4. THE ROLE OF GOVERNMENT AND STANDARDS

> *"To make available, as far as possible, to all the people of the United States, a rapid, efficient nationwide and worldwide wire and radio service with adequate facilities at reasonable charges."*
>
> *Communications Act of 1934*

Empowered by the Communications Act of 1934, the Federal Communications Commission (FCC) set out to achieve the mission defined above. See Communications Act (1934). This worthwhile goal had, in large measure, been achieved by the 1960's. In fact, by the mid 1960's, the depth of penetration of plain old telephone service (POTS) far exceeded what was originally envisioned by the sponsors of the Act. In order to achieve this so-called, "universal" and "affordable" service, the FCC initially believed that the public would best be served by a monopoly where economies-of-scale would provide the affordable part and rate averaging the universal part. About this same time, a new product was developing that would have far-reaching effects, not only on the telecommunications environment, but on the FCC as well--namely the programmable computer.

By the mid 1970's, the distinction between computer processing and communications became blurred as these two technologies converged. It was apparent that any regulation based on the dichotomy between computer processing and communications could not long endure. Over the next two decades, the FCC conducted a series of inquiries known as Computer I, II, and III. See FCC (1970, 1973, 1977, and 1986). As these inquiries progressed, the philosophy of the FCC, the Congress, and the Justice Department changed. Rather than regulate and monopolize, this new philosophy encouraged deregulation and competition. Depth of penetration of POTS would be supplemented with a new goal--breadth of services. The competitive environment under marketplace control would yield new innovative features and functions to meet the service demands of an emerging new information society. The old objective of universal, affordable POTS was not replaced, but a new objective was added, namely Peculiar and Novel Services or PANS.

This new philosophy resulted in the deregulation of customer premises equipment and enhanced services in 1981, the divestiture of AT&T in 1984, and the yet-to-be implemented open network architecture (ONA) concept in 1987. However, these changes have not come about without problems. Although many expected benefits occurred, new issues arose. How these issues evolved, and their current status, is the subject of the following paragraphs.

After two decades of controversy over competition in the carrier industry, a dramatic organizational change occurred on January 1, 1984. The year before, Judge Greene had approved the Modified Final Judgment (MFJ) dissolving the Bell system. See Green (1983). This divestiture divided what was then the largest corporation in the world with some $150 billion in assets serving over 100 million subscribers into eight independent companies, seven Regional Bell Operating Companies (RBOCs) and AT&T. Figure 4-1 indicates the geographic area covered by the seven RBOCs, and also indicates the 1991 ISDN deployment level in terms of percentage of total lines for each RBOC. This event culminated a series of deregulatory, pro-competitive, initiatives involving all three branches of the United States Government but still left the local exchange carriers as virtual monopolies. Technologies such as wireless communications systems, cable TV, and satellites could be used to by-pass the local exchange, and introduce competition in that area.

The Federal Communications Commission, the Department of Justice, the National Telecommunications and Information Administration, and Judge Greene's District Court are still (in 1993) clarifying and refining the organizational restructures imposed by the (1984) divestiture. In order to understand how these government policies and actions have affected today's networks, and may impact future structures, it is necessary to review the major regulatory events of the past, today's regulatory posture, and what may happen in the future.

Table 4-1 lists, in chronological order, several major actions and events that have occurred as the result of Government actions affecting the telecommunications industry.

One change occurred in March 1988 when Judge Greene issued his decision allowing Bell operating companies (BOCs) into the voice-mail and electronic mail markets. The decision also permits transmission of information services, but continued the ban on origination of information. Recently (1992), Judge Greene lifted the ban and allowed the BOCs to provide information gateway services and the FCC permitted the telephone industry to provide TV services.

A report and order issued by the Federal Communications Commission (FCC) following the Third Computer Inquiry (FCC, 1986) replaced structural separation requirements for enhanced services operations of AT&T and the BOCs with nonstructural safeguards. Initially this included the imposition of Comparably Efficient Interconnection (CEI) and Open Network Architecture

