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X.25 PRIMER

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X.25 Primer

Table of Contents

Evolution of Packet Switching.....	1
Packet-Switched Data Network Example and Terms.....	2
Considerations for Using Packet-Switched Data Networks.....	3
The CCITT X.25 Recommendation.....	3
PAD Connection.....	4
Why is SNA Still Important?.....	4

Evolution of Packet Switching

Packet Switching, as it is known today, evolved from a concept first described by Paul Baran of the Rand Corporation in 1964. Paul Baran participated in a communications study for the U. S. Air Force with the objective of developing a totally survivable communications system. The published description of this study was used in the early development of packet-switched data networks.

One of the earliest and most publicized packet-switched data network was sponsored by the Advanced Research Projects Agency (ARPA) of the U. S. Department of Defense. It was known as ARPANET and became operational in 1969. ARPANET links together university and research laboratories around the United States to provide a time-sharing and distributed computing network.

During the 1970's, a number of countries announced plans to develop packet-switched data networks. In France the Public Telephone and Telegraph (PTT) announced plans for TRANSPAC; in Canada the Trans-Canada Telephone Systems announced plans for DATAPAC; and in Japan the Nippon Telegraph and Telephone Public Corporation announced plans for Digital Data Exchange-Packet (DDX-P). In addition, a number of other enterprises began the development of private packet-switched data networks; among these were TYMSHARE which eventually evolved into the public packet-switched data network offering known as TYMNET.

Another public packet-switched data network that emerged in the last half of the 1970's was TELENET. A great deal of knowledge obtained during the development of ARPANET was applied to TELENET.

As these networks evolved, the problem of equipment interface standards emerged. Equipment required to be attached to the packet-switched data networks was manufactured by many vendors and in many cases did not have the proper interface for attachment. This situation arose due to the lack of a communication architecture for the industry. To address problems such as these, a CCITT study group was formed, and during the period of 1973 to 1976 developed a packet-switched data network interface proposal which was approved in 1976 and became known as CCITT Recommendation X.25. CCITT is an abbreviation for the International Telegraph and Telephone Consultative Committee which is a study group chartered by the United Nations.

Early packet-switched data networks that implemented CCITT Recommendation X.25 did so with some variations, thus, inconsistencies arose. Further study and work was done to address these inconsistencies and in 1980, a revised CCITT Recommendation X.25 was approved. The public packet-switched data networks have agreed to implement this version by January 1982 to minimize the differences between the various networks, thus providing data terminal equipment manufacturers a standard interface for equipment development.

Packet Switched Data Network Example and Terms

A packet-switched data network (Figure 1) supporting the CCITT X.25 Recommendation consists of communication lines and interconnecting Data Circuit-Terminating Equipment (DCE) and includes programmable computers with an operating system capable of executing communication oriented programs. Users of packet-switched data networks connect their Data Terminal Equipment (DTE), e. g. terminals or host systems, to the DCE via a communications circuit. Users from many different organizations or companies may connect to the packet-switched data network. Data coming from the DTE's are placed in packets of sizes ranging in the order of 64, 128, 256, 512, and 1024 bytes depending on the particular packet network. Different packet networks implement different packet sizes but, 128 bytes is the common implementation. The data packets entering the DCE are routed over the internal packet network to a destination DCE. The communication processors in the network route the data to a destination DTE. How the data is routed through the packet network is a function of the network. Alternate paths may be available to bypass failing components or congestion points in the network. Error recovery for data flowing through the network is the responsibility of the packet network. Should the network be unable to recover, it has the responsibility to notify the DTE.

The communication facilities that interconnect the DCE's are usually high speed communication lines in the range of 56,000 bits per second. Packet-switched data networks allow a set of communication facilities to be shared by a large number of users. In some countries, the use of packet networks may be the only economical choice of data communication users because of the high cost of leased or dedicated communication facilities.

Users of public packet-switched data networks are usually charged an initial connection charge, an hourly rate based on connection time, and a charge for the number of packets sent into the network. This charge is normally based on the number of kilo packets; that is, each one thousand packets. The initial connection charge and connection time rate are normally based on the baud rate of the terminal. There are also additional charges for modems, ports, and communication lines.

