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of

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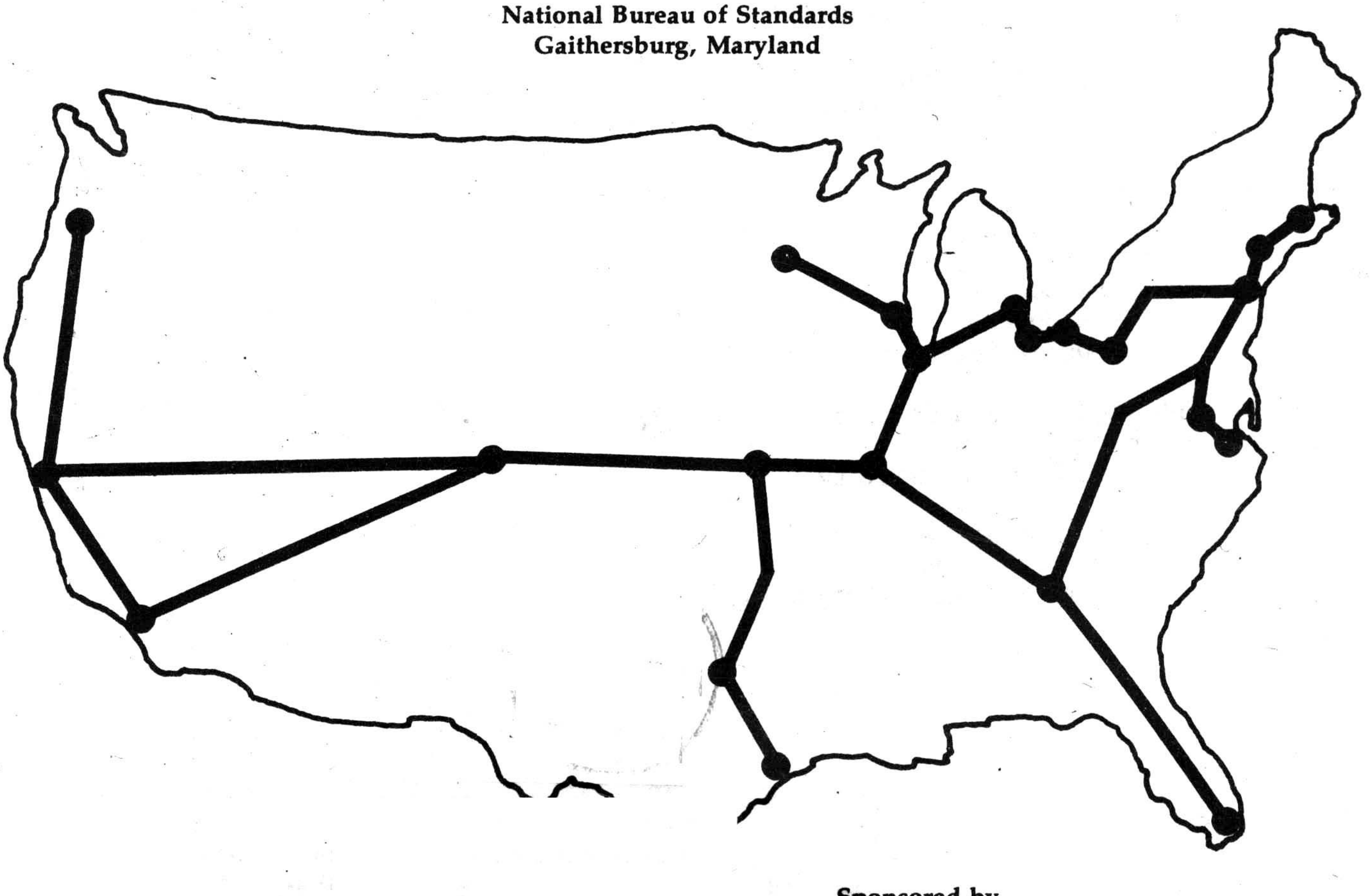

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COMPUTER AND DATA COMMUNICATIONS
STANDARDS ORGANIZATIONS

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ABSTRACT

This paper describes various organizations that have been established to deal with standards. Although its focus is primarily on the committees and task groups that are involved with data communication standards activities, it attempts to place these activities in a larger perspective by also describing the parent organization in which these activities are performed, the formal and informal working relationships between these organizations, as well as some of the generally universal procedures by which standards are developed, approved, and implemented.

INTRODUCTION

The need to establish standards has existed at least as long as there has been a civilized society. Certainly, the need was recognized at about the time of the second bartered exchange of goods or services that occurred in the world's first marketplace. For many thousands of years, the only kinds of standards required were those concerned with relatively simple measurements of a few physical things. As long as populations were relatively immobile and locally produced goods were locally marketed and consumed, differences in standards for the measurement of length, weight, and time from one community to another were not a critical matter.

For those countries at the forefront of the industrial revolution, the need for a variety of engineering and product quality type standards at both the national and international levels became increasingly evident during the 19th century. Between the mid-1800's and the present, a large number of nationally and internationally oriented groups were formed, merged, disbanded, and reorganized to address standards for various technologies and to serve the needs of different industrial, commercial, and professional constituencies.

There are presently such a large number of standards organizations in existence that an exhaustive coverage of this entire subject would be extremely difficult. However, among the most active of these organizations are those with committees and task groups responsible for developing computer and data communication standards. This high level of standards activity is largely due to the rate of innovation associated with the merging information processing and data transmission technologies that has occurred mostly during the past decade. By confining the scope of this paper to consider only those organizations having significant influence on, or interest in computer and data communication standards, the number of organizations is reduced to manageable size. Reviewing the sequence of significant events that have brought about the present structure of national and international organizations for dealing with computer and data communication standards should provide perspective for understanding how these organizations operate and interact.

There are two parts to this paper. The part immediately following is a chronology accounting for each organization, its history, purpose and present status; in some cases, organizational interrelationships are identified. The second part describes how these organizations interact in the standards development process.

ORGANIZATIONS

Table 1 provides a chronologic listing of the organizations described in this section, with the year in which each was established.

