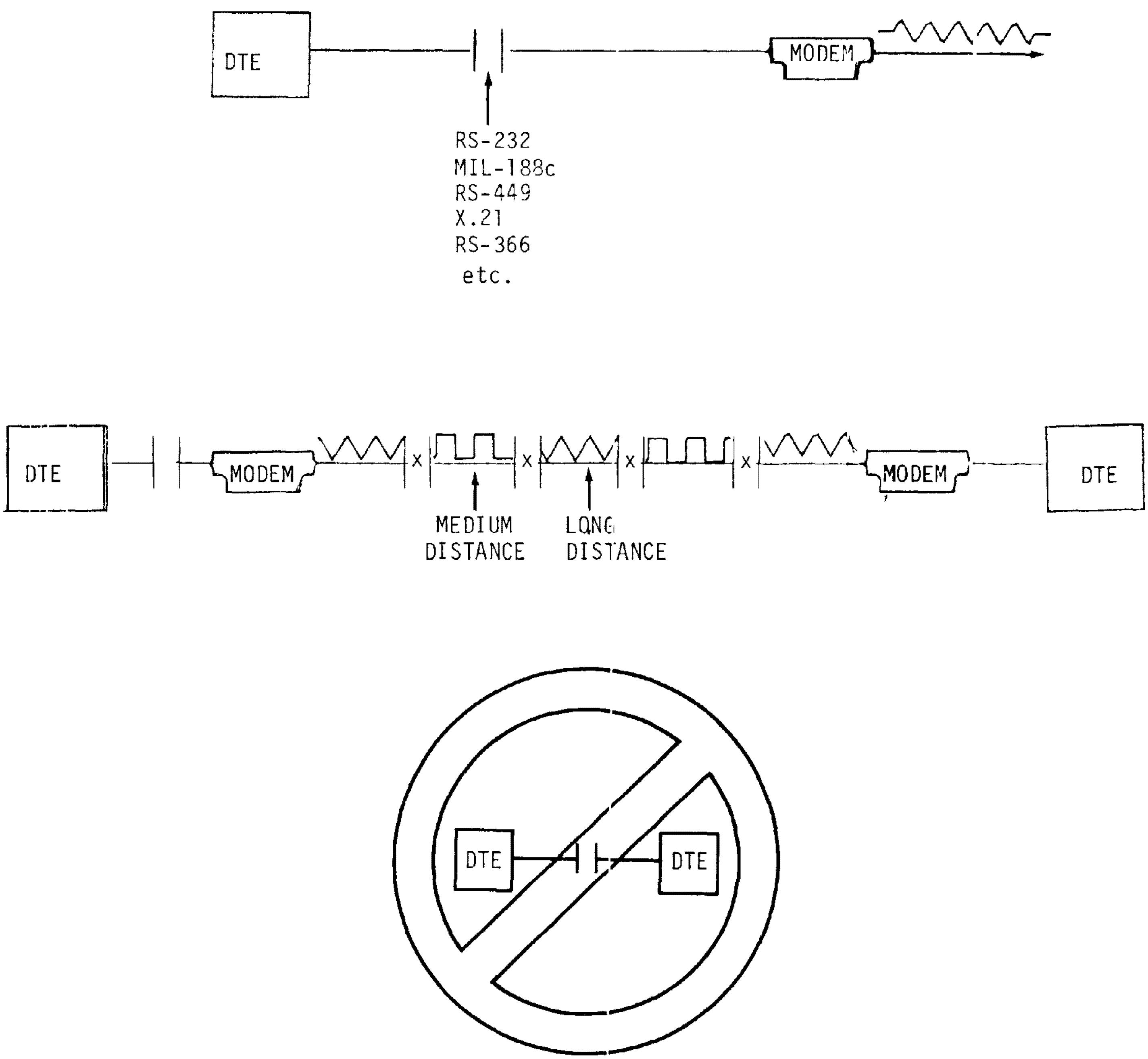

Figure 5.4. Today's world for data users.

needed between ISDN terminals supported by an ISDN network and non-ISDN terminals supported by today's conventional network. All of these interworking issues are just beginning to be studied. And there is much to be done.

5.8.2 CCITT Work on adaptation to ISDN

The questions are often asked, "What is the fate of X.25, given ISDN? Is X.25 doomed to an early death?"

Switching Adaptation

Study Group VII is currently studying a rough draft Recommendation concerning the adaptation of existing X.25 terminal equipment to the ISDN world where packet switching will be available through the S interface. Figure 5.5 illustrates one such terminal adaptor. What has not been widely recognized is that to describe such a terminal adaptor, one needs to make some supposition as to how packet switching services will be available through the S interface. And once one accepts that, it is a very short step to replacing this combination of equipment with an ISDN terminal that operates in the packet mode over the S interface. Hence, there would be a new packet switching interface standard.

Study Group VII has begun work on two other draft Recommendations. One applies to packet switching, and the other applies to circuit switching technology, represented by X.21.

A related adaptation issue is the transition from current data terminal speeds (found in Recommendation X.1, for example) to what seems to be the core capability represented by ISDN: the availability of transparent 64-kb/s switched paths through the ISDN.

Rate Adaptation

The CCITT has agreed in two study groups (VII and XVIII) that rate adaptation will be done on the current X.1 user rate to the 64-kb/s speed, and that it will be done by a two-stage process illustrated in Figure 5.6. The current existing data rates will be adapted to the nearest higher speed that is part of the family (2n times 8 kb/s), and then in a second stage, will be changed to 64 kb/s.

The standard that has been proposed--the draft Recommendation dealing with X.21 terminal adaptation--is one that is self-recognizable; at least one can scan the 8- or 16-kb/s stream and determine whether or not rate adaptation

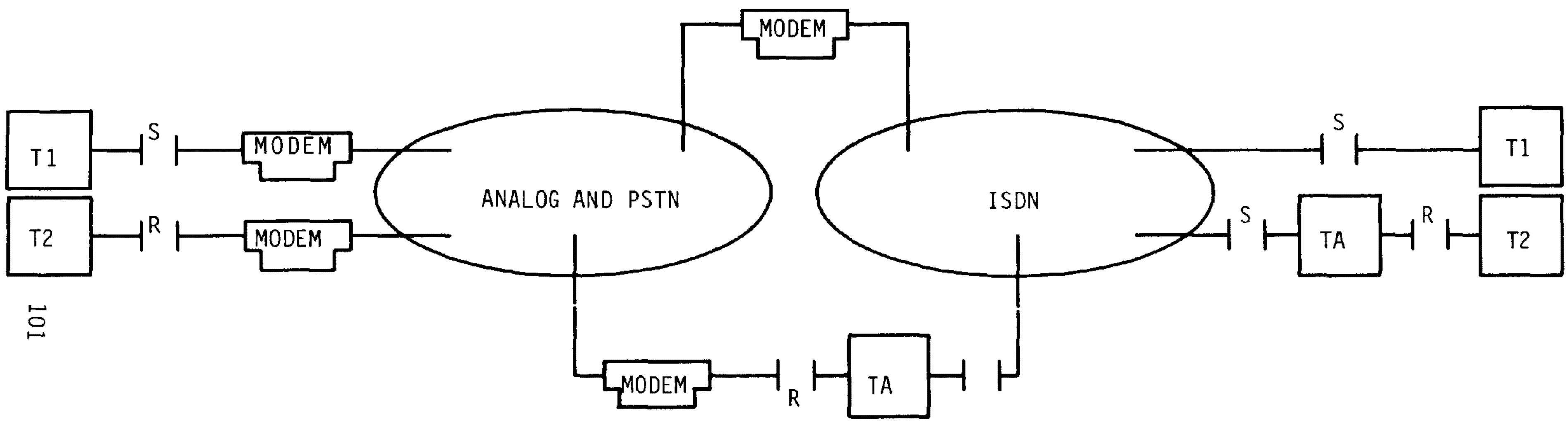

Figure 5.5. A transitional terminal adaptor (x.25 terminal equipment to the ISDN).

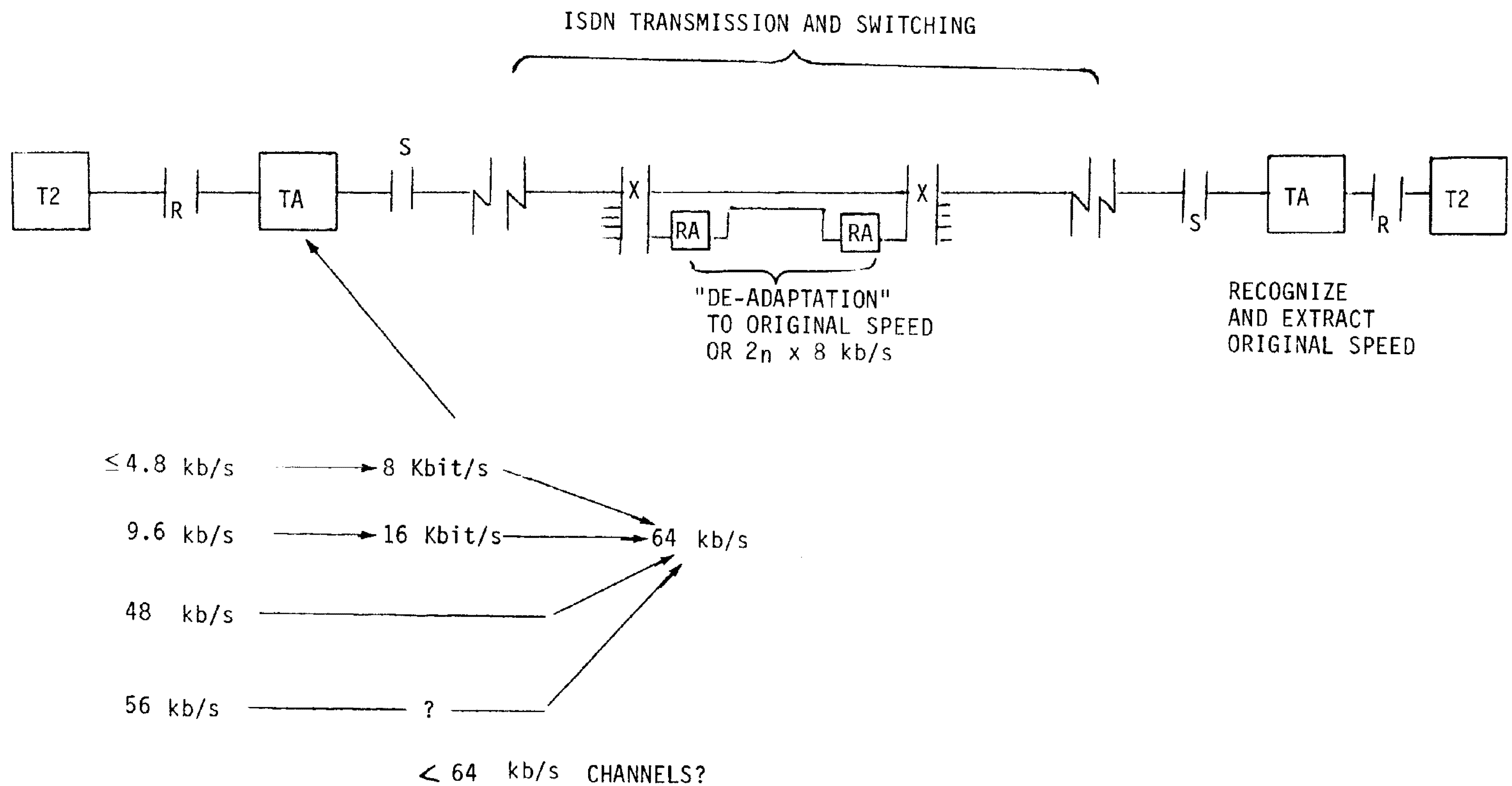

Figure 5.6. Rate adaptation: circuit switching.

has occurred, and, if so, what the original speed was and so be able to extract the information from it.

What has not yet received wide support in the ISDN community is the possibility of providing, at the T interface, channels whose actual speed is less than 64 kb/s. And whether that condition will continue to stand, given the forces that work on 32-kb/s voice, is unclear.

An alternative method for rate adaptation for packet switching services is shown in Figure 5.7. There is no padding of the bit stream from the X.1 user rate to the 64-kb/s rate. Rather, one takes advantage of the inherent frame-oriented structure of packet-switching protocols and uses the HDLC flag filling mechanism to fill idle time in the 64-kb/s bit stream so that the buffering capabilities of the terminal adaptor are not overrun. Also under discussion, although not universally agreed to, is the possibility for the terminal adaptors to interleave within this channel, at the frame level, other frames from other terminal equipment.

Another question concerns data speeds faster than 64 kb/s. These speeds are not too common within the present network. Some of the satellite carriers provide higher digital circuit speeds, which people have assembled into their own private data networks. Many questions remain to be studied regarding higher speed channel capacities at the user interfaces to the ISDN and for the service provider interface to the ISDN.

The concept that has received the most attention is the provision of channel capacities at speeds greater than 64 kb/s simply by providing many 64-kb/s channels (Figure 5.8).

The difficulty with this arrangement is that so far the ISDN network planners have not shown much enthusiasm for bit sequence integrity across such wide bandwidth. This means that the terminal might be responsible for the time synchronization of the order of bits across these 64-kb/s channels. Is this a satisfactory arrangement for the user?

Terminal portability has been mentioned for the ISDN, and now much discussion is held on whether or not it will be possible to take the user/network interface being defined for ISDN and apply it as a common physical interface for many environments as seen in Figure 5.9. To do this, one may need to adapt the X.1 data rate simply for transmission over the S interface. In addition, local control of the modem will need to be carried as well through (perhaps) another portion of this interface.

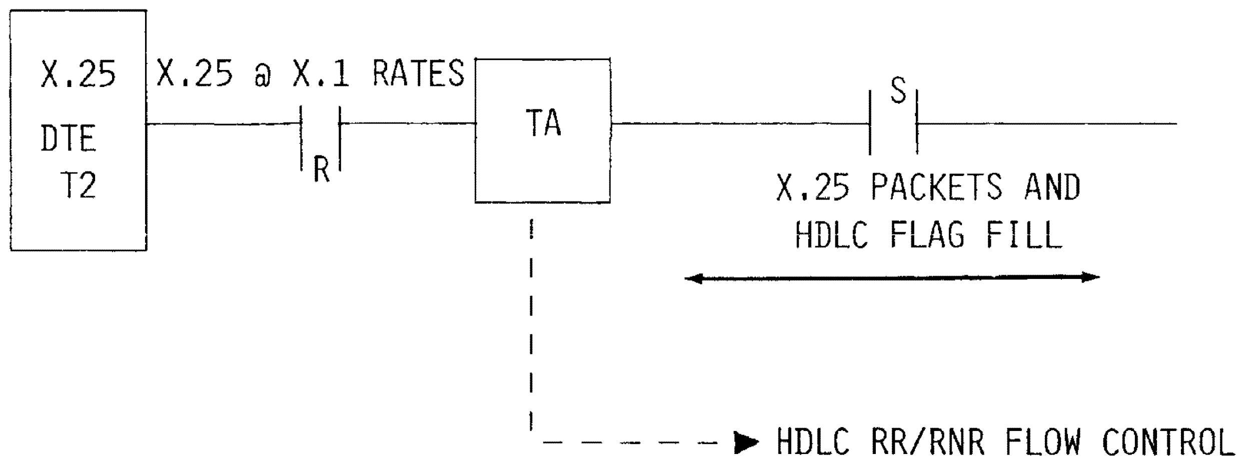

Figure 5.7. Rate adaptation: packet switching.

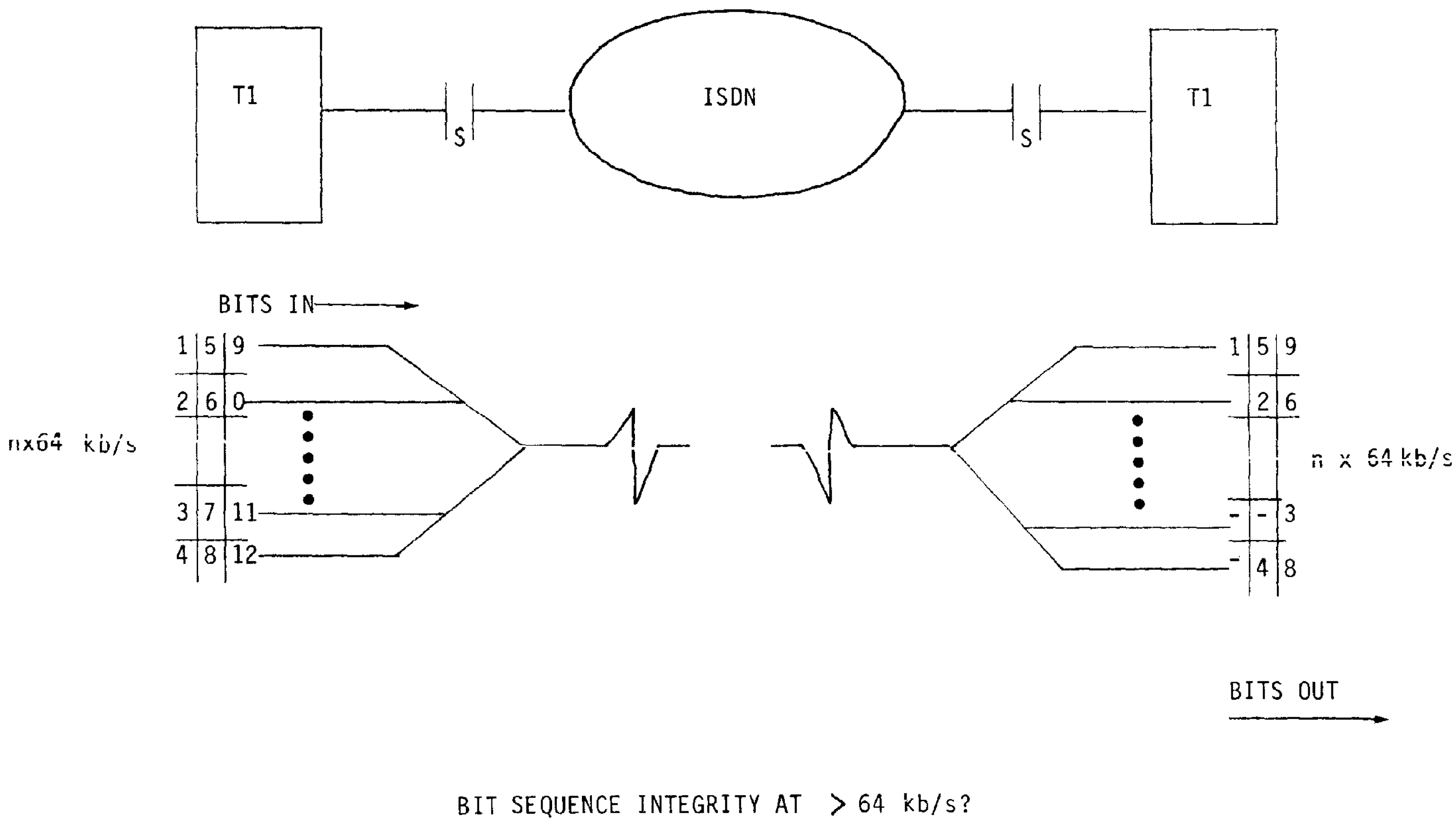

Figure 5.8. Channel capacities at speeds greater than 64 kb/s.

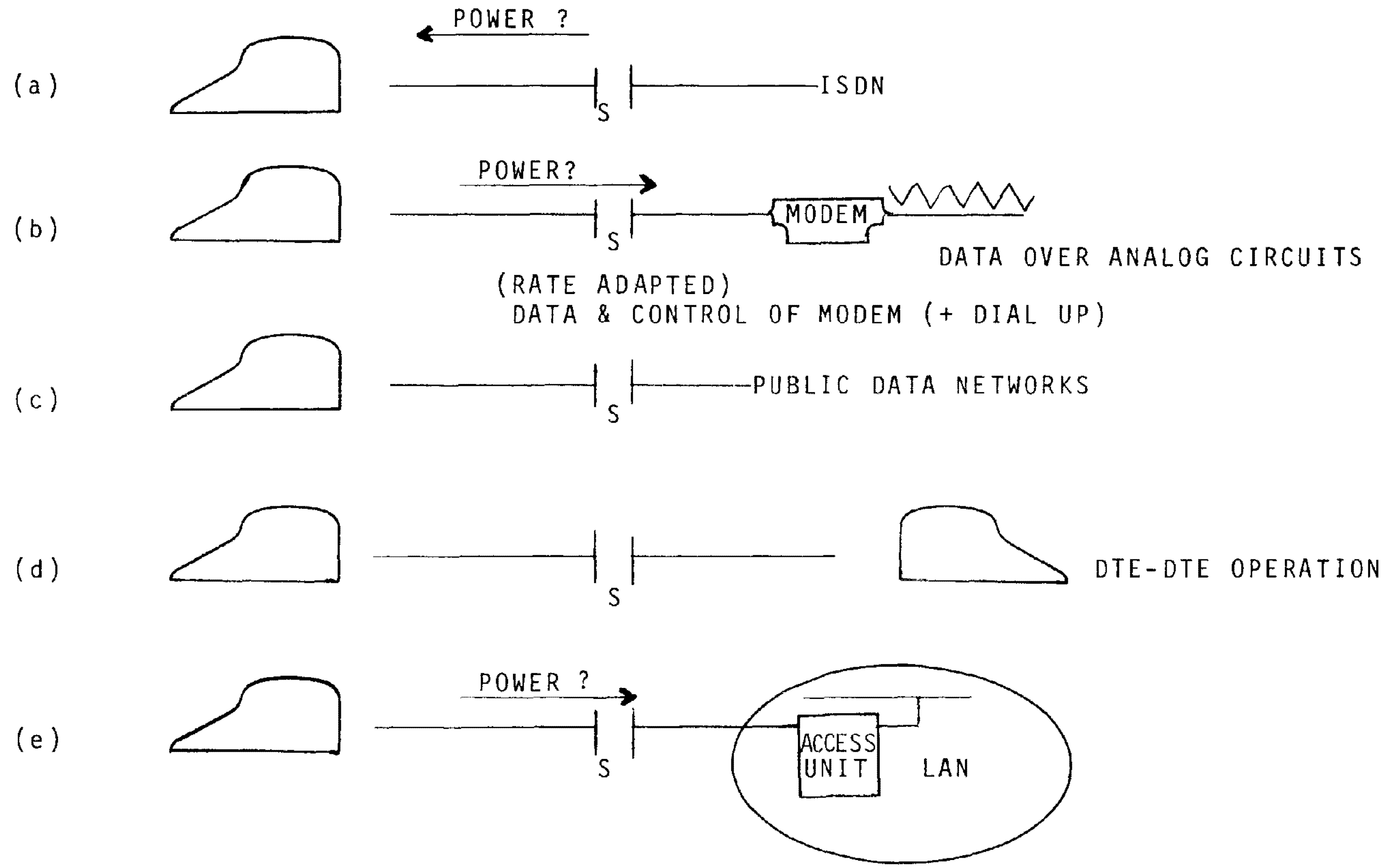

Figure 5.9. Possible applications of physical interface for many environments.

Direct DTE-DTE operation seems to be a technical possibility, and it seems also to be possible to use an interface like the S interface to get into a local area network, providing one draws the boundaries cleverly or correctly--a subjective evaluation, to be sure.

The IEEE 802 work on local area networks has been focusing on standards for operation over the transmission system that comprises the LAN for getting into and off that transmission system, and for data terminal equipment specifically built to operate with LAN's. Not all data terminal equipment in the world will be specifically built to operate on LAN's.

Local area networks will also need to provide for interfaces matching data terminal equipment that will not always be used in the LAN environment. If a good job is done here, one candidate interface would be the S interface for ISDN.

5.8.3 Concluding Comments

Will ISDN swallow up the dedicated networks? From the user's view, the ISDN interface has the potential to provide access either to fully integrated networks, or to separate, dedicated service networks through a common interface. The actual data networks will probably not be, at least for the remainder of this century, universally absorbed into a ubiquitous, single, ISDN within this country.

One positive step is the consideration of one common, worldwide interface for all of the dedicated service networks, therefore providing terminal portability. However, it is important that a measure of choice for the user be preserved. When the user accesses either the local network (e.g., PBX) or the local operating company through such an interface, the freedom must exist to choose the next step. Examples would be for the user to a) continue using the local network for transmission, b) access a dedicated network of his/her choice, or c) access private networking facilities.

In terms of this latter, private networking facilities in the ISDN environment can be constructed to and from semipermanent ISDN circuits. These circuits can then be accessed readily during times of private circuit overload. The CCITT is now considering user-to-user signalling in this respect. Although the concept is not yet clarified and agreed upon, the implications of allowing user-to-user signalling over public network facilities to support, perhaps, the internal signalling for management of private network control are exciting.

A hoped-for outcome of ISDN studies is the rationalization of charging structures among the networks so that they may evolve into a more uniform arrangement for the common interface.

The ISDN may be expressed as that once-in-a-century opportunity to alter today's telecommunication infrastructure. One key aspect in the transition from today's world to the ISDN world is the study of the interworking. Both the technical details of the international system, and the economics of providing telecommunication transport services will be changed.

As a result, the future offers the user greater flexibility in the design, access, and operation of both public and private networks. Since the user is the ultimate voter, the one who will either buy or not buy ISDN-provided services, it is essential that the user community participate in the development of ISDN standards.

5.9 A U.S. Information System Planner's View of the ISDN

The information system planner's perspective on the ISDN approaches the concept of integration primarily as one of transport integration. Several aspects from this perspective are listed here and discussed further below:

1. the concerns over the development of ISDN standards, including their relationship to OSI;
2. some reasons why the data user finds the idea of an ISDN attractive;
3. major ISDN considerations related to U.S. regulatory policy; and
4. concerns over the evolving ISDN trends, which are deviating from the original concepts.

5.9.1 ISDN Standards

It is generally agreed that a single, worldwide ISDN standard (or set of standards) will promote compatibility and will minimize product development and eventually user cost. However, the possibility of these standards' acting as a constraining force on the information system industry is not resolved by merely making the specifications general enough to permit flexibility. As in all standards development work, the standards should also be performance oriented, outlining the desired results, but not detailing the design, thereby minimizing inhibitions to technological innovation.

While the ISDN standards should be forward looking (with regard to technology), they should be forward looking in a way that recognizes existing investments in private networks, data bases, and application systems that cannot be scrapped and that must be accommodated in the development of interfaces for the ISDN.

The ISDN Recommendations must also ensure the transparency of the data streams from the point of view of code and protocol independence. The user should not be burdened with changes to his/her data stream or interfaces because of ISDN standards requirements.

