Ameritech

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Technical Interface Specifications for X.25 Service

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TECHNICAL REFERENCE NOTICE

Section (Technical Interface Specifications for X.25 Service over a Northern Telecom, Inc. (NTI) platform) of this Technical Reference is published by Ameritech to inform the industry of a view of the generic requirements describing Ameritech's Technical Interface Specifications for the Region's Public Packet Services.

Section 2 (Technical Interface Specifications for X.25 Service over a Bolt Bernack Newman (BBN) Platform) is a preliminary draft of our X.25 interface to our packet network. This specification is applicable to X.25 host DTE's and other vendor PADs accessing our network. The information covered herein is based upon BBN Interface Specification Report No. 5500 and BCR's LADT interface specification. The technical information is primarily based on BBN documentation and the discussions concerning addressing are based upon the BCR documentation. This document is not all inclusive and it will be updated as BBN releases the technical documentation related to the upgraded C30's.

As LADT addressing becomes finalized by BCR and the FCC we will be updating the addressing portion of this specification.

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1. Technical Interface Specifications for X.25 Service over a Northern Telecom, Inc. (NTI) Platform

1.1. Introduction

This Interface Technical Reference describes an X.25 interface between Data Terminal Equipment (DTE) and a public packet switched data transport capability currently being considered for implementation. The implementation of this interface is based on Northern Telecom SL-10 packet switching equipment and is subject to BOC business decisions and final tariff approval. For specific implementation details the user should consult with the particular Ameritech operating company from which service is provided.

The X.25 interface will be one of two user access protocols implemented on this network, the other is an interface to asynchronous DTEs. This document describes the operation of the X.25 interface when:

- it is making outgoing virtual calls to other X.25 DTEs or asynchronous DTEs,
- it is receiving incoming virtual calls to other X.25 DTEs or asynchronous DTEs,
- it is sending or receiving data over a permanent virtual circuit to another X.25 DTE or asynchronous DTE.

Note that in order to make or receive virtual calls from asynchronous DTE, the X.25 DTE must implement the X.29 procedures described in AM TR-NPL-000003. The X.29 capabilities will manifest themselves on this X.25 interface through the use of X.25 data packets with the Q bit set to 1.

The interfaces to this packet switched data transport capability is based on 1980 versions of CCITT Recommendations. When the 1984 versions of these standards become finalized, this network capability will evolve to remain compatible with these new standards.

Section 1.2 of this document provides an overview of this interface. Section 1.3 discusses the capabilities available from this interface, and Section 1.4 discusses the physical level, link level and packet level procedures supported by this interface.

1.1.1. Terminology

This section defines the relevant terms and their abbreviations used in this Technical Reference.

Data Terminal Equipment (DTE) - Customer equipment which connects to a communications channel as a data source and/or link. The DTE may be considered to begin at the communications interface unit on a host computer or terminal equipment.

Data Circuit-terminating Equipment (DCE) - BOC equipment which connects to the customers DTE and provides a communications channel.

Physical Level - The physical level provides the mechanical, electrical, functional and procedural characteristics to pass blocks of data through the physical level and to ensure that this data is received virtually error free. The blocks of data are referred to as frames at this level.

Packet Level - The packet level provides the functional and procedural characteristics to set up, maintain (i.e., control the transfer of data) and clear virtual calls and maintain permanent virtual circuits between DTEs. Both data and control information is transferred in transmission units called packets. Each packet is transferred across the interface within a single link level information frame and only one packet may be contained in an information frame.

Virtual Circuit - A virtual circuit is a logical connection across a packet switched network that emulates a point-to-point circuit by insuring data integrity, transparency and data sequence.

Virtual Call - A virtual call is a virtual circuit that is only set up for the duration of the call. A DTE initiates the call setup procedure when it wants to establish a virtual connection to another DTE, and initiates the call clearing procedure when it wants to disconnect this circuit.

Permanent Virtual circuit - A permanent virtual circuit is a virtual circuit which is established between two DTEs and remains indefinitely in the data transfer phase, no set up or clearing procedures are required to send data across this circuit.

Logical Channel (LC) - A logical channel is a packet level distinction which allows the DTE to derive multiple logical channels from a single physical access line. This is accomplished by specifying a logical channel number for every packet which crosses the DTE/DCE interface. Each virtual circuit utilizes one and only one logical channel of a physical access line.

1.1.2. Companion Documentation

This document relies on the use of other documents in conjunction with this one in order to describe the end-to-end service being offered. Those documents are as follows:

- 1980 CCITT Yellow Book Recommendations:
  - X.3
  - X.21

– X.25

– X.28

– X.29

1.2. X.25 Network Interface Overview

The X.25 network interface supports the physical link, and packet levels of CCITT Recommendation X.25 as set forth below. The physical level interface is provided as specified in Section 1.4.1 and is compatible with CCITT X.21 bis. The link level protocol is the bit oriented LAPB data link control procedures and is described further in Section 1.4.3. X.25 Virtual Call (VC) and Permanent Virtual Circuit (PVC) services are supported at the packet level. All essential (E) and most of the additional (A) facilities designated in CCITT Recommendation X.2 for Virtual Call and Permanent Virtual Circuit services are supported at the X.25 interface. The services provided at this network interface are discussed further in Section 1.3, and the packet level protocol that is implemented at this interface is discussed in Section 1.4.3.

1.3. X.25 Services

There are four aspects of the service that is available at the X.25 network interface. They are the data transfer modes (virtual call, permanent virtual circuit and direct call), the user settable service options that effect these modes, the addressing options for this interface, and the maintenance capabilities available to this interface.

1.3.1. Data Transfer Modes

There are three modes of data transfer available on a logical channel within an X.25 interface. Virtual call service allows the transfer of data on an as needed basis, a logical channel is set up when the call is initiated and torn down upon call completion. It also allows the reuse of idle logical channels to access other destinations on the network. Permanent virtual circuit service, in contrast, dedicates a logical channel to a particular destination, and leaves that virtual circuit set up even when there is no data to transfer on it. The third mode of data transfer, direct call service, is a hybrid of the two modes of data transfer. Like a virtual call, the channel is setup only when the call is initiated. But like a permanent virtual circuit, the amount of call setup required is minimal. These modes will be discussed further in the following sections.

1.3.1.1. Virtual Call Service

The X.25 Virtual Call service is supported. The X.25 DTE initiates a virtual call by sending a call request packet across the interface to the DCE. The contents of this and other packets will be discussed in Section 1.4.3. Among other things the call request packet contains the address

of the remote DTE the user is calling and the per-call service options being requested for this call. At the remote DTE/DCE interface the DCE signals this call attempt by transmitting an incoming call packet across the interface to the DTE. This packet contains among other things the address of the calling DTE and the per-call service options which are being requested for this call. The remote DTE accepts this call using a call accepted packet and the DCE at the local DTE/DCE interface signals this to the DTE using a call connected packet. The DTE/DCE interfaces are now in the data transfer state ready to transmit data using the per-call and subscription service options agreed to during the above negotiation process and during service provisioning, respectively. This procedure and the exact formats of these packets are as specified in Section 1.4.3 of this document and CCITT Recommendation X.25. In addition to call setup and clearing virtual call service provides the following capabilities:

1. Interface initialization
2. Multiplexing with other virtual calls and permanent virtual circuits
3. Sequenced data transfer
4. Out-of-band data transfer

Sequenced data transfer means that data packets are delivered to the user in the same sequence as they were transmitted and without duplication. Out-of-band data transfer refers to the ability to send a limited amount of data on the virtual circuit which will not be delayed by flow control mechanisms; this is provided in the X.25 interrupt procedures.

1.3.1.2. Permanent Virtual Circuit Service

The X.25 permanent Virtual Circuit service is supported. It provides the same capabilities as Virtual Call service except for the call setup and clearing procedures. Certain facility negotiation performed at call setup time for virtual calls are handled through service provisioning for permanent virtual circuits.

1.3.1.3. Direct Call

The X.25 Direct Call service is supported. It provides the same capabilities as Virtual Call service. This service differs from virtual call service in the way a customer sets up the call. With Direct Call Service a call request packet is defined at subscription time and this information is used when the customer does not specify values in per-call call request packets. The call is still initiated by a call request packet, but the user need not fill in the values for all the addresses, facilities, etc. With direct call service, a user may overwrite the subscription values defined simply by providing the requested information in the per-call call request packet.

1.3.2. User Settable Service Options

Through the use of X.25 optional user facilities the network interface can be tailored to the user's needs. Various call setup and data transfer parameters (i.e., window and packet sizes) can be set on a per-call or subscription basis allowing the optimal use of the interface for the given application. Service options can also be set so that the interface provides access to private subnetworks, if security is required. Finally service options can be set to allow use of three types of specialized virtual calls: Fast Select, Reverse Charging and Priority Calls. The actual protocol used to identify the request of these service options will be discussed in Section 1.4.

1.3.2.1. Subscribed Service Options

At service initialization (subscription) time, several user parameters must be set either by the customer or by using the network specified default values.

1.3.2.1.1. Logical Channels Ranges

The first case of user settable subscription items in the range of logical channels, and the segregation of these channels among the four types of logical channels defined in CCITT Recommendation X.25 Annex A. these four types are:

1. permanent virtual circuit logical channels
2. one-way incoming logical channels for virtual calls
3. two-way logical channels for virtual calls
4. one-way outgoing logical channels for virtual calls.