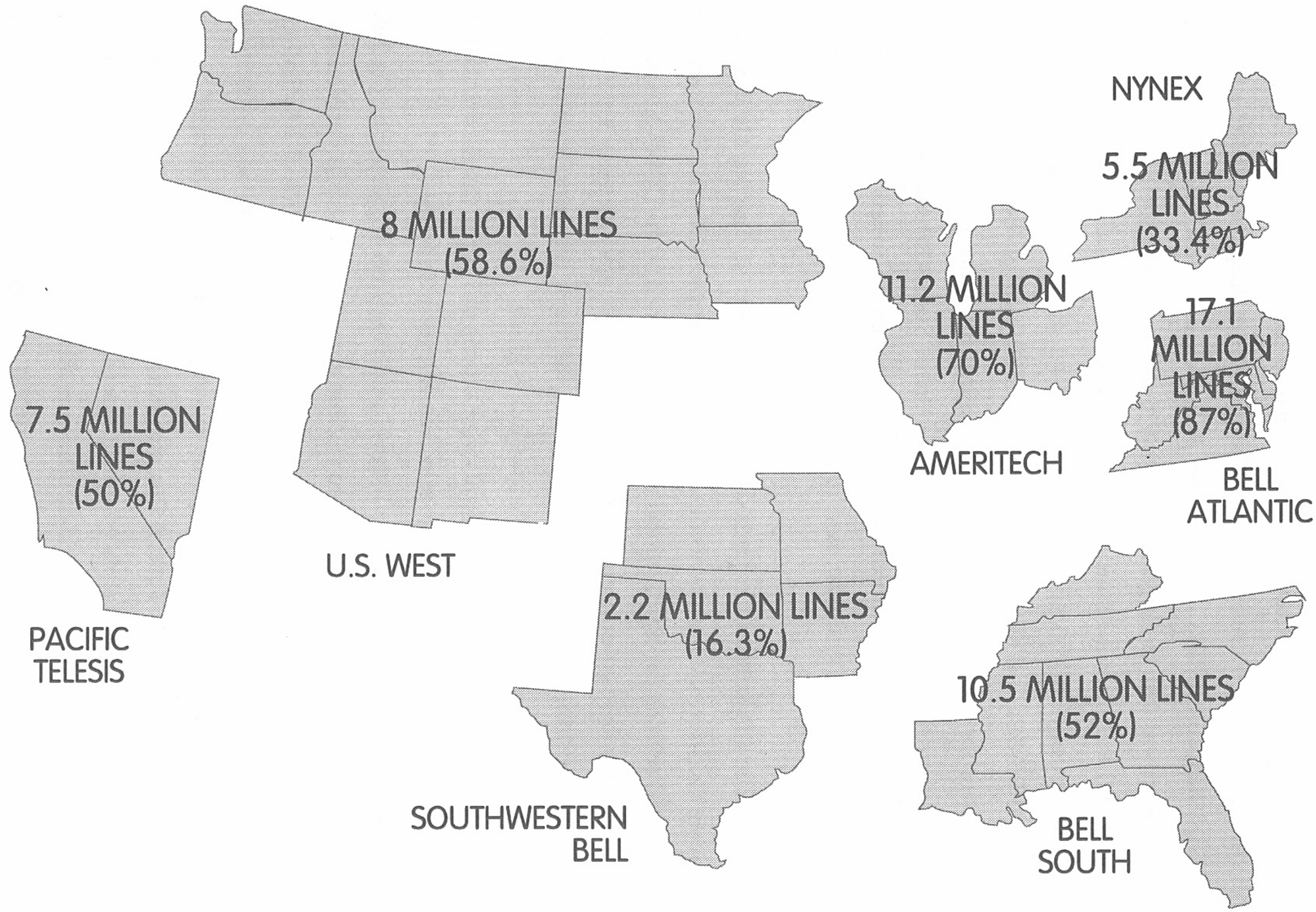


Figure 4-1. ROBC development of ISDN in terms of access lines.

Table 4-1. Government Actions Affecting the Telecommunications Industry

Year	Action	Comment
1893	Bell Patents Expired	Competition Begins
1910	Mann-Elkins Act	Interstate Commerce Regulation
1913	Kingsbury Commitment	Interconnections Required
1927	Radio Act	
1934	Communications	Enabling the FCC
1949	AT&T Antitrust Suit	Ultimately led to Divestiture
1956	Hush-a-Phone Decision	
1956	Consent Decree	AT&T out of Processing Business
1962	Communication Satellite Act	
1968	Carterphone Decision	Interconnect allowed CPE Industry Starts
1969	MCI Application Approved	Start of Long Distance Carrier Competition
1972	Domestic Satellite Decision	Open Sales Policy
1971	Computer I Final Decision	Open Field to Specialized Carriers
1974	AT&T Antitrust Suit	
1975	FCC Equipment Registration	Interconnect Market Expands
1977	Execunet Decision	
1980	Computer II Final Decision	Basic/Enhanced Dichotomy
1983	Modified Final Judgment	Divestiture with Business Restrictions on BOCs
1984	Divestiture (AT&T and BOCs)	Equal Access Required
1986	Computer III Report and Order	Open Network Architecture
1987	Computer III Supplementary Order	
1988	ONA Plans Approved in Part	
1989	BOCs Allowed in Voice and Electronic Mail Market	BOCs Permit Access to Enhanced Service Providers
1992	BOCs Allowed to Provide Information Services	Business Restrictions on BOCs Partially Lifted
1992	FCC Permits Telecos in TV Service Market	Introduced Competition to Cable TV Industry

(ONA) plans. Approval. of an ONA plan was contingent on the unbundling, identification, and offering of Basic Service Elements (BSEs). The development of these ONA plans involved a complex interplay between a number of conflicting interests--the carriers, the equipment manufacturers, new entrepreneurs, regulators, and users. This complex process has been long and involved, but ultimately ONA is expected to have a major impact on the telecommunications industry and the network infrastructure in the United States. Compliance with ONA is a condition for removal of the RBOCs structural separation requirements imposed by the FCC.

4.1 The ONA Model

The Bell Operating Companies have developed a common ONA model to facilitate the development of their ONA plans. This common model, known as the Bellcore model, is illustrated in Figure 4-2. It depicts the generic elements of any ONA connection to a BOC's network.

The Bellcore model encompasses three main components: (a) Basic Serving Arrangements (BSAs), (b) Basic Service Elements (BSEs), and (c) End-user Complementary Network Services (CNSs). Under such an approach, a BSA--comprising the Enhanced Service Provider's (ESP's) access arrangement to a BOC network--must be taken as a precondition to ordering various optional BSEs associated with a particular BSA.

Despite the reliance on a common model, the plans of each RBOC still varied widely with respect to the number of specific BSAs identified and the number of BSEs offered.

Figure 4-3 lists a number of applications that the Enhanced Service Providers contemplate under ONA. These applications have been divided into five major service categories--passive, interactive, transitional, messaging, and polling. Obviously all of these would not be required in every access area, but subsets may be useful in many areas. The ONA plans were approved in part in 1988. Court proceedings have delayed the process, but ONA is expected to influence the network infrastructure for sometime to come. Standards, both national and international, will also have major impact on this infrastructure as discussed below. The material in Section 4.2 is based on a similar discussion given by Jennings et al., (1993).