A key issue for the information system planner is the functional compatibility of the ISDN with the OSI Reference Model, especially layers 1 through 3 (see Section 4). The ISDN must maintain functional compatibility with these layers. One issue at the ISDN standards table is contention resolution (when more than one terminal wishes to communicate in the same time frame). At what OSI layer does it take place and where does it fit in the ISDN model? From an OSI point of view, contention resolution is a lower layer function, layer 1, and not a layer 3, or higher layer, function, nor should it be an NT1 function. These aspects will continue to be discussed in CCITT work, and need to be considered in terms of the impact that ISDN has on other standards activities. To be avoided is the development of a set of ISDN standards that will cause existing standards to be redone or reshaped.

Standardized subscriber services should be available with ISDN, as well as with other networks. This point deals, in effect, with the upper levels of OSI. There are questions to be considered: Will the dedicated service networks be able to provide subscriber services, as they do today, in an ISDN environment? Or, will all of these dedicated networks disappear, so that the only access for subscriber services will be through the ISDN?

5.9.2 User Expectations

The user, in order to benefit from the ISDN, must have a common access arrangement to all services with minimum effect because of the system. The ability to access multiple services through the same port is a very significant economic advantage of the ISDN, but the information transmission must be transparent to the user. The full advantage of the 64-kb/s capacity (and beyond) should be available to the user and not just lower rates (such as 32 kb/s). The importance to the user of end-to-end connectivity with bit-sequencing integrity cannot be minimized. It is still unclear to what extent the ISDN can provide the compatibility to integrate voice and data. Finally, the user is very interested in arrangements for the attachment of devices with existing X.21, X.21bis, and X.25 interfaces. An adaptor for such attachments can become the interface, replacing the CCITT standards for interconnection, thereby simplifying attachment of existing terminals.

5.9.3 U.S. Regulatory and Competitive Environment

The U.S. information systems industry supports and is part of the U.S. participation in the CCITT. All interested parties in the U.S. must consider the ultimate effect of CCITT Recommendations on the U.S. competitive environment. Compromises in the CCITT arena are always being reached with PTT's who, although they represent a variety of approaches, normally cluster toward provision of services on a monopoly basis. The CCITT documents must be reviewed with a concern for regulatory aspects as well as technical aspects. The FCC is, at present, the U.S. voice (and conscience) on regulatory issues, and is playing a key role in U.S. ISDN policy (see Section 5.2).

In the United States, for example, certain physical terminations for basic digital services may be classified as customer premises equipment and are provided on an unregulated, competitive basis. This is just not true in most other countries. Although the basic transmission service interface on customer premises should conform to international standards where appropriate, it should also contain only the minimum function necessary to terminate the service and should be nondiscriminatory.

Two other concerns from a regulatory perspective involve separation of services and competition within basic services. The ISDN services should allow basic and enhanced service separation, two underpinnings of the current U.S. environment. There is the possibility that ISDN Recommendations could be defined in such a way as to prevent this separation. Competition within basic services should not be precluded, but should be provided for. This competition is in the interest of the United States as a whole.

In general, if specifications are written and defined in CCITT Recommendations that affect these regulatory policies outlined above, then the telecommunication industry in the United States will find itself in the chicken-and-egg syndrome, saying, "I would like to do that, but I cannot because the ISDN Recommendation in the CCITT does not allow it."

5.9.4 Concern Over Evolving ISDN Trends

There are several concerns relating to the changes that are "eroding" the original ISDN concept. These changes, both quantitative and qualitative, are leading to varying perceptions of the ISDN. Some of the observed trends in these perceptions are summarized below.

First, there are uncertainties that flow from the very name of the network that juxtaposes four specific concepts, in four words: integration, services, digital, and network. This allows considerations on "integrated services" and "integrated network," as well as the meaning of integration in either case. Generally, the U.S. telecommunication community does not view the ISDN as an integration of service providers in any way. The U.S. services stem from many sources, and will continue to do so, as opposed to the situation in most European countries.

To say that the underlying transport mechanism in the ISDN is the digital network does not mean that there is only one network available in the United States on a national basis. This has never been the concept in the United States. Rather, it is the integration of transport services which becomes the ISDN.

In addition to the qualitative trends related to concepts and definitions of the ISDN, there are measurable changes evident. One of these trends is evident in the fate of the "interface points" that initially were to be part of the ISDN model. These interface points have been replaced by "reference points" where interfaces may (or may not be) located and defined. Line termination is now considered internal to the network and the T reference point becomes the user interface. In some PTT's there will not be a T interface available, but only an S (for enhanced services) interface.

Originally there was even a U interface designated in the model. This interface has disappeared completely. The original intent of the U interface was to tie together the customer access interface and the transmission media. There is still interest in the United States for defining a U interface.

Another concern about the changes in the ISDN concept is the emphasis being placed on packet switched services and on hybrid interfaces. These emphases speak of rapidly evolving new technology and the transition problems of the period.

The first case refers to such questions already discussed as, "Will the ISDN be the only digital network available?" A few years ago, some presentations showed the ISDN as a digital pipe. At the end of that digital pipe are the packet switched service, the circuit switched private network, leased lines, etc. Some CCITT work, at present, seems to imply that, in effect, the ISDN will be the only digital network facility available and that only a packet switched interface will be offered to the user and to information systems operations.

The second case--the hybrid concept--is a newcomer to the ISDN scene. As a transitional interface for analog equipment, it does not fit the ISDN definition, yet it is to be found in the draft Recommendations. Confusion resulting from this paradoxical situation can be troublesome. The hybrid interface is unique and is not a step forward in the defining of ISDN interfaces.

Finally, there is concern over the apparent urgency (rush, even), on the part of some nations, to achieve early ISDN recommendation approval (as explained in Section 5.3). This urgency could become a serious problem if it were to affect negatively the CCITT consensus process. Paradoxically, in contrast to the expressed urgency, there is the need to take more time (than has been usual in the past for such issues) for widespread discussion on the ISDN. Burgeoning interest abounds worldwide. In the United States, this interest is being indicated by persons who are critically concerned with the underlying networks and services that will be provided. So far, these concerns have not been adequately presented or resolved.

5.10 A U.S. User's View of the ISDN

The user is ultimately the key to the ISDN implementation. The user either will buy or will not buy the provided services. This section outlines some of the user's concerns about the ISDN, and offers a discussion on bankers as users.

5.10.1 Bankers as Telecommunication Users

Banks constitute a segment of moderately heavy users of telecommunication services and facilities. Until recently, banks generally used only standard services--voice, data, record--but this is changing to include many new services.

Bankers are becoming sophisticated telecommunication users. The banking business is in the process of migration to a transaction-processing business. Although the transition is slow now, over the next few years banks will likely be deriving direct revenue from transaction processing. As new services are multiplying, based on the new ways of doing business, banks are also changing.

The new telecommunication/computer banking activities evolve from the economical necessity to reach the broad base of user terminals already in place, or soon to be in place. Banks will have an important role to play as the clearing house of transactions that will actually occur over these links.

Currently, many banks are in the process of implementing X.25 packet switched networks of their own, in addition to using some of the public data networks. These private networks for large banks will first evolve into national data networks, and then international data networks.

Other services that banks are looking at, in common with other users, are video teleconferencing and information services.

5.10.2 Concerns of Users in General

There are many users and groups of users, in addition to bankers, who are becoming increasingly more sophisticated in their use of telecommunications. At the basic level, the user is concerned with what the network can co, how well it can do it, and how much the user will be charged. Even so, it is doubtful if any of the users yet has the vision to realize fully the revolutionary implications of a truly functional ISDN. Some of these functions, relative to the user's perspective, are explored below.

Services

The range of services, old and new, is of interest to the user. Obviously, the current services are expected to be supported. These include full period switched voice, voice-derived data, switched low-speed data (e.g., TLX, TWX), switched medium-speed data (packet), full-period, high-speed data (generally available now at the right price with specially constructed facilities), and certain specialized services (e.g., program channels, video).

The ISDN is expected to have all of these services available. The ISDN studies, so far, have not included much study on specialized services, although there are some new references to providing the required higher rates. Two other basic services envisioned to be available are high-speed, circuit-switched data/voice (to 64 kb/s), and the ability to provide security to the user drop at a very reasonable cost, which cannot be done readily now.

Access and Control

Users are interested in both access and controls. Basically, will users in the ISDN environment have control over their own destinies? Some recent examples will highlight this concern.

The recent European strictures on private data networks are attempting to force users into use of public packet networks. The packet network divorces the users from direct access to the actual transport mechanism, and thereby inhibits them from setting their own priorities.

Similarly, there has been recent controversy over the potential elimination of private wire service altogether. If this were to occur, it would essentially limit the user's control over his/her own destiny as to when and how quickly he/she can talk--whatever the price.

The ISDN, of course, does not preclude dedicated circuits, but it is not clear that such circuits are being fully considered. There are certain functions for which the user must have an absolute control over communication facilities in order to operate. When the user sets the priorities, of course, the user pays the premium--but it is worth it. One example from banking, with respect to dedicated lines, is the necessity of providing immediately accessible circuits for broker trade. What happens when a broker circuit goes down? It can be disastrous to a user if the decision to withdraw these services is made--willy-nilly--by a PTT or a carrier.

Another aspect of control is the user's ability to monitor the network's performance. Whether by design or not, the current analog plant permits users to implement rather extensive data networks, and at the same time (e.g., through sidetones) to be able not only to monitor the performance but to isolate faults. The notion of end-to-end user signalling in ISDN discussions is encouraging in this respect, but more must be done.

Quality

The concerns a user has about the quality of service in the ISDN are the ordinary concerns about the present system. They include questions about the grade of service, analog performance over the digital network, the digital error rate performance, how much monitoring to assure quality, and how much quality at what price?

Relative to the last question ("Quality at what price?"), the last few years have indicated that users have been willing to sacrifice a good deal of quality in exchange for a cheaper service. A concern expressed in Section 5.1 of this report (that the ISDN should not be overdesigned for data when it will be used 90% for voice) is valid. However, the reverse of that should not be true. The fact that the service is usable for voice should not preclude the user from choosing to use it for data, even if the quality is not there. The notion of a 32-kb/s voice circuit could present problems if the only user access is analog.

Transparency

The user is interested in a transparent network. The ISDN offers hope of improving the protocol independence that can be achieved with X.25 networks, for example.

Physical Attributes

The physical characteristics at the user's interface are important. The view at the back of the racks in a computer center is a very frightening scene. The user community, in general, would like to put away its RS-232 interfaces for good. The ISDN discussions on a 2- or even 4-wire interface are very encouraging. The user is interested in full-duplex connectivity for the circuits.

Although users--by and large--do not expect guarantees on minimal transmission delays (having used satellites and packet switched networks) they would like to have an understanding of the transmission delay characteristics of the network so they can plan for them.

The capability of the ISDN to support multipoint communication is uncertain. However, this type of network will be around for a long time, even though some are being superceded by data networks. Some technique must be found to support them.

Efficiency

Will the ISDN make efficient use of the bandwidth available? If the price is low enough, of course, the user will not be really exposed to the waste that could be occurring. It appears that for a long time the ISDN might provide very capable circuits that indeed do very little. In addition to efficient use of bandwidth, it is hoped that the ISDN will be able to avoid sudden mismatches that can cause a network not to function.

Cost

The ultimate bottom line for the user is cost. Obviously, extensive capital is/will be put into the ISDN by common carriers (or PTT's). Much of today's analog equipment will be deleted from the network; eventually there will be less equipment providing more services.

These changes will take time, and it will possibly be an excruciating process. The possibility exists that, in the United States, the benefits of an ISDN will have to await fiber optical long-haul transmission coast-to-coast. Until then, analog channels for long-haul will continue to be cheaper than digital. Also, although 32-kb/s voice is an improvement in efficiency over 64 kb/s, this solution to the problem requires more study, especially in view of the inability to afford sufficient quality for analog transport of 9.6-kb/s data.

5.10.3 Operational Ground Rules

The telecommunication user is expecting certain advantages from the ISDN. Certainly, the telecommunication user community should be better off in an ISDN environment, or at least as well off as now. To achieve this basic objective, the options for services should expand with no radical changes in service options already existing. Expected advantages include facilitation of voice encryption (for privacy), and service quality improvement as the digital interface is brought right to the user.

Above all, market forces should prevail in the introduction of the ISDN to assure that offered services are truly advantageous to the user as well as to the common carrier.

6. THE NEW SERVICES: TELETEX, VIDEOTEX, AND FACSIMILE

The traditional CCITT-defined services are telegraphy (including telex), telephony, and data. The "new" CCITT services are the nonvoice, telegraphy-related "telematic" services. In this provisional term, "telematic," the CCITT includes such services as teletex, videotex, and facsimile (although facsimile is a very old service). There is general, worldwide interest in these services--and associated supplementary services--particularly as they relate to the ISDN.

The responsibility for the international standardization of these services belongs to the CCITT. Recommendation A.21 defines the CCITT's views on collaboration with other international organizations on issues relating to the CCITT-defined nonspeech services. (For a discussion of the meaning of a "CCITT-defined service," see Cerni, 1982a.) This Recommendation asserts that the CCITT has sole responsibility for operational, technical, and tariff principles of the CCITT-standardized services. It states further that other international organizations are invited to give specialist advice on matters of mutual interest when made on a timely basis.

The international standardization of these services is being affected, inevitably, by the national condition of the various countries involved in the process. The historical national situations are also affecting, and will continue to affect, the eventual implementation of these services.

6.1 Introduction

This section of the report, which is a generalized discussion of the new services, presents an overview of the current situation in regard to new services and international standardization. It offers a) a comparison between the telecommunication environment in the United States and that of most European nations; b) a summary of recent attempts to develop a unified U.S. position on videotex standards for presentation to the CCITT; c) a discussion of the telematic services; and d) a review of the historical development of facsimile, tracing its evolution as one of the oldest (1840) telegraphy services into a new digital service.

6.2 Overview of the U.S. and PTT Telecommunication Environments

The U.S. telecommunication environment, built on competition and free enterprise, affords both strengths and limitations to U.S. carriers, as does the quasi-monopolistic PTT environment to European carriers. The following discussion compares the U.S. common record carrier environment to that of the European PTT's.

6.2.1 Historical/Traditional Background

In the U.S. environment, each new service contemplated by a carrier must be analyzed carefully as to its potential effects both on the viability of the company and on the plant in place. During the past two decades, the record carriers have increasingly offered such services as message, telex, private leased channels, terminals, and switching equipment. The stockholders to whom the carrier is responsible are not eager to witness premature retirement and/or forced obsolescence of existing plant by the forced introduction of additional services; the carrier, of course, must continuously deal with the amortization of existing plant.

The PTT's, in general, do not have to struggle with these problems to the same extent as does a competitive carrier. Since the PTT has a (quasi) monopoly on all telecommunications, it is possible for it to subsidize the new record services (for example) with telephone service revenue. The PTT is not as constrained by equipment in place because the PTT does not have stockholders.

In addition, the regulated U.S. carrier, who is responsible to the FCC for tariffs, classification of services, approval of certain new services, etc., cannot function in the same autonomous style as does the PTT. The PTT functions as a total entity--the postal, telephone, telegraph services, and FCC all rolled into one.

These differences help to account for the fact that certain PTT's have been able to move ahead in a more progressive, experimental fashion in the past several years than has the U.S. carrier, who is more bound by extensive plant, financial accountability, and regulation.

6.2.2 Videotex: A Case in Point

Illustrative of the possible consequences of these different environments is the way videotex standards have been developed in the European CEPT organizations and in North America. The following discussion records a unique approach taken in the United States as a response to the need for a unified U.S. position.

CEPT Position (May 1981)

Within the CEPT community, several experimental videotex systems (especially in the United Kingdom and in France) were implemented (before those in the United States or in Canada) to test the market and to assess the utility of videotex systems. Consequently, agreement was reached in CEPT (May 1981) on certain videotex standards (a combination of two experimental systems) for presentation to CCITT Study Group VIII. At this time, the United States had not yet made any formal position on the protocol at the presentation level. Without a position, the United States would have been at a disadvantage at the CCITT, not being able to present, in a unified form, its own interests.

U.S. Action (January 1982)

The preparation of the CEPT document revealed the urgent need for the United States to examine the proposed CEPT standards and to determine what was in the best U.S. interests. Consequently, a Videotex Technical Experts Panel (directed by U.S. CCITT Study Group B) was formed in January 1982. The 12 members represented a broad spectrum of U.S. industry and government interests, as well as standards organizations. The panel members represented U.S. Study Group B, banking/financial industry, newspapers, FCC, Department of Commerce, U.S. common carriers, cable television, U.S. National Communication System (NCS), the computer and semiconductor industries, ANSI, and EIA.

The work of the panel was to compare the existing experimental systems with the proposed enhanced, and more flexible, systems in the light of U.S. market trial results and the needs of the U.S. marketplace. The hoped-for consequences of these studies was a recommended U.S. position concerning the final resolution of CCITT Recommendations F.100 and S.100 to assist the study groups and working parties to which these questions had been entrusted. Therefore, the specific tasks assigned to the U.S. panel were to:

1. review the U.S. market requirement for videotex service with emphasis on the diversity of present and future applications;
2. review the videotex technical standards alternatives available to satisfy the requirements; these included:
   - CEPT (May 1981)
   - Bell System Presentation Level Protocol (May 1981)
   - Provisional Session Level Protocol (November 1981);
   - Draft North American Presentation Level Protocol (May 1982);
3. recommend to U.S. Study Group B a U.S. position on videotex standards that best met the present and future needs of the U.S. market;
4. coordinate resulting Recommendations with U.S. Study Group A for submittal at international CCITT meetings; and
5. prepare a technical contribution addressing Question 24, Study Group VIII, to represent the U.S. Recommendations for videotex standards for submittal by U.S. Study Group B to CCITT Study Groups VIII and I.

The foundation of the panel's work was task number 2 above. The North American Presentation Level Protocol had been under development by ANSI and the Canadian Standards Organization following a 1½-year effort on the part of AT&T and others. In addition, a provisional session layer protocol had been proposed.

On the international level, there were existing (November 1980) standards, definitions, and Recommendations which the panel reviewed. In general, these international standards, definitions, and Recommendations (F.300, S.100) were (are) not complete and are intended as guidelines for further study. These references are:

1. videotex service: The CCITT study of videotex during the 1977-1980 Study Period resulted in Recommendation F.300, Study Group I, which provided a broad working base.

2. videotex terminals: a) During this same period, CCITT Study Group VIII developed S.100, a technical Recommendation; b) there was an established international information exchange for interactive videotex; c) CCITT Recommendation V.3 established international alphabet No. 5; d) ISO Standard 6937 presented a coded character set for text communication; and e) there were code extension techniques for use with the ISO 7-bit coded character set, ISO standard 2022-1973.

In addition to the work indicated above, the CCIR is studying the required standards for broadcast teletext services for general reception by standard TV sets of various systems (525 line/30 frame, versus 625 line/25 frame).

U.S. Position Defined (August 1982)

The panel successfully completed its task after seven meetings, and in August 1982, three U.S. contributions were presented to CCITT Study Group VIII. This work is detailed in 6.3.2 below.

6.3 The Telematic Services

The following discussion on the CCITT-defined telematic services includes mention of several Recommendations. The complete titles of these Recommendations, and of all Recommendations referred to in this report, can be found in Appendix G.

6.3.1 Teletex

Teletex is a new, fast, telegraphy service which offers many sophisticated features combining certain office typewriter facilities (including editing functions) with transmission functions. Teletex employs a character set which is a large superset of ASCII (American Standard Code for Information Interchange). Teletex terminals are designed to communicate via public switched networks. Since it is aimed at facilitating and accelerating the exchange of ordinary correspondence, teletex can be made interoperable with telex, even for international transmission via international carrier. Figure 6.1 illustrates a typical teletex configuration.

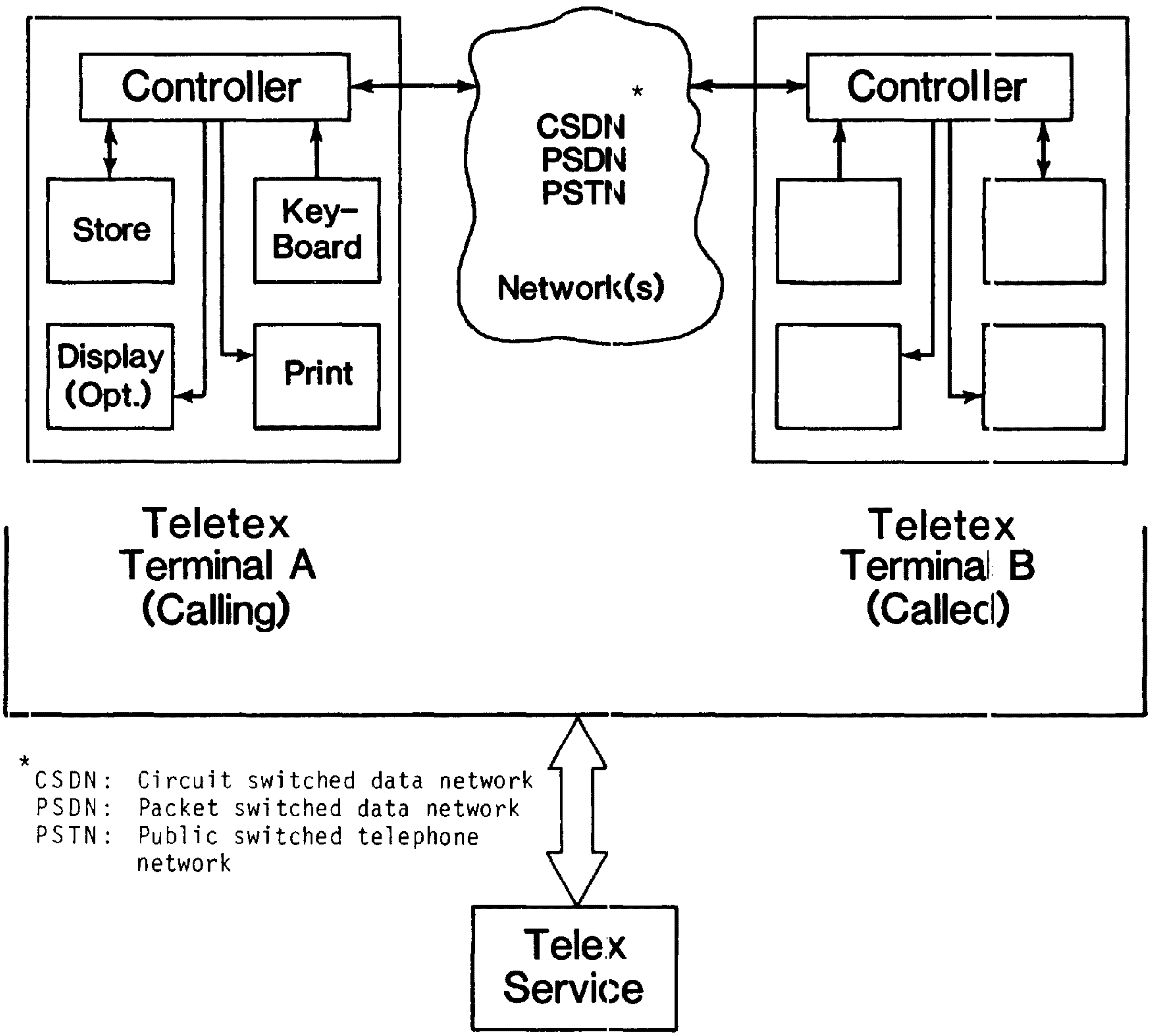

Figure 6.1. A "typical" teletex configuration (courtesy Joe D. Weatherington, 1982).

In 1980, the CCITT plenary assembly approved Recommendation F.200 which serves as an essential working base for present and future teletex studies and offers the necessary information for the installation of this new service. Some technical aspects of teletex can be found in CCITT Recommendations S.60, S.61, and S.62.

6.3.2 Videotex (and Teletext)

Videotex can be broadly defined as the two-way, interactive service that transmits text and graphics to the user's TV from some remote computerized data base, and also permits the user to have some control over the data viewed. Teletext is a one-way broadcast mechanism that employs the NTSC (National Television System Committee) TV signal to transmit text and graphics to the user's TV but offers no interactive capability. Although teletext is under the purview of CCIR in general, it is discussed here because both videotex and teletext will be employing the same presentation level protocol, i.e., the same alphabet, character coded set, etc.

The following discussion has two separate parts. The first is an overview of both videotex and teletext, and the second is a summary of the development events (particularly in relation to international standards) of videotex since 1978. Since no attempt is made in these pages to discuss technical details, the interested reader is referred to the CCITT documents.

Typical Videotex and Teletext Services

Figure 6.2 offers a schematic of a "typical" videotex/teletext configuration. The house on the left (A), represents the user (although the use, certainly, is not limited to home use), and the terminal equipment indicated includes the decoder-controller, keyboard keypad, and display screen (TV). On the right, (B) is the schematic teletext capability. The lower right (C) represents the information source, the data base(s). This data base could be replaced by a host computer, or whatever equipment contains the communications and application software necessary to perform the functions of videotex and teletext. Below the data base is the information provider(s) (D), who supplies a wide range of information input to the data base, for teletext or videotex services. The transaction service(s) (E) is indicated as having interactive capability (with the decoder/controller at the user's terminal) for the videotex service only.