The value of (1) above must always be greater than or equal to the number of permanent virtual circuits the user has subscribed to. If the value of (2) is non-zero, it allows the user to restrict one or more logical channels for incoming virtual calls only. This facility ensures that one or more logical channels will be available for incoming virtual calls, regardless of the amount of outgoing calls at the DTE/DCE interface. Likewise, if the value of four is non-zero, it allows the user to restrict one or more logical channels for outgoing virtual calls only. If both two and four are zero and three is non-zero, then all virtual calls will be contending for the same logical channels and no resources will be dedicated to either direction of calling.

Using these logical channel parameter settings, two more facilities may be accessed, incoming calls barred and outgoing calls barred for virtual calls. If the number of two-way and one-way incoming logical channels for virtual calls is zero and the number of one-way outgoing logical channels is non-zero then the only virtual calls which will be accepted at the interface are out-

going virtual calls, and incoming calls will be barred for the entire interface. Likewise, if the number of two-way and one-way outgoing logical channels for virtual calls is zero and the number of one-way incoming logical channels is non-zero, then the only virtual calls which will be accepted at the interface are incoming virtual calls, and outgoing calls will be barred for the entire interface.

1.3.2.1.2. Default Packet Level Parameters

Three packet level parameters: throughput class, maximum packet size, and window size, control the flow of data across a virtual circuit (virtual call or permanent virtual circuit) at the X.25 interface. When these parameters are not negotiated on a per-call basis, as will be discussed in Section 1.3.2.2, their default settings will be controlled by the values agreed upon at subscription time. The default values can be selected from the following ranges, with the network default specified in parentheses:

1. throughput class - 75, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 48000 BPS (largest class less than or equal to user line speed)

2. packet size - 16, 32, 64, 128, 256, or 512 byte (128)

3. window size - 1 through 7 (2)

It should be noted that these parameters are negotiated for both directions of data transfer and at each of the DTE/DCE interfaces. The network does not constrain the packet size to be the same in both directions, but it does not do packet splitting or combining. So the packet size must be the same at both interfaces for a given direction.

Likewise, the throughput class must be the same at both interfaces for a given direction. But it is not required that the throughput classes be the same in either direction of transmission.

The window sizes though, for a given direction, may have different values for the interfaces at either end of the connection. Also, the value of the window size parameters may be different for each direction for transmission.

The user's choices for these default values will in most cases be dependent on the predominant application which the X.25 interface is meant to support.

1.3.2.2. Per-Call Service Options

The three packet level parameters mentioned above can also be negotiated away from the specified default values on a per-call basis. This capability provides a degree of flexibility to the interface, so that the parameters specified at subscription time can be altered for individual calls which may have different packet level requirements.

In order to take advantage of these capabilities, a user must first subscribe to the negotiation facility and then do the actual per-call negotiation, using standard procedures. The facilities referred to here are as specified in CCITT Recommendation X.25. To negotiate the throughput class on a per-call basis, the user must subscribe to the throughput class negotiation facility and use the throughput class negotiation facility field in the call request and call accepted packets of the virtual call. To negotiate the packet and window sizes on a per-call basis, the user must subscribe to the flow control parameter negotiation facility and use the flow control parameter negotiation facility fields in the call request and call accepted packets of the virtual call.

1.3.2.3. Privacy Service Options

The X.25 network interface provides access to several of the X.25 Closed User Group facilities, allowing the user to build private subnetworks using the resources of the public packet switched network. These groups are specified on a subscription basis, and an individual DTE may belong to multiple CUGs. A CUG permits the DTEs belonging to the group to communicate with each other, but precludes communications with certain other DTEs, depending on the options selected.

The CUG facility is supported in accordance with CCITT Recommendation X .87.

A DTE may belong to up to 10 CUGs. When a DTE belongs to multiple CUGs, the user must specify on a subscription basis which of these is the preferential CUG. The preferential CUG is assumed when no CUG is specified by the user during virtual call setup.

Membership to a particular CUG must be authorized by the user membership authority responsible for that CUG. It is the responsibility of the users of the CUG to establish membership authorities for their respective CUGs. When a DTE is authorized to Join a particular closed user group by the appropriate membership authority, their inclusion in this group is performed by service provisioning. At the time of inclusion, the DTE will be assigned a two digit CUG index number which is to be used in the CUG selection facility field of the call request packet when they originate calls within that CUG. In order to be able to signal the CUG index number in this way, the user must subscribe to the CUG Selection Facility. This CUG index number will have local significance, as it applies only to the CUGs subscribed to by that DTE. Other members of the same CUG may have different index numbers associated with that CUG.

There are six subscription facilities associated with CUGs that are supported at this interface and described below. In these descriptions the term open part of the network refers to the group of DTEs which are not part of any CUG.

A. Closed User Group - this is the basic facility that enables the user to belong to one or more CUGs; having this facility alone requires that all calls made at the user's DTE/DCE interface be to other members of their subscribed CUGs.

B. Closed User Group with Outgoing Access - this is an extension to (A) which also enables the user to make outgoing calls to the open part of the network, and to DTEs having the incoming access capability (C). This facility applies to all calls made at the user's DTE/DCE interface.

C. Closed User Group with Incoming Access - this Is an extension to (A) which also enables the user to receive incoming calls from the open part of the network, and from DTEs having the outgoing access capability (B). This facility applies to all calls made at the user's DTE/DCE interface.

D. Incoming Calls Barred within a Closed User Group - this is a supplementary facility to (A), (B) or (C) which, when subscribed to for a given CUG, permits the DTE to originate virtual calls to DTEs in this CUG, but precludes the reception of incoming calls from other DTEs in this CUG. This facility is specified on a per-user per-CUG basis.

E. Outgoing Calls Barred within a Closed User Group - this is a supplementary facility to (A), (B) or (C) which, when subscribed to for a given CUG, permits the DTE to receive incoming virtual calls from DTEs in this CUG, but prevents the DTE from originating virtual calls to other DTEs in this CUG.

F. Closed User Group with privileged and non-privileged member - This is an extension to (A), (B), (C), (D) or (E) which enables privileged members of a CUG to make outgoing calls or receive incoming calls from other privileged or non-privileged members of the same CUG. The non-privileged members of the CUG are barred from calling each other. This facility is subscribed on a per-user per-CUG basis.

All six of these facilities are subscription items, and the only per-call signaling that is used to effect these services Is the COG selection facility field.

In addition to these six CUG facilities, there are two other subscription options available which automatically limit access to or from a given DTE. These options are:

A. Outgoing Inter-network or InterLATA Calls Barred. This subscription facility enables a network to option whether outgoing inter-network or interLATA calls are allowed from the user interface. This facility is optioned on a per-user interface

basis. If the facility is set, the network will prevent any user from making inter-network or lnterLATA calls originating from the user interface.

B. Incoming Inter-network or InterLATA Calls Barred. There are two optional user facilities in this category. The first facility is incoming inter-network or interLATA reverse charged calls barred. The second facility is incoming inter-network or interLATA normal charged calls barred. These user facilities, if subscribed to, authorize the DCE to block incoming inter-network or interLATA calls requesting reverse or normal charging, respectively.

Both of these service options (all three facilities) are subscription items, and require no per-call signaling to use them.

1.3.2.4. Special Call Service Options

Three types of specialized virtual calls are accessible at the DTE/DCE interface.

1.3.2.4.1. Fast Select Calls

User may send and receive limited amounts of data to and from the destination DTE during the call setup phase of a virtual call using the Fast Select Facilities specified in CCITT Recommendation X.25 and implemented at this interface. In order to take advantage of this capability the calling DTE must use the Fast Select Facility in the call request packet, and the called DTE must subscribe to the Fast Select Acceptance Facility. If this is the case it allows the calling DTE to transmit up to 128 octets of data in the user data field of the call request packet. This data will be delivered to the called DTE in the user data field of an incoming call packet, if this DTE subscribes to Fast Select Acceptance Facility. The called DTE then responds with either a call accepted packet or a clear indication packet with a user data field of up to 128 octets of data. This data will be delivered in the user data field of a call connected or call clearing packet. Note that, if the called DTE accepted the call and then later attempted to put data in the clear request packet. This data would not be delivered and the call would be cleared with a procedural error cause.

Additionally, the calling DTE may indicate a restricted response to the fast select call request packet, by specifying a different value for the fast select facility field. When this is the case, the called DTE may only respond to the incoming call packet with a clear indication packet with a user date field of up to 128 octets of data.

If the called DTE does not subscribe to the fast select acceptance facility, the DCE will respond to a fast select call request packet from the calling DTE with a clear indication packet with the cause "fast select acceptance not subscribed."

The significance of the call connected packet and the clear indication packet with the cause "DTE originated" as a direct response to a call request packet with the fast select facility is that the call request packet with the user data field has been received by the called DTE.

1.3.2.4.2. Reverse Charging Calls

Users may initiate virtual calls which they want to have billed to the destination DTE of that call. This is done using the reverse charging and reverse charging acceptance facilities. During the call setup the calling DTE signals across the DTE/DCE interface that they are requesting reverse charging by setting the reverse charging facility field in the call request packet. Note, that this signaling is done on a per-call basis. If the called DTE subscribes to the reverse charging acceptance facility, then the called DTE will receive the associated incoming call packet with the reverse charging facility field set, and the remainder of the call setup will be the same as for standard virtual calls. If the called DTE does not subscribe to the reverse charging acceptance facility, then the call will be cleared with the cause code being "reverse charging acceptance not subscribed."