Two types of logical connections can be made between two DTE's. These connections are permanent virtual circuit and virtual call.

A virtual circuit gives the users of a packet network the appearance of an actual end-to-end connection. A virtual call is temporary logical connection between two DTE's. It is initiated by one DTE signalling a call request (connection) to the network. The temporary connection is terminated by a clear command from the DTE. A permanent virtual circuit is analogous to a point-to-point leased connection. It appears to be a permanent connection between two DTE's and requires no call setup or clearing by the DTE.

Considerations for Using Packet-Switched Data Networks

If the volume of traffic and connection time becomes excessive, the cost of using the public packet network could exceed the cost of dedicated leased facilities from a common carrier. These factors should be evaluated before a public packet offering is chosen. Another factor to consider is response time (Figure 2). Data entering a packet network from a DTE may experience additional delay through the network before it reaches the destination DTE when compared to a traditional leased line network. Data must pass through packet network communication processors before it reaches its destination. Each communication processor introduces a delay. That delay time varies from network to network and must be provided by the packet-switched data network supplier.

The CCITT X.25 Recommendation

The CCITT X.25 Recommendation is the standardization of the interface between the users Data Terminal Equipment (DTE) and the public packet networks Data Circuit-Termination Equipment (DCE) for synchronous DTE's.

The CCITT Recommendation X.25 defines three levels of the DTE to DCE interface (Figure 3).

The first level is the Physical Level which describes the mechanical, electrical, functional, and procedural characteristics to activate, maintain, and deactivate the physical link between the DTE and the DCE and is referred to as X.21 or X.21 bis.

CCITT Recommendation X.21 defines the physical interface between the DTE and DCE as a fifteen pin connector. Of the 15 pins, a maximum of six interchange circuits are used to accomplish connection, data exchange and disconnection. CCITT Recommendation X.21 is a simplified interface when compared to RS-232C and RS-366 interfaces used today with data terminal equipment.

CCITT Recommendation X.21 bis defines the physical interface for DTE's that are to be connected to public packet networks using the V Series Recommendation modems, e.g. V.24 or RS-232C.

The second or Link Level describes the link access procedure for data interchange across the link between the DTE and DCE and is implemented using a procedure called Link Access Procedure (LAP) or Link Access Procedure Balanced (LAPB). LAPB is based on the HDLC standard as defined by the International Organization for Standardization (ISO).

The third or Packet Level describes the packet format and control procedures for the exchange of packets containing control information and user data between the DTE and DCE.

PAD Connection

There also exists a large number of terminals in customer premises that use the Start/Stop communication protocols. Users of these terminals will desire to occasionally attach to the packet-switched data networks. To permit attachment, CCITT has developed a set of recommendations for this type of attachment. For Start/Stop terminals, these recommendations are known as X.3, X.28, and X.29 (Figure 4).

X.3 defines a function within the DCE known as the Packet Assembler Disassembler (PAD). This is the function that assembles the data characters from the Start/Stop terminal into packets which then can be routed through the network.

X.28 defines the control sequence between the Start/Stop terminal and the PAD. Control sequences are the characters an operator enters to establish the connection and disconnection from the packet network.

X.29 defines the control sequence between the host computer and the PAD. PAD parameters are controlled by the host computer to allow proper communication from the terminal to the host computer.

Why is SNA Still Important?

CCITT Recommendation X.25 addresses the Data Terminal Equipment connection to a packet-switched data network, not communication between Data Terminal Equipment. Many users of data communications today believe that X.25 will allow their non-IBM terminal equipment or non-IBM host systems or whatever to communicate with their IBM host systems or vice versa, but this is not necessarily true.

CCITT Recommendation X.25 provides the implementors of communication networks with another form of connection along with the leased analog, digital, or switched analog, that may be at their disposal today. It's like picking up the phone and dialing internationally to France. The connection can be made but unless you speak French, no communication exists.

SNA can and does provide the higher level protocols necessary for a meaningful communication between two application programs or between an application program and a terminal.