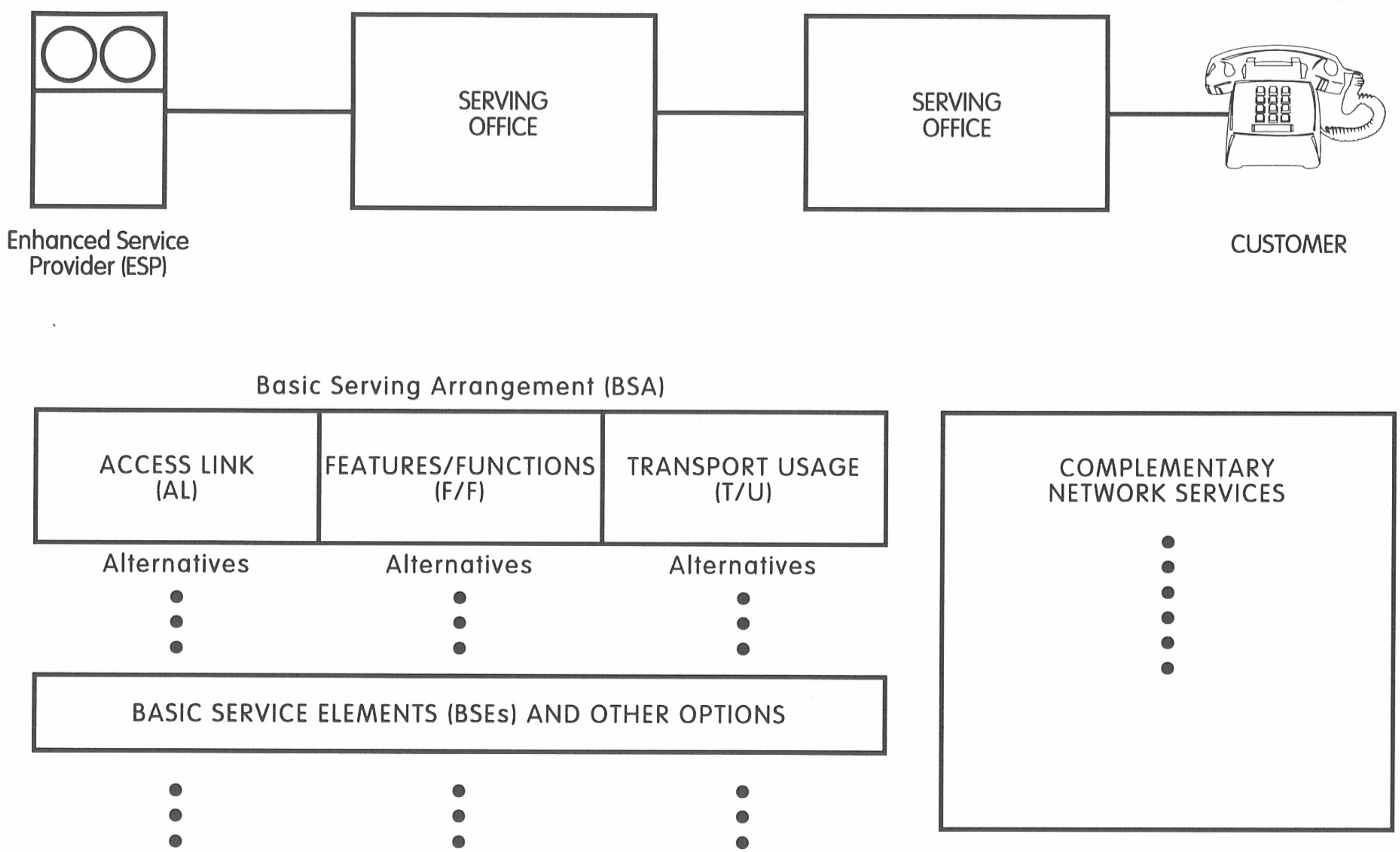


Figure 4-2. Bellcore's ONA model.

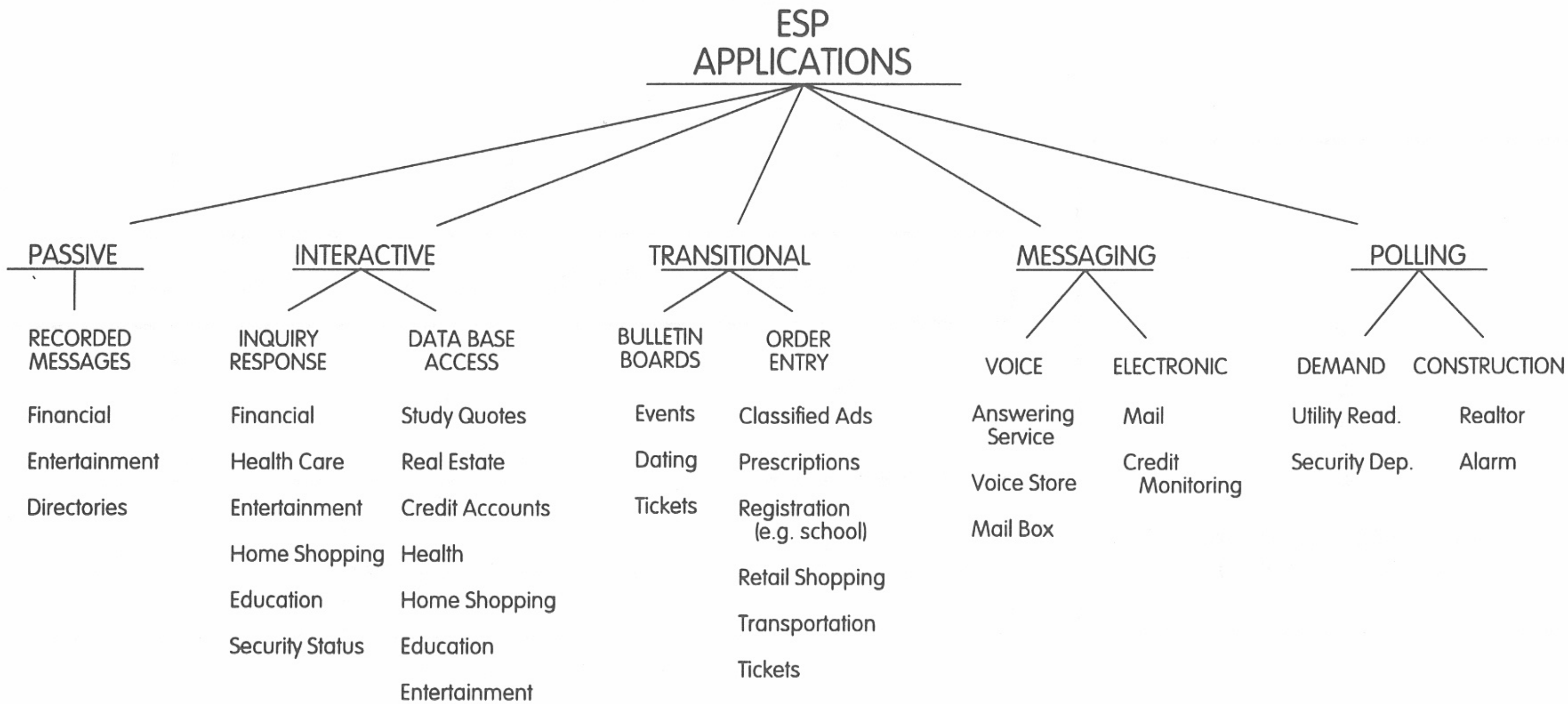


Figure 4-3. Enhanced service providers application breakdown.

4.2 The Standard Making Process

Before describing the process for developing standards, it is useful to define what is meant by a "standard" and who needs it. Cargill (1989) defines a standard as follows: "A standard is the deliberate acceptance by a group of people, having common interests or backgrounds, of a quantifiable metric that influences their behavior and activities by permitting a common interchange."

For telecommunication standards there appear to be two viewpoints: one technical and the other functional. Technically, two pieces of equipment are standardized if they can communicate with each other or if they can both be used with the same interconnection. The alternative functional view is the documented standard that specifies approved means of accomplishing a set of tasks or functions. In this case, different implementations may meet the standard but may still be incompatible with each other due to various options.

Benefits of telecommunication and information-processing standards are often market driven. These benefits include interchangability, convenience, risk reduction, interconnectibility, safety, ease of use, and technical integration.