TABLE 1: LISTING OF ORGANIZATIONS DESCRIBED

International Telecommunications Union (ITU)	1865
National Bureau of Standards (NBS)	1901
International Electrotechnical Commission (IEC)	1906
American National Standards Institute (ANSI)	1918
Electronic Industries Association (EIA)	1924
International Organization for Standardization (ISO)	1926
National Communications System (NCS)	1963

The International Telecommunications Union (ITU)

The need for a form of data communication standards began to be recognized during the early 1850's as a result of the initiation of commercial telegraph services in both Europe and America. During the mid-1850's and early 1860's, the need for some kind of organization that could produce international agreements on such things as alphabets, codes, and signaling conventions became increasingly critical in Europe as these telegraph services began crossing national boundaries. Thus in 1865 the Union Telegraphique Internationale was established as a treaty-level, inter-governmental organization. This evolved into the present International Telecommunications Union (ITU) following a reorganization in 1932 that incorporated responsibilities for standards involving radio as well as telegraphic and telephonic methods of communication.

The ITU seeks to coordinate the work of national Government and private bodies by promoting the development of technical facilities and their efficient operation, and to improve the efficiency, usefulness, and availability of telecommunication services. It also participates in the United Nations' Expanded Program of Technical Assistance and acts as an executive agent for telecommunication projects financed by the UN Special Fund in various countries.

Most technical issues, including the development of standards, are delegated within the ITU to one of two committees: The Consultative Committee on International Radio (CCIR) and the Consultative Committee on International Telegraph and Telephone (CCITT). Only the second of these committees has significant involvement with the other organizations described by this paper in the area of data communication standards.

The CCITT has been established to examine and make recommendations on technical, operational, and tariff matters relating to telegraphy, facsimile, and telephony. The technical activities of the CCITT are allocated among some 17 study groups six of which are involved with data communications. These six study groups and the respective topics with which they deal are:

SG III - Tariff Principles
SG VII - New Data Networks
SG VIII - Terminals
SG IX - Telegraph Practice
SG XIV - Facsimile
SG XVII - Data Transmission

It is important to note that the CCITT is a communications common carrier oriented organization. That is, it has been established to serve the needs of carriers, or administrations as they are called, involved in international communications. Strictly speaking, the role of CCITT is to devise those standards necessary for the operation of international telecommunication facilities and services. In most countries of the world, for example, these telecommunication services are provided by the Postal Telegraph and Telephone Administrations that are Government agencies; as a consequence, standards produced by CCITT are called recommendations. They are prepared to represent agreements between Governments and they are processed as treaties. In the U.S., these telecommunication services are provided by private industry and the State Department is responsible for U.S. representation in the CCITT.

There are two general categories of the CCITT recommendations pertinent to data communication; they are the Series V Recommendations relating to data transmission over telephone or telex networks and the Series X Recommendations relating to data transmission over public data networks. Altogether, there are presently about 50 approved recommendations with the majority being those in Series V.

The National Bureau of Standards (NBS)

The latter part of the 19th century saw enormous industrial development in the United States--development of the steel industry, railroads, telephone, and electric power. As these industries became more sophisticated and more technical, needs repeatedly arose for uniform standards, new measurement technology, and quality control. During the 1890's, there was an emerging concern for the consumer and for fairness in the marketplace. Most manufactured articles and materials were of variable quality, such as: the tensile strength of steels, the compressive strength of concrete, the durability and dyeing behavior of textiles. The infant electrical industry had no universally acceptable measurement methods for the volt, the ampere, the ohm, or the watt, and there was no international agreement for the definitions of these quantities.

On March 3, 1901, President McKinley signed a law establishing the National Bureau of Standards; the bill called for NBS to start operations on July 1, 1901. Although the initial emphasis of NBS attention was focused on the marketplace needs for weights and measures, from the very beginning the Bureau was also heavily involved in basic research leading to the growth of science and the application of technology.

Since 1946, NBS has been active in the general field of electronic digitial computers; SEAC, the first usable, large-scale, stored program, digital computer was built by NBS and made available for use by other Government agencies in May of 1950. The SWAC and DYSEAC computers were designed and built by NBS prior to 1955 and the design of the PILOT computer was completed in 1957, long before equipment of comparable capability became commercially available.

In the decade between 1955 and 1965, NBS made a number of significant contributions to the rapidly evolving state-of-the-art in computer systems architecture, hardware component and software design; the range of these NBS contributions included such areas as pattern recognition, optical scanning devices and innovative computer applications that involved time-sharing and teleprocessing, multi-programming and multi-processing.

In 1965, Congress passed PL 89-306, known as the Brooks Act, which designated the Department of Commerce and the National Bureau of Standards with responsibilities for:

(1) Providing scientific and technological advisory services to other Government agencies with regard to automatic data processing and selected systems.
(2) Making appropriate recommendations to the President concerning the establishment of uniform Federal automatic data processing standards.
(3) Undertaking research in computer science and technology as needed to fulfill the above responsibilities.

Following the enactment of PL 89-306, NBS created the Center for Computer Sciences and Technology and established under its direction the Federal Information Processing Standards (FIPS) program. In 1972, the Center became the Institute for Computer Sciences and Technology. The first Federal Information Processing Standard, issued as FIPS PUB 1 in 1968, adopted ASCII for mandatory use by all Federal agencies and required computers brought into the Federal inventory after July 1969 to have ASCII capability. There are presently some 53 FIPS PUBS that are either management informational bulletins, guidelines, or standards. The 27 FIPS PUBS that are standards each impose certain mandatory requirements or constraints on the procurement, application, or use of computers by the Federal community. Of the 27 standards, 7 pertain to data communications.

The International Electrotechnical Commission (IEC)

In 1906, the International Electrotechnical Commission was formed to facilitate the coordination and unification of national electrotechnical standards and to coordinate the activities of other international organizations in this field. In 1947, the IEC became affiliated with the International Organization for Standardization (ISO) as its Electrical Division; however, the IEC retained its technical and financial autonomy and remains an independent organization. Although involved in a number of areas concerned with electronics and electrical equipment design and construction, the only direct involvement of the IEC with data communication standards is in the standardization of connectors employed between various computer system and communications equipments. IEC Technical Committee 48B has the ISO responsibility for selecting and recommending standard connectors for various applications.

U.S. participation in the IEC is provided by the U.S. National Committee that was established for this purpose in 1907 and which since 1931 has been affiliated with the American National Standards Institute and its predecessor organizations.

The American National Standards Institute (ANSI)

ANSI is the national clearinghouse and coordinating agency for voluntary standards in the United States. It is a nonprofit organization incorporated under the laws of the State of New York and is located in New York City. Its sponsoring membership consists of a federation of approximately 180 trade associations and professional societies, and over 850 companies.