1.3.2.4.3. Priority Calls

User may initiate virtual calls which they want to have delivered on a priority basis. The packets associated with these virtual calls usually have a lower delay than normal virtual calls to the same destination user. There is a per-call and subscription facility associated with priority calling. A user may specify on a per-call basis that the packets of a virtual call are to be transported through the network on a priority basis by setting the traffic class facility field in the Call Request packet to the prioring class setting. The per-call facility field can also be set to the normal class setting forcing normal treatment of the data associated with the virtual call. A user may also specify on a subscription basis the default manner in which data (virtual call and permanent virtual circuit) is to be transported, normal or priority traffic class basis. This default manner is used whenever a per-call specification is not present in the Call Request packet.

Because priority virtual call will commonly have tariff implications (higher rate for these calls) a subscription option is available to selectively reject reverse charged calls being delivered on a priority basis. This option, called the Incoming Priority Class Reverse Charged Calls Barred Facility is a per-interface subscription facility. With this facility subscribed to an X.25 DTE will only receive normally charged calls and reverse charged calls with only the normal traffic class. Reverse charged calls with priority traffic class will be blocked within the network and cleared to the originating DTE with a cause code of incompatible destination.

1.3.3. Access Line Addressing

The network numbering plan for virtual call services complies with CCITT Recommendation X.121. Network address consist of 10 digits (not including the DNIC). All 10 digits must be pre-

sent whenever an address is given in the address field of a intra-network call request and call accepted packet. The address in the address field of inter-network calls will be dependent upon the numbering plan implemented by the destination network. Six options for the assignment of addresses to access lines are available to users:

1. A network access line is assigned a single address.

2. A network access line is assigned multiple contiguous addresses in blocks of 10, 100 or 1000 addresses (i.e., all the addresses have the same initial 9, 8, or 7 digits respectively). A single profile of service options and facilities apply to the access line as a whole (all address have access to the same service options and facilities).

3. A network access line is assigned multiple network addresses. Each network address can be optioned to different services and facilities. With this feature all call request packets must contain the calling DTE address.

4. A network access line may be part of a group of access lines which is considered a multiple line hunt group. The hunt group may have a single address associated with it and the individual lines are only accessible through this single address.

5. A network access line may be part of a multiple line hunt group. The hunt group may be assigned multiple addresses and the individual lines may only be accessible through the hunt group addresses.

6. A network access line may be part of a multiple line hunt group. The hunt group may be assigned a single address and each of the lines in the hunt group may be individually addressable.

7. A network access line may be part of a multiple line hunt group. The hunt group may be assigned multiple addresses and each of the lines in the hunt group may be individually addressable.

1.3.3.1. Multiple Line Hunt Group

A multiple line hunt group is an association among up to 30 network access lines. As a subscription option, the customer specifies an ordered list of the addresses which the hunt group is to consist of (a hunt list). This hunt group will be assigned an address (single or multiple addresses), incoming calls to this address will be distributed across the lines of the hunt group using distribution algorithms discussed below. Once a virtual call is assigned to a particular access line, it is treated as a regular call (e.g., if the access line fails, the virtual call will be disconnected). All packets associated with an individual virtual call are routed over the same access line.

The distribution of incoming virtual calls across the members of the hunt group is accomplished using one of the following three mechanisms. First, a hunt on busy option is available. With this mechanism, all incoming virtual calls will be delivered to the first access line on the hunt list, so long as this line has an available one-way incoming or two-way logical channel. If this line is busy then the incoming virtual call will be delivered to the next access line on the hunt list, so long as this line has an available one-way incoming or two-way logical channel. If this line is also busy, then the next line is attempted, and so on. If all lines are busy then the virtual call is cleared. This entire process starting at the beginning of the hunt list, is repeated for each incoming virtual call which has as its call address the address(es) of the hunt group.

The second hunting mechanism is referred to as a rotary hunt. This mechanism keeps track of the line on which the last incoming virtual call was delivered. Using this information, the rotary hunt attempts to deliver the next incoming virtual call to the next access line on the hunt list. The first access line on the hunt list is used as the next access line on the hunt list when the hunting option is being initiated and when the last incoming virtual call was delivered to the last access line on the hunt list. If there are no available one-way incoming or two-way logical channels on the access line which has been selected, the network uses the hunt on busy mechanism to find an available logical channel, for this incoming virtual call only. The next incoming virtual call will select an access line based on the rotary mechanism.

The third hunting mechanism is referred to as a load sharing hunt. With this option, the customer specifies a subscription parameter D per access line, which represents the number of virtual calls the network will deliver to an access line before moving to the next access line on the hunt list to deliver subsequent incoming calls. This mechanism allows the user to load the various access lines to different levels of usage.

1.3.4. User Maintenance Capabilities

There are five capabilities which are available to aid the user in the operations and maintenance of their X.25 network access lines. These capabilities are:

1. access line takedown,
2. user initiated self-testing,
3. idle line probe,
4. DTE use of cause code and diagnostic packets,
5. and DTE call redirection.

1.3.4.1. Access Line Takedown

In CCITT Recommendation X.25 there exists what is known as a restart capability, which allows the user to send a packet across the DTE/DCE interface (on logical channel 0) which will clear all virtual calls and reset all permanent virtual circuits. This capability is commonly used-when error conditions become prevalent on an access line resulting in link level failure and is automatically initiated by the link layer. At other times the user may need to have control of a manual restart procedure so that they may take their access line out of service for some period of time, for example to alter the configuration of their DTE ports. Two access line takedown procedures are available to users, and are initiated by notifying the user's ABOC maintenance contacts.

1.3.4.1.1. Unconditional Access Line Takedown

A user may call, by standard voice telephone, and request an unconditional take down of an access line. The line that is taken out of service remains in that state until the user requests that it be returned to service. The network will take the line out of service by clearing all virtual calls and resetting all permanent virtual circuits towards the remote DTEs and by initiating a packet level restart toward the local DTE. At both ends of each virtual circuit the diagnostic information in the restart, reset or clearing packet will be as follows.

PACKET TYPE	CAUSE CODE	DIAGNOSTIC CODE
Restart	03 (Network Congestion)	135
Clear	09 (Out of Order)	135
Reset	07 (Network Congestion)	135

Once the restart is completed, the network takes the link out of service by initiating the link level disconnect procedures specified in Section 1.4.2.3.4.

1.3.4.1.2. Conditional Access Line Takedown

A user may call, by standard voice telephone, and request a conditional take down of an access line. This is the feature which allows the user to gracefully (without disrupting any existing virtual calls) take an access line out of service. Based on the users request, action is taken to prevent any new virtual calls from being set up on the designated access line. Existing virtual calls and permanent virtual circuits are unaffected. When the network detects that all virtual calls have been terminated, the network will take the line out of service by initiating the restart procedure at the interface and then initiating the link level disconnection procedure. Note, that the restart procedure will result in resetting of all permanent virtual circuits at the local and remote interface. The diagnostic information that will appear in the restart and reset packets will be as follows.

PACKET TYPE	CAUSE CODE	DIAGNOSTIC CODE
Restart	03 (Network Congestion)	142
Reset	07 (Network Congestion)	142

The line will remain out of service until the user calls and requests it be returned to service.

1.3.4.2. User Self Testing Capabilities

A DTE may place a virtual call to its own address. The network performs incoming call logical channel selection (and access line selection when a hunt group is employed) in the usual manner. Using this capability, users may perform test on their DTE packet level procedures.

1.3.4.3. Idle Line Probe

Idle line probe is an optional subscription facility agreed to for a period of time. This facility provides a simple sanity test on the DTE/DCE interface. If a DTE subscribes to this facility, the DCE will periodically send a Clear Indication packet on an idle logical channel. The DTE must transmit a Clear Confirmation packet within the response period, the DCE will disconnect the link level and attempt to reconnect the link level.

There are two timers associated with this facility. The idle timer indicates the period of time after which the DCE will spontaneously send a Clear Indication packet on an idle logical channel. The response timer indicates the length of time within which a Clear Confirmation packet to the outstanding Clear Indication packet should be received. Both the idle and response timers are set on a per-user interface basis during subscription time.

1.3.4.4. DTE Use of Cause Code and Diagnostic Packets

Normal data transfer is interrupted or terminated by the issuance of Restart, Reset, and Clear Packets. The issuance of these packets usually indicates the existence of an error condition and an attempt to return to a known state from which normal data transfer may begin again. Currently CCITT Recommendation X.25 constrains the DTE to set the bits of the cause code in these packets to zero. A subscription option is available which allows the users to insert any valid cause code specified in CCITT Recommendation X.25. For users who do not subscribe to this option, their use of cause and diagnostic codes is limited by the procedures specified in Section 1.4.5.1.2 of this document.

Two other subscription options available to users affect the manner in which diagnostic packets are sent and received. The Diagnostic packet is used to indicate error conditions under circumstances when the usual methods of indication (i.e., reset, clear and restart with cause and diagnostic codes) are inappropriate or unavailable. The first subscription option suppresses the

issuance of all diagnostic packets by the network, when it is subscribed to the user. The default condition allows the network to issue and deliver diagnostic packets to the DTE. The second subscription option allows the DTE to issue diagnostic packets to the DCE, when subscribed to by the user. The default condition does not allow the DTE to issue diagnostic packets.