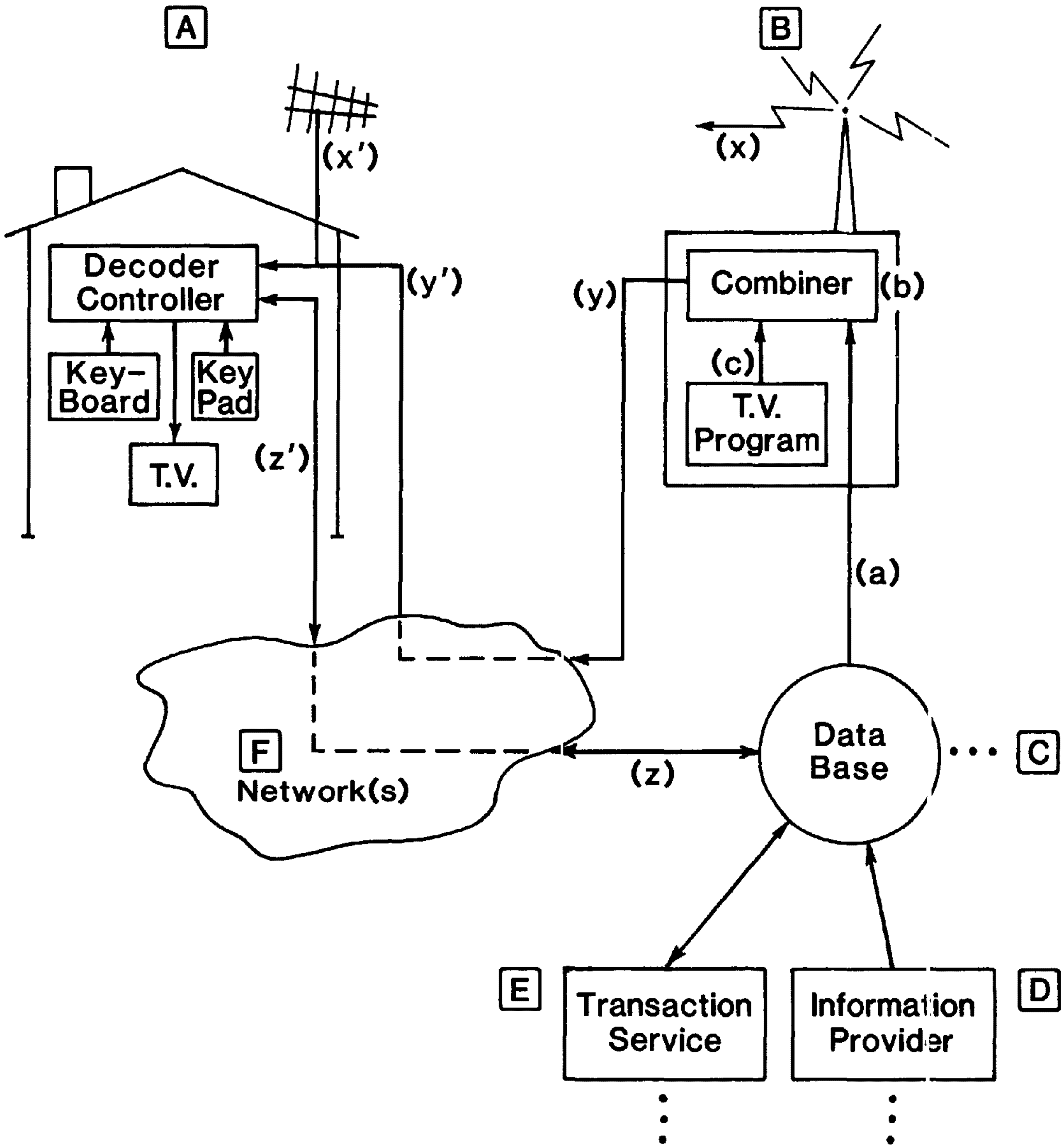

Figure 6.2. A "typical" videotex/teletext configuration. (Courtesy Joe D. Weatherington, 1982.)

The section representing the network(s) (F) indicates four things: a) broadcast teletext may use an existing network (such as cable TV) instead of the antenna; b) the videotex service is not obliged to use the same transmission network in both directions; c) there is no intent, internationally, to limit videotex or teletext to a particular transport mechanism; and d) the diagram implies the possibility of hybrid configurations, using teletext through the broadcast mechanism in the information input directions, and cable, or another network, for the response. The concept of the OSI model (Section 4) is to make the data flow that is conveyed between peer protocols at the presentation layer transparent from its transport mechanism. Therefore videotex applies equally well to the appropriate use of the existing telephone circuit switched network, existing packet networks, and two-way cable systems.

In the teletext operation, the information is transmitted from the information provider via the computer and data base (a) to the "combiner" (b), where it is combined with a TV program (c). This is then broadcast in any typical NTSC television mode (x), including satellite. As mentioned, this TV signal could also be handled by cable (y). The reception of the signal in the house can be by direct antenna coupling (x') or by cable (y').

For videotex, the input message generated by the transaction service (E) and/or the information provider (D) can be transmitted by the same mode discussed above, or by another network (z). The response can come back through (z') or on another network.

Predominant Development Activity of Videotex Technical Standards

Figure 6.3 illustrates the basic videotex activity since 1978. As can be seen by (A), the United Kingdom's Prestel, France's Antiope, and Canada's Telidon coding schemes were introduced into the standards discussions by 1978. These three systems exerted the predominant influence at this time in the international arena, although there was a significant level of activity by both Germany and the United States. Japan (as indicated by the dotted line) was also becoming involved, with preliminary work on their CAPTAIN system.

In 1980, at the VIIth Plenary Assembly, the CCITT adopted Study Group VIII's Recommendation S.100, which contains elements of the coding schemes (basically incompatible) of each of the three above-named systems: Prestel, Antiope, and Telidon. Because of time constraints, Study Group VIII was unable to resolve the incompatibilities but promulgated S.100 anyway, as a basis for further work needed to reach a complete definition of the specifications

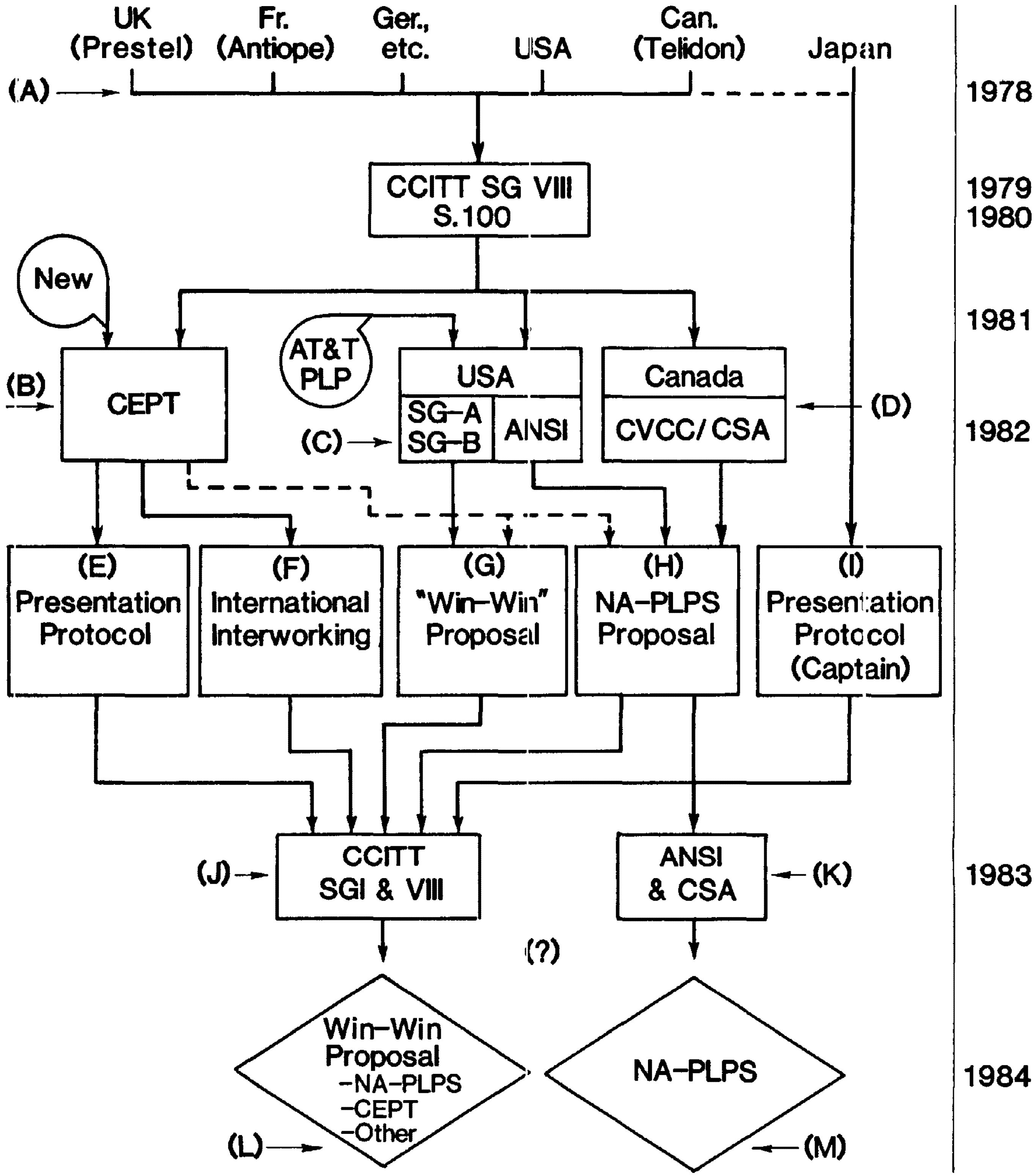

Figure 6.3. Predominant development activity of videotex technical standards. (Courtesy Joe D. Weatherington, 1982.)

required to produce a videotex service. Both Europe and North America have consequently based their studies on S.100, considering only the upper layers of interconnection.

The European community, through CEPT (B in Figure 6.3), after an evaluation of their market tests and their service introductions of Prestel, Teleletel (France) and Bildshermtext (Germany F.R.), has combined the additional functionality needed with the S.100 functionality. These requirements, plus the vast majority of S.100's coding for the two mosaic systems, constitute the presentation protocol (E) that has been presented to the CCITT by the European administrations. Some European members of CEPT have also proposed a way of reaching international interworking (F).

Meanwhile, as indicated by (H) on the diagram, the United States and Canada, in a successful joint effort, have proposed the North American Videotex/Teletext Presentation Level Protocol Syntax (N.A.-PLPS). This document combines all of the functionality and the majority of the coding found in S.100 with AT&T's Presentation Level Protocol. The groups involved were/are U.S. CCITT Study Groups A and B, ANSI, CVCC (Canadian Videotex Consultative Committee), and CSA (Canadian Standards Association).

The N.A.-PLPS proposal made to CCITT will be processed through ANSI as well as through CSA (K). It will be dealt with in the United States in the manner indicated in Section 2.3 of this report. The possibilities of acceptance of this proposal by 1984 look excellent at the present time (M).

A third presentation protocol from Japan (I), based on their CAPTAIN system is also being presented to and considered by CCITT.

The CEPT International Interworking Proposal (F), also referred to in Section 6.2, is not totally acceptable to the U.S. consensus group from Study Groups A and B. The work of the experts panel resulted in the U.S. "win-win" proposal (indicated by G), which proposes another framework for the international videotex Recommendation. This proposal appears to accommodate the diverse market requirements as expressed in the Recommendations that have been developed in the various countries, including the broader capability that seems to meet the needs of North America. Efforts are being made to coordinate the time scale for these proposals.

The U.S. CCITT group believes that the "win-win" proposal offers an international recommendation which permits all three proposed protocols (E, H, I), as well as any national data syntaxes, to be fully integrated. The U.S. goal at this time is to formalize this proposal as a joint Study Group I and VIII videotex Recommendation within the 1982-83 time frame (J) for approval as the 1984 Plenary Assembly (L).

[Study Group VIII's meeting in November 1982 was not balanced by a formal Study Group I meeting, as one is not planned until 1984. However, since the July workshop, the Videotex Working Party of SG I did meet for 3 days, and jointly with the Videotex Working Part of SG VIII for 1 day, the week prior to the SG VIII meetings. This joint meeting produced an excellent proposal that essentially approved the approach of the U.S. "win-win" proposal.]

6.3.3 Facsimile

After 140 years of history, facsimile appears to be coming into its own in the 1980's, especially as a general business communication service. There has been extremely rapid development in advanced facsimile techniques in the past few years.

The following discussion on facsimile not only presents a history of facsimile, but also illustrates and ties together some key points made in this report. These points include:

1. the role of the CCITT in ensuring international telecommunication compatibility;
2. the importance of CCITT Recommendations in both domestic and international telecommunication markets;
3. one way in which modern digital (especially) technology is affecting the structure of international organizations such as the CCITT;
4. the working and interworking of standards groups, internationally and in the United States; and
5. the rapid growth of digital telematic services and the rapid movement toward their convergence and integration.

What is Facsimile?

Although facsimile is a widespread, worldwide service, most people are unfamiliar with it, or have but a hazy idea of what it is.

In general, facsimile is a means of scanning and reproducing any type of graphic information--black and white text, handwritten information, pictures (black and white and in color)--from one facsimile machine to another over normal telecommunication channels. Since the ability to reproduce detail is limited only by the scanning and printing process and the connecting transmission system, facsimile is the most versatile graphic communication means known.

The advantages of facsimile's versatility, however, have not outshone four of its intrinsic disadvantages which have traditionally resulted in the use of facsimile only when there was no other usable alternative. These traditional disadvantages are: slowness of transmission, poor quality of the received document, lack of quick recovery from errors, and inefficiency of bit use (one page uses 5×10^5 bits, even with compression). Improvements are now being made in all these respects.

Brief History of Facsimile

Facsimile first appeared in the 1840's at the same time as telegraphy and Morse code. The earliest synchronized pendulum arrangements were followed in 1850 by the cylinder and screw arrangement. By 1865 (founding year of the ITU) the facsimile service was born when a commercial document facsimile system was introduced in France. Worldwide facsimile service continues to this day.

The potential use of facsimile for commercial picture transmission was clearly evident by the 1920's. In 1922, a picture was transmitted by radio from Rome to the United States, and by 1926, a transatlantic facsimile service for news photo transmission was firmly established.

There are now four classes or groups of facsimile terminals defined by the CCITT. Group 4 includes the newest, digital facsimile.

Facsimile Standardization

CCITT: As stated in the introduction to Section 6, facsimile standardization is centered in the CCITT. Until 1980, facsimile studies were entrusted to Study Group XIV, "Facsimile Telegraph Transmission and Equipment." Study Group XIV was responsible for the promulgation of the facsimile-related T-series Recommendations.

At the 1980 Plenary Assembly, Study Group XIV was discontinued, and facsimile studies were combined with those of teletex and videotex in Study Group VIII. The reasons for this include several developments. Study Group VIII had redefined "Text" to mean anything intended for human comprehension that was presentable on a two-dimensional medium, including the CRT screen as well as a piece of paper. Since facsimile is included in that definition, facsimile was "absorbed by definition." In addition, there is the increasing tendency to put the various types of coded information that can be put on a piece of paper (pictures, electronics drawings, diagrams, pure text, etc.) into one document distribution system or service. This mixed mode operation will require common control procedures for the telematic services.

The facsimile Recommendations, dealing with apparatus and control procedures, include T.0 (1956) to T.4 (1980), all of which deal with apparatus, and T.30, which deals with the control procedures of facsimile transmission over the telephone network.

The related F-series service (Study Group I) Recommendations include F.80 (since 1958) and the new (1980) F.160, F.170, and F.180 Recommendations; F.170 and F.180 describe, respectively, bureaufax and telefax. Bureaufax refers to the service offered by PTT's in Europe. The message received by the PTT (from another PTT) is picked up from the PTT bureau by the addressee, or transmitted from the PTT office to the addressee (if the addressee is a subscriber to the national telefax service), or it is mailed to the recipient. In telefax, the message is sent from subscriber to subscriber through office machines.

Current CCITT activity centers on facsimile digital apparatus, Group 4. Issues of concern include resolution, mixed-mode architecture and control procedures, digital phototelegraphy, and facsimile transmission over the public data networks including transmission in common with teletex and videotex.

ISO: The ISO has not been active in facsimile in the past, and there are no ISO facsimile standards. Interest was beginning to develop (1979) in these issues in TC-95/SC-15, but TC-95 was merged with TC-97. The present TC-97/SC-18 group, dealing with text preparation and presentation, may do something with facsimile via common control procedures and mixed mode. In addition, if TC-97/SC-19 becomes established to study office machine characteristics, it may include facsimile in its studies.

ECMA: The European Computer Manufacturer's Association (ECMA), which contributes to ISO and to CCITT, has an active technical group working on the same subject as ISO's TC-97/SC-18. In addition, ECMA has a group on coded character sets that is considering whether or not to study facsimile (image) coding and compression.

United States: The principal (and perhaps only) facsimile standardization activity in the United States has been in the EIA's (Electronic Industries Association) TR-29 committee on facsimile systems and equipment. This committee, which includes representatives of U.S. manufacturers, common carriers, government agencies, and U.S. affiliates of foreign manufacturers, acts as a facsimile "subset" of U.S. CCITT Study Group B. Members of TR-29 are the only facsimile experts in the U.S. CCITT Study Group B, and they prepare the U.S. contributions for the CCITT.

The EIA committee TR-29 also generates its own facsimile industry standards, which are compatible with those of the CCITT. The committee also influences government standards on facsimile since there is government agency membership in TR-29. This kind of coordination has resulted in recent NCS standards which are completely compatible with EIA and CCITT standards.

There has been little ANSI activity on facsimile to the present. The ANSI X3VI group has the same scope as ISO TC-97/SC-18 and has established liaison with EIA TR-29, which will serve as facsimile adviser to ANSI through X3V1.

Importance of CCITT Facsimile Recommendations to the United States

The CCITT facsimile Recommendations are critically important to the U.S. manufacturer, carrier, and user in the international arena.

The U.S. manufacturer must build to standards accepted by the European PTT (for example) if export trade is to be expected. Customarily, the PTT's demand that any equipment connected to their networks (including facsimile terminals) be based on CCITT Recommendations. However, following CCITT Recommendations is a necessary, but not always sufficient, condition. Individual countries also have their own unique requirements.

The U.S. common carrier, who may also be a manufacturer, cannot provide international service if the U.S. end of the circuit is not compatible. Neither can the facsimile user communicate internationally if the equipment does not meet international Recommendations.

The Future of Facsimile

All indications at present point to increased use of facsimile since improvements are being made on all fronts. Faster transmission and better printing techniques and contrast assure that there will always be applications for which facsimile is the best answer. This is especially true for subject matter that cannot be character coded or coded in some fairly efficient graphic scheme. Extensions, additions, and successors to facsimile apparatus, techniques, and technology will live on because they are capable of handling any kind of graphics.

This expanding future for facsimile appears inevitable, even if the process is no longer called facsimile. The techniques and processes outlined in facsimile standardization, coupled with the newest concept of "text" indicate that the future, all-purpose "text" machine may have more characteristics that are associated with today's facsimile machines than with today's text machines.

7. MESSAGE HANDLING SYSTEMS (MHS)

The ongoing development of both telematic services and the computer-based store-and-forward services requires more and more ability of the public data network (PDN) to "handle" the information passing through it. The term "Message Handling Systems" (MHS) refers to these abilities or resources provided by the PDN.

Question 5 of CCITT Study Group VII is a new (1980) question titled, "Message Handling Facilities." Attempts are being made to replace "facilities" by "systems" because of the confusion in the CCITT over the exact meaning of facilities.

This section of the report offers a description of MHS, which is seen as a network support activity for the user's interaction with the nonvoice services.

7.1 General Goals of CCITT Question 5/VII

In recognition of the immensity of their task, the CCITT Rapporteur Group for 5/VII has specified a working plan that will cover two study periods, at least. The expectation for the 1981-1984 Study Period is the development of a general Recommendation(s) that will set the stage by defining an MHS model. Such a model will act as a tool to permit the identification of user requirements and the specification of the areas that need standardization to facilitate international exchange.

The main objectives of this work on MHS may be summarized as:

1. specification of the requirements for MHS so that it can support message preparation, transport, storage, conversion, varied terminal access, telematics and other high-level applications, and interworking among the various services to be provided by MHS;
2. determination of those facilities and services that are suitable for provision over a PDN;
3. use of the OSI Reference Model as the basis for the work;

4. development of the required Recommendations for international MHS; and
5. determination of the impact of MHS on existing Recommendations as well as the relationship of MHS with other CCITT-defined services.

7.2 The Meaning of Message Handling Systems

The "handling" of information in MHS refers only to the store-and-forward relay of messages from user to user; MHS does not include interactive services.

The "messages" in the PDN with which MHS is concerned include all types of text (e.g., office documents, personal correspondence, commercial text), facsimile, "raw" data, vectorgraphics, "voice mail," video, etc. Messages may consist of anything that can be put into discrete units.

7.2.1 The Functional MHS Model: User and Message-Transfer Services

Figure 7.1 illustrates the most general concept of the system. The end users are referred to as "originators" and recipients," or originating users and receiving users, and may be people or computer processes. The message service comprises the functions that work together to provide the accurate relay of the message from the originator to the recipient.

The functions contained in the message service have been partitioned into two main subsets, the message transfer service (MTS) and the user agent component (UA). Figure 7.2 illustrates this functional model.

The MTS, essentially the store-and-forward relay component of the system, provides the means for the cooperating UA's to manage their exchange of messages. These user-oriented services include the message transfer itself, the capability to send one message to several recipients, time stamping, priority levels, delivery and nondelivery notifications, and content conversion.

The UA function within the message service is the component that interacts directly with the user. The cooperating UA services would include message circulating and obsoleting, notification of user receipt, and advice on recipient capabilities.

Two different types of UA functions can be considered. In the first type, the simpler case, a single UA interacts with one user, either an originator or a recipient, providing the service directly. Study Group VII is not concerned with standards for this kind of interaction because this kind of service is provided across a single computer-based mail service, for example, or within a single provider.

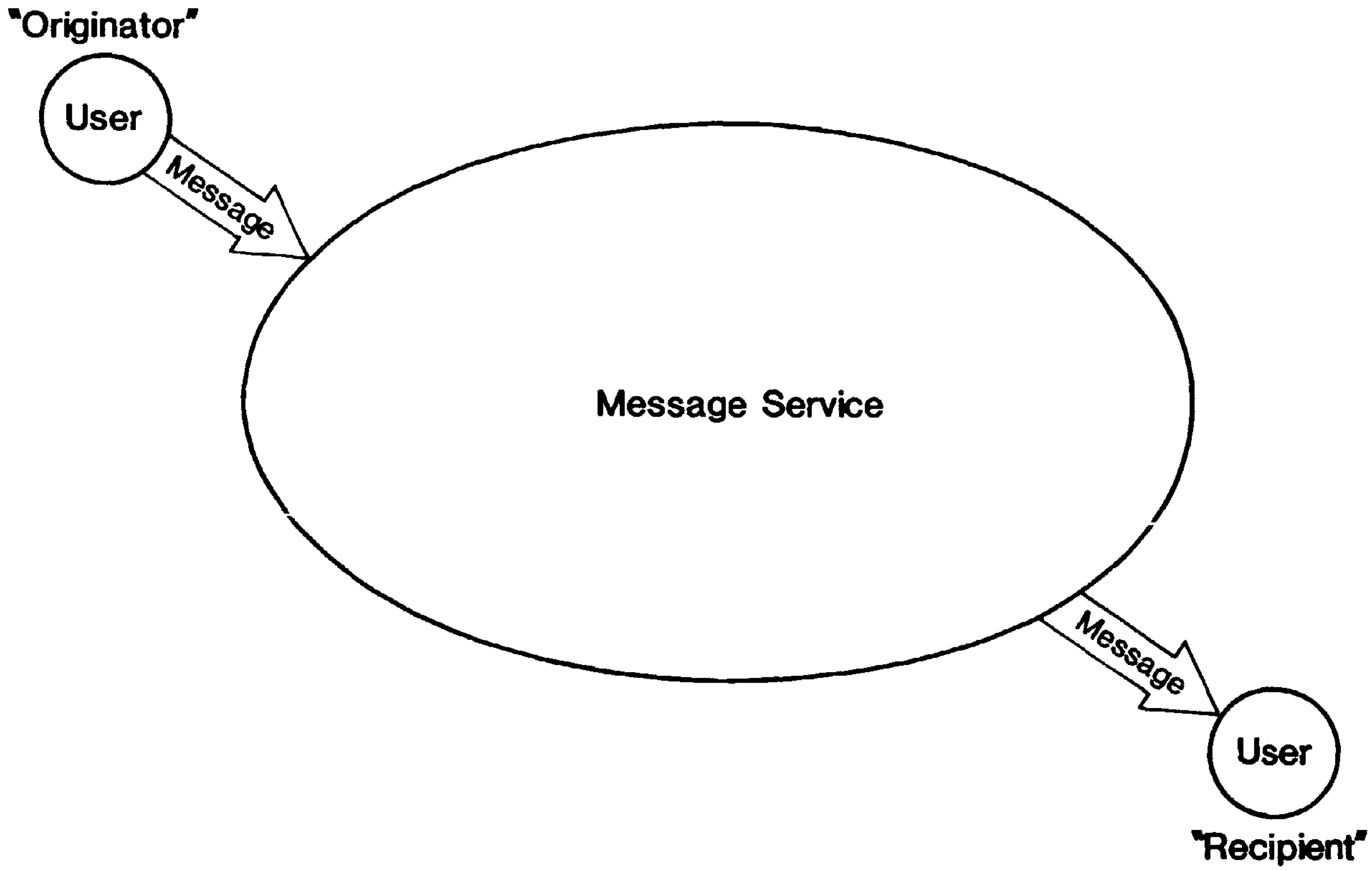

Figure 7.1. End users and the message service.

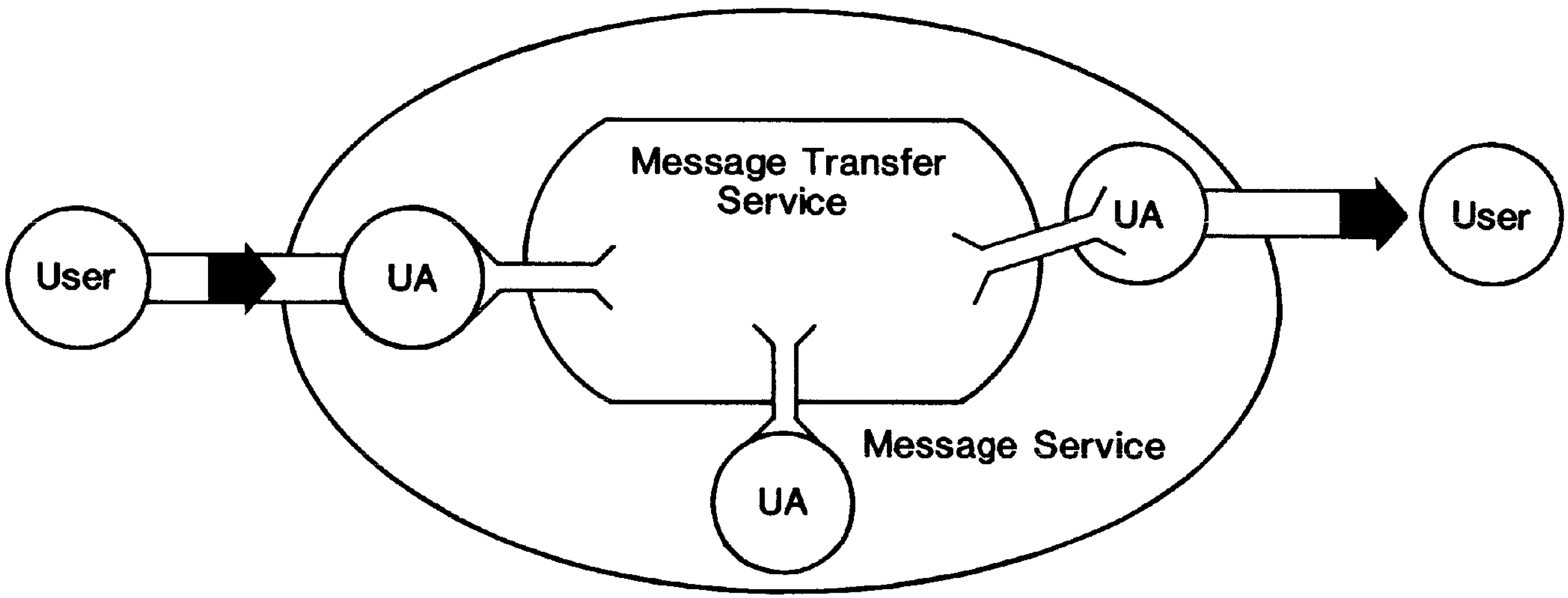

Figure 7.2. Message Transfer Service and User Agents within the Message Service.