ANSI was originally organized as the American Engineering Standards Committee (AESC) in 1918 by five engineering societies: the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Society of Civil Engineers, the American Society of Mining and Metallurgical Engineers, and the American Society for Testing Materials. The AESC's initial purpose was to provide means for coordinating the standards issued by its founding organizations, eliminating confusion and duplication among those standards. Its first act was to invite three Federal departments to join and work with the founding societies: the War Department; the Navy Department, and the Department of Commerce. Enlarged in 1920 by the addition of trade associations, as well as more technical and professional societies, the AESC was reorganized in 1928 as the American Standards Association (ASA) to provide a more workable structure. The organization was again restructured and renamed in 1966 when the ASA became the United States of America Standards Institute (USASI). In 1969, the present name, American National Standards Institute (ANSI), was adopted.

As the national clearinghouse for standards, ANSI provides the machinery for developing and approving standards that each reflect a national consensus. Technical societies, trade associations, consumer groups, and the like make up the Member Bodies of ANSI. Other classes of members are Company Members, Sustaining Members (individuals or organizations not otherwise eligible for membership but interested in standards development), and Honorary Members.

Financial support for ANSI comes from dues paid by Company Members, Member Bodies, and Sustaining Members. An additional source of income is derived from the sale of American National Standards.

Over 3500 American National Standards have been published. Of these, more than one-third have been submitted to ANSI by other competent organizations that had developed standards through their own procedures. The balance have resulted from the work of designated ANSI standards committees.

ANSI is the United States Member Body of the International Organization of Standardization (ISO). The United States' viewpoints to be presented in the technical work of the ISO may be developed through a designated ANSI standards committee, a committee of another U.S. industry or professional society standards organization recognized by ANSI, or through a committee specifically organized by ANSI to act as a U.S. Advisory Committee to an ISO Technical Committee.

There are some 300 standards committees that have been established under ANSI to deal with the various technical areas that our society has deemed to be suitable subjects for standardization; each standards committee is responsible for managing the development and processing of standards in a particular field. For example, standards committees under the letter A, such as A10, A11, and A17 are concerned with standards for the construction industry; standards committees under B deal with mechanical things (e.g., B11 is responsible for Safety Standards for Machine Tools); the standards committees under the letter X are concerned with information systems and standards committee X3 is responsible for standards involving computers and information processing.

Committee X3 was established in 1960 and is sponsored by the Computer and Business Equipment Manufacturers Association (CBEMA). As sponsor, CBEMA acts as the secretariat providing essential clerical and administrative support, and is responsible to ANSI for the general administration of X3.

As with other ANSI standards committees, the actual development of standards under X3 is accomplished by various technical committees or task groups whose membership includes the necessary technical specialists. For example, there are some 25 technical committees operating under X3 for dealing with standards ranging from optical character recognition (X3A1), to magnetic tape (X3B1), Fortran (X3J3), character codes (X3L2), and I/O interface standards (X3T9).

Standards for data transmission and data communication are the responsibility of technical committee X3S3 that was established in 1961. Because of the broad diversity of its program, the allocation and scheduling of work performed under X3S3 by the more specialized, standards-making task groups is carried out by a planning task group (X3S31) whose principal members include the X3S3 chairman and secretary together with the other task group chairmen. Presently, the six standards-making task groups and the subjects they deal with are:

X3S32 - Glossary
X3S33 - Transmission Formats
X3S34 - Control Procedures
X3S35 - System Performance
X3S36 - Signaling Speeds
X3S37 - Public Data Networks

Traditionally, new task groups are established under X3S3 as necessary to deal with newly identified issues that existing groups are not equipped to handle; when a task group completes an assigned task, it usually reverts to a standby or dormant status with its membership being available to assist in maintaining the standards it has produced.

Since it was established in 1961, X3S3 has produced 11 standards dealing with various aspects of data communication system design, specification, and performance. In fact, X3.1-1962 entitled "Synchronous Signaling Speeds for Data Transmission" was the first standard produced under ANSI committee X3. About half of these existing standards produced by X3S3 have been revised and reissued several times to account for innovation and change in data transmission technology. There are presently a number of other standards in various stages of development.

The Electronic Industries Association (EIA)

The Electronic Industries Association (EIA) was organized in 1924 as the Radio Manufacturers Association; after several reorganizations and mergers with similar trade associations, the present name was adopted in 1957. In 1965, the EIA absorbed the Magnetic Recording Industry Association, and in 1975 the Eastern and Central Divisions of the Association of Electronic Manufacturers were merged with the Distributor Products Division of EIA. The EIA is thus a national trade association representing the interests of the full spectrum of manufacturers of electronic products.

The engineering and technical activities of the association are conducted through its Engineering Department. Over 4,000 industry and Government representatives participate in approximately 225 of the Department's committees engaged in the development of EIA Standards and Engineering Bulletins. These committees also prepare industrywide technical positions and recommendations on proposed congressional legislation, Government regulations and standards dealing with electronic equipment. The Engineering Department also manages the public review and comment resolution phase of the EIA standards development process. The EIA relates to other standards-making bodies through the technical committees of its Engineering Department; by means of various technical advisory groups, the Engineering Department is responsible for directing the Association's international standardization activities which interface through ANSI with the CCITT, IEC, and ISO.

In the area of data communication standards, the EIA Engineering Department has established two technical standards committees: TR29 on facsimile and TR30 on data transmission systems and equipment. TR30 in turn operates two subcommittees, TR30.1 and TR30.2, dealing respectively with standards for signal quality and interfaces. To ensure close coordination with corresponding ANSI standards development efforts and interests, EIA TR30 and ANSI X3S3 hold joint meetings on a regular basis. In addition, several individuals participate in both EIA and ANSI subcommittees.

The International Organization for Standardization (ISO)

During the early 1920's, partly as a result of the national inconsistencies recognized during World War I, the professional engineering societies in various industrialized countries became increasingly concerned with the need for establishing some form of international cooperation in the area of engineering standards. In 1926, representatives of the national standards bodies of about 20 of the principal industrialized countries convened in New York and established the International Federation of the National Standardizing Associations (ISA). Over the next 20 years, this organization evolved to become the present International Organization for Standardization (ISO). It is perhaps important to note that electrical engineers played a leadership role in these activities, probably as a result of experiences gained in their earlier international successes in establishing the ITU and IEC.

Initial emphasis by the ISA focused on mechanical and electrical engineering standards; however, by the early 1930's standards for a number of other subjects such as paper sizes, cinematography, and textiles were also being addressed.