The development of standards is a multistep process. One typical example is shown in Figure 4-4. An estimated time scale for major processes is given on the left side of the figure and potential organizations that could be involved with each step are listed on the right. The process begins with the establishment of a need or requirement. This could come from a variety of sources including service providers, equipment suppliers, and the users themselves. Each group may approach this need from a different perspective. The providers, for example, tend to view their networks as all encompassing, capable of meeting a variety of users needs, and having long productive lifetimes. The users on the other hand are more interested in an immediate implementation to meet their specific application. Needs may also evolve from special groups formed for that purpose. For example, the International Federation for Information Processing (IFIP) tends to be a prestandards organization that investigates only the need for standards, not their development.

After the need is established, the next step is to develop a basic framework for standards development. This framework scopes out the standardization activities needed to develop a particular standard or set of standards, e.g., for network management. This framework provides an overview of what is, and what is not, to be standardized. Detailed models then refine the

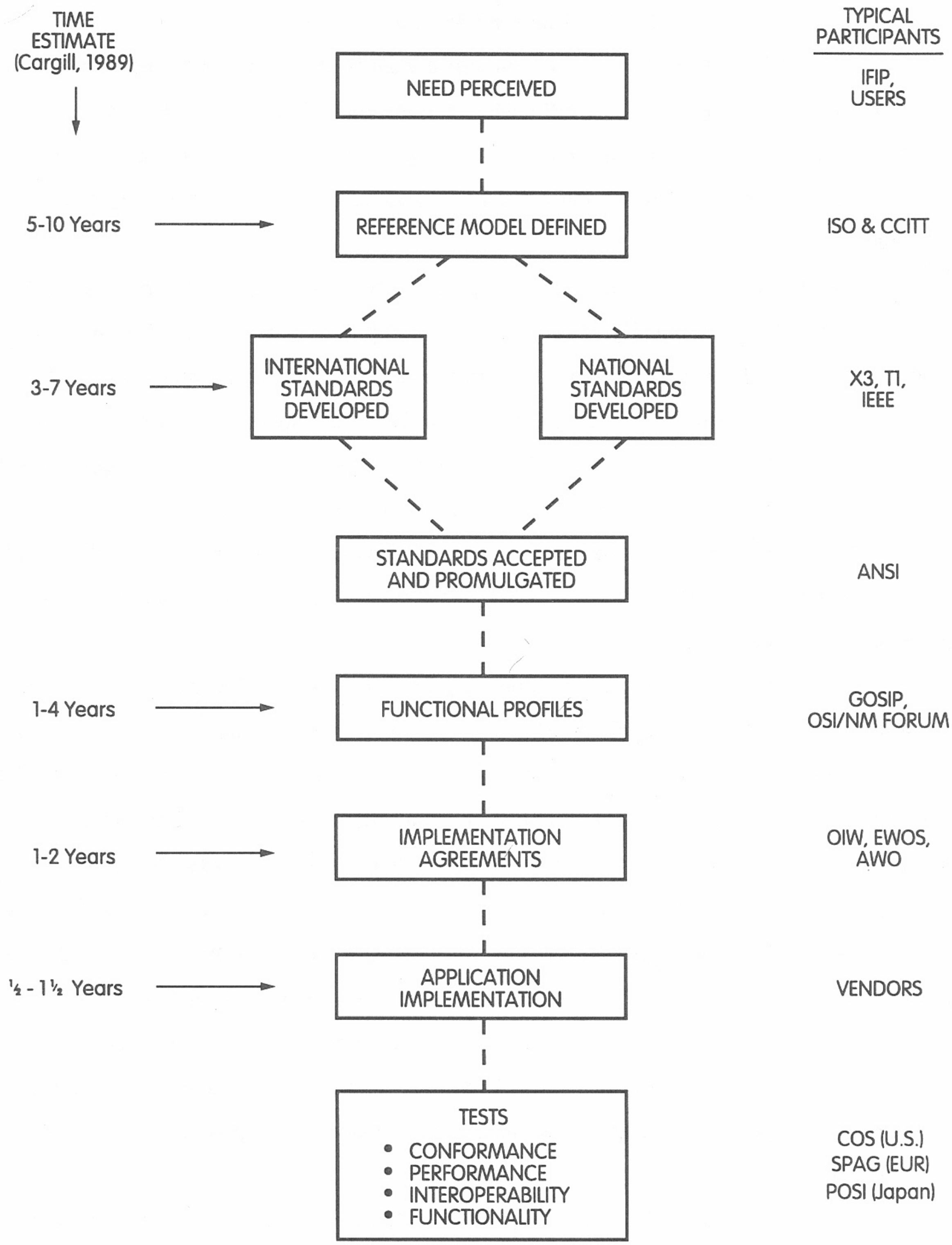


Figure 4-4. The standards-making process.

basic framework. This functional architectural model leads to standards development by national and international bodies. These bodies typically concentrate on standards for specific environments such as local area networks, or long-haul networks. Some are concerned with terminal access to transmission systems, some for computer communications, others for Integrated Services Digital Networks (ISDNs) or for telephony. The ultimate goal of these standards is to enable the development of interoperable, multivendor products for information processing systems and telecommunication networks.

Once the standards are developed, accepted, and promulgated by industry providers, other user-oriented organizations must develop specifications which identify the options and sets of protocols called "profiles" or "suites" that a given implementation should support. Separate functional profiles may be needed for different applications (e.g., electronic mail, file transfer, or network management) and for different physical networks (e.g., connection-oriented or connectionless). Thus, the Government's Open System Interconnection Profile (GOSIP) defines Federal procurement profiles for "open system" computer network products. Such profiles may change as technology improves and as standards evolve. New profiles are added as new applications arise.

The functional profile specifies what sets of functions are to be implemented and how they should appear to external systems. There are many possible ways to implement a profile in hardware and software, but, externally, the functions should all appear identical.

Profiles may be derived from many sources and various architectures. Some vendors have profiles based on their proprietary architectures such as the Systems Network Architecture (SNA) used in IBM networks. The profile is used to provide interoperability, but interoperability still requires agreements on how they should be implemented. These so-called implementation agreements (IAs) or system profiles are derived by consensus among users, vendors, and system integrators at various forums and workshops both national and international. For example, the Open System Interconnection (OSI) Implementors Workshop (OIW) that is sponsored by NIST and the IEEE Computer Society is developing IAs for emerging network management standards. Implementors workshops including those in Europe and Asia may submit profiles to the International Standards Organization (ISO) which can issue International Standardized Profiles (ISPs).

Products implemented according to the IAs must then be tested to certify that they meet specifications. There are several kinds of testing, including

Conformance Testing to verify that an implementation acts in accordance with a particular specification (e.g., GOSIP).

Performance Testing to measure whether an implementation satisfies the performance criteria of the user.

Functional Testing to determine the extent to which an implementation meets user functional requirements.