It is the second type of UA function that is a subject for international standardization. In this case, the functions will involve two cooperating UA's, one for the originator and one for the recipient. The message transfer system is necessary for a connectionless, message-switched service over the PDN. Therefore, since the real possibility emerges that the two UA's will belong to different administrations, CCITT standardization is required so that users can "talk" across the boundaries. The proposed protocols are discussed below.

7.2.2 The Layered MHS Model: Representation and Protocols

The techniques used within the OSI representation of functions and layered modelling are being applied to the MHS. This has resulted in a preliminary OSI-complementary MHS model. Figure 7.3 represents the simplest two-layered form of the MHS model. An overview of this model is presented below.

Representation

When the UA's employ the MTS as their medium of cooperation, different types of discrete functions are definable, and different types of entities can represent these functions. Figure 7.4 indicates the MTS entities within the two-layered representation; MTSA refers to the message transfer agent, and MTSA refers to the message transfer service access, making the MTS available through the message-transfer-layer/user-agent-layer boundary.

The physical mapping of these entities permits the identification of the necessary communication protocols. The three systems of particular interest are shown in Figure 7.5. System S3 represents a single physical system employing all the types of functions being performed in both the MTS and the UA. It could be possible, for example, to implement only the relay entity within the MTS. These functions (store-and-forward processes) are within the stand-alone system, S2. It would also be possible to access the store-and-forward relay functions through an intelligent terminal as diagrammed in System S1.

Figures 7.6 through 7.8 show various configurations in which these physical systems provide the basis for possible message handling systems. Figure 7.6 represents a stand-alone mail system to which various nonintelligent I/O (input/output) devices are attached for access. Figure 7.7 indicates that certain UA functions (editing, mail storage, etc.), selected out of the processing system into an intelligent terminal, can still permit entry back into

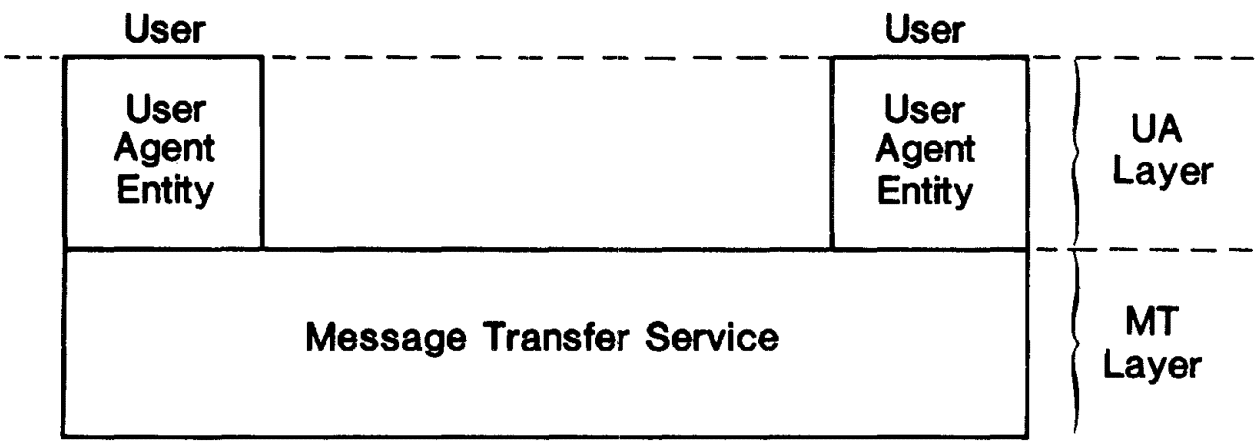

Figure 7.3. Layered representation of the MHS model.

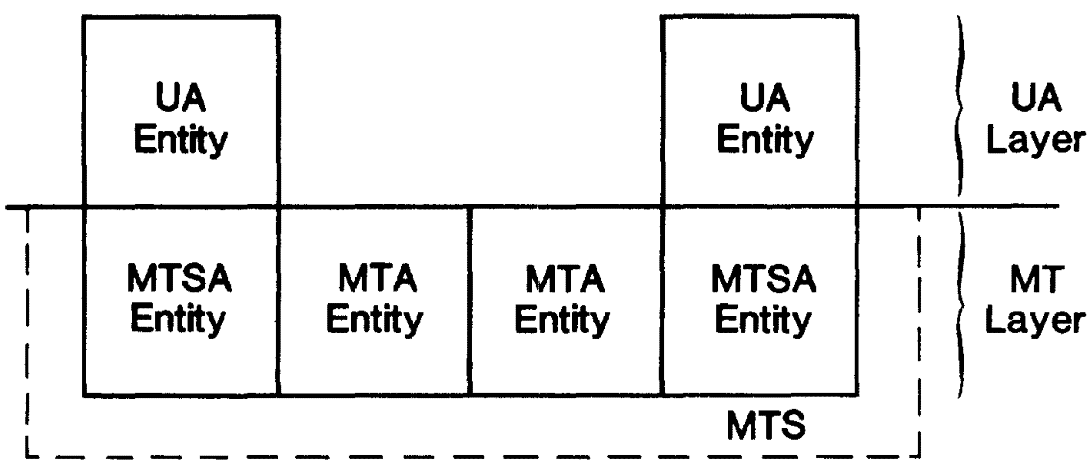

Figure 7.4. Entities of the MTS within the layered representation.

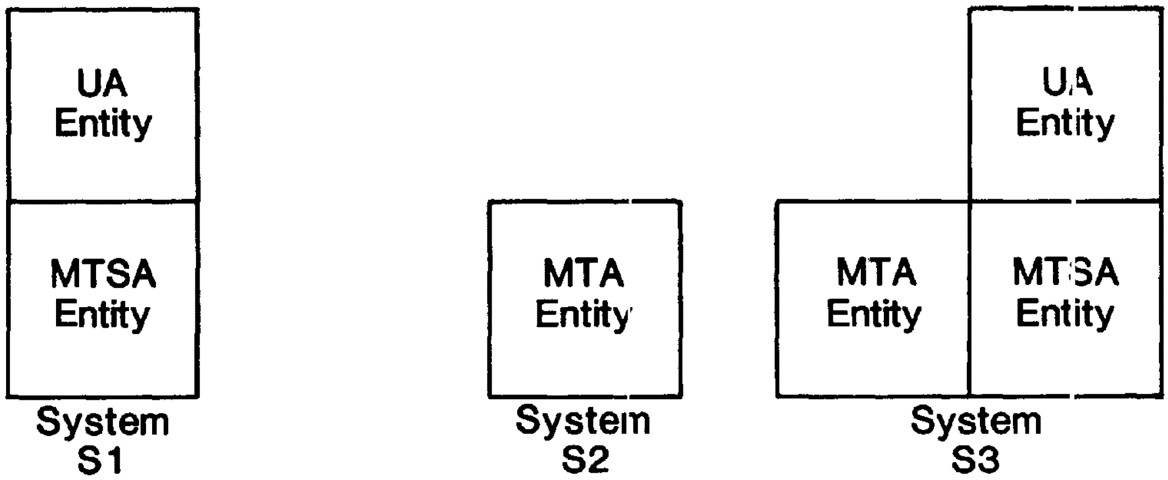

Figure 7.5. Physical mapping of MHS model entities.

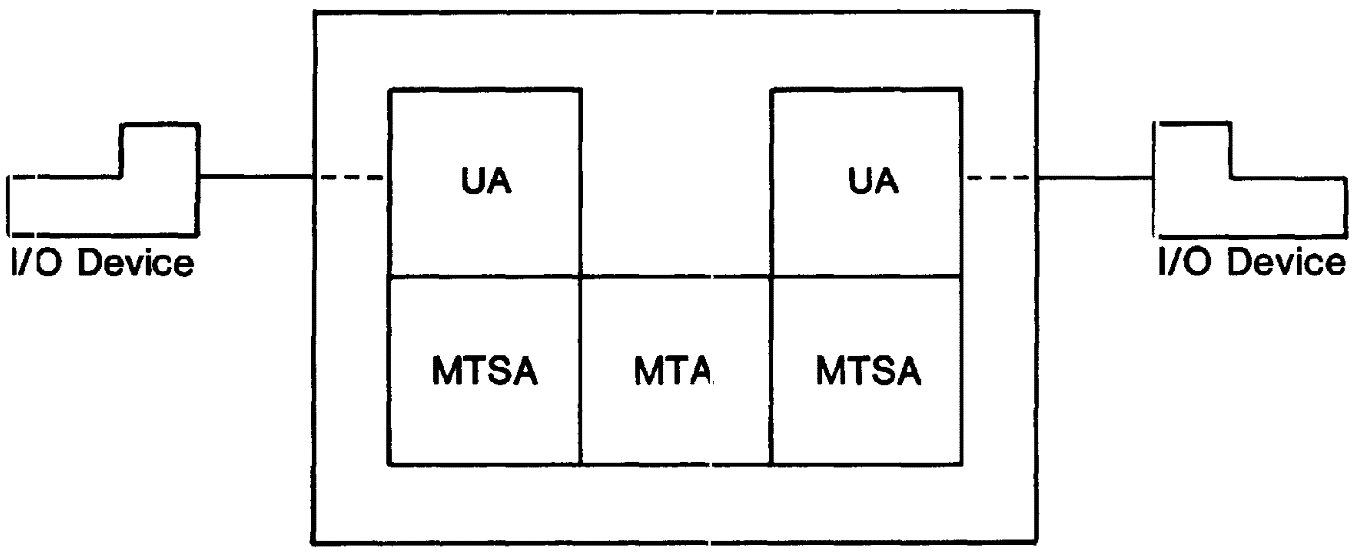

Figure 7.6. Message service provided by a single processing system.

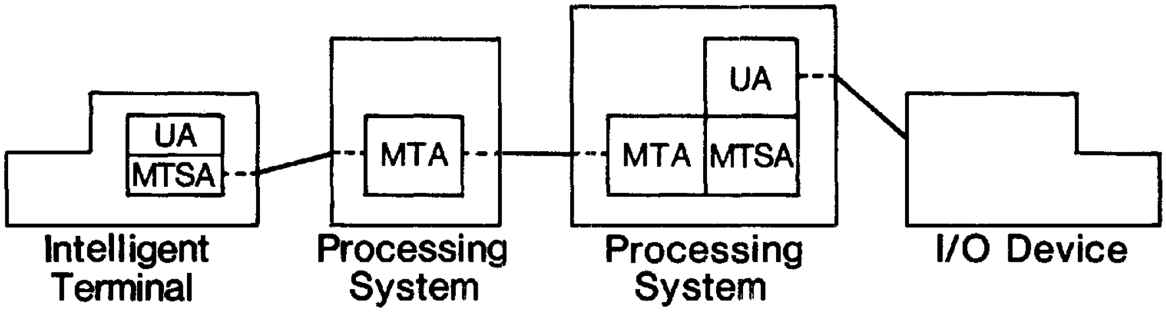

Figure 7.7. Message service provided by interconnected processing systems (example configuration 1).

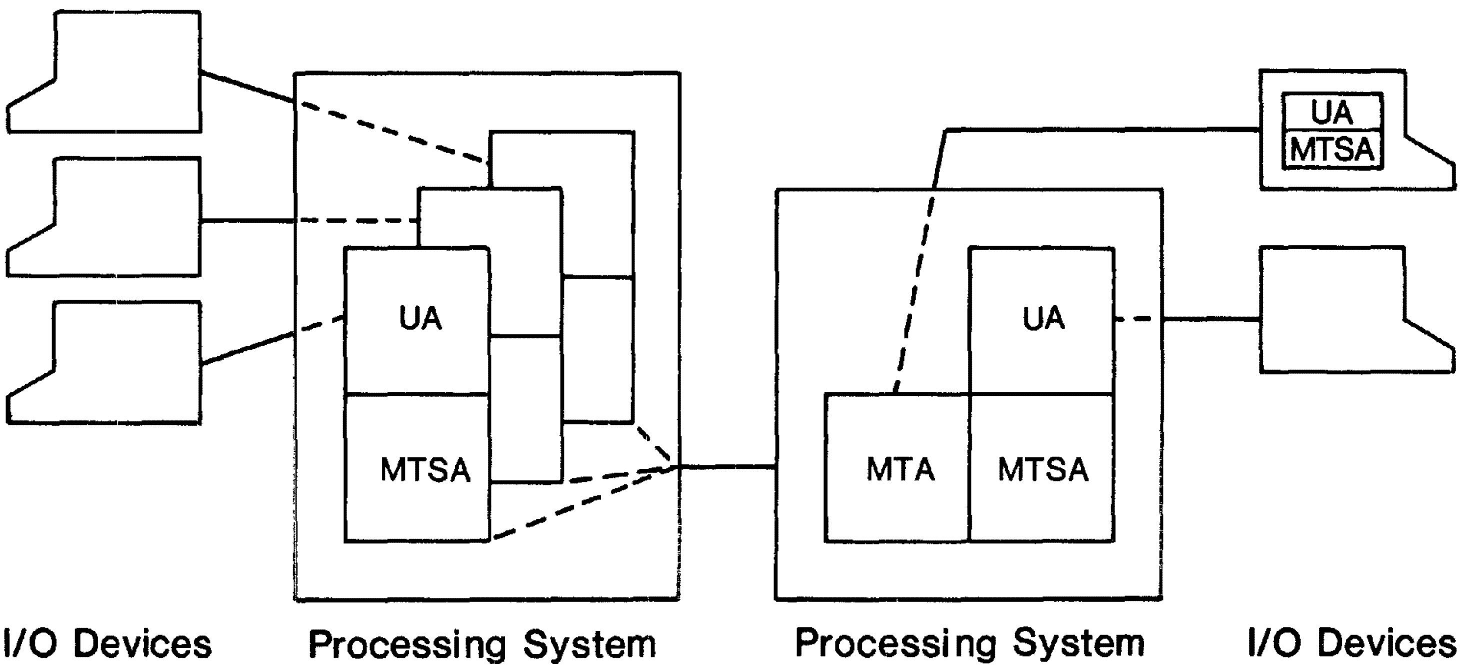

Figure 7.8. Message service provided by interconnected processing systems (example configuration 2).

the mail system. Figure 7.8 represents various mail systems, all interconnected and talking to one another, some of which are back ending intelligent terminals and some of which are not. Basically, this permits the capability of the total message transfer.

Required Protocols

The CCITT Rapporteur Group, in isolating the above configurations, has identified three protocols (P1, P2, and P3) for inclusion in the (hoped for) 1984 Recommendation(s). These protocols are indicated in Figure 7.9. Protocol P1, the backbone of the MTS, allows the store-and-forward relay entities to transport the messages; P2 operates between cooperating user agents; and P3 is the message transfer service access protocol (encompassing the telematic services also.)

Figure 7.10 illustrates the location of the MHS in the OSI model. As such, MHS is an application of OSI. The MTSA and MTA entities are application-layer types of entities residing on the top of all the other OSI layers; P1 and P3 are application-layer protocols.

Protocol P2, however, since it actually uses the capabilities provided to it within the MTS, is even an application protocol of an application protocol. It is depicted at the very top of Figure 7.10.

7.2.3 MHS Naming and Addressing

Naming and addressing are important aspects of MHS, being intrinsic to message relay of any kind. Ideally, the user of the message handling service (even in the initial stages) should be able to address the message to anyone, worldwide, who has a user agent. However, the required directory service is extremely difficult to achieve. Such an international global directory service is a long-term goal to be undertaken in the 1985-1988 Study Period.

Meanwhile, a first approach to a solution of this problem outlines a subset of this task. Work has been done to identify two basic naming and addressing structures for implementation in the initial service.

The two forms of naming encompass a) the architectural attribute set, and b) the terminal-oriented attribute set. In each case the user agent is identified by a specific O/R (originator/recipient) name.

In a) above, the O/R name includes three identifiers: the country name, a management domain name (unique to each country), and a user-attribute set (unique to each domain). This will permit users in the different administrative message handling systems to communicate with each other.

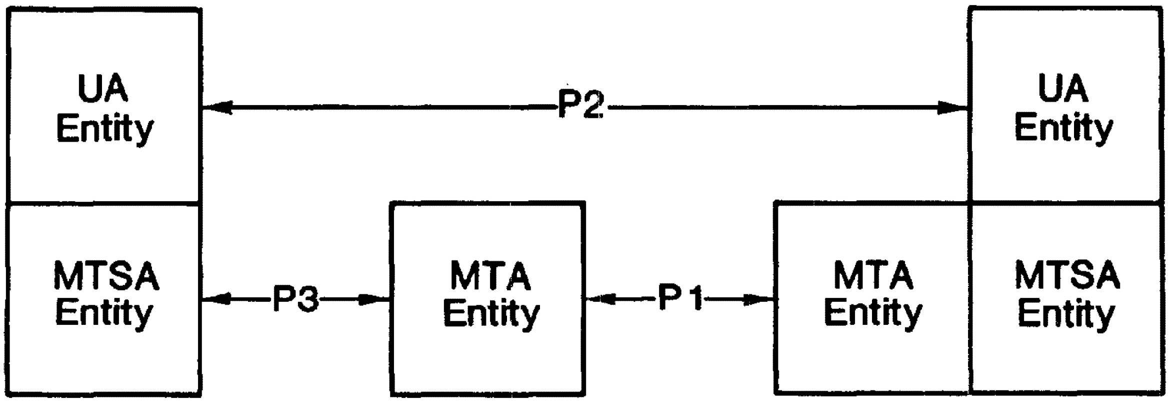

Figure 7.9. Protocols in the MHS Model.

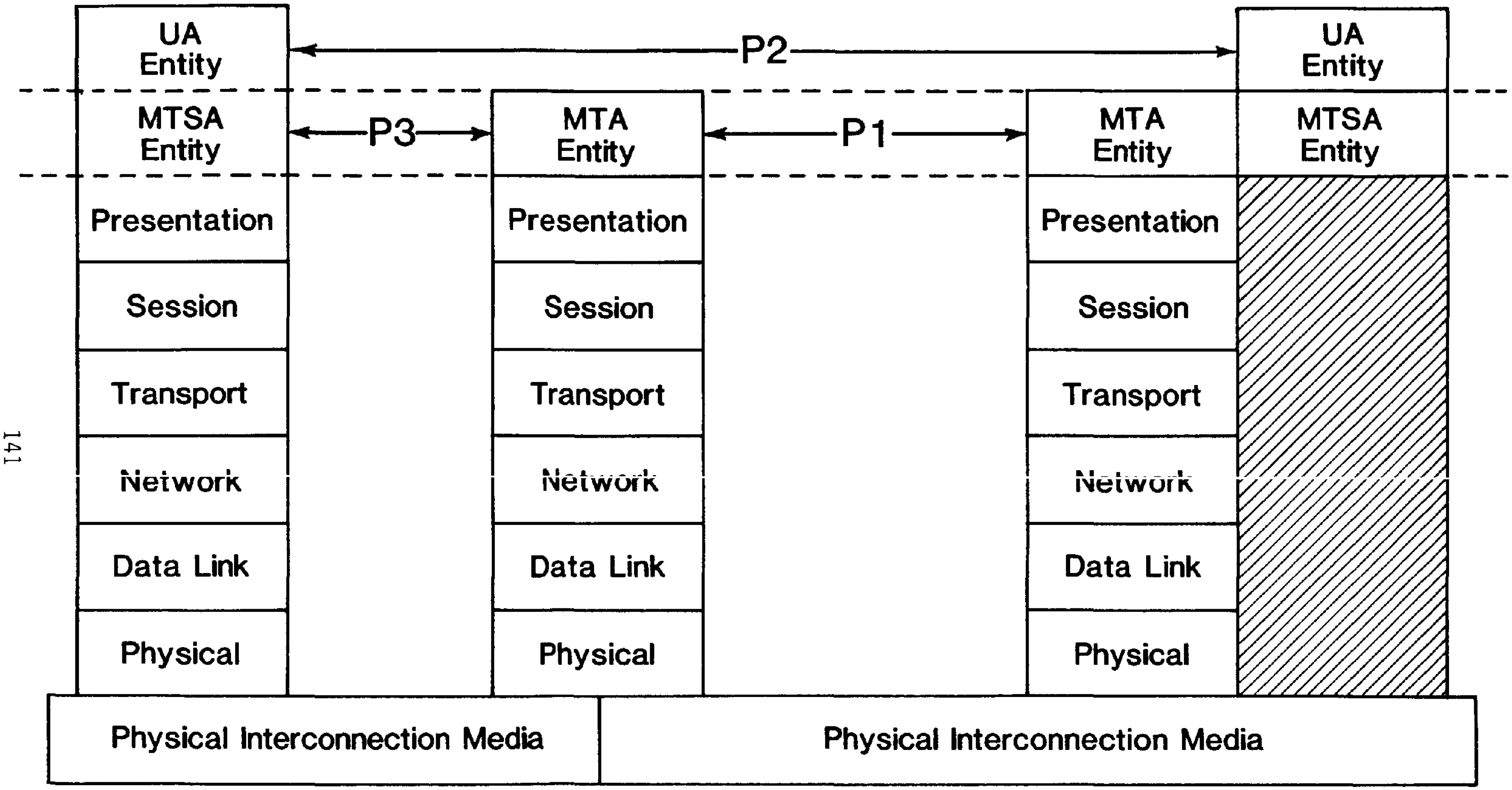

Figure 7.10. Location of MHS in the OSI Model.

The second case, b) above, permits the incorporation of the telematic services within the MHS model (and within the initial Recommendation). This allows users to generate and transport messages to a specific telematic terminal simply by specifying the X.121 address of that terminal. (Recommendation X.121 is "The International Numbering Plan for Public Data Networks.")

Clearly, these O/R names, specified by the user, are at the very top of the message handling model, and therefore, at the top of the OSI model. The names must be mapped throughout the layers of all the intervening protocols to the network layer for translation into the suitable form required by whatever network is being employed in any particular case.

7.2.4 Applications of MHS

The future applications of the MHS are anticipated to be extensive. Possibly the first applications of the Recommendations will be interconnection of computer-based mail systems and the enhancement of certain telematic services. The Recommendations are being developed with sufficient flexibility to accommodate such prospective applications as data base retrieval and inquiry services, electronic distribution and publishing, file transfer, and "office of the future" applications (such as invoicing, tax reporting, and requisitioning).

8. CCITT SIGNALLING SYSTEMS: A 50-YEAR SAGA

The previous sections of this report have offered summary discussions of both standards work and standardized services. This section is presented to show half a century's work in the ITU/CCITT on Recommendations for international signalling systems. (Instead of signalling systems, this chronology could have been developed, as well, for transmission or switching systems.) After tracing the development of signalling systems from 1930 to 1980, and after observing the lifetime of Recommendations as they relate to signalling systems, the reader will be in a better position to evaluate the work of the ITU.

8.1 A History of CCITT Signalling Systems

For the context of this presentation, a signalling system is defined as a structured mechanism for communication between distant points for the information transfer regarding connection control. Signalling systems, required for communication between humans and machines, and machines and machines, provide the facilities to support their respective telecommuncation service requirements.

The three CCITT telecommunication services considered here are telex, telephony, and data. Telex and data signalling systems are considerec briefly. The telephone signalling systems are considered in more depth, and Section 8.2 deals with the details of Signalling Systen No. 7. Table 8.1 lists the 18 CCITT signalling systems.

Table 8.1 The 18 CCITT Signalling Systems

Service	System Designation
Telex	A, B. C. & D
Telephony	1, 2, 3, 4, 5, 5bis, R1, R2, 6, & 7
Data	X.70, X.71, X.60, X.75

8.1.1 Telex Signalling Systems

In the early 1930's, national telex networks were being installec, mainly in Europe, and so CCITT (CCIF, in those days) developed two internaticnal telex signalling systems, labelled A and B. The national networks also made extensive use of these "international" systems for national applicaticns. Then as requirements developed, Signalling System C was developed in the 1960's for intercontinental traffic, and Signalling System D was developed in the 1970's to incorporate the new technology of stored program control. All four telex signalling systems are still in operation, and will not disappear in the near future.

8.1.2 Telephone Signalling Systems--A Chronology

The first telephone signalling system was developed in the early 1930's, when the national networks became partially automated. International Signalling System No. 1 (SS No. 1) was operated manually, operator to operator, was extremely simple, had one voice frequency, and supplied only what was absolutely required. Even so, SS No. 1 was not taken out of service completely until 1980.

Later in the 1930's, as the requirements for international traffic increased and manual service was no longer sufficient, a semi-automatic system was developed, ready for specification in 1939. Signalling System So. 2 had five functions in the signal repertoire: seize, answer, pulsing, clear forward, and clear back. However, because of World War II, SS No. 2 was never implemented for international traffic. A SS No. 2-type system is still used extensively in Europe.

Following World War II, the question arose again: "How are we to handle international traffic?" The national networks had become automated, and there were new requirements for the signalling system. Two proposals were made (one voice frequency and two voice frequencies) and in lieu of settling for one or the other, two new signalling systems were standardized in 1954, SS No. 3 and SS No. 4.

Signalling System No. 3 was designed for terminal and transit operation, but has been used only for terminal operation. The last No. 3 circuits were taken out of service in Europe in the late 1970's.

Signalling System No. 4, the two voice-frequency system, was similar to No. 3 in line signalling, but had a more extensive address signalling format. Number 4 is still in widespread use in Europe.

In the mid-to-late 1950's, intercontinental traffic expanded (undersea cables played a part) and the interworking required added capabilities, especially in the backward direction for failed calls. The resultant SS No. 5, standardized in 1964, was widely implemented immediately.

At about this same time, an enhanced version of SS No. 5 was being developed, and in 1968 SS No. 5bis was standardized. However, because No. 5 was already in place, No. 5bis has never actually been used.

In 1968, the CCITT formally recognized the existence of two international non-CCITT signalling systems in operation in two regions, one in North America and the other mainly in Europe. So, the CCITT gave these systems a "stamp of approval," and called them Regional Signalling Systems R1 (North America) and R2 (Europe).

Signalling System R1 is similar in many respects to SS No. 5 ; R1, however, has a digital version. Signalling System R2 is the deluxe version of per-circuit signalling systems. Basically, when a signal is wanted, it is received. It has a rich repertoire of functions and can double the capacity. It is partly out of band and so its register signalling is continuous and compelled.