As the threat of war increased during the late 1930's, a number of countries stopped participating and by 1942 ISA ceased to exist. A successor organization reflecting the interests of the national standards organizations of 18 allied countries was formed in 1944 and functioned briefly as the United Nations Standards Coordinating Committee. When the war had ended, this committee was instrumental in convening a meeting in London during October 1946 of some 64 delegates representing 25 countries to consider the reformation of the ISA. This group established itself as the provisional General Assembly of the International Organization for Standardization and drafted the ISO Constitution and Rules of Procedure. The first official ISO General Assembly met in Paris in 1949; subsequent meetings have been convened every three years, with the last being held in Geneva in 1976.

ISO is financed by dues and contributions from its members. Additional revenue is gained from the sale of International Standards and other publications. Like its predecessor organization ISA, the ISO voting membership at the technical committee level consists of Member Bodies representing the national standardization organizations in their respective countries. These are referred to as participating or "P" members. Only one such organization in each participating country may be admitted to ISO membership. The American National Standards Institute is the U.S. Member Body. Besides the U.S., there are some 20 other participating countries with "P" member status. About an equal number of other countries do not participate on a regular basis but attend ISO meetings as observers; these are designated as "O" members. In addition, there are a number of other organizations, such as the CCITT, the World Meteorological Organization (WMO), and the International Civil Aviation Organization (ICAO), that participate with ISO as liaison members.

Standards development effort in ISO is organized by subject matter and performed under technical committees, subcommittees, and working groups in much the same way as related American national standards work is organized and performed by the ANSI standards committees, technical committees, and task groups; in fact, there is generally a one-for-one correspondence between the ISO technical committee structure and the committees operated by each of the various national standards organizations that constitute the ISO membership. Thus, ISO Technical Committee 97 corresponds to ANSI Sectional Committee X3 on computers and information processing. There are 16 subcommittees under TC97 and SC6 is the one responsible for data communication standards. With one exception, the work performed by Subcommittee 6 of TC97 corresponds identically with that of ANSI Technical Committee X3S3 on data transmission standards; the exception is that a new ISO subcommittee (TC97/SC16) has recently been established to address the development of standards for open system interconnection--a subject in which ANSI X3S3 has at least strong interests but perhaps only partial responsibilities since this area also has significant software implications.

Through ANSI, the U.S. holds the secretariat functions and provides administrative support for operating TC97, SC5 (Programming Languages), SC6 (Data Communications), SC11 (Flexible Magnetic Media for Digital Data Interchange), SC12 (Instrumentation Magnetic Tape), SC14 (Data Elements), and SC16 (Open System Interconnection).

The National Communications System (NCS)

President Kennedy issued a memorandum in 1963 directing the establishment of a National Communications System that would draw on the assets established by the major telecommunications users within the Executive Branch to provide better communications support for the critical functions of Government. The intent of this action was to accomplish the blending of existing, independently procured and operated assets so that they could function as a single integrated system, in contrast to building a separate new telecommunications system. Accordingly, the National Communications System was defined as--"that telecommunication system which results from joining together, technically and operationally, the separate telecommunications systems of the several Executive Departments and Agencies which have significant capability for providing telecommunications." When it was established in 1963, the telecommunication assets of the Department of Defense, Department of State, the Federal Aviation Administration, the General Services Administration, and the National Aeronautics and Space Administration were considered major components of the NCS. Other components of the system included certain assets of the Department of Interior, Department of Commerce, Atomic Energy Commission, Federal Communications Commission, and the U.S. Information Agency. Although several of these agencies have been restructured in the intervening years since 1963, and in one case (the AEC) totally reorganized, this initial distribution of NCS assets has remained essentially the same.

Because of the nature of its mission, policy direction for development and operation of the NCS was initially assigned to the Director of Telecommunications Management in the Office of Emergency Preparedness. However, these functions were taken over by the Office of Telecommunications Policy when that office was established in 1970.

The Secretary of Defense is designated as the Executive Agent of the NCS with direct responsibilities for ensuring that unified operations and technical planning among the NCS constituent agencies are conducted in accordance with the national needs. The objective is to ensure the evolution of a cost-effective National Communications System capable of providing necessary communications for the Federal Government under all conditions ranging from a normal situation to national and international crises, including nuclear attack. The Secretary of Defense has in turn designated the Director of the Defense Communications Agency to serve as the Manager of the NCS, with responsibilities for performing these functions as well as overseeing the day-to-day operations of the NCS. The Office of the Manager is located in the same facility as the Headquarters of the Defense Communications Agency and the NCS staff assigned to this office receive both technical and administrative support from the DCA, although they are organizationally separate.

Since the NCS was organized in 1963, one of the major problems recognized as requiring resolution was that of establishing standards sufficient to ensure that the telecommunication facilities and assets independently procured and operated by the various NCS constituent agencies could interoperate to function as a coherent single system. The Federal Telecommunication Standards program was established as directed by the Office of Telecommunications Policy in 1972 to address this problem. Under this program NCS was given the responsibility, by the General Services Administrator, for the development of Federal Telecommunication Standards for NCS interoperability and for the computer-communications interface. Further, by agreement with NBS, mutual repsonsibilities were identified for the joint development and issuance of standards related to data transmission and teleprocessing. The Federal Telecommunications Standards Committee (FTSC), composed of representatives of the NCS constituent agencies and NBS, was established to advise the Manager of the NCS with regard to this program and to perform in accordance with the following objectives:

(1) To develop, coordinate, and promulgate the technical and procedural standards required to achieve operational compatibility among functionally similar networks of the National Communications System;
(2) In concert with the NBS, to develop and coordinate technical and procedural standards for data transmission and the computer-telecommunication interface; and
(3) To increase cohesiveness and effectiveness of the Federal telecommunication community's influence on national/international standards program and on the FIPS Program.

There are presently 10 Federal Standards adopted and approved for telecommunication application within the NCS; five of these have been jointly processed by NBS as FIPS.

ORGANIZATIONAL INTERACTIONS

Some of the operating procedures and means for interaction among the organizations developing computer and data communications standards have already been mentioned in describing these organizations. Such formal arrangements among groups and committees working in similar technical areas are essential to avoid duplication of effort and ensure that consistency is maintained in related standards produced by the different groups. The sections that follow briefly describe the more significant formal interactive procedures that have been established. Figure 1 provides a schematic representation of some of these organizational and procedural arrangements.