1.3.4.5. DTE Call Redirection

At service initialization time the user may subscribe to the DTE call redirection service. This service allows the user to specify a list of up to 255 alternate DTEs. When the primary DTE is in a failed, or out of service condition, incoming calls addressed to that DTE will be rerouted to the first DTE on the list of alternate DTEs. If this DTE is also in a failed, or out of service condition, the call will be rerouted to the next DTE on the list, and so on. The DTE Call Redirection service is applicable to virtual call, permanent virtual circuit and direct call service.

1.4. X.25 Interface Protocol

In the previous section, the various services that are available at the X.25 network interface are specified. The physical, link and packet level of the protocol used to implement these services will be discussed here. This protocol is based on the 1980 version of CCITT Recommendation X.25, where additional details or modifications to this protocol are required, they will be supplied in this section.

1.4.1. Physical Level

Multiple forms of physical interfaces will be available to users of X.25 access lines. These will include both analog and digital interfaces as well as synchronous and asynchronous ones. Separate interface specifications have been written to describe the various physical interfaces available. For digital interfaces the user should refer to Technical Reference AM TR-NPL-000007. For analog interfaces the user should refer to Technical Reference AM TR-NPL-00000I.

1.4.2. Link Level

The link level protocol provides for the data interchange between a DCE and a DTE over the single access link between them. It also provides for link error control, link error recovery, link initialization and termination, uniform flow control, recovery from procedural errors, transparency, and frame synchronization. Both information and control frames are transferred across the access link in transmission units called frames.

The link level protocol supported at the DTE/DCE interface conforms to CCITT Recommendation X.25 LAPB procedures and is based on the principles and terminology of the High Level Data Link (HDLC) procedure specified by the International Organization for Standardization (ISO). The default values of the link level parameters in this network implementation are:

1. The link level window size, parameter k, is 7 frames.

2. The acknowledgment timer, parameter T1, is 3 seconds.

3. The maximum number of attempts to obtain an appropriate response to a transmitted frame, parameter N2, is 10.

4. The maximum number of bits in an information frame (excluding flags and 0 bits inserted for transparency), parameter N1, is 4208 bits (526 octets).

These link level parameters are user settable on a per-access line subscription basis. The selectable parameter values are as follows:

1. k = 1 to 7 in steps of 1

2. T1 = 1 to 15 in steps of 1 second

3. N1 = 1 to 15 in steps of 1

4. N2 = 1 to 4,208 in steps of 1

In the following sections, details in addition to those provided in the above reference will be provided for additional procedures implemented by this network.

1.4.2.1. Link Level Frame Structure

The network supports all aspects of the frame structure identified in X.25 section 2.2, with the exception of the link channels states, identified in X.25 section 2.2.12, which the network does not detect.

1.4.2.2. Link Level Procedural Elements

This network supports the use of all the procedural elements specified in Section 2.3 of CCITT Recommendation X.25. A summary of the link level commands and responses used at this interface is as follows:

1. Information Transfer (command)

    A. I (Information) Frame

2. Supervisory (commands and responses)

    A. RR (Receive Ready) Frame

B. RNR (Receive Not Ready) Frame

C. REJ (Reject) Frame

3. Unnumbered (commands)

A. SABM (Set Asynchronous Balanced Mode) Frame

B. DISC (Disconnect) Frame

4. Unnumbered (responses)

A. DM (Disconnected Mode) Frame

B. UA (Unnumbered Acknowledgment) Frame

C. CMDR (Command Reject) Frame

D. FRMR (Frame Reject) Frame

The description and function of these frames are as specified in Section 2.3 of CCITT Recommendation X.25.

1.4.2.3. Link Level Procedures

The procedural step for the setup, disconnect, reset and transfer of information on this link are specified in the following sections. The use of the Poll/Final Bit is discussed first because it may be utilized in any of these of procedural steps.

1.4.2.3.1. Procedure for the Use of the Poll/Final Bit

In addition to the uses specified in Section 2.4.3 of CCITT Recommendation X.25, the P/F bit will be used as follows.

If the network is in a retransmission state (retransmitting an I-frame with the P bit set to one in response to the REJ command from the DTE) and a valid RR or REJ frame is received but without the F bit set to one (on), the N(R) or the non-final response is used to update V(S) such that the next retransmission may be a different frame with the P bit on. If all frames are acknowledged, the last acknowledged frame is retransmitted. The retransmission state is cleared by a valid response frame with the F bit on.

The network also used the P/F bit to deliver queued I frames to a DTE which is in a busy condition. During polling the network transmits the first unacknowledged I frame with the poll (P) bit

on. If the network receives, in response to this, a RNR with the F bit on. Then the next polling I frame will not have the P bit on. If the RNR acknowledges an I frame, this polling will continue with the next I frame which is unacknowledged. The network will reset the N2 counter whenever it receives a valid RNR. If after transmitting an I frame, timer T1 expires the I frame will be retransmitted with the P bit on.

The network uses P bit for timer recovery. When the network enters the timer recovery condition, it transmits, with the P bit on, the oldest unacknowledged I frame and starts timer T1. Upon the expiration of T1 with no response from the DTE, the oldest unacknowledged I frame (with P bit on) is retransmitted and the timer reset again. This procedure is repeated N2 times. If there is still no DTE response, then the network begins transmitting a DM command every T1 seconds up to N2 times. If the DTE does not initiate recovery at any time during this period, then the network will follow the N2 attempts with the transmission of SABMs indefinitely.

If the DTE sends a response frame with the F bit set, but no previous command had the P bit set, the network will reset the link by sending a DM to the DTE.

1.4.2.3.2. Link Level Set-Up

Procedures for the set-up of the link level are as specified in Section 2.4.5.1 of CCITT Recommendation X.25. Set-up attempts are signaled through the use of a SABM (set asynchronous balanced mode) command and are acknowledged through the use of a UA (unnumbered acknowledgment) response. Upon the reception of the UA, the link is considered to be in the information transfer phase.

1.4.2.3.3. Information Transfer

The procedures used during the information transfer phase are as specified in Sections 2.4.5.2 and 2.4.6 of CCITT Recommendation X.25.

Additionally, when the DCE is in the busy condition it does not ignore the contents of the information field of a received I-frame, but it responds with an RNR at the earliest opportunity.

The network does not inform the packet level procedures of a zero-length information field.

If the network receives a frame with a bad address field, the frame will be discarded.

If the DTE goes into the DTE Busy State during the information transfer phase, the DCE will use the polling procedure discussed in Section 1.4.2.3.1 to deliver frames queued at the DCE.

1.4.2.3.4. Link Disconnection

During the information transfer phase, the DTE shall indicate disconnecting by transmitting a DISC command to the DCE. The DCE will respond to the DISC command with an UA response

and enter the disconnected phase. Should the DCE wish to initiate the disconnection of the link, It will send the DISC command and start timer T1. Upon reception of the UA response from the DTE, the DCE will stop the T1 timer. Should timer T1 expire before reception of the VA response, the DCE will retransmit the DISC command and restart the timer. After transmission of the DISC command N2 times by the DCE, the link enters the disconnected phase.

1.4.2.3.4.1. Disconnected Phase

The disconnected phase is implemented as specified in Section 2.4.5.4 of CCITT Recommendation X.25. Additionally, if the DCE enters the disconnected phase after detecting error conditions or exceptionally after recovery from an internal temporary malfunction, it will indicate this by sending a ON response rather than a DISC command. The DCE will also start timer T1 at the time of sending the DM. If timer T1 expires before the reception of a SABM or DISC command from the DTE, the DCE will retransmit the DM and restart the timer. After transmission of the DM response N2 times, the DCE will begin transmitting SABMs indefinitely.

1.4.2.3.5. Link Resetting

The link resetting procedures are as specified in Section 2.4.9 of CCITT Recommendation X.25.

1.4.3. X.25 Packet Level Elements

The packet level access protocol provides the interface procedures required to set up, maintain (I.e. control the transfer of data) and clear virtual calls and maintain permanent virtual circuits between DTEs. Both data and control information are transferred in transmission units called packets. Each packet transferred across the interface is contained within a single link level information frame. Only one packet may be contained in an information frame. The packet types, formats and procedures are those given in CCITT Recommendation X.25 for virtual call and permanent virtual circuit. These procedures apply to packets that have been successfully transferred across the DTE/DCE interface by the physical and link level protocol.

1.4.3.1. Basic Packet Level Attributes

The packet level interface attributes specified in X.25 are supported including:

1. Default maximum user date field length of 128 octets,

2. Default sequence numbering modulo 8, and

3. Default packet level window size of 2.

The optional user facilities described in Section 1.4.3.12 can add additional choices to these network default values on either a per-call or subscription basis.

1.4.3.2. Logical Channels

X.25 logical channels are identified by a four bit logical group number and an eight bit logical channel number. This allows a maximum of 4096 logical channels to be supported at the interface. Logical channel 0 is reserved for control packets which affect the entire interface (i.e., Restart and Diagnostic packets). The actual number of logical channels that a user may access is a subscription option which is agreed to at service initialization time. Any number of logical channels up to this agreed to maximum value may be used as described below.