IBM's X.25 interface capability (Figure 5) will allow a wide variety of IBM SNA products to communicate through either public or private data networks that have interfaces complying with CCITT Recommendation X.25 (Geneva, November 1980).

The X.25 NCP Packet Switching Interface Program Product provides an X.25 interface that operates in conjunction with the Advanced Communication Function/Network Control Program/Virtual Storage (ACF/NCP/VS). The X.25 Program Product permits communication through packet-switched data networks with SNA terminals,

processors and other IBM 3705-II or 3705-80 Communications Controllers. This Program Product also allows communication through packet-switched data networks to products that offer a native X.25 interface. PAD control for certain asynchronous terminal types is provided by the X.25 Program Product in accordance with CCITT Recommendation X.29. Control of PADs for other terminal types can be accomplished by a customer-provided application program. Another feature of the Program Product allows an application program to control certain X.25 interface functions.

X.25 attachment capability for selected SNA terminals and processors is also provided by the IBM 5973-L02 Network Interface Adapter (NIA), an RPQ stand-alone unit. One version of the Network Interface Adapter will attach an IBM 4331, 8100 System, System/34, or System/38 to a packet-switched data network. The other version will permit attachment of a broad range of SNA terminals and processors. Changes to the SNA products are completely avoided by incorporating all conversions between SDLC and X.25 communication protocols within the Network Interface Adapter.

Additional information concerning the IBM's use of the X.25 Interface may be obtained from the General Information Manual, "The X.25 Interface for Attachment of IBM SNA Nodes to Packet-Switched Data Networks", GA27-3345.

PUBLIC - SWITCHED DATA NETWORK

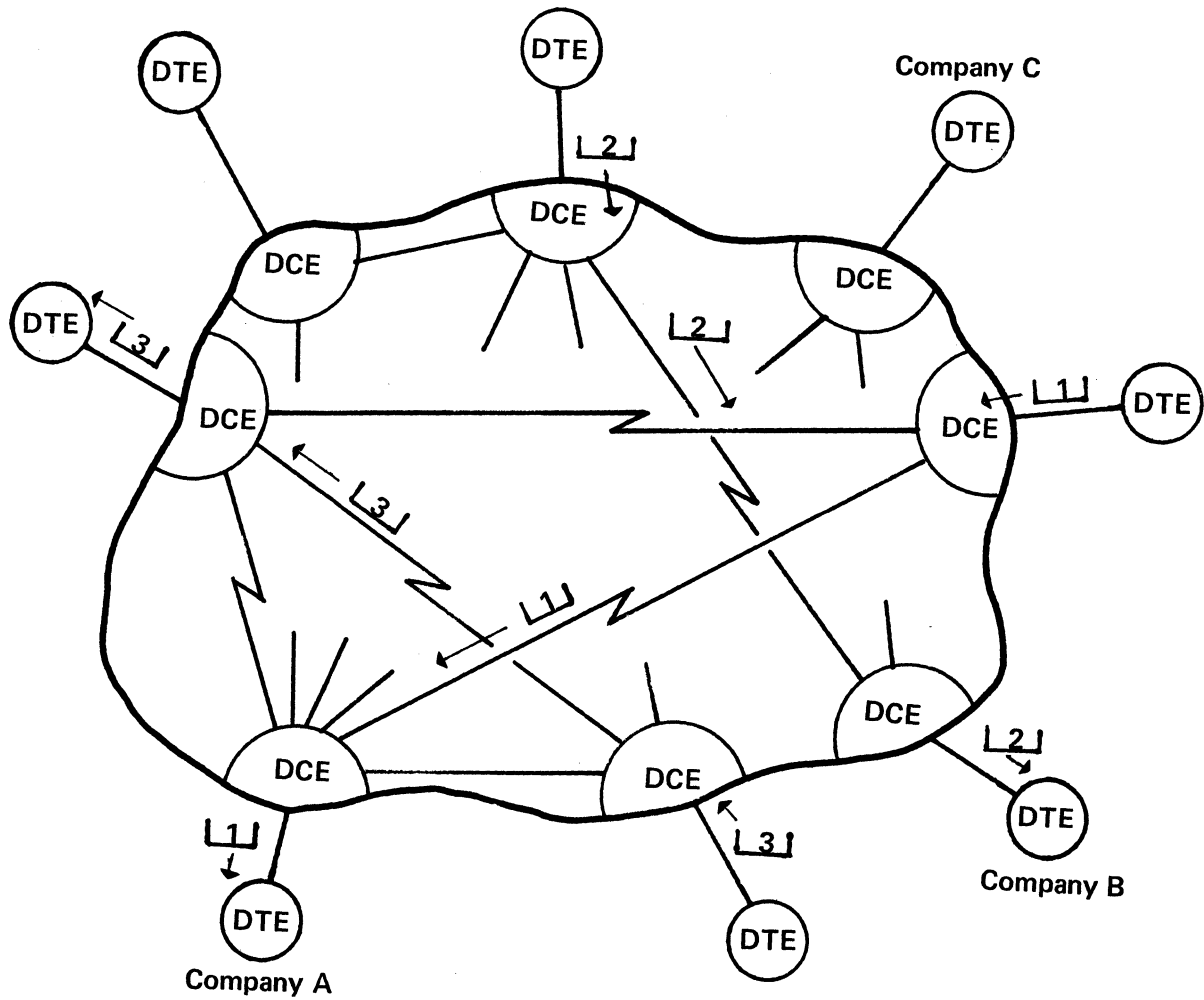
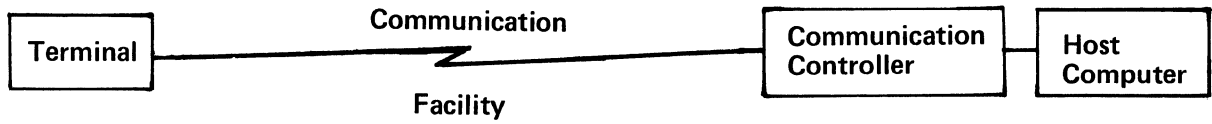