In addition to these formal procedures, there are several effective, informal arrangements that have evolved largely as a result of the cooperative spirit that pervades the voluntary standards development community. For example, since the labor available for developing ANSI and ISO standards is all volunteered (i.e., contributed by individuals and their employers who are interested in seeing standards produced), there is a general willingness to share and exchange pertinent information among individuals as well as among committees and task groups. Such informal arrangements are usually fostered by ANSI technical committee and task group chairmen who see to it that papers produced within their respective areas are distributed to other chairmen and to other committees and individuals expressing interest. It is not unusual for people to actively participate on several committees or for an individual serving as a regular participant in one ANSI group to be on the mailing lists of several others. Occasionally, group chairmen, recognizing areas of mutual interest or concern, will convene a joint meeting to explore these common areas with their collective memberships.

EIA TR30--ANSI X3S3

The two technical committees, EIA TR30 and ANSI X3S3, are responsible to their respective organizations for the development of data communication standards. By formal arrangement, these committees hold their regularly scheduled meetings jointly with the host and meeting location being alternately provided by the EIA Engineering Department and CBEMA (the sponsor and secretariat for X3).

Traditionally, reflecting the interests of their respective constituencies, EIA TR30 and its subcommittees have tended to focus on standards having impact on the hardware and engineering aspects of communications and terminal equipment design (e.g., signal quality and interfaces) while ANSI X3S3 and its task groups have addressed standards having software (procedural), computer systems or networking implications. As a consequence, there is little possiblity of duplicate effort since the issues addressed by the two organizations are generally complementary to each other. The joint meetings, however, provide the respective memberships with a perspective of the current status of all work underway in both organizations. Further, as a matter of practice, standards in this area that are approved by EIA for industry use are automatically considered for ANSI processing and adoption--first by X3S3 and then by X3; the joint meetings facilitate this procedure by alerting the X3S3 membership to the issues and problems being resolved by TR30 during the development phase.

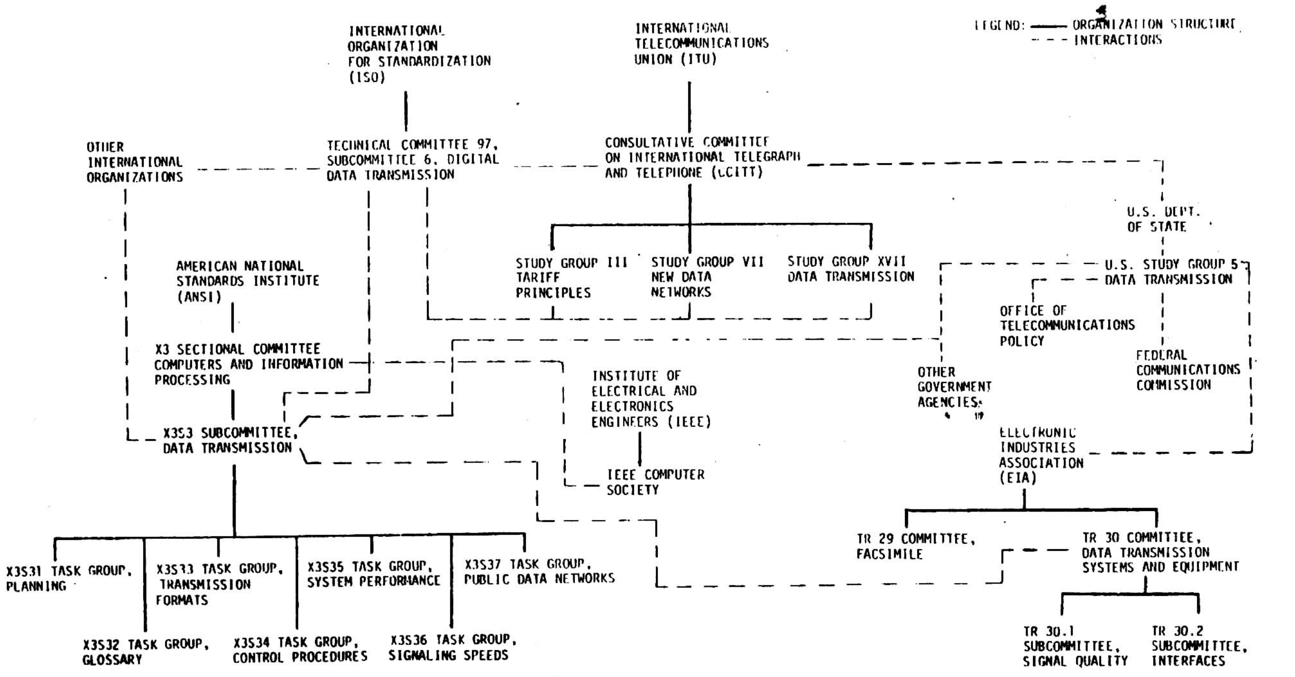

Figure 1: Organizations Concerned with Data Communications Standardization

ANSI X3S3--ISO/TC97/SC6

As previously mentioned, ANSI is the member body through which U.S. positions and interests are represented in ISO. As a consequence, there are formal working relationships established generally along subject matter lines between the various ISO technical committees and subcommittees and their respective ANSI counterpart committees. For the subject of data communication standards, the pertinent interacting committees are ANSI X3S3 and ISO/TC97/SC6.

The SC6 secretariat, which in this case is also provided by ANSI, is responsible for managing the distribution of technical documents and correspondence between SC6 and all of the SC6 member bodies and liaison organizations. Technical documents distributed by the secretariat may include draft national standards or other working papers submitted by various member bodies for international consideration; member body comments, reflecting national positions, on proposed ISO standards or other issues subjected to SC6 ballot; papers resulting from SC6 plenary or working group meetings. Correspondence handled by the secretariat include announcements of meeting arrangements, preparation and distribution of minutes of SC6 meetings and its working groups, and various other administrative announcements. In all of these functions, the SC6 secretariat (as well as the secretariats of all other ISO committees) plays a vital role in the general conduct of the subcommittee's business maintaining an orderly operation and managing the collection and dissemination of information among the participants.

A second part of the formal relationship between ANSI X3S3 and ISO/TC97/SC6 involves the X3S3 responsibility for designating the delegations to participate and represent the U.S. interests at SC6 plenary and working group meetings. In addition to determining the composition of the delegation, a chief delegate is appointed as well as principal spokesmen for various agenda items. As a part of this process, X3S3 also develops "instructions for the delegation" by reviewing the issues to be considered by ISO; thus by X3S3 consensus, the U.S. position to be represented with respect to each issue is identified.