Interoperabilitv Testing to duplicate the "real life" environment in which an implementation will be used.

Most vendors have not yet had their equipment certified for compliance with presently established standards because testing agencies in early 1993 are still in the process of establishing criteria for compliance testing and certification. There are a number of specific national and international organizations actively working to evolve this type of testing criteria. One is the Corporation for Open Systems (COS), a U.S.-based company developing tests for the OSI Reference Model's Layers 1 through 4, which deal with physical, data link, network, and transport services and protocols. Another is the Standards Promotion and Applications Group (SPAG), a European group establishing tests for Layers 5 through 7, dealing with session, presentation, and application services and protocols. Yet another is NIST which is overseeing the setting of standards for GOSIP.

The entire process is estimated to take anywhere from 11 to 22 years, but actually it is never complete since changes occur and new standards evolve as technology and needs change. Figure 4-5 shows the major standards organizations involved in developing telecommunications, radio, and information processing standards in the United States. The Telecommunications Industry Association (TIA) formed in 1988, recently accredited by the ANSI, plays a leading role in developing standards for telecommunications equipment and systems, fiber optic components and systems, and for mobile and cellular radio equipment. Organizations such as the European Telecommunications Standards Institute (ETSI) and the Information Technology Steering

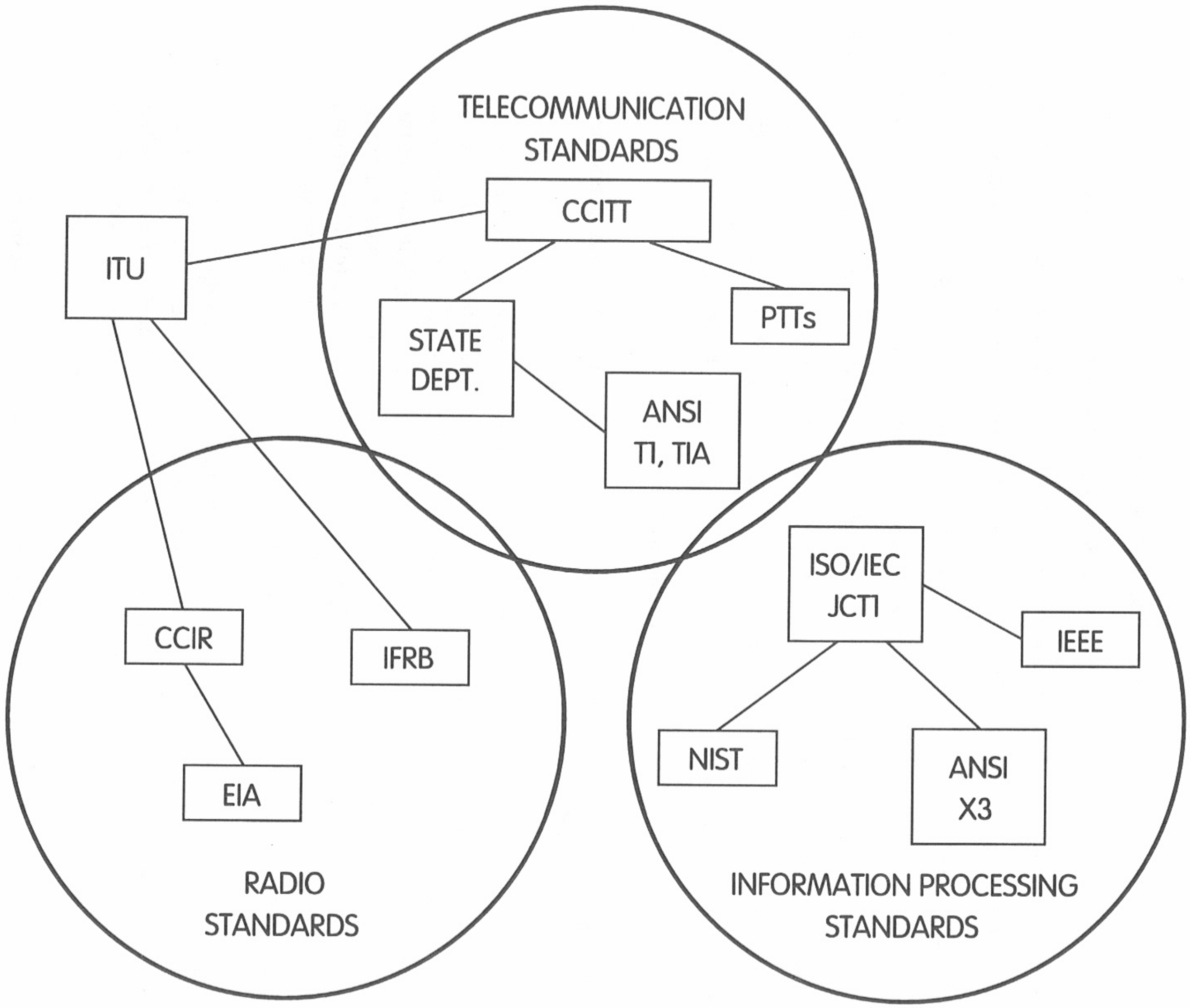


Figure 4-5. Major groups involved with standards for telecommunications and information processing.

Committee (ITSTC) are expected to develop standards for the European Community (EC) which will impact global networks. For a detailed description of the total organization structure and the standards making process see Jennings et al., (1993).

4.3 The OSI Model

An important result of the international standards-making process is the open system interconnection (OSI) reference model and the set of related standards resulting from this model. This set of international OSI standards attempts to ensure the interoperability of future telecommunications networks. They are, however, still incomplete (e.g., B-ISDN) and many organizations are attempting to resolve the problems. The OSI concept is addressed briefly because it has considerable impact on future network architectures such as B-ISDN and on the implementation of networks based on this model. See CCITT (1988c).