Logical channel assignment is in accordance with CCITT Recommendation X.25 Annex A. For permanent virtual circuits, the user must specify the logical channel number for each permanent virtual circuit applying to an interface. For each range of logical channels for virtual calls (i.e., 2-way and one-way outgoing) applying to an interface, the user must specify the logical channel number where the range begins and the logical channel number where the range ends. If either the outgoing calls barred or the incoming calls barred facility applies to an interface, the user must specify the logical channel number where the range of assigned logical channels for virtual calls begins and the logical channel number where the range ends. There may not be any gaps between the ranges of logical channels.

Any packet type which is received on out-of-range logical channel (e.g., one which was not assigned at subscription time) results in a clear indication packet being sent on that logical channel. The network does not require a clear confirmation response and will ignore any clear confirmation response sent on that logical channel by the DTE.

When an incoming call is to be sent to the DTE, the network uses the lowest available logical channel. In order to minimize call collisions, it is expected that the DTE uses the highest available logical channel for call requests.

1.4.3.3. Basic Structure of Packets

The structure and type of packets that are implemented on this network are as specified in Section 3.2 (Table 5/X.25) of CCITT Recommendation X.25, with the following exceptions. The three packets which are solely associated with Datagram service, are not implemented on this network. The DTE REJ (Reject) command which is used with the packet retransmission facility is not implemented on this network.

1.4.3.4. Handling of Network Addresses

All 10 digits of the called network address must be present in the call request packet, for IntraLATA calls. IntraLATA calls that have less than 10 digits in the called address field will be cleared. Inter-network calls to networks with a DNIC differing from the DNIC of the network

from which the virtual call is initiated will be handled in the following manner. The called address in the call request packet must consist of a leading 1, followed by the DNIC of the called part's network, followed by their network address. The length and format of the called party's network address will be destination network dependent. If the calling address field is provided in the call request packet, the network will verify that it is correct, and if it is not provided the network will insert it.

1.4.3.5. Octet Alignment of User Data Field Lengths

The network does not require user data be an integral number of octets. A subscription option exists which causes all I frames sent to a DTE to be padded with zeros, such that it will result in the data field being an integral number of octets. Also, these DTEs have to provide to the network (DCE) user data fields with an integral number of octets.

1.4.3.6. Transparency of User Data

All user data present in user data fields of X.25 packets is passed transparently by the network. This includes bits 8 and 7 of the first octet of the call user data field of Call Request and Fast Select Call Accepted Packets.

Cause code fields supplied by the DTE in Clear, Reset and Restart Request packets are passed transparently by the network only if the user subscribes to the maintenance option which allows the DTE to use non-zero cause codes in Clear, Reset and Restart packets. Diagnostic fields supplied by the DTE in Clear Request packets are passed transparently by the network only if the associated cause code is valid.

1.4.3.7. Effects of Physical and Link Level Failures

The physical and link level protocols notify the packet level of problems by disconnecting at the link level. Whenever the link level disconnects, the packet level institutes the packet level restart procedure on the DTE/DCE interface. This causes the remote ends of all permanent virtual circuits on this interface to be reset and all virtual calls on this interface to be cleared. When the physical and link level become operational once again (link level connection is reestablished), the packet level institutes another restart procedure. This causes the remote ends of all PVCs to be reset (with the cause "DTE RESET"), indicating that they are now capable of transferring data.

1.4.3.8. Significance of Packet Types

The various packet types have different levels of significance. Packets that are referred to as having local significance only describe the state of the local DTE/DCE interface and provide no information about the remote DTE/DCE interface. Packets that are referred to as having end-to-

end significance provide information on the end-to-end connection between the local DTE and remote DTE including the local and remote DTE/DCE interface.

1.4.3.8.1. Significance of Call Accepted, Call Connected and Interrupt Confirmation Packets

Call Accepted, Call Connected and Interrupt Confirmation Packets have end-to-end significance.

1.4.3.8.2. Significance of Receive Ready, Receive Not Ready and Data Packets

The packet sequence numbers, P(S) and/or P(R), in the Receive Ready, Receive Not Ready and Data Packets transferred across the DTE/DCE interface normally only have local significance. The network does not necessarily transmit a packet level RR or RNR to the remote DTE, when it receives one from the local DTE.

If the D bit procedures are being used then the sequence numbers have end-to-end significance.

The user date in the Data Packets has end-to-end significance because it is passed transparently through the network.

1.4.3.8.3. Significance of DCE Clear, Reset and Restart Confirmation Packets

DCE Clear, Reset and Restart Confirmation packets have local significance. Local significance permits a confirmation packet to be sent as soon as the network has cleared or reset the logical channel, rather than after the remote DTE has confirmed the reset or clear indication. If after receiving the Restart Confirmation Packet, the local DTE sends data on a Permanent Virtual Circuit for which the remote DTE has yet to respond with a Reset Confirmation, the network will queue the data until the remote DTE confirms the reset. If the remote DTE is not operational, the DCE will transmit a reset indication (cause Network Congestion or Out of Order) to the local DTE.

1.4.3.9. Flow Control Principles

The network follows the standard flow control principles specified in Section 4.4.1.3 of CCITT Recommendation X.25. These principles include using packet sequence numbering modulo 8 and controlling window mechanisms with the exchange and monitoring of Packet Send Sequence Numbers P(S) and Packet Receive Sequence Numbers P(R). Additionally, if the network receives a data packet containing a P(S) that is out of sequence but within the window, the network will reset the virtual circuit with the cause local procedural error.

The DTE can advance the packet level window by using Data, Receive Ready, and Receive Not Ready Packets. When the DTE flow controls the DCE by using a RNR packet, the network

queues packets to be transmitted to the DTE. When the DTE clears the busy condition by sending a RR, the network will transmit data packets until the window is closed (reach upper edge of window) or it has no further packets to sent to DTE. If the DTE is not able to process these packets, then it must reset the link in order to recover. The network takes no action if the DTE does not rotate its packet level window.

1.4.3.10. Support of D, M, and Q Bits

The network support of the Delivery Confirmation (D) Bit, More Data Mark (H) Bit, and Qualifier (Q) Bit are specified in the next three sections.

1.4.3.10.1. D Bit Support

The network follows the standard principles specified in Section 4.4.1.4 of CCITT Recommendation X.25. Additionally, on receipt of confirmation for a D Bit packet, the network acknowledges all non-D Bit packets up to the next outstanding D Bit packet or all outstanding packets if there are no outstanding D Bit packets.

1.3.4.10.2. M Bit Support

The More Date Mark procedures are supported as specified in Section 4.3.4 of CCITT Recommendation X.25. The network does not perform packet fragmentation and recombination (i.e., the same maximum packet size is supported at each end of a virtual circuit for a given direction of transmission). Additionally, non-full data packets with the M Bit set and the D Bit not set are delivered with the M Bit not set.

1.4.3.10.3. Q Bit Support

The Qualifier Bit is supported as specified in Section 4.3.6 of CCITT Recommendation X.25 Additionally, if the DTE transmits an inconsistent Q Bit within a single complete packet sequence, the network will reset the virtual circuit with the cause code of local procedural error. A complete packet sequence is defined as a series of contiguous data packets which have the exact maximum user data field, have the M Bit set to 1 and the D Bit set to 0, followed by any other data packet. The Q Bits of these sequences are consistent only if they are all set to one or all set to zero throughout the sequence.

1.4.3.11. Diagnostic Packet

The diagnostic packet is used to indicate error conditions under circumstances when the usual methods of indication (i.e., reset, clear and restart with cause and diagnostic codes) are inappropriate. The conditions under which the network will send the diagnostic packet are as specified in CCITT Recommendation X.25.

There are two subscription options associated with the use of diagnostic packets. First, the user may request that the network block all diagnostic packets from being sent to their access line. Second, the user may request the ability to issue diagnostic packets to the network.

1.4.3.12. X.25 User Facilities

The following is a list of the X.25 user facilities specified in CCITT Recommendation X.25. Some of them are used by an X.25 DTE on a per-call or subscription basis to gain access to some of the services described in Section 1.3.2 of this document. Others are not supported on this network.

In general, when there are multiple request for the same facility, this network only recognizes the last of these requests.

Unless otherwise stated the procedures, formats and coding of these facilities are as specified in Section 7 of CCITT Recommendation X.25.

1.4.3.12.1. Extended Packet Sequence Numbering

The extended packet sequence numbering facility allows packet sequence numbering to be done modulo 128. This facility is common to all logical channels at a DTE/DCE interface, and applies to both virtual calls and permanent virtual circuits. The facility is requested on a subscription basis.

Extended packet sequence numbering is not currently supported on this network.

1.4.3.12.2. Non-standard Default Window Sizes (Standard Default is 2)

The non-standard default window size facility allows the selection of the default window size from the list of sizes supported by the network (see Section 1.3.2.1.2 of this document). This default value applies to all permanent virtual circuits and those virtual calls at the DTE/DCE interface which do not perform per-call flow control parameter (window size) negotiation. This facility is a subscription option.

This facility is supported on this network.

1.4.3.12.3. Non-standard Default Packet Sizes (Standard Default is 128)

The non-standard default packet size facility allows the selection of the default packet size from the list of sizes supported by the network (see Section 1.3.2.1.2 of this document). This default value applies to all permanent virtual circuits and those virtual calls at the DTE/DCE interface which do not perform per-call flow control parameter (packet size) negotiation. This facility is a subscription option.