The year of 1968 was a busy one for signalling systems. A fourth signalling system was standardized (R1 and R2 were only approved, however), and

SS No. 6 opened the world to common channel signalling in telephony. Actually, the idea was not new since it had been used in the early 1950's in telegraphy circuits.

The technique, feasible with the advent of computer-controlled switching equipment, provides an expanded service and facility range and a substantial increase in the signalling repertoire for the telephone signals and for network management signals. Common channel signalling offers a reduction in both answer-signal and post-dialing delays. Above all, signalling is removed from the speech path, offering a transparent speech path.

Interest was high in SS No. 6, worldwide, and many nations hoped to be able to implement it right away, since it can be operated via analog and digital transmission facilities. However, because of the difficulties involved in this system, it was subject to extensive field trials involving several administrations, including the United States. This produced upgrading, and SS No.6 now provides excellent service. It is used in North America and in the Pacific region, and its use is growing. It has not been widely implemented in Europe.

With rapid advance of technology and with the ISDN in mind, CCITT is in the process of developing SS No. 7, which is optimized for the digital environment. The ISDN signalling activities include: subscriber-line local exchange, PABX-local exchange, SS No. 7-ISDN user part, end-to-end signalling capability, and interworking between ISDN and other CCITT signalling systems.

The initial standardization of SS No. 7 was approved in 1980. Signalling System No. 7 supports telephone and nonvoice services and is optimized for operation over 64-kb/s digital channels. Being built into the system is the flexibility to evolve with future enhanced service requirements. Section 8.2 expands the discussion of SS No. 7.

8.1.3 Data Signalling Systems

Table 8.2 provides a tabular overview of the four (to date) data signalling systems (those rows in brackets) and their relation to the data standards for interfaces. Although the telephone signalling between the subscriber and the exchange has never been a matter of study for the CCITT, data systems have required that the CCITT specify more detail within the national system itself.

8.2 Signalling System No. 7

Section 8.1 has presented a general summary of CTITT signalling systems. This section considers SS No. 7 in greater detail by presenting a) the overall

Table 8.2. Overview of the Four Data Signalling Systems

Recommendation	Type of Standard	Field of Application	Remarks
X.20	Interface	Between DTE & DCE for start-stop services on PDN's	Defines physical characteristics and call control procedures U.C. 1 and 2* Duplex Operation
X.20bis	Interface	Use on PDN's of DTE designed for interfacing to asynchronous duplex V-series modems	Interim measure until X.20 is provided U.C. 1 & 2
X.70	Signalling	Terminal & transit control signalling for start-stop service on international circuits between asynchronous data networks	U.C. 1 & 2; Decentralized; in-band link-by-link; en-bloc and overlap for transit
X.21	Interface	Between DTE &DCE for synchronous operation on PDN's	Defines physical characteristics & call control procedures U.C. 3 to 7 Duplex operation
X.21bis	Interface	Use on PDN's if DTE designed for interfacing to synchronous V-series modems	Interim measure until X.21 is provided U.C. 3 to 7
X.71	Signalling	Technical & transit control signalling system on international circuits between synchronous data networks	Decentralized; in-band link-by-link en-bloc
X.60	Signalling	Common channel signalling for circuit switched data applications	International and national SS No. 7 for single & multi-services digital networks; data user part in Rec. X.61
X.25	Interface	Between DTE & DCE for Terminals operating in packet mode on PDN's	U.C. 8 to 11 Structured in accordance with OSI layered model Physical level (X.21, X.21bis) Link level Packet level
X.75	Signalling	Terminal & Transit control procedures & data transfer system on international circuits between packet switched data networks	U.C. 8 to 11 Structured in accordance with OSI layered model (see above)

*UC: User Class

structure of SS No. 7, b) a comparison of SS No. 6 and SS No. 7, and c) the current work of CCITT Study Group XI on SS No. 7.

8.2.1 Background

Signalling System No. 7, the latest common channel signalling protocol SPC (stored-program control) switching system, is the first CCITT signalling system that has been specified with national--rather than international--use as the intent. Although the other international systems have always had national variations, this had not been the intent of the specification activity of the CCITT in the past. The 1980 specifications of SS No. 7 were largely the work of Study Group XI (and Study Group VII) and followed two study periods of work (8 years). These studies were the direct outgrowth of questions posed in 1973 by Special Group D (later Study Group XVIII) concerning the basic requirements for switching and signalling in the integrated digital network (IDN). Signalling System No. 7 is considered to be the preferred system for the IDN for both telephony and data, and is being planned as the preferred system for interexchange signalling in the future ISDN.

The 1980 Recommendations specifying SS No. 7 are Q.701 to Q.741, which can be found in the CCITT Yellow Book, Vol. VI, fascicle VI.6. Appendix G includes the titles of these Recommendations.

8.2.2 A Comparison of Signalling System Nos. 6 and 7

Because some of the work on SS No. 7 has been done in parallel with that of the digital version of SS No. 6, the questions are often asked, "What is the advantage of SS No. 7? Couldn't No. 6 do the job?

Although SS No. 6 is a flexible common channel system, able to work with any SPC system regardless of facilities, the original specifications (1968 and 1972) were done when all data were transmitted on analog facilities. Because the relatively low bit rate (2.4 kb/s) forced the minimizing of transmission delay, messages had to be resequenced; retransmission occurred, at times, whether or not the message received was known to be correct. This required some complications in the telephone procedures and in the messages furnished for resequencing.

The resultant processes involved in the resequencing checks in SS No. 6 were viewed by some future-looking administrations as too complex and possibly too difficult for implementation in the anticipated digital networks. (They have not been as difficult as envisioned in 1972.) Therefore, the designers of the resultant new system, SS No. 7, have taken great pains to ensure sequence control of the messages all the way up through the network layer of the system.

As one major reason for the development of SS No. 7, this discussion, above, reflects the rapid development of advanced digital techniques in the past decade, and the fear that SS No. 6 would prove inadequate for responding to the needs of the 80's. As a consequence of the rapid development of SS No. 7, the digital version of SS No. 6 might never be implemented (similar to the fate of SS No. 5bis).

Certain parameters of SS No. 6 and SS No. 7 are compared in Table 8.3. The following paragraphs give an overview of these features.

Table 8.3 A Comparison of Signalling Systems Nos. 6 and 7

Parameter	No. 6	No. 7
bit rate	2.4 (4 & 56) kb/s	64 (4.8) kb/s
link capacity	2000 ckts	40,000 ckts
message capacity (level 4)	8 bytes	58 (256) bytes
signal unit length	fixed	variable
routing code	bands	destination
protocol structure	integrated	layered
sequence under error & failure conditions	repeated & out-of-sequence messages	maintained

Signalling System No. 6 was originally specified for 2.4 kb/s; in 1976, 4 kb/s and 56 kb/s were specified for the digital version. Although SS No. 7 is specified primarily for 64 kb/s, it is usable at any bit rate. In particular, 4.8 kb/s is mentioned in the specifications because some administrations are planning to put in digital exchanges long before they have much penetration of digital transmission.

Because of the differences in bit rates, and in the protocol, there is a very large increase in the number of circuits that can be signalled for in SS No. 7 (40,000), as compared to the 2,000 circuits in SS No. 6.

The message capacity of SS No. 6 is small--8 bytes--and reflects the effort to save bits in the specifications. Signalling System No. 7 can handle 58+ bytes (according to the interpretation of the specifications) and for national usage SS No. 7 can handle 256 bytes. Although even these messages are short compared to some packet protocols, they are more than sufficient for signalling uses.

The signal unit length is fixed in SS No. 6, reflecting, again, the desire for efficiency by the designers. Signalling System No. 7 has a variable unit signal length.

To route a message in SS No. 6, two things must be known: the link the message is associated with, and the band number of the message. The band number tells basically, what group of circuits the message is for, up to 16 circuits. In SS No. 7, however, the circuits are grouped by a node designation, and up to 4000 entities--circuits, etc.--can be handled between two destinations for any given user.

The totally integrated protocol structure of SS No. 6 (designed prior to the layered structures of today) has limited flexibility and requires changes in order to add new features. Signalling System No. 7, however, has a layered protocol which minimizes the interactions of the different protocol functions.

The last parameter listed in Table 8.3, the sequence under error and failure conditions, has already been touched upon above.

8.2.3 The Structure of Signalling System No. 7

Signalling System No. 7 is a layered protocol (the layers are called "levels"), and there is a relationship between the 4 levels of SS No. 7 and the layers of the OSI Reference Model (and with X.25 as well). The overall structure of SS No. 7 has two main parts: the message transfer part (levels 1 to 3) and the user part (level 4).

The Message Transfer Part (MTP)

The Three MTP levels closely track the first three layers of the OSI Reference Model. These MTP levels are referred to, respectively, as the signalling data link, the signalling link functions, and the signalling network functions.

Level 1: Level 1 accommodates a variety of data transmission facilities. It also allows data rates that are in the G, X, and V series of Recommendations.

Level 2: Level 2, which looks very much like level 2 of X.25, can be summed up as containing functions for delimiting, error and sequence control, failure detection, and link recovery. The delimiting in SS No. 7 is exactly the same as that for X.25. The error and sequence control is different. It is a positive-negative acknowledgement system that assures that error-free messages are received in the same order as they were transmitted. As soon as an error is detected, or suspected, all the messages are retransmitted from that point on.

Level 3: Level 3 of SS No. 7 is different from level 3 of X.25 because SS No. 7 is a network protocol and X.25 is an access protocol. Signalling System No. 7, level 3, deals with the functions related to message handling, network management, routing, and failure recovery.

As a network protocol, SS No. 7 routes messages to a destination node. The international version specifies 14 bits for this function; the North American version is planning 20 bits (an allowed option).

Signalling System No. 7 is a connectionless protocol and has no means, at the network level, of setting up connections. Signalling System No. 7 resembles a permanent virtual circuit, established by administrations from the originating node to the destination node, with whatever circuit identity code is there. A 40-bit field specifies a unique relationship which is called a signalling relation.

Level 3 is, nonetheless, defined as a network protocol, and therefore signalling network management is also defined. The signalling network status is able to be determined at any time, thereby permitting routing control.

Although SS No. 7 permits both associated and nonassociated modes of operation, the truly associated mode (working between a pair of nodes) would not require the originating and destination point codes. The designers of SS No. 7 intended to have a full, nonassociated or quasi-associated network operation.

Great pains were taken to make sure that any message for a given signalling relation--a 40-bit field--would follow exactly the same path under normal conditions. The "same path" may be a different path in each direction, according to the routing structure, but the messages in the forward direction will go by the same path, and the messages in the backward direction will go by another path (maybe). This path will always be the same.

Under failure conditions, no messages are lost nor will messages ever be repeated. Signalling System No. 7 has a changeover and changeback procedure which ensures an extremely reliable network.

User Part (Level 4)

Level 4 in SS No. 7 goes up through OSI layers 4-7. Layer 4 is really a null function, because some layer 4 functions are included in SS No. 7 Level 3. Two kinds of users are allowed in SS No. 7--the telephone user and the data user.

Telephone User Part (TUP): Most of the work for the TUP is based on SS No. 6, because of the improved reliability in SS No. 6. The TUP is often referred to as "the user part for telecommunication circuits." This reflects the VIIth Plenary Assembly statement that the ISDN will evolve from the telephone network. As such, the work on the telephone network should be used as a basis for Recommendations for ISDN signalling.

Data User Part (DUP): The DUP was specified for public circuit switched data. This was based on Recommendation X.87 which defines functions used for data services, and spells out the capabilities needed for data services. Recommendation X.61 specifies these.

8.2.4 Study Group XI and Signalling System No. 7

Working Party 2 of Study Group XI is entitled "Signalling System No. 7," and is responsible for five questions. Brief titles of these questions are:

1. Signalling Network Structure (1/XI)
2. Message Transfer Part Extensions (2/XI)
3. Telephone User Part (3/XI)
4. New User Parts (4/XI)
5. OAM (Operations and Maintenance) Measurements (14/XI)

Key issues in each of these questions are discussed below.

Question 1/XI

Signalling network structure has had little momentum in the past because SS No. 6 was specified for many years before international application (1978). Consequently, the SS No. 6 network (particularly in the Pacific area)--which grew rapidly--has little structure.

Study Group XI is still not making much progress on structure, but has made great progress in defining some standard routing labels, such as a point code allocation scheme. Using the X.121 numbering plan as the starting point, each international signalling point will have point code allocations to be administered by the CCITT. The United States, for example, will have available about 320 of these codes--with great room for expansion.

Another issue that has emerged is the possibility of using SS No. 7 as a bearer of SS No. 6, to accommodate those administrations who have already invested money into programming their switching machines to work with SS No. 6. At present this has not stimulated much interest because the SS No. 7 development in the international environment has not yet made much progress.

Question 2/XI

The administrations who have started implementing the MTP of SS No. 7, as specified in 1980, are concerned that future changes might be required, and see that they might be penalized, in effect, by their early standardization (see Section 3.5). Other administrations look forward to implementing SS No. 7 in the late 80's, hoping to have all needed enhancements for such developments as the ISDN.

Because SS No. 7 is a connectionless protocol, there is a flow-control problem with it. One specific concern is the clear distinction between network failure and network congestion. Agreement has been reached that there will be flow control at levels 2 and 3 (level 1 has no flow control, because it is not a connection, per se). Flow control for level 2 has already been defined, and that for level 3 is under study.

Question 3/XI

The group studying the TUP has been very active, mainly because studies on the ISDN user parts are included. Other considerations are 1) the messages not related to the telecommunication circuit (similar to "direct signalling" in the Bell System), by which, for example, in a data base search, a preliminary inquiry can be made as to the busyness (busy status) of the circuit; 2) end-to-end messages, such as the so-called user-to-user ISDN messages that will pass transparently through the network; and 3) PABX applications; these applications for the ISDN are also considered in Working Party 6 of Study Group XI.

Question 4/XI

"New user parts" include extensions to SS No. 7, especially in relationship to the OSI layering. Problems have emerged in the relationship between the 4-level protocol of SS No. 7 and the 7-layer OSI user-related protocols. Another problem relates to the PABX SS No. 7 network access. Assurance must be made that the customer's signalling access does not interfere with the network itself. The issues related to maintenance involve status information, the updating (maybe remotely) of generics (system programs), and the establishment of new routing. A final issue involves the interface of SS No. 7 with other protocols such as those connected with X.25 access into network operation centers with resultant transmission of the obtained information across the network (strictly involving telephone signalling and switching).

Question 14/XI

Although there has not been much activity yet on OAM issues, the measurements needed for SS No. 7 are being defined. There are two basic approaches to this: bottom-up--the definition of primitives, or basic measurement, that can be made on the system, followed by an analysis of the uses that can be made of those primitives to furnish certain functions; and top-down--starting with the users and determining the primitives.

8.2.5 Summary

There is a great effort going on in SS No. 7 development in the CCITT, reflected by the numbers of participants in the working group. The large number of contributions to every meeting is also indicative of the broad interest. The diversity of opinion is extensive and issue resolution--especially in the difficult problem of layering--will be a monumental task. However, unless this resolution occurs, so that the SS No. 7 can be viable and can grow, the world community may find itself working on SS No. 8.

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APPENDIX A: DRAFT RECOMMENDATION I.xxw

Annex 3

(to Part II)

DRAFT RECOMMENDATION I.xxw : General aspects and principles relating to Recommendations on ISDN user/network interfaces

1. Recommendation G.705 gives the conceptual principles on which the ISDN should be based. The main feature of the ISDN is the support of a wide range of services, including voice and non-voice services, in the same network by offering end-to-end digital connectivity.

A key element of service integration for the ISDN is the provision of a limited set of standard multipurpose user/network interfaces. These interfaces represent a focal point both for the development of ISDN network components and configurations and for the development of ISDN terminal equipment and applications.

An ISDN is recognized by the service characteristics available through user/network interfaces, rather than by its internal architecture, configuration or technology. This concept plays a key role in permitting user applications and network technologies to evolve separately.

The ISDN will provide a basic network transport capability for a variety of services (ranging from alarms and telemetry through voice, interactive data and bulk data, to broadband video applications) using a variety of telecommunication modes (from leased and semipermanent connections to circuit and packet-switched connections).

In addition to the basic transport capability, depending on the national regulatory arrangements, the ISDN could also incorporate information storage and processing facilities, e.g., in case of CCITT standardized communication services, such as Teletex, Videotex and others.

2. Figure 1 shows some significant examples of ISDN user/network interfaces. The following cases are identified corresponding to :

1) access of a single ISDN terminal;

2) access of a multiple ISDN terminal installation;

3) access of multiservice PBXs, or local area network, or, more generally, of private networks.

In addition, depending on the particular national regulatory arrangements, ISDN user/network interfaces may include access of :

4) specialized services networks;

5) specialized storage and information processing centres;

6) other single or multiple services carrier networks.

3. User/network interfaces standardization is required to allow :

1) different types of terminals and applications to use the same interface;

2) portability of terminals from one location to another (office, home, public access points) within one country and from one country to another country;

3) efficient connection with private networks, specialized service vendors and other carrier networks.

4. User/network interfaces should be specified by a comprehensive set of characteristics, including :

1) physical and electrical characteristics;

2) performance characteristics;

3) maintenance and operation characteristics;

4) bit-stream format, in terms of channel aggregation;

5) service and feature selection procedures, signalling procedures and protocol procedures for the information transfer.

5. In addition to the multiservice capability the ISDN user/network interfaces should allow for additional capabilities (as compared with the existing X series interfaces) such as the following :

1) a multidrop connection, possibly with socketized simple interface, to which a variety of different terminals can be connected;

2) choice of bit rate, switching mode, coding method, etc., on a call-by-call basis, over the same interface, according to the user's need on a particular call;

3) capability for compatibility checking in order to check whether calling and called terminals can communicate with each other.

6. For defining the interface characteristics a layered functional specification method should be applied, using an OSI-type of reference model, suitably adapted to allow for the specifics and requirements of the ISDN.

7. The reference configuration for ISDN user/network interfaces define the terminology for various reference points and the types of functions than can be provided between reference points. Recommendation I.xxx contains the reference configurations and shows significant applications.

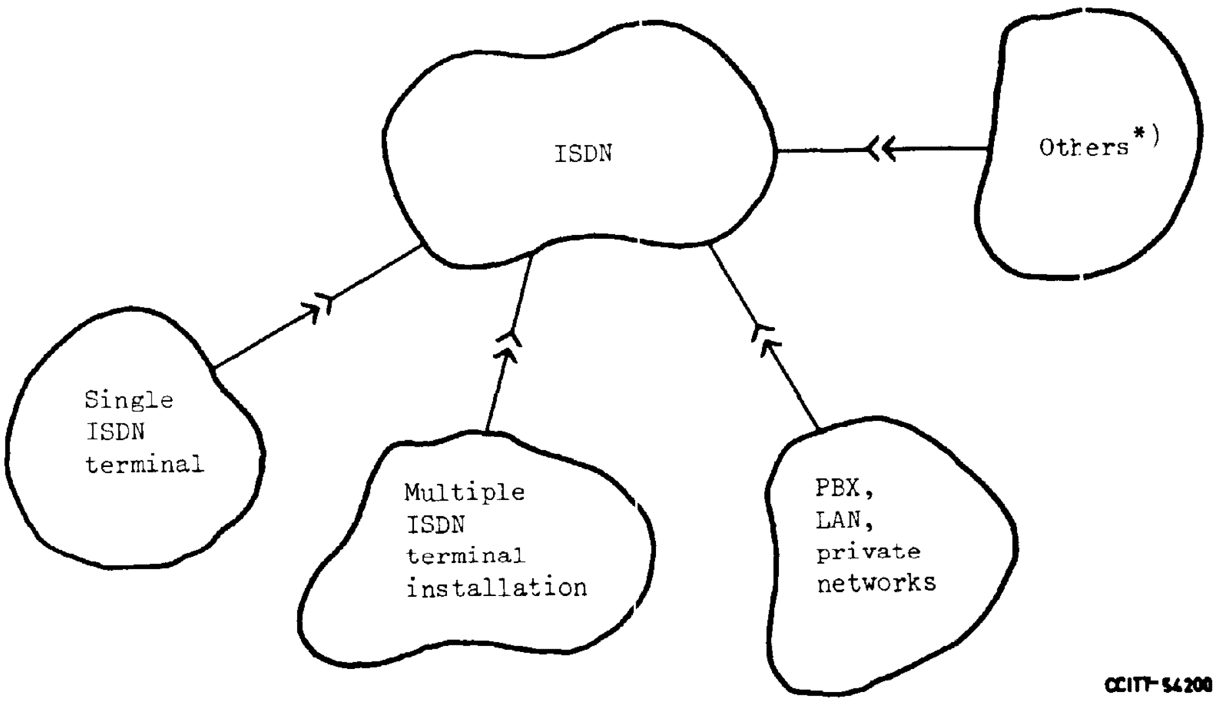
8. As an objective the number of different interfaces should be kept to a minimum. In order to meet this objective, a distinction is necessary between the channel structures supported by the interfaces, and the access capabilities reflecting the digital channels actually available and supported by the particular networks accesses.

Recommendation I.xxy covers these aspects.

9. In order to prevent an unnecessary diversification of interface characteristics, and yet to retain sufficient flexibility to meet the users and network and services providers needs, a modular approach should be applied in defining each type of interface. This is achieved by reflecting the layered functional specification method also in the structure of these Recommendations. Therefore, the Level 1 type characteristics applicable to one or various types of interfaces are given in Recommendations the I-... series; the Level 2 characteristics in the I-... series, and the Level 3 characteristics in the I-... series.

A particular type of physical interface appearing at a location corresponding to a specific reference point can then be fully specified by selecting the appropriate Recommendations applicable to the relevant functional levels (for example, for the basic user/network interface of Recommendation I.010, Level 1 of I.101, Level 2 of I.201 and Level 3 of I.301 apply jointly).

10. The principles outlined above should be applied when other ISDN-access interfaces are to be developed in the future.



*) Depending on national regulation, this may include :

1) specialized services networks;

2) other carrier networks;

3) specialized information processing centres.

Figure 1 - ISDN user/network interface examples

APPENDIX B: DRAFT RECOMMENDATION I.xxx

COM XVIII-No. R 8-E

II.4 Draft Recommendation I.xxx : ISDN user/network interfaces - Reference configurations

II.4.1 General

II.4.1.1 This Recommendation provides the reference configurations for the ISDN user/network interfaces.

The reference configurations are conceptual configurations useful in identifying various possible physical user access arrangements to the ISDN. Two elements are used in the reference configurations : the reference points and the functional groupings. The reference points are conceptual points useful in separating functional groupings, each of which may correspond in certain arrangements to physical equipment or combination of equipment. Physical user/network interfaces may or may not appear at the location of reference points according to the specific user access arrangements. The ISDN user/network interface Recommendations apply to physical interfaces that occur at a specific ISDN reference point location. Layout and application examples of the reference configurations are given in section 2.

II.4.1.2 From the user's perspective, the ISDN is completely described by the characteristics which can be observed at the ISDN user/network interface, including physical, electrical, protocol, service, and performance characteristics. The key to defining, and even recognizing, ISDN is the specification of these characteristics. These specifications will form the basis for work on user applications and terminal equipment, as well as ISDN capabilities, services, and the many other aspects of the ISDN.

II.4.1.3 An objective of ISDN is that a limited set of compatible user/network interfaces can economically support a wide range of user applications, equipment and configurations. The number of different user/network interfaces should be minimized to maximize user flexibility through terminal compatibility (from one application to another, one location to another, and one service to another), and to reduce costs through economies in production of equipment and operation of both the ISDN and user equipment.

However, some different interfaces are required for applications with widely different information rates, complexity or other characteristics so that many simple applications are not burdened with the cost of providing complex applications.

II.4.1.4 An objective is to have the same interfaces used even though there are different configurations (e.g., single terminal versus multiterminal connections to a PABX versus direct connections into the network etc.) or different national conditions (e.g., on the boundary of the ISDN).

II.4.1.5 The implications of these objectives on the specific user/network requirements must be examined to determine whether excessive costs or other penalties are involved in meeting them.

II.4.2 Reference configurations

II.4.2.1 The reference configurations for ISDN user/network interfaces define the terminology for various reference points and the types of functions that can be provided between reference points. Figure 1 shows the reference configurations, while Figure 2 shows significant applications of such configurations.

II.4.2.2 The reference points are conceptual points useful in separating functional groupings, represented in Figure 1 as square blocks. In certain physical configurations, the reference points may correspond to physical interfaces. The I-Series Interface Recommendations apply to physical interfaces appearing at given reference points. Reference points S and T in Figure 1 are identified as ISDN reference points. Only the bit rates which relate to recommend channel structures according to draft Recommendation I.xxy apply to physical interfaces appearing at S and T reference points. R is not an ISDN reference point and may be subject to other Interface Recommendations, e.g. the X-Series Recommendations.

Note : There are no reference points assigned to the transmission line, since an ISDN user/network interface is not envisaged at this location.

II.4.2.3 Figure 1a gives the main reference configuration comprising functional groupings NT1, NT2 and T1. Figure 1b illustrates that T1 may be replaced by T2 and TA.

II.4.2.4 The functions which compose the functional groupings NT1, NT2, T1, T2 and TA can vary with the physical implementation method used for the access. It is possible for a function to be null or to be located in different functional groupings depending upon the arrangement selected. The descriptions below are given for significant examples for functional groupings. The given function lists are neither exhaustive nor mandatory.

Note : The functional groupings are described in relation to the layers of the OSI Reference Model being developed under Question 27/VII. Further study is required to assess the suitability of applying the OSI model to the ISDN (see Question 1/XVIII, point B).

II.4.2.4.1 NT1 - Network Termination 1. This includes functions that may be regarded as broadly belonging to Layer 1 (Physical) of the OSI Reference Model. These functions are intended to be associated with the proper physical and electrical termination of the network. NT 1 functions may include :

- line transmission termination;
- Layer 1, line maintenance functions, such as test loops and performance monitoring;
- timing;
- power feeding;
- Layer 1, upward multiplexing;
- interface termination, including multidrop termination employing Layer 1 contention resolution.

II.4.2.4.2 NT2 - Network Termination 2. This may include functions broadly belonging to Layer 1 and to higher layers of the OSI model, such as Layer 2 (Data Link) and Layer 3 (Network). PABXs, Local Area Networks and Terminal Controllers are significant examples of equipment or combination of equipment which provide NT2 functions. These functions may include :

- protocol handling at Layers 2 and 3;
- Layers 2 and 3, upward multiplexing;
- switching;
- concentration;
- Layers 2 and 3, maintenance functions.

In certain physical configurations, NT2 functions at Layers 3 and above may be null. A network termination acting as a simple terminal controller is an example of such configurations.

In certain other physical configurations NT2 functions at Layers 2 and 3 may be null, as described in section 2.5.1.