The seven-layer OSI model is illustrated in Figure 4-6. Narrative descriptions of the value-added services provided by protocols in each layer to the adjacent layer above are quoted from Federal Standard 1037B (1991). They are as follows:

> Media Layer: Layer 0. This is not currently a Federal standard but is concerned with the infrastructure of the network.
>
> Physical Layer: Layer 1. The lowest of seven hierarchical layers. The Physical Layer performs services requested by the Data Link Layer. The major functions and services performed by the Physical Layer are: (a) Establishment and termination of a connection to a communications medium; (b) Participation in the process whereby the communication resources are effectively shared among multiple users, e.g., contention resolution and flow control; and, (c) Conversion between the representation of digital data in user equipment and the corresponding signals transmitted over a communications channel.
>
> Data Link Layer: Layer 2. This layer responds to service requests from the Network Layer and issues service requests to the Physical Layer. The Data Link Layer provides the functional and procedural means to transfer data between network entities and to detect and possibly correct errors that may occur in the Physical Layer.
>
> Network Layer: Layer 3. This layer responds to service requests from the Transport Layer and issues service requests to the Data Link Layer. The Network Layer provides the functional and procedural means of transferring variable length data sequences from a source to a destination, via one or more networks while maintaining the quality of service requested by the Transport Layer. The Network

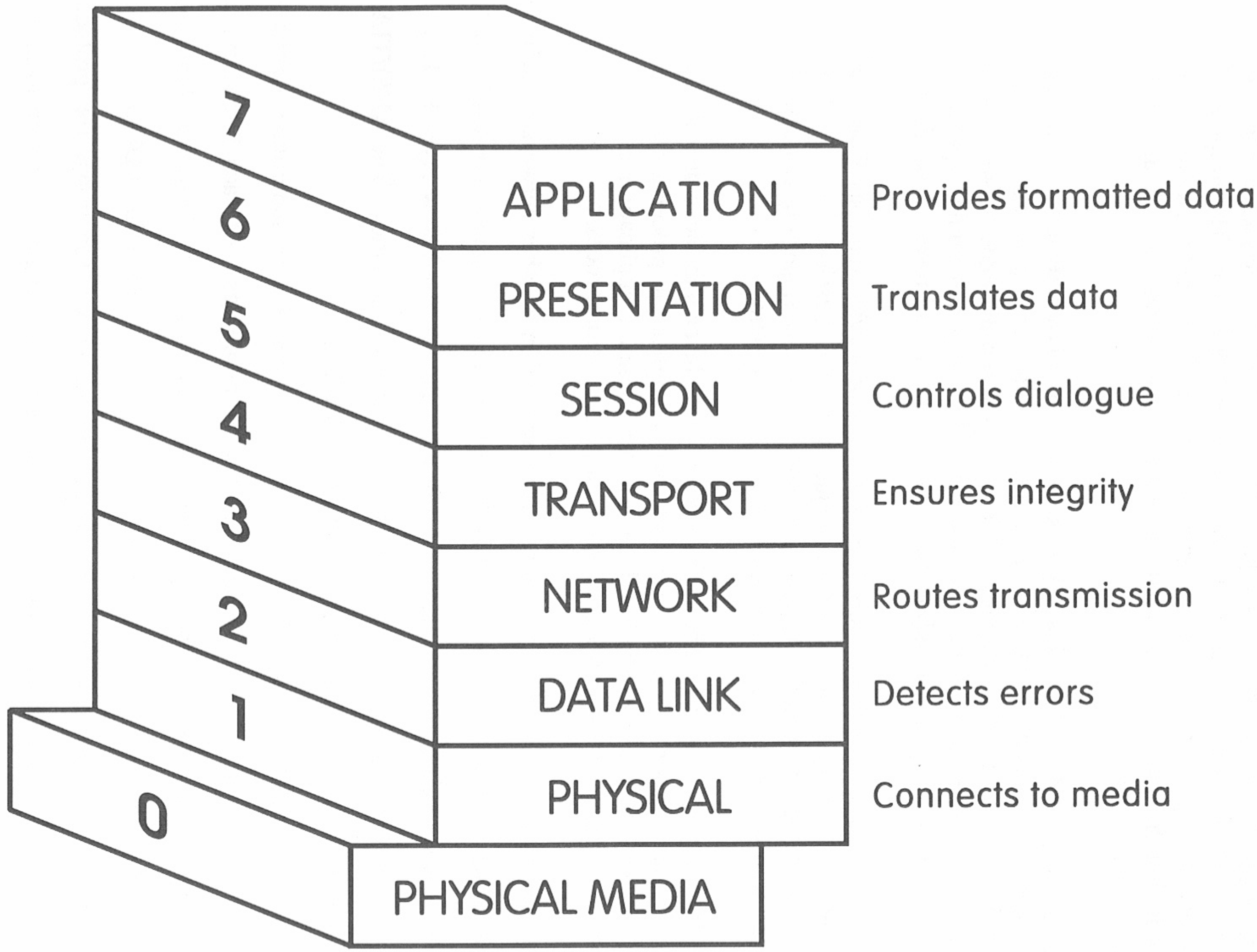


Figure 4-6. Protocol reference model for data communications.

Layer performs network routing, flow control, segmentation/desegmentation, and error control functions.

Transport Layer: Layer 4. This layer responds to service requests from the Session Layer and issues service requests to the Network Layer. The purpose of the Transport Layer is to provide transparent transfer of data between end users, thus relieving the upper layers from any concern with providing reliable and cost-effective data transfer.

Session Layer: Layer 5. This layer responds to service requests from the Presentation Layer and issues service requests to the Transport Layer. The Session Layer provides the mechanism for managing the dialogue between end-user application processes. It provides for either duplex or half-duplex operation and establishes checkpointing, adjournment, termination, and restart procedures.

Presentation Layer: Layer 6. This layer responds to service requests from the Application Layer and issues service requests to the Session Layer. The Presentation Layer relieves the Application Layer of concern regarding syntactical differences in data representation within the end-user systems.

Application Layer: Layer 7. The highest layer. This layer interfaces directly to and performs common application services for the application processes; it also issues requests to the Presentation Layer. The common application services provide semantic conversion between associated application processes.

Layer 1 assumes the existence of physical communication to other network elements as opposed to the virtual connectivity used by the higher layers. The transmission media including network topology is sometimes denoted as layer 0, since it is logically below layer 1. Layer 0 is concerned with switch placement, concentrators, lines, and line capacities. The ANSI/TIA is making a effort to develop an infrastructure standard for level 0.

There is an abstract boundary between adjacent layers that is sometimes called an interface. This boundary separates functions into specific groupings. At each boundary, the service that the lower layer offers to its upper neighbor is defined. The important functional entities that are transmitted between peer level layers are protocol data units (PDUs).

The protocols specified for all layers define the network's functional (or protocol) architecture. The specification of these protocols is needed to implement a service to an end user. Implementation of these protocols in hardware and software can be accomplished in many ways. The details of the implementation are not part of the architecture. One major advantage of this layered architecture concept is that lower-layer implementations can be replaced as technologies advance; for example, when a fiber link replaces a coaxial cable. The only requirement is that any new implementation provide the same set of services to its adjacent upper layer as before.

It is not always necessary to implement every layer or every protocol within a layer. For example, error checking, a function of Layer 2, may not be necessary on links with low error characteristics.