This same kind of delegate identification and delegation instruction process takes place under general direction of the U.S. Department of State in preparation for CCITT study group meetings. Preparations for CCITT SG VII and SG XVII meetings are conducted by U.S. Study Group 5.

ISO/TC97/SC6--CCITT SG VII and SG XVII

In recognition of the fact that ISO and CCITT have overlapping areas of interest and potential for unnecessary duplication of effort, these organizations have established a written agreement which attempts to identify areas of mutual and exclusive responsibility. This agreement, known as CCITT Recommendation A.20, was initially drafted by CCITT and approved by both ISO and CCITT in 1964; it has since been amended and reaffirmed in 1968 and 1972 as additional areas of mutual concern have been identified. Although the provisions of Recommendation A.20 are written in the form of a general agreement between the two parent organizations, the specific items that are described by it have impact only on the relationships between the respective work programs of ISO/TC97/SC6 and CCITT Study Groups VII and XVII.

In many cases, this written agreement has served as a basis for justifying the use of each other's existing standards as well as the means for determining which organization should undertake responsibility for new standards projects. For example, in the area of alphabets (or character sets and encoding conventions), an item identified by A.20 to be of mutual concern, CCITT adopted as Recommendation V.3 entitled "International Alphabet No. 5" the existing ISO standard ISO/646 entitled "Seven-Bit Coded Character Set for Information Processing Interchange." Similarly, in the area of error detection, an item identified by A.20 to be of primary interest to CCITT, ISO incorporated the CCITT polynomial for code independent error control (Recommendation V.41) into IS 3309, entitled "Frame Structure for High Level Data Link Control" instead of initiating development of a different error detection method.

Besides the formal agreement spelled out by Recommendation A.20, many of the CCITT SG VII and SG XVII members participate in meetings of ISO/TC-97/SC6 as representatives of an officially recognized liaison organization and vice versa. Other individuals participate in both organizations, serving as members of their respective national delegations in ISO meetings and as employees of their national common carrier organization in CCITT activities. In addition, most of the other informal arrangements previously described are employed in the interactions between ISO and CCITT. Unfortunately, in spite of these extensive agreements and arrangements, technical issues addressed by these organizations are not always treated with mutual understanding or consistently resolved to the satifaction of both ISO and CCITT.

While there are examples that could be cited indicating the frustrations and difficulties involved with interactions between organizations with different objectives, schedules and priorities, these cases and a large number of others could also serve to illustrate the interests and motivations of participants in these organizations to produce technically sound, mutually consistent results.

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DATA NETWORK PROTOCOL STANDARDS

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Abstract

The ANSI architecture for communication systems made up of independent control levels is described, and advantages of the structuring are outlined. The ANSI standards on formats of transmitted ASCII characters and ASCII communication headings are reviewed. Present work of ANSI on standardizing code-independent communication headings is described and a comparison of code-independent and character-oriented headings is presented. A family of three proposed ANSI communication heading standards is outlined, along with details of the format encoding. A report is made of the communication heading and architecture standards efforts in ISO, and the relationship of the communication heading control level to other control levels.

Before meaningful discussion of data network protocol standards can begin, it is first necessary to provide a description of the relationship between the network protocols and the other communication and non-communication protocols that are involved in transferring and interpreting information from the origination device, called a terminal node, to the destination device (terminal node). It should be noted that the term "terminal node" as used here may be as simple as an operator-oriented terminal, such as an inquiry-response display, or as complicated as a host computer. As used in this paper, a terminal node is any data communication device that originates or receives data over communication facilities, since, no matter how simple or complicated a terminal node is, there are certain basic communication functions performed.

The terminal node (including the operator or program) is considered by ANSI Sub Committee X3S3, Data Communications, to be composed of five major control layers as shown in Figure 1.

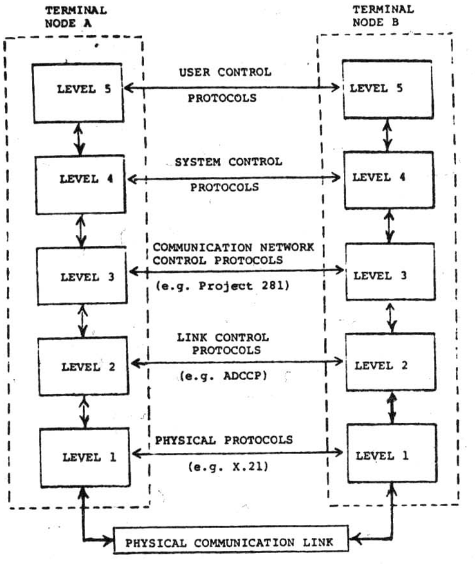

Figure 1

The reasons for dividing the DTE control functions into five separate control levels are:

- the relationship of the various control functions can be better understood when they are subdivided into logical groupings.

- each control level can be designed functionally independent of the other levels, thereby allowing: 1) assignment of each level to the appropriate standards committee, 2) permitting any given control level to be modified or upgraded without affecting other control levels, and 3) the functional independence of each level provides data and control transparency to the upper control levels. The following is a short description of the control levels in Figure 1:

Level 1 is the physical interface between the node and the communication link. At this level, the physical, electrical and signal interchange is defined to establish, maintain, and disconnect the physical link between a terminal node and a network node or between two terminal nodes. An example of Level 1 standards is EIA RS232C.

Level 2 is the data link control level which contains the control functions needed to reliably transfer data across a single communication link. These functions include link address, block or frame sequence numbering, retransmission procedures, etc. Examples of Level 2 standards are BSR X3.66, the bit-oriented Advanced Data Communication Control Procedures (ADCCP), and X3.28, the ASCII data link control procedure standard.

Level 3, communication network control, contains the control functions necessary to transfer data across more than one data link, i.e., across a network. Functions at this level include data assurance/integrity and flow control from origination node to destination node. Examples of Level 3 standards are the CCITT X.25 Level 3 packet formats, and the ANSI X3 Project 281, Code-Independent Message Heading Formats, which will be discussed in detail later.

Level 4, system control, includes the control functions necessary to identify the characteristics of the information being transferred, for example the data code in the information field, the format and controls for presentation of the information field on an output device (e.g., number of print characters per line, tabulation settings, etc.), and whether the data is encrypted and/or compacted.