II.4.2.4.3 T1 - Terminal Type 1. This includes functions associated with ISDN Terminal Equipment complying with ISDN Interface Recommendations, such as digital telephones, data terminal equipment and integrated services terminal equipment. T1 may also provide connection to other terminal equipment.

II.4.2.4.4 T2 - Terminal Type 2. This does not include all the functions required for terminal equipment complying with ISDN Interface Recommendations, but it includes functions associated with terminal equipment complying with other Interface Recommendations, such as the X-Series Interface Recommendations.

II.4.2.4.5 TA - Terminal Adapter. This includes interface and protocol adapting functions to allow a T2 terminal to connect at the ISDN user/network interfaces.

II.4.2.5 Figure 2 shows some significant applications of the reference configurations to certain physical implementations. The examples given in Figure 2 are not intended to be either exhaustive or mandatory. Square blocks in Figure 2 represent physical entities (equipment or combination of equipment).

II.4.2.5.1 Figures 2a and 2b show two applications of the reference configurations, in the cases where NT2 functions are null at Layer 2 and above. In particular, Figure 2a shows the direct connection between T1 (or T2 + TA) and NT1. Figure 2b describes the direct connection of multiple T1's (or T2's + TA's) to NT1 using a multidrop arrangement (e.g. a bus with Layer 1 contention resolution). This means that when physical interfaces are applied at S and T, on these cases, all of their characteristics must be identical.

<u>Note</u> : Feasibility and characteristics of the multidrop arrangement are under study in conjunction with the Level 1 (Physical) specification of the I-Series Recommendations.

II.4.2.5.2 Figure 2c shows the provision of multiple connections between NT2 and T1's (or T2's + TA's). NT2 may include various types of distribution arrangements, such as star, bus or ring configuration included within the equipment. Figure 2d shows a case where a bus distribution is used between terminals and the NT2 equipment.

II.4.2.5.3 Figures 2e and 2f show arrangements where multiple connections are used between NT2 and NT1 equipment. In particular Figure 2e illustrates the case of multiple NT1 equipment, while Figure 2f refers to the case where NT1 provides Layer 1 upward multiplexing of the multiple connections.

II.4.2.5.4 Figure 2g shows the case where NT1 and NT2 functions are merged in the same equipment, the corresponding merging of NT1 and NT2 functions for other configurations in Figure 2 may also occur.

II.4.2.5.5 Figure 2h illustrates the case where TA and NT2 functions are merged in the same equipment; the corresponding merging of TA and NT2 functions for other configurations in Figure 2 may also occur.

II.4.2.6 Figure 3 further illustrates examples of the correspondence between ISDN reference points and physical user/network interfaces according to possible alternative user and network arrangements.

II.4.2.7 The reference configurations given in Figure 1 apply for the specification of the channel structures and access arrangements given in Recommendation I.xxy, with the exception of channel structures for the hybrid access arrangement. For this arrangement the reference configuration given in Figure 4 applies. This reference configuration includes the analogue connection to an analogue terminal, such as an analogue telephone. T1 may be replaced by T2 and TA as illustrated in Figure 1b.

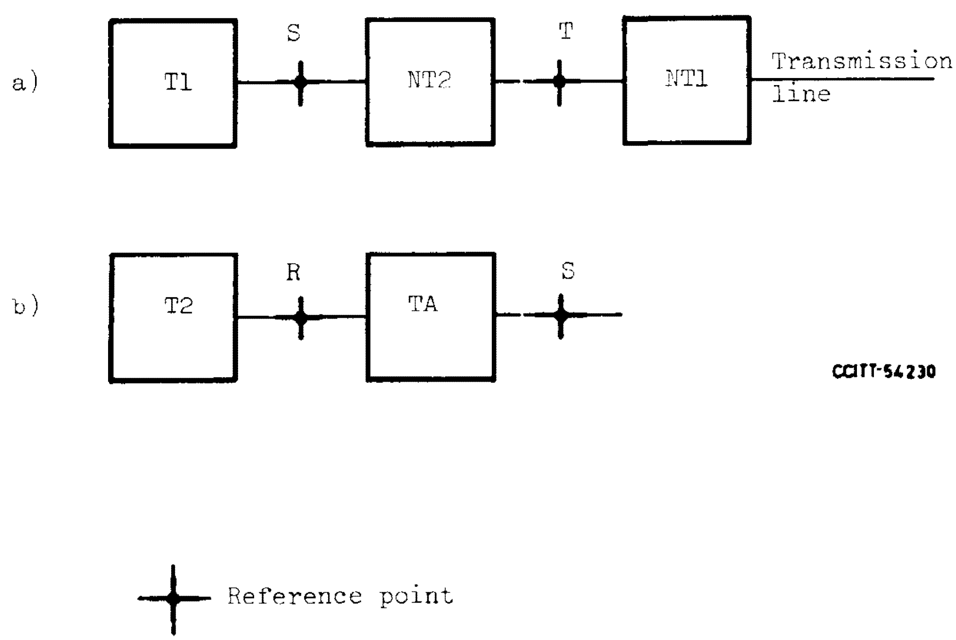


Figure 1 - Reference configurations for the ISDN user/network interfaces

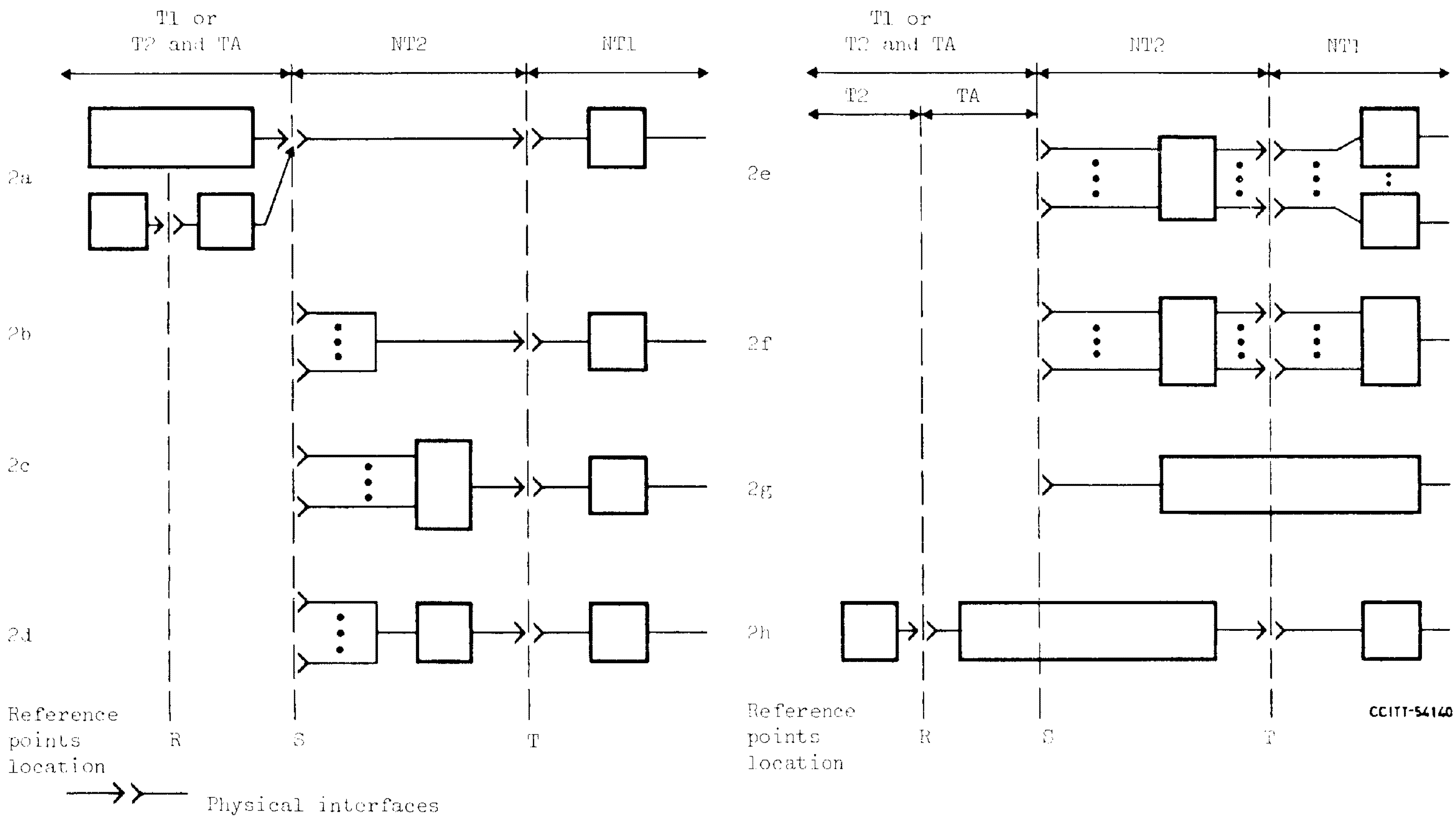


Figure 2 - Significant applications of the reference configurations for ISDN user/network interfaces to physical configurations

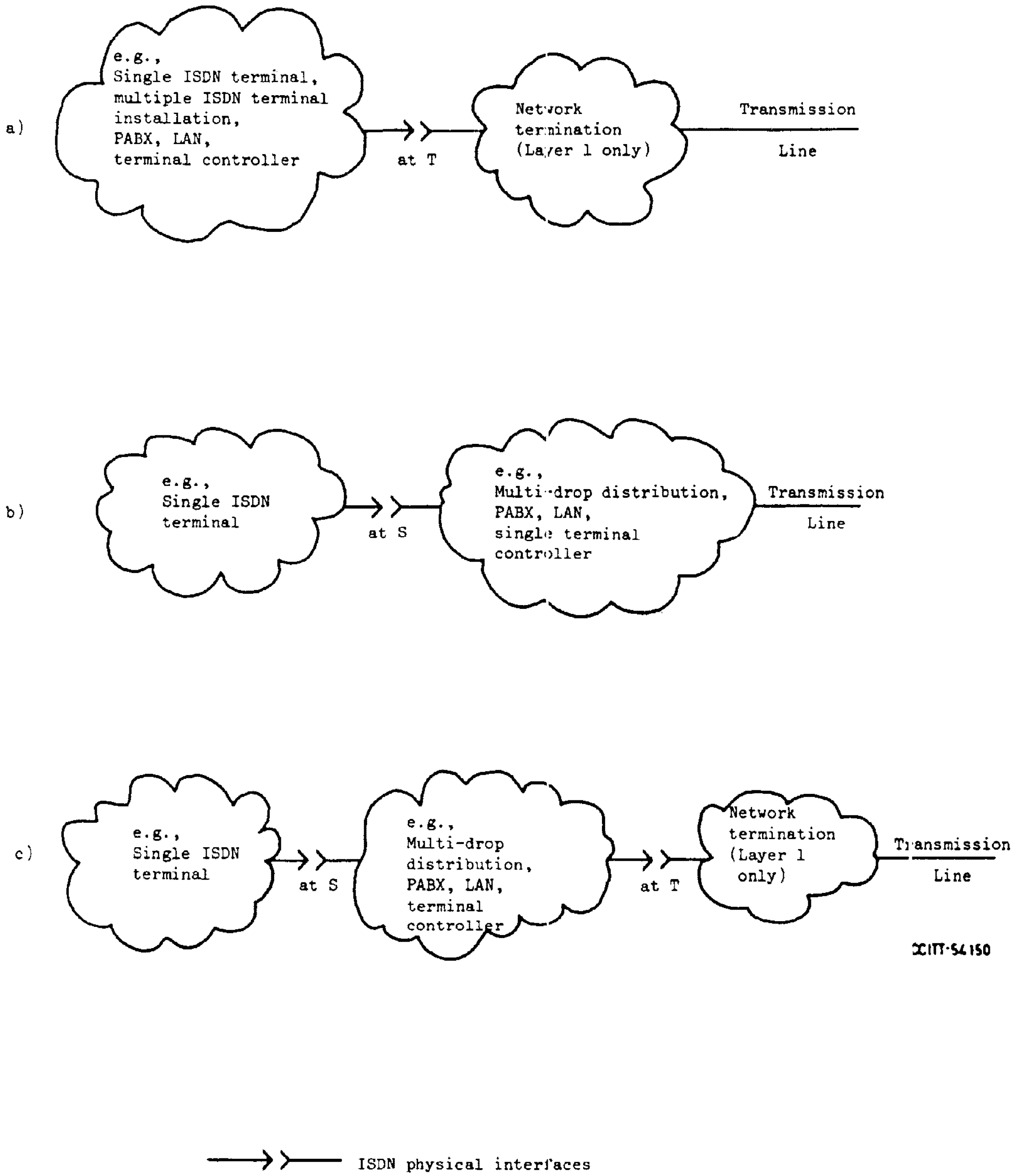


Figure 3 - Some examples of the correspondence between ISDN reference points and physical interfaces in alternative ISDN user/network arrangements

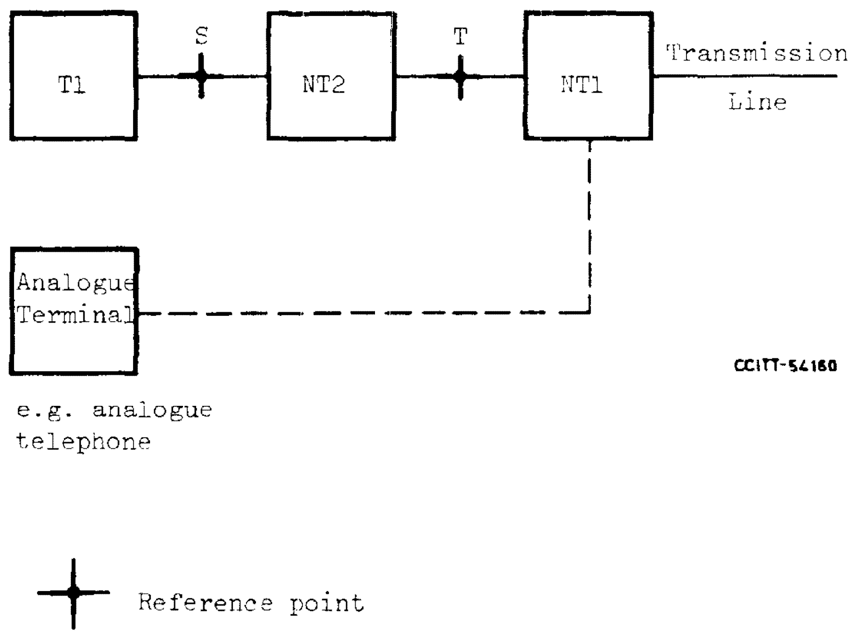


Figure 4 - Reference configuration for
hybrid access arrangements

APPENDIX C: DRAFT RECOMMENDATION I.xxy

II.5 Draft Recommendation I.xxy : ISDN user/network interfaces - Channel structures and access capabilities

II.5.1 General

In order to minimize the variety of standard ISDN user/network physical interfaces this Recommendation defines limited sets of both channel types and channel structures for such interfaces.

A channel represents a portion of the information-carrying capacity of the interfaces through which it is carried.

Channels are classified by channel types, which have common characteristics.

The channel types, defined in section II.5.2, are combined into channel structures, defined in section II.5.3. As used in this Recommendation a channel structure defines the total digital information carrying capacity across a physical interface.

In an actual access arrangement some of the channels available across an ISDN user/network physical interface, as defined by the applicable channel structure, may not be supported beyond the interface. In this Recommendation the capability provided by those channels appearing across the interface that are actually available for communication purposes, is referred to as the access capability provided through the interface.

II.5.2 Channel types and their use

II.5.2.1 B-channel

II.5.2.1.1 A B-channel is a 64 kbit/s channel.

II.5.2.1.2 A B-channel may be used to carry a variety of digital information streams, on a dedicated, alternate (within one call or as separate calls), or simultaneous basis, consistent with its capacity and the applicable service capabilities. The following are examples of these digital information streams :

i) digital voice at 64 kbit/s according to Recommendation G.711;

ii) digital information streams, such as data, corresponding to circuit or packet switching user classes of service at bit rates less than or equal to 64 kbit/s, including those given by Recommendation X.1;

iii) digital voice at bit rates lower than 64 kbit/s combined with other digital information streams (see ii) above) at compatible bit rates, carried towards the same destination; and,

iv) wideband digital voice encoded at 64 kbit/s.

II.5.2.1.3 Information streams at bit rates less than 64 kbit/s need to be rate adapted to be carried on the B-channel. Rate adaption uses a two stage approach, as follows :

i) adaption to/from 64 kbit/s from/to 8, 16 or 32 kbit/s;

ii) adaption of Recommendation X.1 user rates as follows :

- bit rates of 4.8 kbit/s and below to/from 8 kbit/s;
- 9.6 kbit/s to/from 16 kbit/s;
- 48 kbit/s to/from 64 kbit/s.

II.5.2.1.4 Two technical approaches to handle multiple lower bit rate information streams, as specified in section II.5.2.1.3, should be further considered. One is based on the use of time division multiplexing techniques. The other is based on the use of statistical multiplexing techniques; application of the D-channel protocol should be taken into account. Further study should be directed towards evaluation of both approaches.

II.5.2.2 D-channel

II.5.2.2.1 A D-channel carries digital information streams using a frame-oriented link access procedure (LAP) in accordance with Recommendation I.... (specifying the LAP D protocol).

II.5.2.2.2 The bit rates of a D-channel are specified in section 3.

II.5.2.2.3 A D-channel is used to carry signalling information and may be used to carry telemetry and packet-switched data.

II.5.2.3 C-channel

II.5.2.3.1 A C-channel carries digital information streams using a frame-oriented link access procedure (LAP) in accordance with Recommendation I....

II.5.2.3.2 The bit rates of a C-channel are specified in section II.5.3.2.

II.5.2.3.3 A C-channel may carry telemetry, packet-switched data, and signalling information (which may include some or all of the signalling information for the associated analogue channel).

II.5.2.4 Broadband channel

For further study.

II.5.2.5 Other channels

For further study (e.g. channels carrying information according to Signalling System No. 7).

II.5.3 Channel structures

ISDN user/network physical interfaces at ISDN reference points shall comply with one of the channel structures defined below.

II.5.3.1 Basic channel structure

II.5.3.1.1 The basic channel structure is composed of two B-channels and one D-channel, 2B + D. The bit rate of the D-channel is 16 kbit/s.

II.5.3.1.2 The B-channels may be used independently; i.e. in different connections at the same time.

II.5.3.1.3 With the basic channel structure, two B-channels and one D-channel are always present at the ISDN user/network physical interface. One or both B-channels, however, may not be supported beyond the interface. Therefore, when using the basic channel structure, the following basic access capabilities are possible.

- 2B + D;
- B + D; and
- D.

Note : The basic channel structure may also be used in association with a conventional analogue channel in a hybrid access arrangement; see section II.5.4.2.

II.5.3.2 C-channel structure

The C-channel structure consists of one C-channel. The C-channel is associated with a conventional analogue channel in a hybrid access arrangement; see section II.5.4.2.

The bit rate of the C-channel is 8 kbit/s in some cases and 16 kbit/s in other cases, depending on the type of hybrid access arrangement.

II.5.3.3 Intermediate channel structure

For further study.

II.5.3.4 Primary rate channel structures

These structures correspond to the primary multiplexing rates of 1544 and 2048 kbit/s.

II.5.3.4.1 Multiplexed channel structures

II.5.3.4.1.1 The primary rate of multiplexed channel structures below are composed of some number of B-channels and one D-channel, nB + D. At the primary multiplex rate, the use of Signalling System No. 7 signalling channel instead of a D-channel, is for further study.

II.5.3.4.1.2 At 2048 kbit/s, this channel structure is 30B + D. The rate of the D-channel is 64 kbit/s.

II.5.3.4.1.3 At 1544 kbit/s, the two following channel structures have been proposed for further study :

i) 24B + D, where the bit rate of the D-channel is 4 kbit/s; or

ii) 23B + D, where the bit rate of the D-channel is 64 kbit/s.

II.5.3.4.1.4 The need for providing a multiple D-channel capability is for further study.

II.5.3.4.1.5 With the primary rate multiplexed channel structure, the designated number of B-channels are always present at the ISDN user/network physical interface. One or more of the B-channels may not be supported beyond the interface.

II.5.3.4.2 Broadband channel structure

For further study.

II.5.3.5 Higher rate channel structure(s)

For further study.

II.5.3.6 Other channel structure(s)

For further study.

II.5.4 Examples of application of channel structures

II.5.4.1 Access arrangement for PABX, terminal controller, local area network, etc.

Figure 1/I.xxy illustrates a typical PABX, etc., access arrangements. The PABX, etc. may use a basic channel structure for interfaces located at ISDN reference point S. The basic or primary rate multiplexed channel structure may be used at one or more interfaces located at ISDN reference point T.

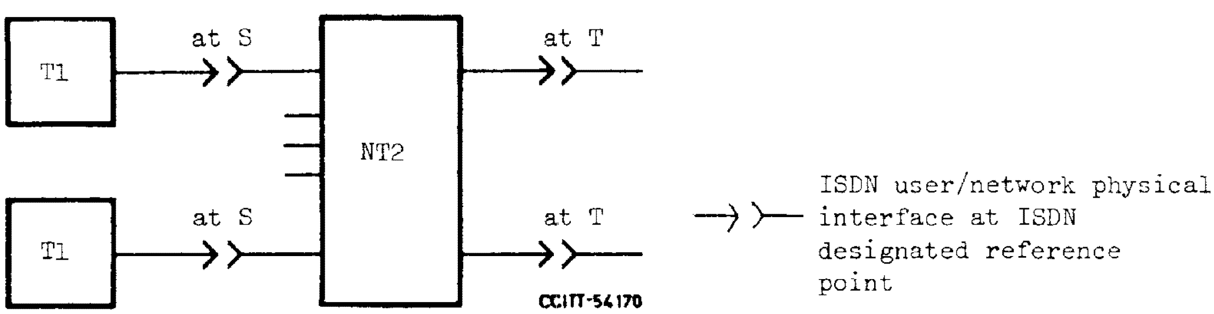


Figure 1 - I.xxy

II.5.4.2 Hybrid access arrangement

Figure 2/I.xxy illustrates a possible configuration for a variety of hybrid access arrangements. A hybrid access arrangement consists of a digital channel structure used in conjunction with an analogue channel. A physical interface is shown at ISDN reference points S and T, where the C-Channel structure or the basic channel structure may be used. In adiition to the analogue channel, the hybrid access arrangement includes one of the following digital access capability :

i) C;

ii) D;

iii) B + D, and,

iv) 2B + D.

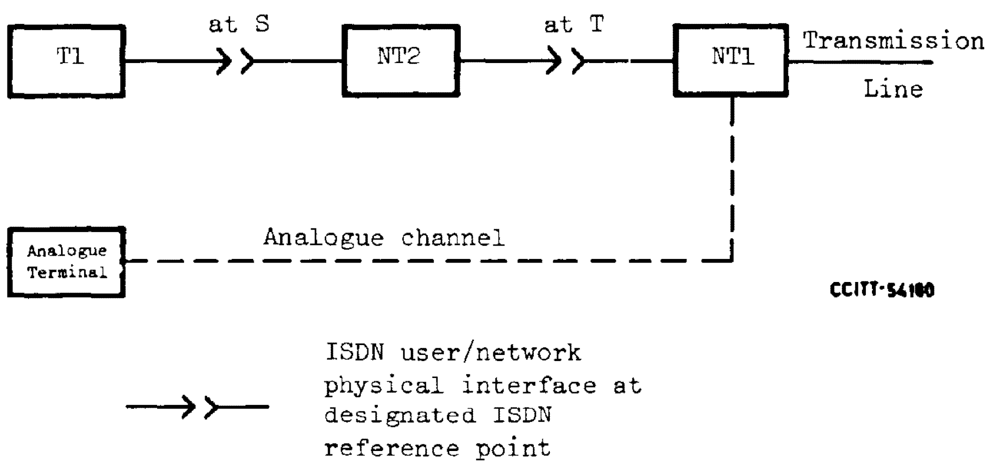


Figure 2 - I.xxy

II.6 Open issues for further study

II.6.1 Some sentiment was expressed for a more appropriate method to specify channel types. Is a channel defined by a transport capacity (e.g. 64 kbit/s), or is it defined by the link access procedure ? Should other characteristics be included such as bit sequence integrity, directionality, and inequality of bit rate in two directions ? The notation of channels could be dependent on the above characteristics. One such approach is proposed in Delayed Contribution DF (GTE International).

II.6.2 An appropriate notation for the signalling channel or channels on the multiplexed channel structure, e.g. for PABX, must be established if Signalling System No. 7 is to be used.

II.6.3 Further study has been proposed on the use of a circuit switched digital channel or channel structure on the hybrid access arrangement. This is in addition to the agreed upon channel structure indicated in the draft Recommendation I.xxy.

II.6.4 The number and specification of channel structures with bit rates above the basic will be studied. Four types of channel structures above the basic are proposed for further study.

a) Intermediate channel structure

Delayed Contribution CG (France) proposes to define such a structure at a bit rate between 400 kbit/s and 800 kbit/s, primarily for covering the needs of medium sized PABXs. A 608 kbit/s channel structure was also proposed as an example for further consideration (see Annex 1). 512 and 704 kbit/s channel structures have also been proposed. However, there was no agreement on the needs to define an intermediate channel structure for an ISDN user/network interface.

b) Broadband channel structure

This structure is intended to support broadband information. This structure could be composed of :

i) an aggregation of B-Channels;

ii) a broadband (unstructured) channel. This structure may or may not include a D-Channel and is described in Delayed Contribution CY (British Telecom, see Annex 2).

c) Higher rate channel structure(s) at bit rate(s) above the primary rate channel structure.

II.6.5 The issue of multiple D-Channels in a single multiplexed channel structure and the D-Channel notation involved also requires further study.