There are limitations to the OSI model. For example, it may be difficult to apply to certain distributed systems where computing functions are dispersed among many physical computing elements. The model does not, in its present form, represent important existing and future services such as telephony. It tends to restrict certain functions to end systems. This can be inconvenient where such functions could be better performed by the network itself.

Figure 4-7 illustrates the application of this model for connecting a user to a computer program via two intermediate packet switching nodes. Note that only the lower layers 1 through 3 are involved at an intermediate node. Layer 4 is concerned with the end-to-end integrity of the information transferred between systems A and B. Actually, a functional architecture based on this model and the subsequent implementations could be different for each link in this configuration. Thus, the protocols from System A to the first node may be entirely different than protocols 1 through 3 between the switching nodes. Even the physical transmission media may differ. Figures 4-8a and 4-8b indicate the relationships between the OSI protocol reference model and conventional data terminal equipment (DTE), as well as data communication equipment (DCE). Figure 4-8c relates this reference model to the functional grouping of the elements in an ISDN. Figure 4-8d illustrates one implementation of the two communicating systems with a subnet containing the two nodal switches. It is also possible for the reference model to take on more dimensions to include the network management and control functions.

Based on the OSI reference model, it is possible to define a number of different functional architectures for a given end-service. This is accomplished by selecting appropriate protocols for each of the seven levels (Linfield, 1990). An example of protocol stacks leading from two applications (file transfer and electronic mail), through the seven OSI levels to seven different physical transmission media is shown in Figure 4-9.

A similar protocol stack has been specified for government use by the National Institute of Standards and Technology (NIST) and is called the Government OSI Profile (GOSIP). Since

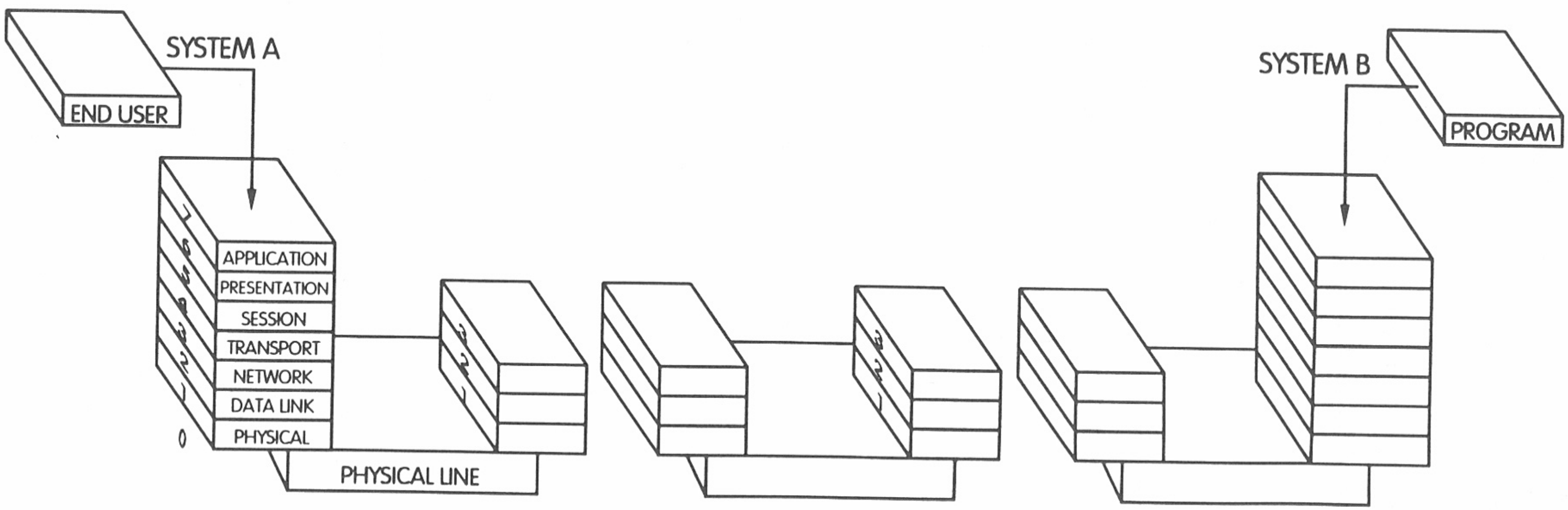
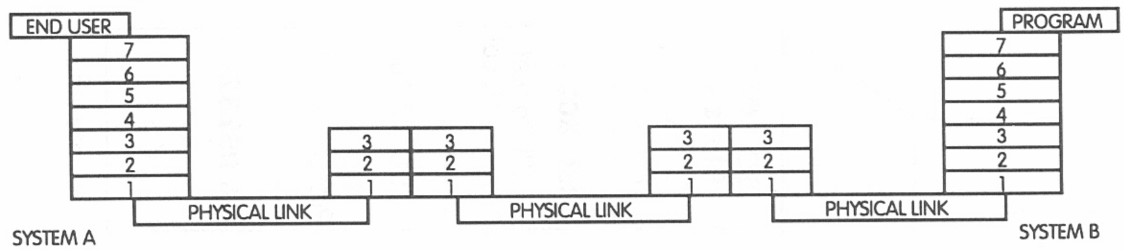
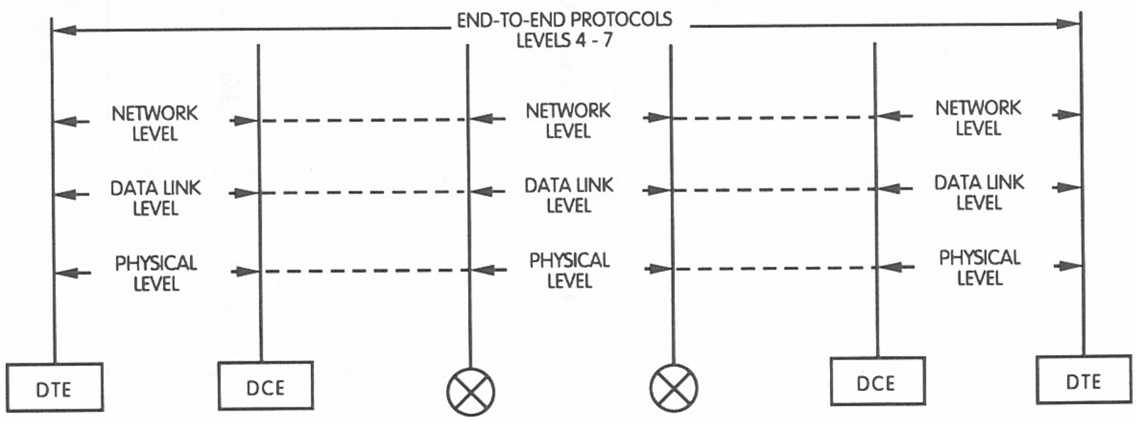


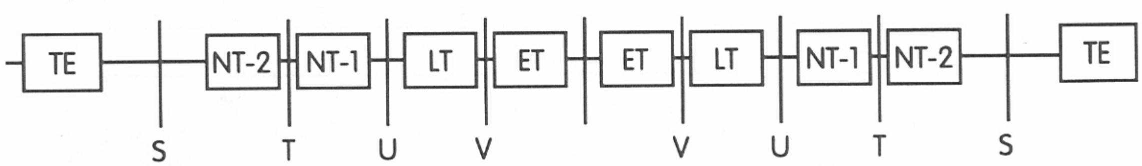
Figure 4-7. Application of protocol reference model to a network with intermediate nodes.