This facility is supported on this network.

1.4.3.12.4. Default Throughput Class Assignment

The default throughput class assignment facility allows the selection of the default throughput class from the list of classes supported by the network (see Section 1.3.2.1.2 of this document). This default value applies to all virtual calls and permanent virtual circuits at the DTE/DCE interface which do not perform per-call throughput class negotiation. This facility is a subscription option.

This facility is supported on this network.

1.4.3.12.5. Flow Control Parameter Negotiation

The flow control parameter negotiation facility, if subscribed to, permits negotiation on a per call basis of the flow control parameters (packet size and window size for each direction of data transfer) associated with a given virtual call. This facility is a subscription option, which when subscribed to allows the use of per call facility fields in virtual call setup packets.

This facility is supported on this network.

1.4.3.12.6. Throughput Class Negotiation

The throughput class negotiation facility, if subscribed to, permits negotiation on a per call basis of the throughput class for each direction of data transfer associated with a virtual call. This facility is a subscription option, which when subscribed to allows the use of per-call facility fields in virtual call setup packets. The network will allow a DTE to request a throughput higher then its subscribed maximum, so long as it is one of those specified in Section 1.3.2.1.2 of this document. If the requested throughput is not one of these specified values the call will be cleared with the cause local procedural error.

This facility is supported on this network.

1.4.3.12.7. Packet Retransmission

The packet retransmission facility, if subscribed to, permits the DTE to request retransmission of one or several consecutive flow controlled packets from the DCE by transferring across the DTE/DCE interface a DTE reject packet specifying the logical channel number and sequence number P(R). This facility is a subscription option, which when subscribed to allows the use of a retransmission capability any time during a virtual call or permanent virtual circuit session.

This facility is currently not supported on this network.

1.4.3.12.8. Incoming Calls Barred

The incoming calls barred facility, if subscribed to, causes the DCE to block all incoming virtual calls to the DTE. This facility causes the entire range of logical channels available for virtual calls (total number of available logical channels minus those dedicated to permanent virtual circuit service) to be defined as one-way outgoing logical channels, thus dedicating all available logical channels to outgoing virtual calls. This facility is a subscription option, which affects the entire interface (with the exception of the permanent virtual circuits).

This facility is currently supported on this network.

1.4.3.12.9. Outgoing Calls Barred

The outgoing calls barred, if subscribed to, causes the DCE to block all outgoing virtual calls from the DTE. This facility causes the entire range of logical channels available to virtual calls (total number of available logical channels minus those dedicated to permanent virtual circuit service) to be defined as one-way incoming logical channels, thus dedicating all available logical channels to incoming virtual calls. This facility is a subscription option, which affects the entire interface (with the exception of the permanent virtual circuits).

This facility is currently supported on this network.

1.4.3.12.10. One-way Logical Channel Outgoing

The one-way logical channel outgoing facility, if subscribed to, restricts the use of the logical channel to originating outgoing virtual calls only. The facility is a subscription option, and effects only the logical channel in question. The rules according to which logical channel group numbers and logical channel numbers can be assigned in this way are given in Annex A of CCITT Recommendation on X.25.

This facility is currently supported on this network.

1.4.3.12.11. One-way Logical Channel Incoming

The one-way logical channel incoming facility, if subscribed to, restricts the use of the logical channel to terminating incoming virtual calls only. This facility is a subscription option, and effects only the logical channel in question. The rules according to which logical channel group numbers and logical channel numbers can be assigned in this way are given in Annex A of CCITT Recommendation X .25.

The one-way logical channel incoming facility, if subscribed to, restricts the use of the logical channel to terminating incoming virtual calls only. This facility is a subscription option, and effects only the logical channel in question. The rules according to which logical channel group

numbers and logical channel numbers can be assigned in this way are given in Annex A of CCITT Recommendation X .25.

1.4.3.12.12. Closed User Group

The closed user group facility is described in Section 1.3.2.3 of this document. This facility is a subscription item, which is signaled on a per-call basis, using the closed user group selection facility. Subscription to this facility applies to all logical channels available for virtual call service.

This facility in currently supported on this network.

1.4.3.12.13. Closed User Group with Outgoing Access

The closed user group with outgoing access facility is described in Section 1.3.2.3 of this document. This facility is a subscription item, which is signaled on a per-call basis, where necessary, using the closed user group selection facility. Subscription to this facility applies to all logical channels available for virtual call service.

This facility is currently supported on this network.

1.4.3.12.14. Closed User Group with Incoming Access

The closed user group with incoming access facility is described in Section 1.3.2.3 of this document. This facility is a subscription option, which is signaled on a per-call basis, where necessary, using the closed user group selection facility. Subscription to this facility applies to all logical channels available for virtual call service.

This facility is currently supported on this network.

1.4.3.12.15. Incoming Calls Barred within a Closed User Group

The incoming calls barred within a closed user group facility is described in Section 1.3.2.3 of this document. This facility is a subscription option, which applies only to virtual calls attempted within the specified closed user group.

This facility is currently supported on this network.

1.4.3.12.16. Outgoing Calls Barred within a Closed User Group

The outgoing calls barred within a closed user group facility is described in Section 1.3.2.3 of this document. This facility is a subscription option, which applies only to virtual calls attempted within the specified closed user group.

This facility is currently supported on this network.

1.4.3.12.17. Bilateral Closed User Group

The bilateral closed user group facility is a subscription option which sets up a closed user group exclusively between two DTEs on the network. Subscription to this facility precludes communications with the open part of the network and DTEs with CUGs (regular and bilateral) with outgoing access.

This facility is not currently supported on this network.

1.4.3.12.18. Bilateral Closed User Group with Outgoing Access

The bilateral closed user group with outgoing access facility is a subscription option which sets up a closed user group exclusively between two DTEs on the network, and also allows communications with the open part of the network and DTEs subscribing to CUGS (regular and bilateral) with outgoing access.

This facility is not currently supported on this network.

1.4.3.12.19. Reverse Charging

The reverse charging facility is a per-call option which is described in Section 1.3.2.4.2 of this document. This facility is signaled in the call request packet of a virtual call and only effects that particular virtual call.

This facility is currently supported on this network.

1.4.3.12.20. Reverse Charging Acceptance

The reverse charging acceptance facility is a subscription option which is described in Section 1.3.2.4.2 of this document. This facility is subscribed to and affects all the logical channels capable of receiving incoming virtual calls.

This facility is currently supported on this network.

1.4.3.12.21. RPOA Selection

The RPOA selection facility is a per-call selection option, allowing the originating DTE to select the identity of the transit network to be used to complete this virtual call. This facility uses the RPOA selection facility field in the call request packet of the associated virtual call and affects only that call.

This facility is currently supported on this network.

1.4.3.12.22. Fast Select

The fast select facility is described in Section 1.3.2.4.1. This per-call facility is signaled using the fast select facility field in the cell request packet of the associated virtual call and effects only that call.

This facility is supported on this network.

1.4.3.12.23. Fast Select Acceptance

The fast select acceptance facility is described in Section 1.3.2.4.1. This subscription facility applies to all logical channels capable of receiving incoming virtual calls.

This facility is supported on this network.

1.4.3.12.24. D Bit Modification

The D bit modification facility is a subscription option which is intended for use by those DTEs implemented prior to the introduction of the D bit procedure. These DTEs were designed to work on public data networks that support end-to-end P(R) significance within a network that supports delivery confirmation (D bit) procedures. The facility, when subscribed to will:

A. Change the value of the D bit from 0 to 1 in all call request, call accepted and DTE data packets received from the DTE, and

B. set the D bit to 0 in all incoming call, call connected and DCE data packets transmitted to the DTE.

This modification will take place on all logical channels at the DTE/DCE interface (virtual call and permanent virtual circuit logical channels).

This facility is supported on this network.

1.4.4. X.25 Packet Level Procedures

This section identifies the procedures used to provide the services specified in Section 1.3 of this document. These procedures are in addition to those specified in CCITT Recommendation X.25.

1.4.4.1. General Packet Level Procedures

The states referred to in this and the following sections, are specified in CCITT Recommendation X.25 (Annex B and C).

The following types of packets are discarded when received by the network.

A. A packet less than two octets in length.

B. A RR, RNR, Interrupt, Interrupt Confirmation or Data packet when in the reset indication state.

C. A packet on a non-zero logical channel when in restart indication state.

D. A Clear Confirmed on a unassigned logical channel.

E. A Reset Request when in reset request state.

F. A Restart Request when in restart request state.

G. A Clear Request when the clear request state.

H. A RR, RNR, Interrupt, Interrupt Confirmation, Reset, Reset Confirmation, Data or Call Accepted packet when in clear indication state.

The precedence among packets to be delivered to the DTE from the network is as follows:

A. Clear Indication, before

B. Reset Indication, before

C. Interrupt, before

D. Data.

When a Clear Indication is transmitted, any Reset Indication, Interrupt or Data Packets awaiting transmission are discarded by the network.

1.4.4.2. Call Setup

There are four major steps in normal call setup, which are delimited by packets sent across either the local (calling) or remote (called) DTE/DCE interface. These packets, with the direction of their transmission specified in parenthesis are as follows:

1. call request packet (local DTE to DCE),

2. incoming call packet (remote DCE to DTE),

3. call accepted packet (remote DTE to DCE), and

4. call connected packet (local DCE to DTE).