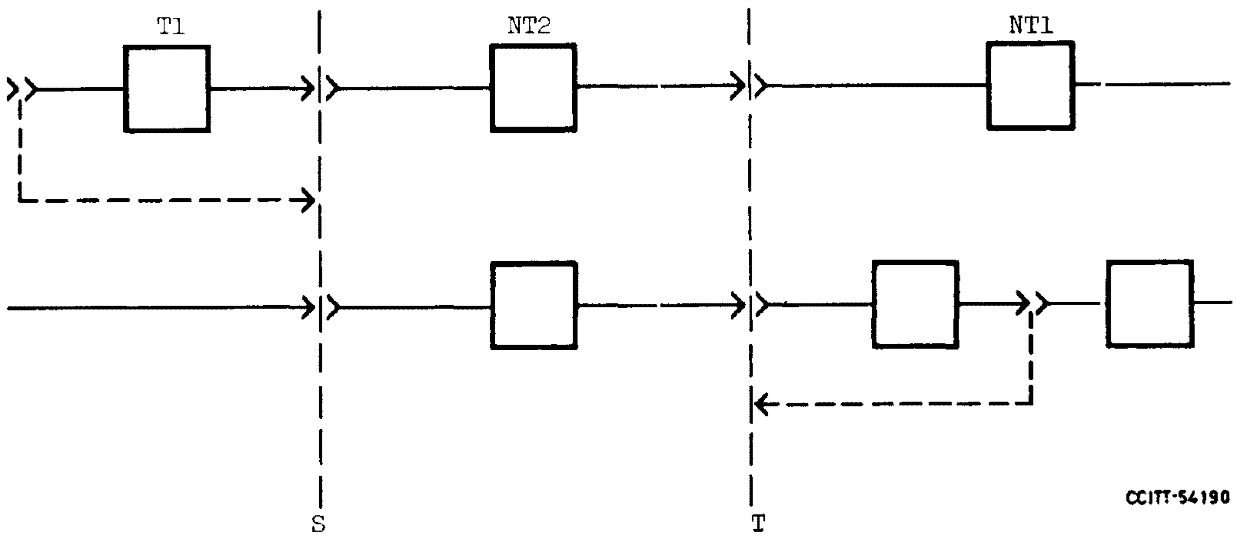
II.6.6 Further study is required to determine the appropriate multiplexed channel structure at the 1544 kbit/s primary multiplexed rate. Possibilities include :

a) 24 B + D (4 kbit/s);

b) 23 B + D (64 kbit/s).

The associated D-Channel notation must also be confirmed.

II.6.7 Additional examples of reference configurations for ISDN user/network interfaces have been proposed as shown below. This should be studied further together with any others proposed for addition to Figure 2 of draft Recommendation I.xxx.



II.6.8 Advice is sought from Study Group VII in order to determine the details of the two stage rate adaption approach as specified in Recommendation I.xxy.

II.6.9 The possible need and specification of other channel types requires further study.

II.6.10 Further study should be directed toward the evaluation of the two alternative approaches to handling of multiple lower bit rate information streams in a single B-Channel :

a) time division multiplexing;

b) statistical multiplexing.

II.6.11 Preliminary draft Recommendation I.xxw - (General Aspects and Principles) was prepared as an example of what may be included in a draft Recommendation and is Annex 3 of this report. Further study is required to determine the appropriate scope of the I. series of Recommendations. Only then then can this preliminary draft Recommendation can be advanced.

APPENDIX D: DRAFT RECOMMENDATION I.xxw *

Proposed Revision to Draft Recommendation I.XXW: General Aspects and Principles Relating to Recommendations on ISDN User/Network Interfaces

1.0 General

1.1 Recommendation G.705 gives the conceptual principles on which an ISDN should be used. The main feature of an ISDN is the support of a wide range of service capabilities, including voice and nonvoice applications, in the same network by offering end-to-end digital connectivity.

1.2 A key element of service integration for an ISDN is the provision of a limited set of standard multipurpose user/network interfaces. These interfaces represent a focal point both for the development of ISDN network components and configurations and for the development of ISDN terminal equipment and applications.

1.3 An ISDN is recognized by the service characteristics available through user/network interfaces, rather than by its internal architecture, configuration or technology. This concept plays a key role in permitting user and network technologies and configurations to evolve separately.

1.4 An ISDN provides a basic network transport capability for a variety of applications (ranging from alarms and telemetry through voice, interactive data and bulk data, to broadband video applications) using a variety of telecommunication modes (including semipermanent, as well as circuit switched and packet-switched connections).

1.5 In addition to the basic transport capability, depending on the national regulatory arrangements, an ISDN could also incorporate information storage and processing facilities, e.g., as could be provided for CCITT recommended services such as Teletex, Telefax and Videotex, or for other services.

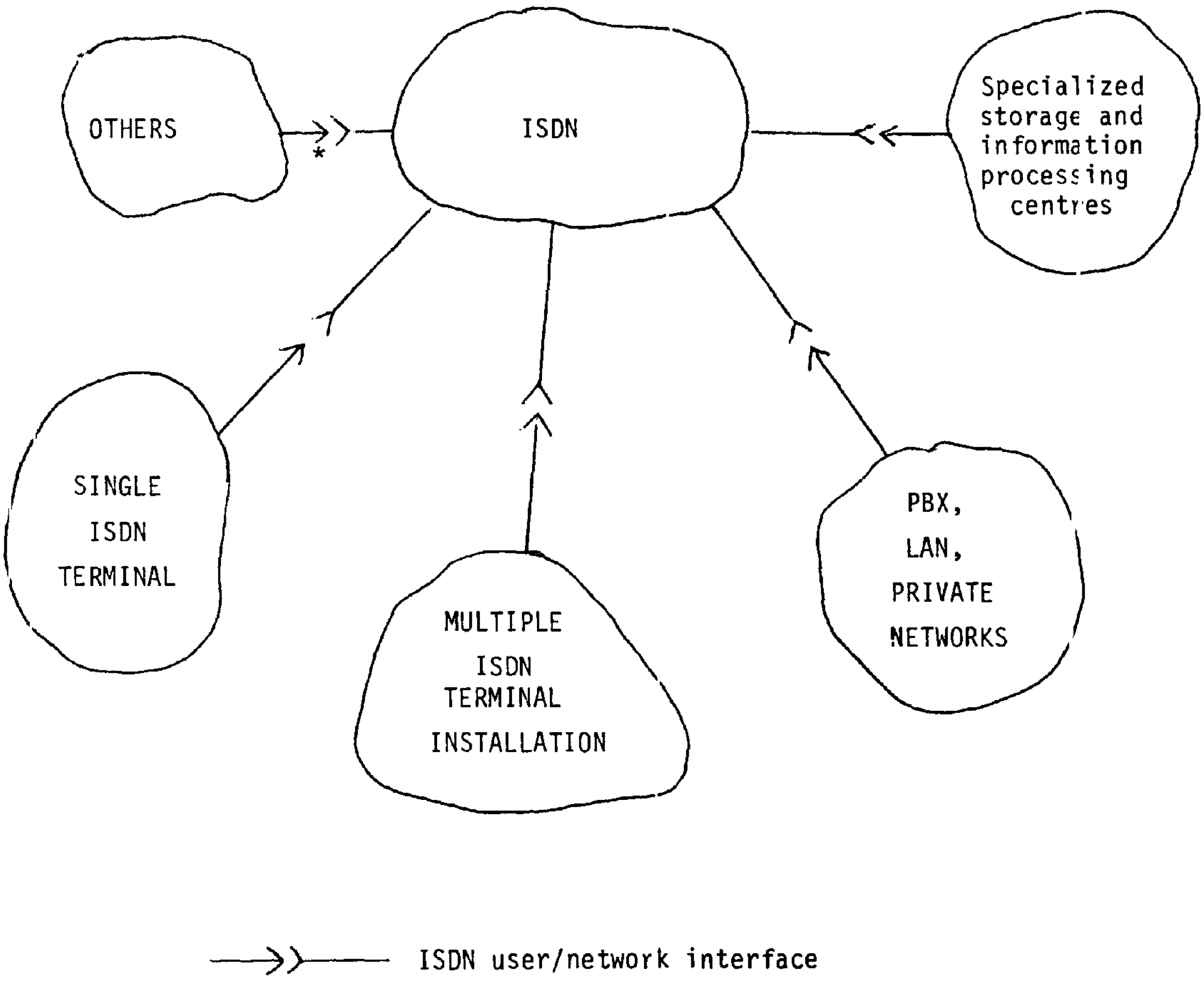
2.0 Interface Applications

Figure 1 shows some examples of ISDN user/network interfaces. The following cases are identified corresponding to:

1. access of a single ISDN terminal;
2. access of a multiple ISDN terminal installation;
3. access or multiservice PBXs, or local area network, or, more generally, of private networks;
4. access of specialized storage and information processing centres.

In addition, depending on the particular national regulatory arrangements, either ISDN user/network interfaces or internetwork interfaces may be used for access of:

* *Typed at ITS from CCITT Temporary Document 2, Meeting of Experts on Q.1C/SVIII, Florence, Nov. 8-12, 1982: Report on the meeting held in Geneva Oct. 18-20, 1982. See also, SG XVIII, Contribution 132.*



*Alternatively internetwork interfaces may apply.

Figure D-1. ISDN user/network interface examples.

5. dedicated service networks;

6. other multiple services networks, including ISDNs.

3.0 Interface Recommendation Objectives

User/network interface Recommendations should allow:

1. different types of terminals and applications to use the same interface;

2. protability of terminals from one location to another (office, home, public access points) within one country and from one country to another country;

3. separate evolution of both terminal and network equipment, technologies, and configurations;

4. efficient connection with specialized storage and information processing centres and other networks;

User/network interfaces should be designed to provide an appropriate balance between service capabilities and cost/tariffs, in order to meet service demand easily.

4.0 Interface Characteristics

User/network interfaces are specified by a comprehensive set of characteristics, including:

1. physical and electromagnetic characteristics;

2. channel structures and access capabilities;

3. user/network protocols;

4. maintenance and operation characteristics;

5. performance characteristics;

6. service characteristics.

In the definition of the interface protocols, a layered functional specification method is applied, using an OSI-type of reference model, suitably adapted to allow for the specifics requirements of an ISDN.

5.0 Interface Capabilities

In addition to the multiservice capability, an ISDN user/entwork interface may allow for capabilities such as the following:

1. multidrop and other multiple terminal arrangements;

2. choice of information bit rate, switching mode, coding method, etc., on a call-by-call or other (e.g., semipermanent or subscription time option) basis, over the same interface according to the user's need;

3. capability for compatibility checking in order to check whether calling and called terminals can communicate with each other.

6.0 Other I-series Recommendations

6.1 The reference configurations for ISDN user/network interfaces define the terminology for various reference points and the types of functions that can be provided between reference points. Recommendation I.xxx contains the reference configurations and shows significant applications.

6.2 The number of different interfaces is kept to a minimum. Recommendation I.xxy defines a limited set of channels, channel structures, and possible access capabilities for the ISDN user/network interfaces. A distinction is necessary between the channel structure supported by the interface and the access capability supported by the particular network access arrangement.

APPENDIX E: DRAFT RECOMMENDATION I.xxx

Proposed Revision to Draft Recommendation I.xxx:
ISDN User/Network Interfaces - Reference Configurations

1.0 General

1.1 This recommendation provides the reference configurations for ISDN user/network interfaces.

1.2 From the user's perspective, an ISDN is completely described by the attributes that can be observed at an ISDN user/network interface, including physical, electromagnetic, protocol, service, capability, maintenance, operation and performance characteristics. The key to defining, and even recognizing, an ISDN is the specification of these characteristics.

1.3 An objective of ISDN is that a small set of compatible user/network interfaces can economically support a wide range of user applications, equipment and configurations. The number of different user/network interfaces is minimized to maximize user flexibility through terminal compatibility (from one application to another, one location to another, and one service to another), and to reduce costs through economies in production of equipment and operation of both ISDN and user equipment. However, different interfaces are required for applications with widely different information rates, complexity, or other characteristics, as well as for applications in the evolutionary stages. In this way simple applications need not be burdened with the cost of accommodating features employed by complex applications.

1.4 Another objective is to have the same interfaces used even though there are different configurations (e.g., single terminal versus multiple terminal connections, connections to a PABX versus direct connections into the network, etc.) or different national regulations.

2.0 Definitions

2.1 Reference configurations are conceptual configurations useful in identifying various possible physical user access arrangements to an ISDN. Two concepts are used in defining reference configurations: reference points and functional groupings. Layout and application examples of reference configurations are given in Section 3.

2.2 Functional groupings are sets of functions which may be needed in ISDN user access arrangements. In a particular access arrangement, specific functions in a functional grouping may be performed in one or more pieces of equipment, or they may not be present at all.

2.3 Reference points are the conceptual points dividing functional groupings. In a specific access arrangement, a reference point may correspond to a physical interface between pieces of equipment, or there may not be any physical interface corresponding to the reference point. Physical interfaces that do not correspond to a reference point (e.g., transmission line interfaces) will not be the subject of ISDN user/network interface Recommendations.

3.0 Reference Configurations

3.1 The reference configurations for ISDN user/network interfaces define reference points and types of functions that can be provided between reference points. Figure 1 shows the reference configurations, while Figures 2, 3 and 4 show examples of applications of such configurations.

3.2 The ISDN user/network interface Recommendations in the I-series apply to physical interfaces at reference points S and T, using the recommended channel structures according to Recommendation I.xx.y. At reference point R physical interfaces in accordance with other CCITT Recommendations (e.g., the X-series interface Recommendations) may be used. Also physical interfaces not recommended by CCITT may appear at reference point R. Note: There is no reference point assigned to the transmission line, since an ISDN user/network interface is not envisaged at this location.

3.3 Figure 1a defines the reference configuration of functional groupings NT1, NT2, and TE1. Figure 1b illustrates that TE1 may be replaced by the combination of TE2 and TA.

3.4 Lists of functions for each functional group are given below. The given function lists may not be exhaustive. For a particular access arrangement, specific functions in a functional group are either present or absent. Note: The functional groupings are described in relation to a layered protocol structure similar to the OSI Reference Model being developed under Question 27/VII. Further study is required to assess the suitability of applying the OSI Reference Model to an ISDN (see Question 1/XVIII, point B).

3.4.1 NT1, Network Termination 1, includes functions broadly equivalent to Layer 1 (Physical) of the OSI Reference Model. These functions are associated with the proper physical and electromagnetic termination of the network. NT1 functions are:

- line transmission termination;
- Layer 1 line maintenance functions, such as test loops and performance monitoring;
- timing;
- power feeding;
- Layer 1 multiplexing; and
- interface termination, including multidrop termination employing Layer 1 contention resolution.

3.4.2 NT2, Network Termination 2, includes functions broadly equivalent to Layer 1 and higher layers of the OSI Reference Model. PABXs, local area networks and terminal controllers are examples of equipment or combinations of equipment that provide NT2 functions. NT2 functions are:

- Layers 2 and 3 protocol handling;
- Layers 2 and 3 multiplexing;
- switching;
- concentration;
- maintenance functions; and
- interface termination and other Layer 1 functions.

For example, a simple PABX can provide NT2 functions at Layers 1, 2 and 3. A simple terminal controller can provide NT2 functions at only Layers 1 and 2. A simple time division multiplexer can provide NT2 functions at only Layer 1. In a specific access arrangement, the NT2 functional grouping may consist of only physical connections.

3.4.3 TE, Terminal Equipment, includes functions broadly belonging to Layer 1 and higher layers of the OSI Reference Model. Digital telephones, data terminal equipment, and integrated work stations are examples of equipment or combinations of equipment that provide TE functions. TE functions are:

- protocol handling;
- maintenance functions;
- interface functions; and
- connection functions to other terminal equipments.

3.4.3.1 TE1, Terminal Equipment Type 1, includes functions belonging to the functional grouping TE and with an interface that complies with the ISDN interface Recommendations.

3.4.3.2 TE2, Terminal Equipment Type 2, includes functions belonging to the functional group TE but with an interface that complies with interface Recommendations other than the ISDN interface Recommendations (e.g., the X-series interface Recommendations) or interfaces not recommended by CCITT.

3.4.4 TA, Terminal Adaptor, includes functions broadly belonging to Layer 1 and higher layers of the OSI Reference Model that allows a TE2 terminal to connect at an ISDN user/network interface. Adaptors between physical interfaces at reference points R and S or R and T are examples of equipment or combinations of equipment that provide TA functions.

4.0 Physical Realizations of Reference Configurations

4.1 Figure 2 gives examples of configurations illustrating combinations of physical interfaces at reference points R, S, and T: separately at S and T, at S only, at T only, and where S and T coincide; each of these is shown with and without a reference point R in the configuration.

4.2 Figures 3 and 4 show examples of physical implementations. The examples given in Figure 3 show physical realizations of functional groupings TE, NT1, and NT2, based on physical interfaces occurring at reference points R, S, and T. The examples given in Figure 4 show applications of the reference configurations to physical configurations when multiple physical interfaces occur at a reference point. The examples given in Figure 4 are not intended to be either exhaustive or mandatory. Square blocks in Figures 3 and 4 represent equipment implementing functional groupings. Note that TE1 or TE2 + TA may be used interchangeably in Figure 4.

4.2.1 Figures 4a and 4b show applications of the reference configurations in the cases where NT2 functions consist of only physical connections. Figure 4a describes the direct physical connection of multiple TE's (TE1's or TE2's + TA's) to NT1 using a multidrop arrangement (i.e., a bus). Figure 4b describes the separate connection of a number of TE's to NT1.

In these cases, all of the characteristics of the physical interfaces applied at reference points S and T must be identical. Note: Feasibility and characteristics of the multidrop arrangement, illustrated in Figures 4a and 4d, are under study in conjunction with the Level 1 (Physical) specification of the I-Series Recommendations.

4.2.2 Figure 4c shows the provision of multiple connections between NT2 and TE's. NT2 may include various types of distribution arrangements, such as star, bus or ring configuration included within the equipment. Figure 4d shows a case where a bus distribution is used between TE's and the NT2 equipment.

4.2.3 Figures 4e and 4f show arrangements where multiple connections are used between NT2 and NT1 equipment. In particular, Figure 4e illustrates the case of multiple NT1 equipment, while 4f refers to the case where NT1 provides Layer 1 upward multiplexing of the multiple connections.

4.2.4 Figure 4g illustrates the case where NT1 and NT2 functions are merged in the same equipment: the corresponding merging of NT1 and NT2 functions for other configurations in Figure 4 may also occur.

4.2.5 Figure h illustrates the case where TA and NT2 functions are merged in the same equipment; the corresponding merging of TA and NT2 functions for other configurations in Figure 4 may also occur.

4.3 The reference configurations given in Figure 1 apply for the specification of the channel structures and access arrangements given in Recommendations I.xxy, with the exception of channel structures for the hybrid access arrangement. For this arrangement the reference configuration given in Figure 5 applies. This reference configuration includes the analogue connection to an analogue terminal, such as an analogue telephone. TE1 may be replaced by TE2 and TA as illustrated in Figure 1b.

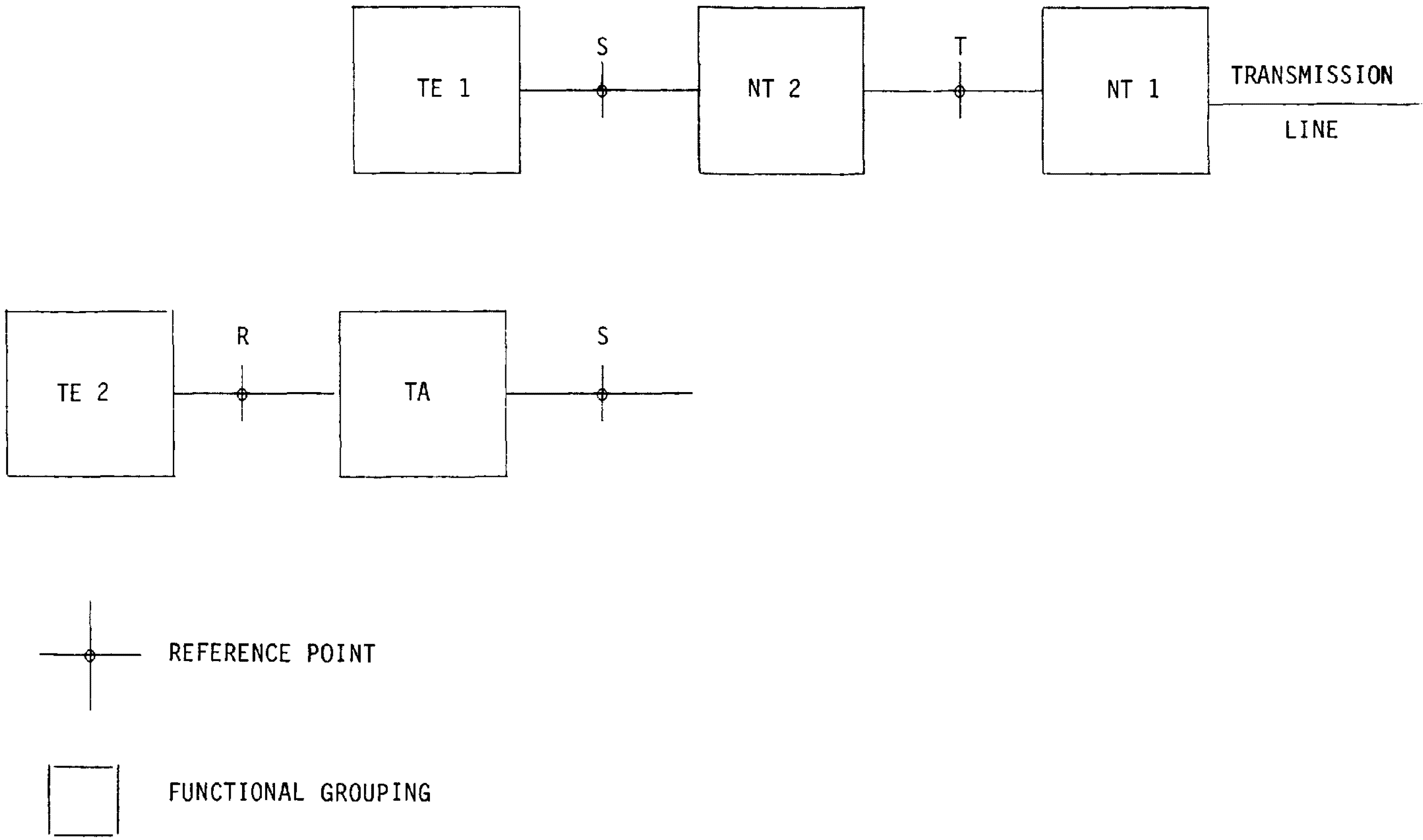
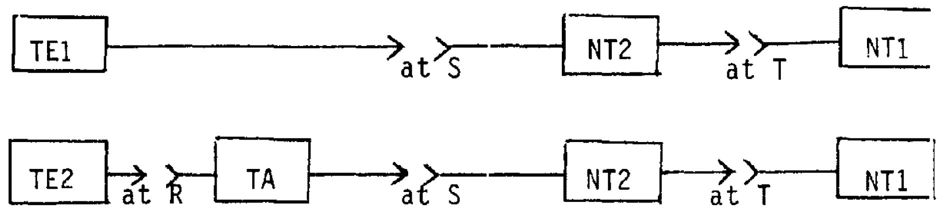


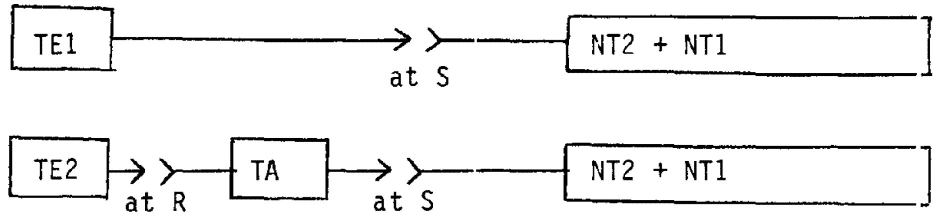
Figure E-1. Reference configurations for the ISDN User/Network interfaces.

(2a)
(2b)



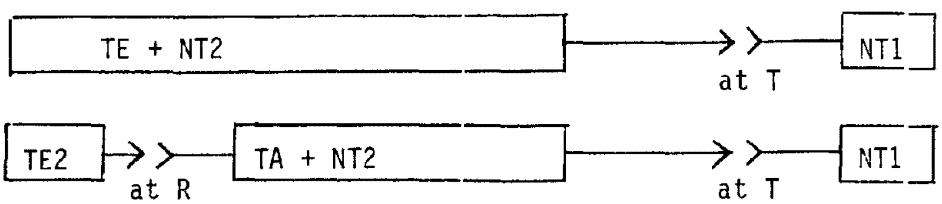
Configurations where ISDN physical interfaces occur at reference points S and T

(2c)
(2d)



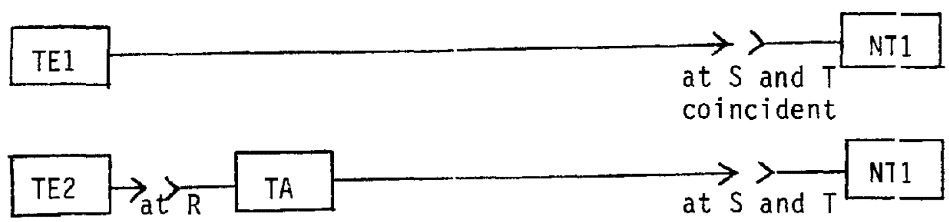
Configurations where ISDN physical interfaces occur at reference points S only

(2e)
(2f)

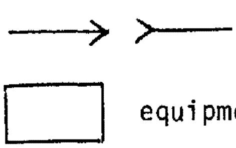


Configurations where ISDN physical interfaces occur at reference point T only

(2g)
(2h)



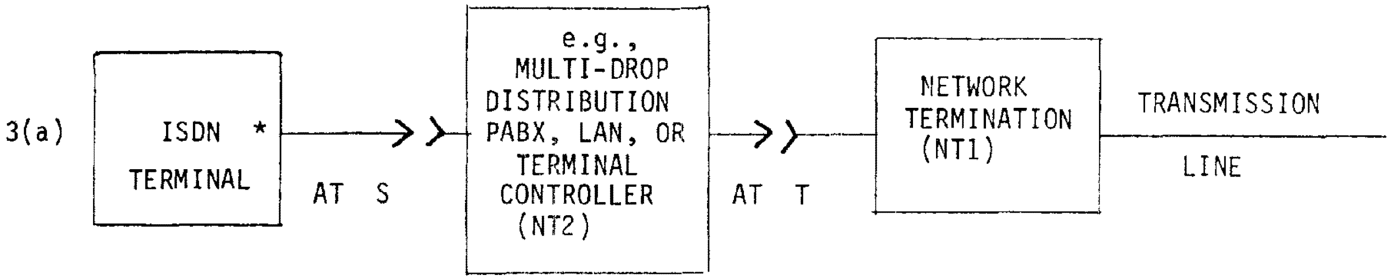
Configurations where a single ISDN physical interface occurs at a location where both reference points S and T coincide



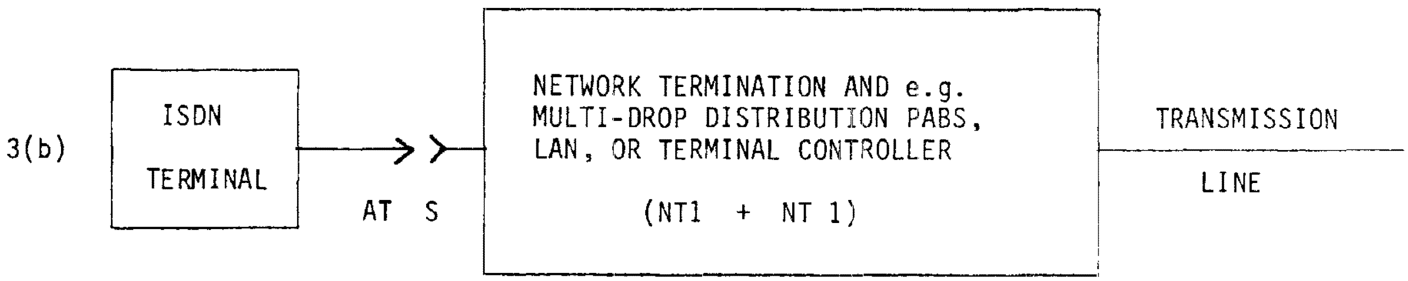
physical interface at the designated reference point

equipment implementing functional groupings

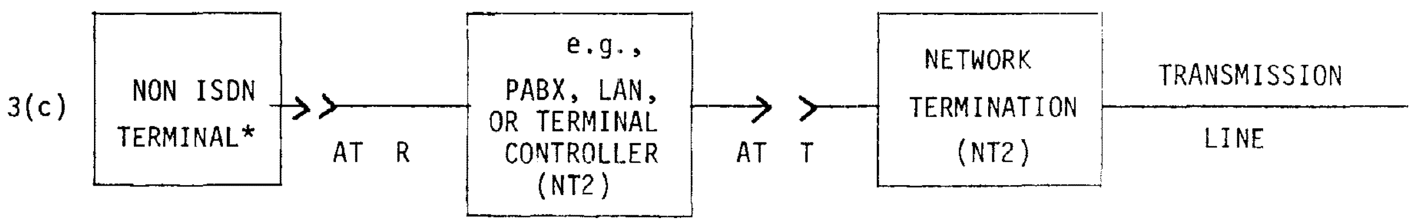
Figure E-2. Examples of physical configurations.