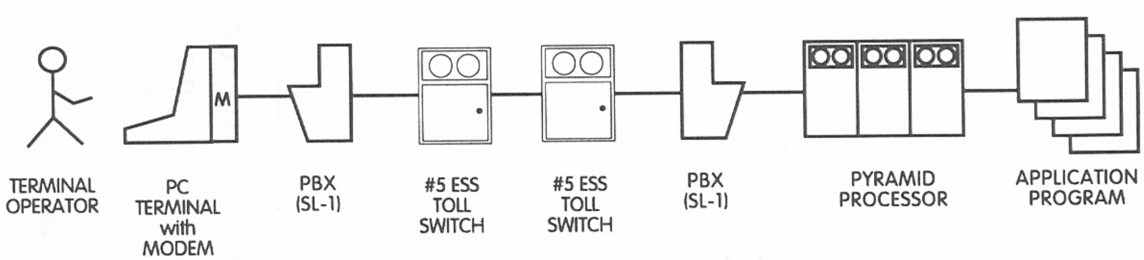
a) OSI Reference Model



b) Functional Groupings



c) Functional Grouping for ISDN



d) Implementation Example

Figure 4-8. Architectural models and an implementation.

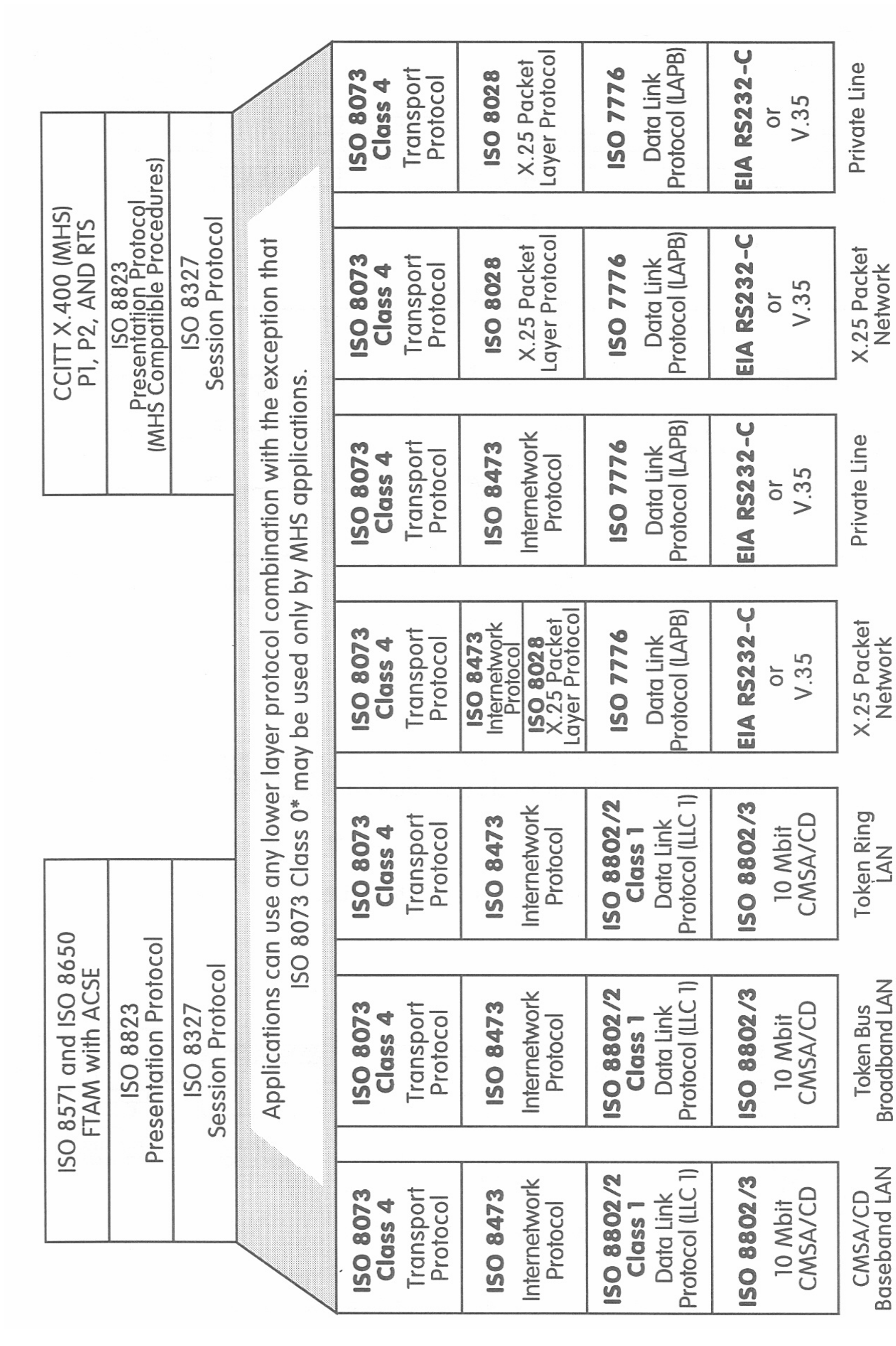


Figure 4-9. Protocol combinations defining specific network architectures.

1990, GOSIP has been mandated as a Federal Information Processing Standard and is defined in Federal Information Processing Standard (FIPS) Publication 146. All government agencies must conform to GOSIP in any future procurement of network products. GOSIP is updated each year. Version 2 became mandatory in August 1991. Version 1 applications covered File Transfer, Access and Management (FTAM), Message Handling Systems (MHS), and the Association Control Service Element (ACSE). Version 2 added applications for virtual terminals and document interchange. Version 2 will support X.25 interfaces, and IEEE 802.2 to 802.6 LAN networks, as well as ISDN. Version 3, effective in 1993, will add network management, directory services, and will support the Fiber Distributed Data Interface (FDDI).