Level 5, user control, contains the formats and end-to-end control functions associated with transferring data between the end users, i.e., the operator or the user application programs.

The standards as developed under this architecture are intended to define interfaces between equivalent control levels in different nodes. These interface standards prescribe the procedures, attributes, etc., necessary to perform the control functions at that control level (for example, the ADCCP BSRX3.66 standard at Level 2). The standards do not specify the boundary between adjacent control levels within a single node since such definition could severely impact the method of implementing the control levels. Thus, by leaving the adjacent control level boundaries unspecified, the control levels may be implemented together on a single logic board within a small node, as separate control programs within a larger node, or even as separate stand-alone boxes.

Control Levels 1, 2 and 3 comprise the data communications portion of the architecture. The standardization effort within ANSI X3S3 is intended to provide control procedures at these three levels that are code-independent and, therefore, transparent to the higher level procedures. Thus, the standards provide a path over which the higher levels may move any kind of data without fear of interaction with the data communications procedures. This has not previously been possible. For example, the ANSI X.28 and X3.57 procedures were based on ASCII control characters such as Start of Heading (SOH), Start of Text (STX), End of Text Block (ETB), and End of Text (ETX), to indicate the beginning and end of a transmitted block, the message heading, and the data, as well as to return acknowledgements for correctly received data. From this, it is clear that the user was not free to compose his data using any and all of the ASCII characters unless he was sure the link over which the information would travel had the optional capability of being transparent. In contrast, the bit-oriented X3.66 ADCCP is not dependent on any code and, therefore, has inherent transparency to permit users to send any bit combinations including facsimile, encrypted data, compacted data, or alternately two or three codes.

Task Group X3S33 History

Task Group X3S33, Data Communication Formats, known as Task Group 3 (TG3), was formed in January 1962 and charged with the task of defining the formats for bits within characters and of characters within a hierarchy of groups, to define functional control requirements and procedures for data systems other than required for control of a data link, and recommend standards where appropriate. With this charter, TG3 has developed three bits-within-characters standards, one character-oriented communication heading standard, and is presently working on a bit-oriented communication heading standard. The standards completed are:

- X3.15-1973, Bit Sequencing of ASCII in Serial-by-Bit Data Transmission; specifies transmission of low order bit first, with parity bit last for serial-by-bit transmission of ASCII.

- X3.16-1973, Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the ASCII; specifies that where a parity bit is sent in serial-by-bit ASCII transmission, the sense of character parity shall be odd for synchronous data communication and even for asynchronous data communication.

- X3.25-1974, Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in the ASCII; specifies the ASCII bit-to-channel relationship, odd character parity where character timing is not separately signalled, and even character parity where character timing is sent by means of a separate timing channel.

- X3.57-1977, Structure for Formatting Message Headings for Information Interchange Using the ASCII for Data Communication System Control; specifies the ASCII characters used to delimit message headings and heading items for basic messages (non-transparent) and for transparent messages, defines the method of indicating the presence or absence of each heading item, defines twelve heading items, and specifies the sequence of these items in the heading. The format of these headings is shown below:

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S            S          E           E
O  HEADING   T   TEXT   T    or     T
H            X          B           X
```

Non-Transparent Format

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DS           DS         DE          DE
LO HEADING   LT  TEXT   LT   or     LT
EH           EX         EB          EX
```

Transparent Format

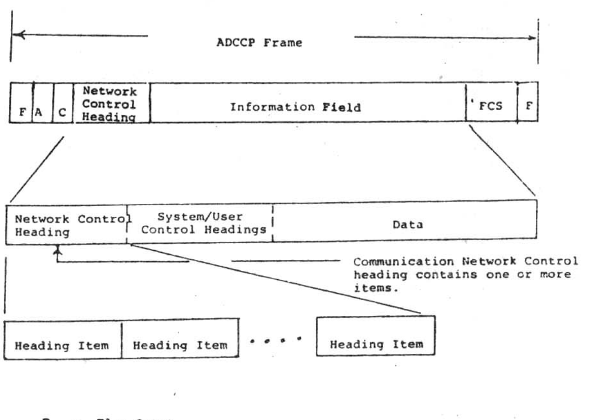
The method of indicating the presence or absence of the heading item (field) was the use of indicator bits in the first two Heading Item Indicator (HII) characters of the heading. An indicator bit was assigned to each of the twelve heading items (fields). The high-order bit of the HII characters is set to one so they will never have the bit combination of an ASCII control character.

At the time the X3.57 ASCII Message Heading standard was developed, the concept of structuring an architecture of independent control levels was not well understood; consequently, there was no attempt made to obtain independence between the communication heading standard and the other control levels. As a result, there is a dependency between the communication heading standard and the data link level procedures, since the ASCII character STX (Start of Text) is used to both end the heading and begin the text portion of a transmission. There is also a form of interdependency with control Levels 4 and 5 since the individual items in the heading are delimited by the ASCII Unit Separator (US), Record Separator (RS), Group Separator (GS), and File Separator (FS) characters.

Present TG3 Work

The present TG3 work is centered on X3 Project 281, Code-Independent Message Heading Formats. In addition to developing code-independent message heading formats and protocols, Project 281 also charges TG3 with investigating data communication network control in both single-system and multi-system networks and identifying interfaces that are appropriate subjects for standardization. TG3 is, therefore, spending considerable time attempting to understand the various control functions that are needed at Level 3, the interaction between elements and control functions of a network, and how Level 3 boundaries can be kept functionally independent of other control levels. Additionally, care is being taken to minimize implementation dependencies, i.e., avoid statements that limit the types of hardware, forms of program support, location of logic, etc.

The relationship of the communication network heading to an ADCCP frame is shown in Figure 2. As with the X3.57 heading standard, the communication heading immediately follows the data link level "heading" so the receiving Level 3 logic looks for the heading immediately behind the ADCCP C (Control) octet. Since the information field in the ADCCP frame may be any combination of bits, there is no requirement that the Project 281 heading be restricted to any "code," either.