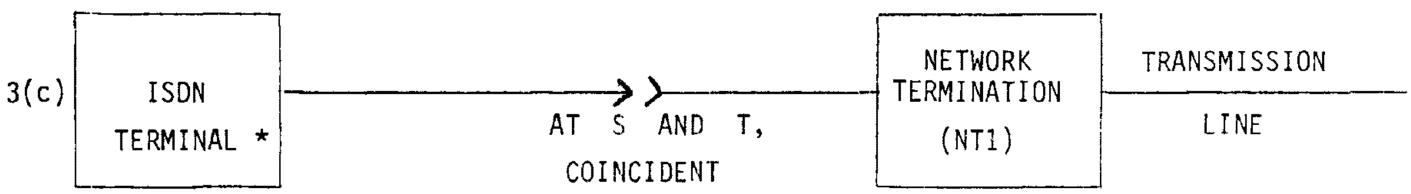
A CONFIGURATION WHERE ISDN PHYSICAL INTERFACES OCCUR AT REFERENCE POINTS S AND T



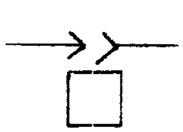
A CONFIGURATION WHERE AN ISDN PHYSICAL INTERFACE OCCURS AT REFERENCE POINT S BUT NOT T



A CONFIGURATION WHERE AN ISDN PHYSICAL INTERFACE OCCURS AT REFERENCE POINT T BUT NOT S



A CONFIGURATION WHERE A SINGLE PHYSICAL INTERFACE OCCURS AT A LOCATION WHERE BOTH REFERENCE POINTS S AND T COINCIDE



PHYSICAL INTERFACE AT THE DESIGNATED REFERENCE POINT

EQUIPMENT IMPLEMENTING FUNCTIONAL GROUPINGS

* SINGLE OR MULTIPLE TERMINAL ARRANGEMENTS

Figure E-3. Examples of implementation of NT1 and NT2 functions.

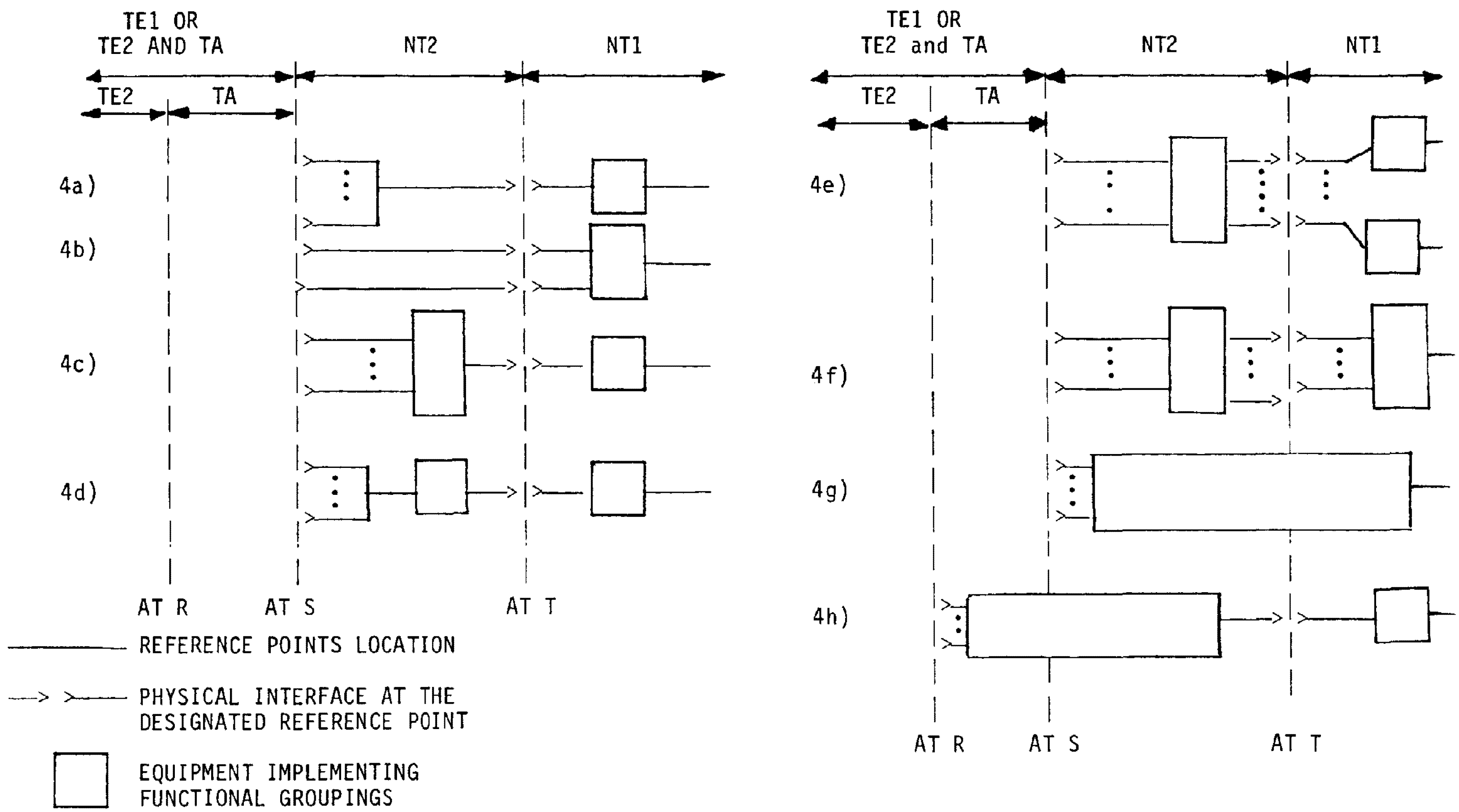


Figure E-4. Examples of physical configurations employing connections.

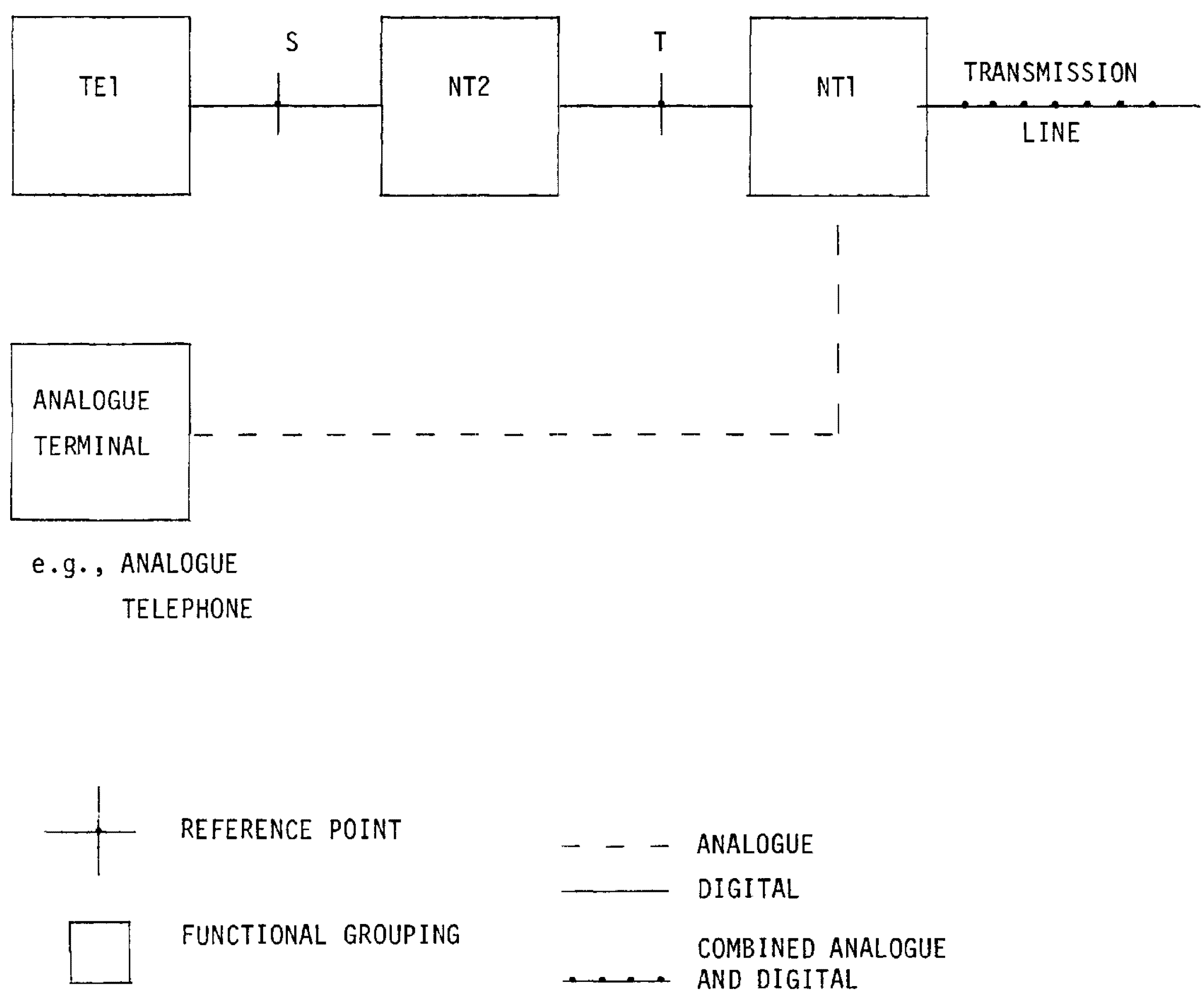


Figure E-5. Reference configuration for hybrid access arrangements for ISDN user/network interfaces.

APPENDIX F: DRAFT RECOMMENDATION I.XXY

Proposed Revision to Draft Recommendation I.XXY: ISDN User/Network Interfaces - Channel Structures and Access Capabilities

1.0 General

This Recommendation defines limited sets of both channel types and channel structures for ISDN user/network physical interfaces.

2.0 Definitions

2.1 A channel represents a specified portion of the information-carrying capacity of the interfaces.

2.2 Channels are classified by channel types, which have common characteristics. Channel types are defined in Section 3.

2.3 The channels are combined into channel structures, defined in Section 4. A channel structure defines the maximum digital information-carrying capacity across a physical interface.

2.4 In an actual access arrangement some of the channels available across an ISDN user/network physical interface as defined by the applicable channel structure, may not be supported by the network. The capability provided by those channels that are actually available for communication purposes, is referred to as the access capability provided through the interface.

3.0 Channel Types and Their Use

3.1 B channel. 3.1.1 A B channel is a 64 kbit/s channel. A B channel is intended to carry a wide variety of user information streams. A distinguishing characteristic is that a B channel does not carry signalling information for circuit switching by ISDN. Signalling information used for circuit switching by the ISDN is carried over other types of channels, e.g., a D channel.

3.1.2 User information streams may be carried on a B channel on a dedicated, alternate (within one call or as separate calls), or simultaneous basis consistent with the B channel bit rate. The following are examples of user information streams:

i) voice encoded at 64 kbit/s according to Recommendation G.711

ii) data information corresponding to circuit or packet-switching user classes of service at bit rates less than or equal to 64 kbit/s, according to Recommendation X.1

iii) wideband voice encoded at 64 kbit/s* and

iv) voice encoded at bit rates lower than 64 kbit/s alone, or combined with other digital information streams carried toward the same destination*.

*These applications are currently under consideration by CCITT.

It is recognized that a B channel may also be used to carry user information streams not covered by CCITT Recommendations.

3.1.3 B channels may be used to provide access to a variety of communication modes within the ISDN. Examples of these modes are:

i) circuit switching

ii) packet switching and

iii) semi-permanent connections.

In case i, the ISDN can provide either a transparent end-to-end 64 kbit/s connection or a connection specifically suited to a particular service, such as telephony, in which case a transparent 64 kbit/s connection may not be provided.

In case ii, the B channel will carry protocols at Layers 2 and 3 according to Recommendation X.25 which have to be handled by the network. The application of D channel protocols for this case is for further study.

In case iii, the semi-permanent connection can be provided, for example by using circuit or packet switching modes.

3.1.4 Information streams at bit rates less than 64 kbit/s need to be rate adapted to be carried on the B channel. Rate adaption uses a two-stage approach, as follows:

i) adaption to/from 64 kbit/s from/to 8, 16 or 32 kbit/s and

ii) adaption of Recommendation X.1 user rates as follows:

- bit rates of 4.8 kbit/s and below to/from 8 kbit/s
- 9.6 kbit/s to/from 16 kbit/s
- 48 kbit/s to/from 64 kbit/s.

Padding bits used for rate adaption need not always be conveyed by the network.

3.1.5 Two technical approaches to handle multiple lower bit rate information streams within a B channel are for further consideration. One is based on the use of time division multiplexing techniques. The other is based on the use of statistical multiplexing techniques, see Section 3.1.3, case ii. Further study should be directed towards evaluation of both approaches.

<u>3.2 D channel</u>. 3.2.1 A D channel may have different bit rates as specified in Section 4.

A D channel is primarily intended to carry signalling information for circuit switching by the ISDN.

A D channel uses a layered protocol according to Recommendations I.... In particular the link access procedure is frame oriented (LAP D) and is based on LAP B of Recommendation X.25.

3.2.2 In addition to signalling information for circuit switching a D channel may also be used to carry telemetry and packet-switched information.

3.3 C channel. 3.3.1 A C channel may have different bit rates as specified in Section 4. A C channel is primarily intended to carry telemetry and packet-switched data.

A C channel is intended to be used with an associated analogue channel (see Section 4.2) and may carry none, some or all of the signalling information for the analogue channel.

The C channel uses a layered protocol that is a compatible subset of the D channel protocol.

3.4 Broadband channels. For further study.

3.5 Other channels. For further study (e.g., channels carrying information according to Signalling System No. 7).

4.0 Channel Structures

ISDN user/network physical interfaces at ISDN reference points shall comply with one of the channel structures defined below.

4.1 Basic channel structure. 4.1.1 The basic channel structure is composed of two B channels and one D channel, 2B + D. The bit rate of the D channel in this channel structure is 16 kbit/s.

4.1.2 The B channels may be used independently; i.e., in different connections at the same time.

4.1.3 With the basic channel structure, two B channels and one D channel are always present at the ISDN user/network physical interface. One or both B channels, however, may not be supported by the network.

The following basic access capabilities are therefore possible:

- 2B + D;
- B + D; or
- D.

Note: The basic channel structure may also be used in association with a conventional analogue channel in a hybrid access arrangement; see Section 5.2.

4.2 C channel structure. The C channel structure consists of one C channel. The C channel is associated with a conventional analogue channel in a hybrid access arrangement; see Section 5.2. Depending on the type of hybrid access arrangement the bit rate of the C channel is 8 kbit/s or 16 kbit/s.

4.3 Intermediate channel structure. For further study.

4.4 Primary rate channel structures. These structures correspond to the primary rates of 1544 kbit/s and 2048 kbit/s.

4.4.1 Multiplex channel structures. 4.4.1.1 The primary rate multiplex channel structures below are composed of some number (n) of B channels and one D channel, nB + D.

4.4.1.2 At the 2048 kbit/s primary rate, this channel structure is 30B + D. The rate of the D channel is 64 kbit/s.

4.4.1.3 At the 1544 kbit/s primary rate, the two following channel structures have been proposed for further study:

i) 24B + D, where the bit rate of the D channel is 4 kbit/s, or

ii) 23B + D, where the bit rate of the D channel is 64 kbit/s.

4.4.1.4 The need for providing a multiple D channel capability is for further study.

4.4.1.5 At the primary multiplex rate, the use of a Signalling System No. 7 signalling channel instead of a D channel, is for further study.

4.4.1.6 With the primary rate multiplex channel structure, the designated number of B channels are always present at the ISDN user/network physical interface. One or more of the B channels may not be supported by the network.

4.4.2 Broadband channel structures. For further study.

4.5 Higher rate channel structure(s). For further study.

4.6 Other channel structure(s). For further study.

5.0 Examples of Application of Channel Structures

5.1 Access arrangement for PABX, terminal controller, local area network, etc. Figure 1 illustrates a typical PABX, or LAN access arrangement. For this particular configuration it is not necessary to apply the same channel structure at both S and T reference points. For example, basic channel structures may be used for interfaces located at reference point S. Either basic or primary rate multiplex or other channel structures may be used at interfaces located at reference point T.

5.2 Hybrid access arrangement. Figure 2 illustrates a possible configuration for a variety of hybrid access arrangements. A hybrid access arrangement consists of a digital channel structure used in conjunction with an analogue channel. A physical interface is shown at reference points S and T, where the C channel structure or the basic channel structure may be used. In addition to the analogue channel, the hybrid access arrangement includes one of the following digital access capabilities:

i) C;

ii) D;

iii) B + D, or

iv) 2B + D.

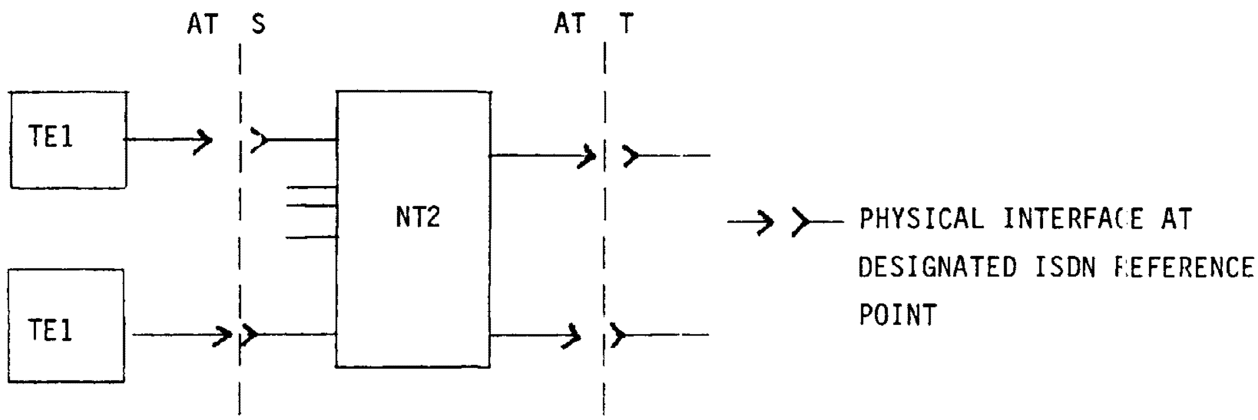


Figure F-1. Example of the reference configurations for ISDN user/network interfaces applied to a physical configuration employing multiple connections.

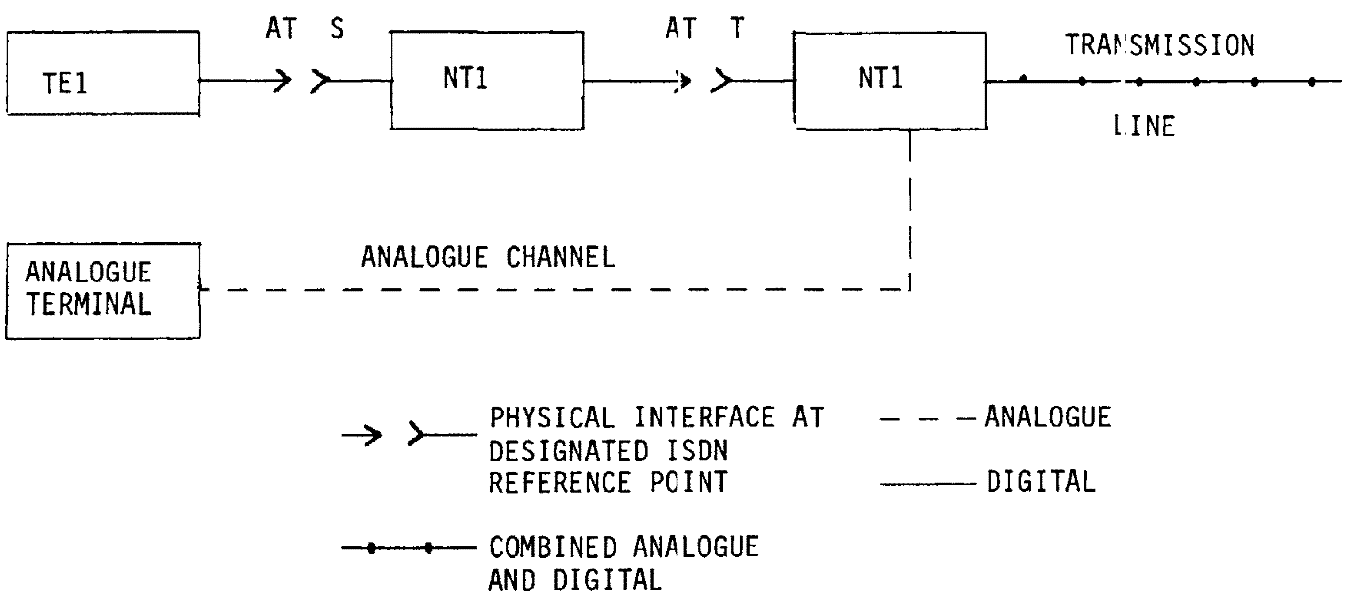


Figure F-2. Reference configuration for hybrid access arrangements for ISDN user/network interfaces.

APPENDIX G: CCITT RECOMMENDATIONS CITED

[Source: CCITT Yellow Book, 1980]

Recomm. Number	Title
A Series	Organization of the work of the CCITT.
A.21	Collaboration with other international organizations on CCITT defined telematic services.
F Series	Telegraph and "telematic services" operations and tariffs.
F.80	Provisions about phototelegrams.
F.100	Scheduled radiocommunication service.
F.160	General operational provisions for the international public facsimile services.
F.170	Operational provisions for the international public facsimile service between public bureaux (bureaufax).
F.180	Operational provisions for the international public facsimile service between subscribers' stations.
F.200	Teletex service.
G Series	General characteristics of international telephone connections and circuits.
G.702	Vocabulary of pulse code modulation (PCM) and digital transmission terms.
G.705	Integrated services digital network (ISDN).
I.xxx	[Draft] ISDN user/network interfaces--Reference configurations.
I.xxy	[Draft] ISDN user/network interfaces--Channel structures and access capabilities.
I.xxw	[Draft] General aspects and principles relating to Recommendations on ISDN user/network interfaces.
Q Series	General Recommendations relating to Signalling and switching in the automatic and semi-automatic services.
Q.701	Functional description of the Signalling System (Message transfer part).
Q.702	Signalling data link.
Q.703	Signalling link.
Q.704	Signalling network functions and messages.
Q.705	Signalling network structure.
Q.706	Message transfer part signalling performance.
Q.707	Testing and maintenance.
Q.721	Functional description of the Signalling System, telephone user part (TUP).
Q.722	General function of telephone messages and signals.
Q.723	Formats and codes.
Q.724	Signalling procedures.
Q.725	Signalling performance in the telephone application.
Q.741	Signalling System No. 7--Data user part. (See also X.61.)

(Continued, next page.)

CCITT RECOMMENDATIONS CITED--Continued:

Recomm. Number	Title
S Series	Alphabetical telegraph and telematic (except facsimile) services terminal equipment.
S.60	Terminal equipment for use in the telex service.
S.61	Character repertoire and coded character sets for the international teletex service.
S.62	Control procedures for the telex service.
S.100	International information exchange for interactive videotex.
T Series	Terminal equipment and transmission for facsimile services.
T.0	Classification of facsimile apparatus for document transmission over the public networks.
T.1	Standardization of phototelegraph apparatus.
T.2	Standardization of Group 1 facsimile apparatus for document transmission.
T.3	Standardization of Group 2 facsimile apparatus for document transmission.
T.4	Standardization of Group 3 facsimile apparatus for document transmission.
T.30	Procedures for document facsimile transmission in the general switched telephone network.
V Series	Data communication over the telephone network.
V.3	International alphabet No. 5
X Series	Data communication networks, services and facilities, terminal equipment and interfaces.
X.1	International user classes of service in public data networks.
X.2	International user services and facilities in public data networks.
X.3	Packet assembly/disassembly facility (PAD) in public data networks.
X.20	Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for start-up transmission services on public data networks.
X.20bis	Use on public data networks of data terminal equipment (DTE) which is designed for interfacing to asynchronous duplex V-Series modems.
X.21	Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for synchronous operation on public data networks.
X.21bis	Use on public data networks of data terminal equipment (DTE) which is designed for interfacing to synchronous V-series modems.

(Continued, next page.)

CCITT RECOMMENDATIONS CITED--Continued:

Recomm. Number	Title
X.25	Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for terminals operating in the packet mode on public data networks.
X.60	Common channel signalling for circuit switched data applications.
X.61	Signalling System No. 7--Data user part. (See also Q.741.)
X.70	Terminal and transit control signalling system for start-stop services on international circuits between anisochronous data networks.
X.71	Decentralized terminal and transit control signalling system on international circuits between synchronous data networks.
X.75	Terminal and transit call control procedures and data transfer system on internaitonal circuits between packet-switched data networks.
X.87	Principles and procedures for realization of international user facilities and network utilities in public data networks.
X.121	The international numbering plan for public data networks.
X.150	DTE and DCE test loops for public data networks.