The DTE initiates call setup by sending a call request packet across the DTE/DCE interface. The network will respond to this call request packet with a clear indication packet, if it cannot set up the call. The cases where this will occur are as described below.

1. Call request packet has an invalid format (cause code in clear indication packet is "local procedure error"):

    - call user data field larger than maximum length
    - non-decimal digit in address
    - incorrect number of digits in address
    - missing facility length field
    - off-value in facility length field
    - value in the facility length field does not match the actual length of the facility field
    - the called address is not present or the calling address is invalid.

2. Call unable to be completed:

    - called address does not exist (clearing cause code is "not obtainable")
    - call collision (clearing cause code is "number busy")
    - all logical channels available for incoming calls at the called address are in use (clearing cause code is "number busy")
    - access barred because of closed user group (clearing cause code is "access barred")
    - invalid facility code or value (clearing cause code is "invalid facility request")
    - remote DTE does not accept reverse charged calls (clearing cause code is "reverse charging acceptance not subscribed").

3. Remote DTE not responding (clearing cause code is "out of order")

4. Network Congestion (clearing cause code is "network congestion")

If none of the above conditions exist then the network will send an incoming call packet to the remote DTE. This packet will contain an address field and facility fields, but the entries of these fields may have been changed by network action (i.e., the closed user group index number will normally be different since it has only local significance). The call user data field (if any) of the call request packet will be placed in the call user date field of the incoming call packet and the network will not act on the content of this field. In the case of a successful call setup the remote DTE will respond with a call accepted packet. If the facilities specified in this packet are compatible (CCITT Recommendation X.25) with the ones requested, the call will be set up by sending a call connected packet to the local DTE that originated the call. If the requested facilities are not allowed then the call will be cleared.

If is recommended that the DTE implement a time-out procedure (T21 in CCITT Recommendation X.25) on the call setup process.

The network implements an internal timer which clears the requested call, if it does not receive the call accepted packet from the remote called DTE within T11 seconds after transmitting the incoming call packet.

If the called DTE attempts to send a call request packet on the same logical channel as the one the incoming call packet is being sent on, that logical channel will go into the call collision state. In this state, the call request packet is accepted as normal and the incoming call packet is assumed to have been discarded. The calling DTE which sent the original call request packet which is associated with the discarded incoming call packet will receive a clear indication packet with the cause code DTE busy.

1.4.4.3. Data Transfer State

After the call setup procedure specified above is completed, the virtual call logical channel is said to be in the data transfer state and stays in that state until either the network, the local DTE or the remote DTE initiates a clearing or restarting. A permanent virtual circuit is continually in the data transfer state except during the restart procedure. While in the data transfer state these logical channels are allowed to send and receive data, interrupt, flow control arid reset packets and still remain in the data transfer state. There are two reset states associated with the data transfer state: DTE reset request, and DCE reset indication, which will be discussed further in Section 1.4.4.5. But if a DTE attempts to send data or interrupt packets while their local DTE/DCE interface is in either of these two states, the DCE will reset the virtual circuit. The logical channels supporting virtual calls will no longer be in the data transfer state if a clear indication packet is issued for that logical channel.

1.4.4.3.1. Data Transfer

The data packets sent and received will conform to the formats specified in Section 6.3 of CCITT Recommendation X.25. The procedures associated with the transfer of data packets will be according to Section 4.3 of CCITT Recommendation X.25 augmented by additional information specified in Sections 1.4.3.9 and 1.4.3.10 of this document. Specifically, the use and significance of D, M, and Q bits in data packets are discussed in these sections. Also, note that the maximum size of a data packet allowed to be used by the DTE is controlled by the network default packet size, the DTEs subscribed non-standard default packet size facility value or the per-call result of the flow control parameter negotiation (maximum packet size). If the DTE attempts to send a data packet larger than this agreed upon maximum, the virtual circuit will be reset with the cause "procedure error."

1.4.4.3.2. Interrupt Transfer

While in the data transfer state the DTE is allowed to send out of band data using the interrupt procedure. Using the DTE interrupt packet (format specified in CCITT Recommendation X.25 Section 6.3.2) the DTE is allowed to transfer one byte of user data to the remote DTE regardless of whether it is currently being flow controlled at the packet level. The interrupt data is delivered to the remote DTE at or before the point in the stream of data packets at which it was generated using the DCE interrupt data packet. The remote DTE confirms the acceptance of this data packet by sending a DTE interrupt confirmation packet which is passed on to the local DTE using a DCE interrupt confirmation packet. The local DTE is not allowed to issue a second interrupt packet until it receives the DCE interrupt confirmation packet associated with the first interrupt packet. If the DTE attempts to issue a second interrupt packet before the first one is acknowledged, the network will reset the virtual circuit with the cause procedure error. There is no internal network timer associated with the confirmation of interrupt packets, the network waits Indefinitely for the remote DTE to respond with an interrupt confirmation packet. During this period the local DTE Is also waiting for this confirmation, since it is not allowed to transmit any more interrupt packets until it receives this confirmation.

1.4.4.4. Clearing

For those logical channels supporting virtual calls the clearing procedures described in this Section and in Section 4.1 of CCITT Recommendation X.25 can be used to return that logical channel to the "ready" (pl) state. In this ready state the logical channel is ready to set up another virtual call using standard call setup procedures discussed above. The clearing can be initiated any time during the ready, call setup, data transfer or resetting states.

1.4.4.4.1. Clearing by the DTE

The DTE can use the clearing procedures to:

- verify that a logical channel is in the ready state (clear while in ready state)
- clear a virtual call that it is in the process of setting up (clear before receiving call confirmation)
- clear a virtual call that it does not want to accept (clear instead of call accepted packet)
- clear a virtual call that is in progress (clear during data transfer or reset phase).

The DTE initiates a clearing by sending a clear request packet across the local DTE/DCE interface. The clearing is completed when the local DTE receives a clear confirmation packet from the local DCE. It is the responsibility of the DTE to implement timer 23 to insure that the network responds to the clear request in an adequate amount of time. The clear confirmation can only be considered to have local significance. But in the case of a clearing during a virtual call in data transfer mode, this clearing may be considered to have end-to-end significance, although the clear confirmation packet has only local significance (see Section 1.4.3.8.3).

1.4.4.4.2. Clearing by the DCE

The DCE initiates clearing procedures for several reasons including: DTE procedural error, network failures and notification of a remote restart. If the clearing is initiated by the remote end of the virtual call issuing a clear request packet, then the local DCE will issue a clear indication packet, but will not pass the clearing cause field if any to the local DTE.

The network initiates a clear by sending a clear indication packet to the local DTE. Also at that time it starts timer T13, if the local DTE responds with a clear confirmation packet before the timer expires then the channel will be in the ready (pl) state. The network reaction to expiration of timer T13 will be discussed in Section 1.4.5.4.

1.4.4.4.3. Clear Collision

If' the DTE and DCE simultaneously transmit a clear request packet and a clear indication packet respectively, on the same logical channel, then the network will consider that the clearing is complete. It will assume that the logical channel is in the ready state.

1.4.4.4.4. Clearing Packet Formats

The formats used for clearing packets (clear request, clear indication, and clear confirmation) are as specified in Sections 6.2.3 and 6.2.4 of CCITT Recommendation X.25.

1.4.4.5. Reset

The reset procedure is used to reinitialize a virtual circuit and in so doing removes in each direction, all data and interrupt packets which may be in the network. Resetting procedures apply to both virtual call and permanent virtual circuits.

A. Resetting by the DTE - The DTE initiates a reset by sending across the local DTE/DCE interface a reset request packet. The reset is completed when the local DTE receives a DCE reset confirmation packet from the local DCE. It is the DTE's responsibility to Implement timer T22 to insure that the network responds to the reset request in an adequate amount of time. The reset confirmation can only be assumed to have local significance.

B. Resetting by the DCE - The DCE initiates a resetting procedure for several reasons including: DTE procedure error. The network initiates a reset by sending a reset indication packet to the local DTE. Also at that time it starts timer T12, if the DTE responds with a DTE reset confirmation packet before the timer expires then the channel will be in the flow control ready state (dl). The network reaction to the expiration of timer T12 will be discussed in Section 1.4.5.4.

1.4.4.6. Restarting

When there is a need to reinitialize all the logical channels at the DTE/DCE interface, the restart procedures may be used. This procedure clears all the logical channels supporting virtual calls putting them into the ready (p1) state and resets all the logical channels supporting permanent virtual circuits putting them into the flow control ready (dl) state. This procedure is used each time the link level is reinitialized, the restart cause used In this case is network congestion. The restart procedure also may be initialized by the DTE.

1.4.4.6.1. DTE Initiated Restarts

The DTE initiates a Restart by sending a restart request on logical channel zero. The network will respond to this request by sending a restart confirmation three seconds after receiving the request. At that time the local DTE may assume that all the permanent virtual circuit logical channels have been reset and are in the flow control ready state, and that all the virtual call logical channels have been cleared and are in the ready state. When the network received the restart request above, it also sent a reset indication to the remote end of each of restarting DTE's permanent virtual circuits and sent a clear indication to the remote end of each of the restarting DTE's virtual calls. The restart is defined to be completed when the local DCE sends the restart confirmation packet to the local DTE. This happens regardless of the state of the remote DTEs.