Figure 1

RESPONSE TIME CONSIDERATIONS

Traditional Leased Line Network



Public - Switched Data Network

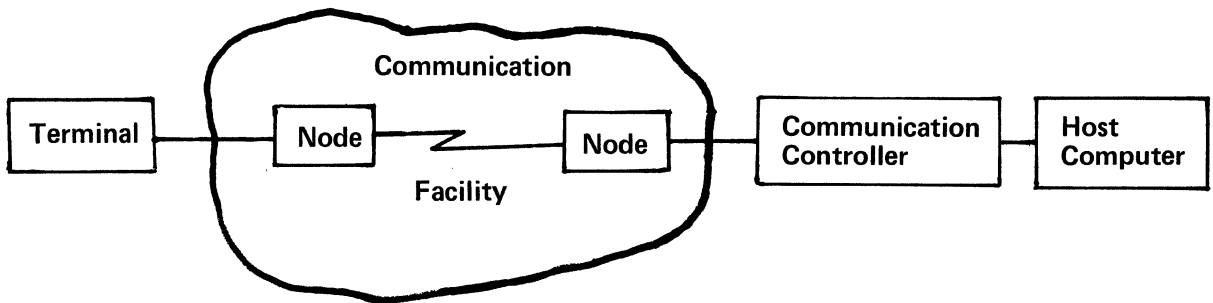