F - Flag Octet
A - Address Octet
C - Control Octet
FCS - Frame Check Sequence (2 octets)

Figure 2

The first efforts of TG3 to develop a heading standard were centered around attempts to translate the X3.57 ASCII heading into a non-code or bit-oriented form. In order to get the equivalent of the X3.57 HII characters, a series of "indicator bits," called the Heading Item Identifier (HID), had to be defined which individually indicated the presence or absence of each possible item in the heading. Sticking with the indicator bit caused some problems, however, since the method has to be expandable to indicate heading items that might be defined in the future. From this, it was clear that the HID could not be a fixed length item and would, therefore, require a length indicator so that the beginning of the other heading items behind the HID could be located. Each heading item required an end of item indication, so a choice had to be made between using a predefined character-like delimiter at the end of each item, or a length (number of bits) indicator for each item. For technical reasons, a length of time indicator was chosen. Then the matter of sequence of items in the heading was attacked and some differences of opinion occurred over which items should be first, i.e., more important and more often used. The result of this debate was the eventual concensus within the Task Group that the heading format problem had not been solved adequately to meet the original criteria, which as maximum flexibility with regard to heading item attributes such as use of the minimum number of bits, flexibility of encoding, length and sequence position in the heading, and ease of interpreting the heading at Level 3 in the receiver.

The Task Group reassessed its work, and came to the conclusion that the heading standard problem was too large and complicated to be handled as a single piece. It was decided to develop a family of three standards which would compliment each other and, taken together, would provide standardization of the communication network control functions. The three standards are: 1) basic formatting of the heading and items; 2) definition and encoding of each item plus basic protocols for control interchange at Level 3; and 3) grouping of the protocols into a hierarchy of classes to provide various capabilities of Level 3 control. To insure consistent numbering of the drafts of the standards, it was decided to use the standard project number, plus an alphabetic character (to indicate one of the three standards), plus a numeric (to indicate the draft level):

- 281F Heading FORMATS
- 281P Heading PROTOCOLS
- 281C Heading Protocol CLASSES

A description of each standard follows.

281F - HEADING FORMAT STRUCTURE FOR CODE INDEPENDENT NETWORK CONTROL

The 281F, Heading Format Structure, standard has the following scope:

This standard specifies the structure for bit-oriented links that employ bit-oriented ADCCP data link control procedures. It prescribes the structure of the formats for communications network control headings transmitted in the ADCCP information field.

This standard applies to general information interchange at the interface between networks, and at the interchange interface between an external data terminal and a network. In addition, it provides a general communication heading capability for optional use within a network, at the interface between data terminals interconnected on a link, and the interface between a data terminal and its network.

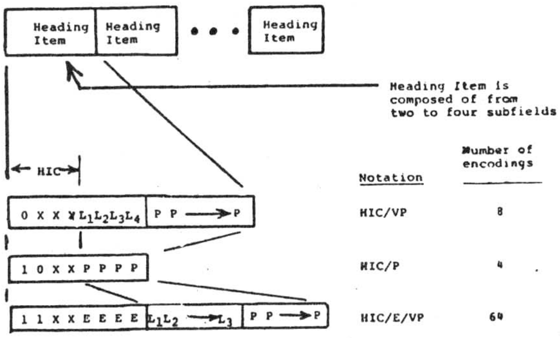
This standard may also be used for general information interchange with any data link control procedure that provides data transparency.

The Task Group desired to modify the bit-indicator (HID) method of describing a heading and considered several new proposals for the heading format, including a heading format containing fixed length items and a hybrid format heading where some items were fixed length and some variable. All these proposals lacked the desired flexibility. Finally, after long debate, the Task Group agreed upon a heading format where each item is basically composed of prefix identifier called a Heading Item Code (HIC) and a parameter sub-field.

Each item, and therefore the total heading, is an integral number of octets in length so as to maintain consistency with ADCCP, which uses octet fields.

A heading item is defined to be in one of three formats, depending upon the length of its contents. The formats are shown in Figure 3. Each heading item consists of from two to four subitems:

1. The Heading Item Code (HIC) - The HIC is an identifier which uniquely specifies a particular heading item. Every heading item has a HIC as the first subitem.



HIC - Heading Item Code
L - Length (in octets) of Parameter
P - Parameter
E - Extender to HIC coding
VP - Variable Parameter (variable in length)
X - HIC bit that may be encoded 0 or 1 depending upon the Item that the HIC encoding identifies.

The length of all formats will be a multiple of octets.

Figure 3

2. The Parameter (P or VP) - The parameter may be either fixed length (P) or variable length (VP) and contains information required by the receiver to properly process the control function contained in the heading item. All heading items have an associated parameter.

3. The Length (L) - The length is an optional subitem. When present, the length is a binary number which specifies the number of octets in the parameter subfield of a variable length item.

4. The Extender (E) - The extender is an optional subitem. When present, the extender is a four-bit subitem which extends the encoding of the HIC to specify additional functions.

There are three types of heading items: those consisting of a HIC and a fixed-length parameter (HIC/P), those consisting of a HIC, a length, and a variable length parameter (HIC/VP), and those consisting of a HIC, an extender, a length, and a variable length parameter (HIC/E/VP). Assignment of the first two bits of the HIC provides for the identification of the three heading item types.

HIC/VP: 0XXX LLLL P----P - This format, identified by a high-order zero bit, provides eight HICs which are associated with a variable length parameter. The four-bit length subitem is a binary number which specifies the number of octets in the parameter.

HIC/P: 10XX PPPP - This format, identified by 10 in the two high-order bits, provides four HICs which are associated with a four-bit fixed length parameter.

HIC/E/VP: 11XXEEEE LLLLLLLL P----P - This format, identified by 11 in the two high-order bits, provides four HICs each having a four-bit extender subitem and a variable length parameter. The extender subitem permits assignment of sixteen functions to each HIC. In this format the length subitem is an eight-bit binary number which specifies the number of octets in the associated parameter.

The format described above has the following advantages:

-items are individually identified by their own HIC, therefore, there is no interdependence between items in the heading, as there was previously between a bit in the HID and its associated item

-items may be variable in length since two of the formats have a length parameter

-items may be arranged in any order in the heading since they are self identifying

-the heading need have little overhead since items may be included in the heading only as needed

-the heading format is expandable in that new items may be defined and included in a heading without destroying a preset heading length, field sequence, etc.

It should be noted that this heading control field encoding method is independent of the control functions performed at Level 3, and, therefore, could be used for the control functions performed at Levels 4 and 5.

281P PROTOCOL STANDARD

The 281P, Protocol, standard applies to the same interfaces as the 281F standard and has the following scope:

This standard specifies protocols and heading item encodings for bit-oriented communication network control headings. The protocols are designed for use on links that employ ADCCP bit-oriented data link control procedures.

Protocols and heading item encodings are prescribed for such communication network control functions as message routing, message accounting, and blocking