Figure 2

CCITT X.25 RECOMMENDATION

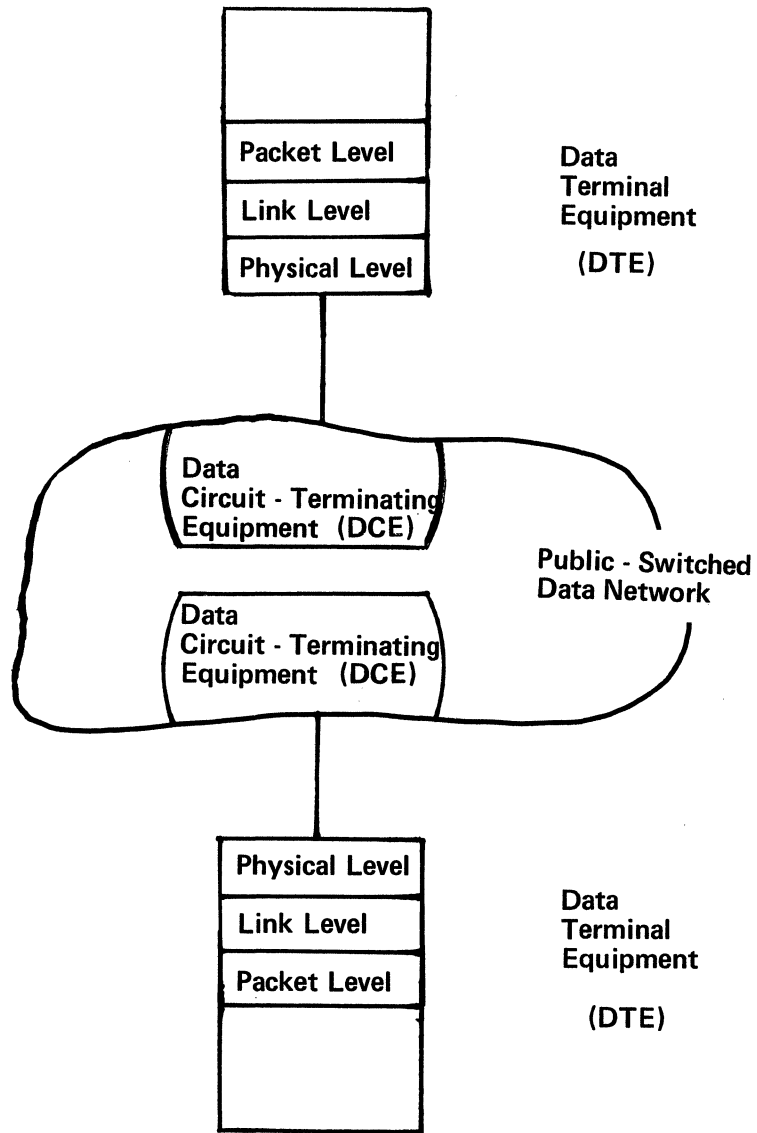


Figure 3

PACKET ASSEMBLER/DISASSEMBLER

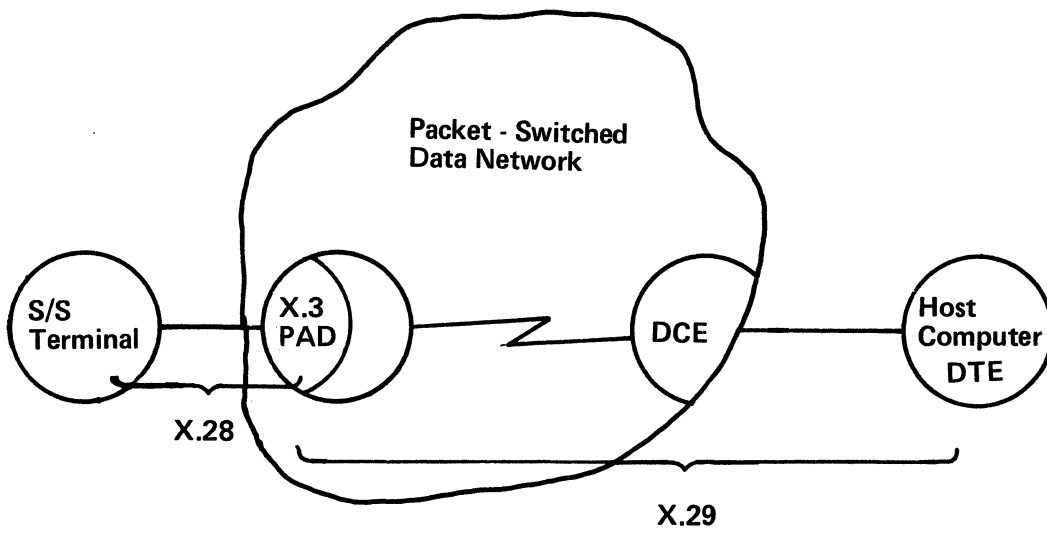


Figure 4

IBM X.25 PACKET SWITCHING SUPPORT

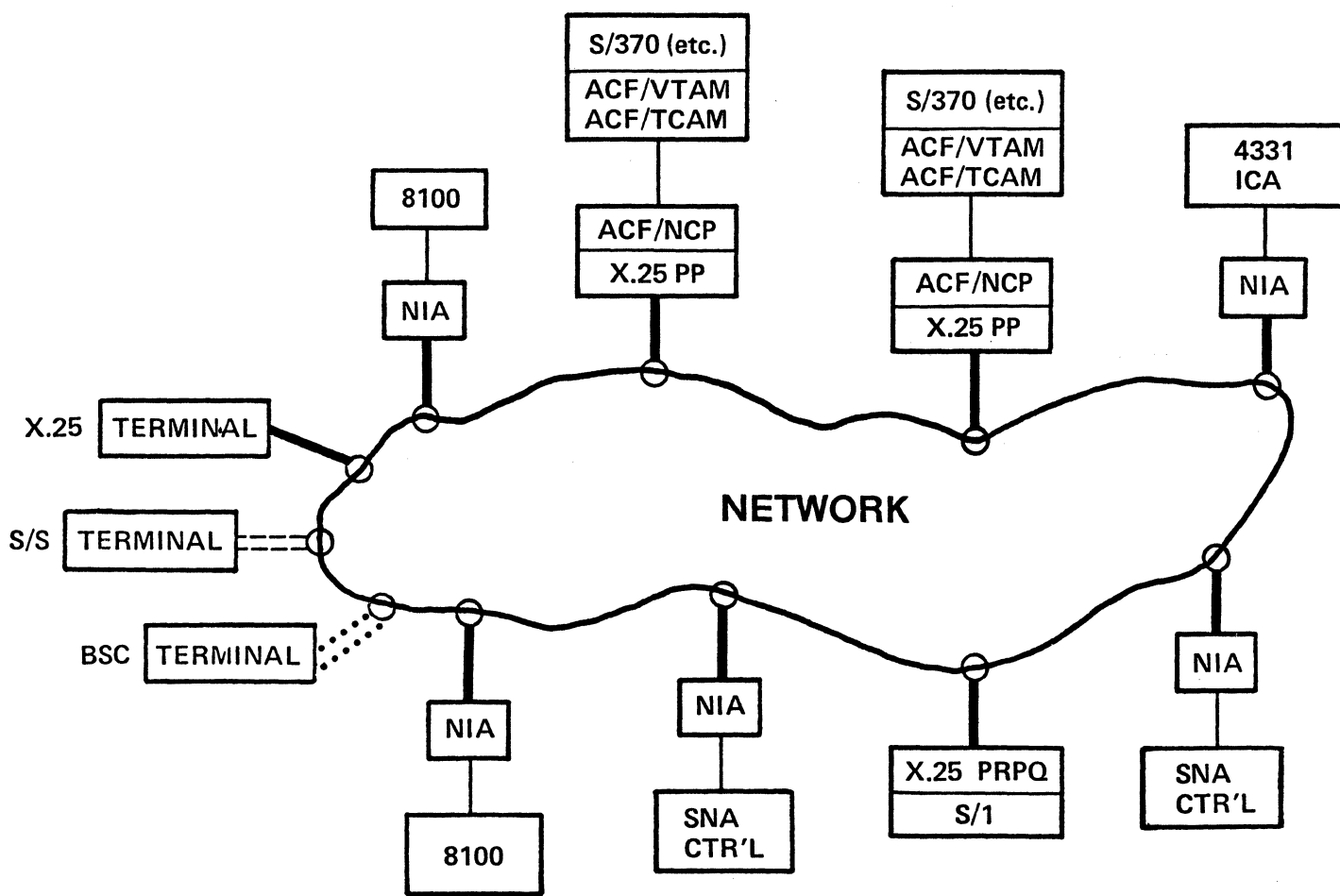


Figure 5

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