If the remote end of a PVC is unavailable then the local DCE will send a reset indication (cause network congestion) to the local DTE after the restart confirmation is sent. If the cause for the reset changes the local DCE will transmit another reset indication packet.

If the remote end of the permanent virtual circuit does not confirm the reset before the restart is completed, the network will queue data from the local end of that permanent virtual circuit (sent after the restart confirmation) and deliver it to the remote end when it confirms the reset. If the permanent virtual circuit is not operational then the network will transmit a reset indication packet (with the cause network congestion or out of order).

If the remote end of a permanent virtual circuit confirms the reset indication and sends data before the restart is completed, this data will be queued and delivered to the local end of the permanent virtual circuit when the restart is completed.

If the local end of a permanent virtual circuit attempts to send any packets before the restart is completed (restart confirmation received), a procedure error will result. A reset indication packet (with cause code of local procedure error) will be sent to that local DTE over that permanent virtual circuit when the restart is completed.

Any incoming calls arriving at the local DCE during the restart process (prior to sending the restart confirmation) are queued in the network. Call indication packets are sent to the local DTE after the restart confirmation packet is sent.

If the local DTE transmits any packets over logical channels used for virtual calls before the restart is completed, a procedure error will result. A clear indication packet (with cause code of local procedure error) will be sent on that logical channel when the restart process in completed.

1.4.6.6.2. DCE Initiated Restart

A DCE initiated restart is issued whenever the link level reinitializes itself. The restart cause used is network congestion. When the DCE starts this procedure by sending a restart indication packet to the local DTE, it also starts timer 110. If the local DTE responds with a restart confirmation packet before the timer expires then the interface will be in the packet level ready state (rl). The network reaction to expiration of timer T10 will be discussed in Section 1.4.5.4.

1.4.5. Network Defined Actions

In this section, the network response to various conditions (network or user generated) will be specified. These conditions are either undefined in CCITT Recommendation X.25, or have been left for further study.

1.4.5.1. Network Action on Improperly Formatted Packets

This section describes the network action on the receipt of improperly formatted packets in states where receipt of these packet types is normal.

1.4.5.1.1. Call Request Packet which is Too Short

If the DTE issues a call request packet which does not contain a facility length field, the network will clear the call.

1.4.5.1.2. Non-zero or Missing DTE Cause or Diagnostic Fields

If the user does not subscribe to the feature which allows the setting of DTE cause fields to values specified in this document, then the following procedures apply.

The bits of the cause field in a clear request packet should be set to zero by the DTE. If' the DTE included non-zero bits in this field or does not include this field, the network will clear the virtual call. The network will transmit a clear indication packet with a cause code of "local procedure error". Upon issuance of this clear indication packet, the network will also transmit to the remote DTE a clear indication packet with a cause code of "remote procedure error".

The bits of the cause field and the diagnostic code field in a reset request packet issued during a virtual call (or permanent virtual circuit) should be set to zero by the DTE. If the DTE includes non-zero bits in either of these fields or does not include these fields, the network will clear the virtual call (or reset the permanent virtual circuit). The network will transmit a clear (reset) indication packet with a cause code of "local procedure error". Upon issuance of this clear (reset) indication packet with a cause code of "remote procedure error".

1.4.5.1.3. Improperly Placed Data Fields

The network will clear the associated virtual call if a data field exist after the packet identifier of the following packets:

- Clear Confirmation,
- Reset Confirmation,
- Interrupt Confirmation,
- Restart Confirmation, or
- Call Accepted.

Clearing indication packets will be sent to the local and remote DTEs with the cause code of local and remote procedure error, respectively.

The network will also clear the associated virtual call if a data field exists after the cause code of a clear request packet or after the diagnostic code field of a reset request packet. Clearing indication packets will be sent to the local and remote DTEs with the cause code of local and remote procedure error, respectively.

1.4.5.1.4. Improperly Formatted General Format Identifier

The network transmits clear indication packets to the local and remote DTE with the cause code of local and remote procedure error, respectively for the following error conditions during a virtual call:

- GFI in other than data packets is not "0001" or "0101"
- GFI in data packets is not "0001", "1001" (Q bit on), "0101" (D bit on), or "1101" (Q and D bit on).

1.4.5.2. Network Action on Unexpected Packets

This section describes the network actions on receipt of properly formatted packets which are not expected. The actions discussed here are in addition to those cases discussed in procedural sections above.

1.4.5.2.1. Unsolicited DTE Confirmation Packets

The network will generate a restart indication packet to the local DTE on logical channel zero, with a cause code of local procedure error, upon reception of an unsolicited Restart Confirmation Packet.

The network will generate a reset indication packet to the local DTE with a cause code of local procedure error, upon reception of an unsolicited Interrupt Confirmation Packet or an unsolicited Reset Confirmation Packet. The above does not apply, when the DTE/DCE interface is in the reset indication state, in which case the unsolicited interrupt confirmation is discarded. It also does not apply, when the DTE/DCE interface is in the clear indication state, in which case both the unsolicited interrupt confirmation and unsolicited reset confirmation packets are both discarded.

1.4.5.3. Network Action on Receipt of an Unauthorized Interrupt Packet

If the DTE attempts to send a subsequent interrupt packet, the network will reset the virtual circuit.

1.4.5.4. Network Action on Expiration of Timers

This section describes the actions taken by the network on the expiration of the four packet level timers associated with an access line. The four timers and the packet which initiates the timer are as follows:

1. T10 - started when DCE issues a restart indication packet
2. T11 - started when DCE issues an incoming call packet
3. T12 - started when DCE issues a reset indication packet
4. T13 - started when DCE issues a clear indication packet

Each of these timers have values which are agreed upon with the owner of the access line during service initialization time, and can be altered like any other subscription option, the value of each timer can be set independently to any value in the following range: 15 to 915 seconds in 15 second steps.

1.4.5.4.1. Restart Indication Timer T10

Timer T10 is started when the network issues a Restart Indication packet. If timer T10 expires, the network will resend the Restart Indication packet and reset timer T10. If timer T10 expires again, the network will remain in the restart Indication state until network craft intervention. If the DTE is allowed to receive diagnostic packets, subscription option is properly set, the network will generate a diagnostic packet to indicate this condition.

1.4.5.4.2. Incoming Call Timer T11

Timer T11 is started when the network issues an Incoming Call packet. If timer T11 expires, the network will clear the virtual call and reset timer T11. At this point subsequent activity is governed by the procedures associated with timer T13.

1.4.5.4.3. Reset Indication Timer T12

Timer T12 is started when the network issues a Reset Indication packet. If timer T12 expires, the network will resend the reset indication packet and reset timer T12. If timer T12 expires a second time the resulting activity depends on whether the effected virtual circuit is a permanent

virtual circuit or a virtual call. If it is a PVC, the circuit will remain in the reset indication state until network craft intervention (a diagnostic packet will also be sent if the DTE is allowed to receive it). If the circuit supports a virtual call, then it will be cleared and subsequent activity is governed by the procedures associated with timer T13.

1.4.5.4.4. Clear Indication Timer T13

Timer T13 is started when the network issues a Clear Indication packet. If timer T13 expires, the network will resend the clear indication packet and reset timer T13. If timer T13 expires a second time the circuit will remain in the clear indication state until network craft intervention (a diagnostic packet will also be sent if the DTE is allowed to receive it).

1.4.5.5. Maintenance Procedures

If network operations initiates an action that results in a virtual call being cleared, a permanent virtual circuit being reset or an access line being restarted, the network defined diagnostic code #135 (Operator Invoked Call Termination) will be given in the diagnostic field.

1.4.5.6. Network Defined Diagnostic Codes

The following diagnostic codes are supported in addition to those defined in the CCITT X.25 Recommendation.

DIAGNOSTICS	BITS 8 7 6 5 4 3 2 1	DECIMAL
Inconsistent Q-bit	1 0 0 0 0 0 0 0	128
DTE has not subscribed to fast select	1 0 0 0 0 0 0 1	129
Non-DTE originated cause field	1 0 0 0 0 0 1 0	130
Packet size incompatible	1 0 0 0 0 0 1 1	131
M-bit without D-bit on non-full packet (X.75 only)	1 0 0 0 0 1 0 0	132
Call rejected because of operator's Refuse command	1 0 0 0 0 1 0 1	133
PVC service data fatal error	1 0 0 0 0 1 1 0	134
Operator invoded call termination	1 0 0 0 0 1 1 1	135
Accept too long (X.25-76 only)	1 0 0 0 1 0 0 0	136
DTE call on IVC channel (X.25 only)	1 0 0 0 1 0 0 1	137
DTE call on PVC channel (X.25 only)	1 0 0 0 1 0 1 0	138
Call missing source address (hunt group)	1 0 0 0 1 0 1 1	139

Call with incorrect source address	1 0 0 0 1 1 0 0	140
(X.75 with wrong DNIC only)		
Link level disconnected	1 0 0 0 1 1 0 1	141
Link taken out of service	1 0 0 0 1 1 1 0	142
Idle timer probe expired	1 0 0 0 1 1 1 1	143
Bad cause field	1 0 0 1 0 0 0 0	144
Destination address on direct call only interface	1 0 0 1 0 0 0 1	145
Octet not aligned when alignment subscribed	1 0 0 1 0 0 1 0	146
Non-zero facility area at X.75 gateway	1 0 0 1 0 0 1 1	147
Badly constructed facility/utility area	1 0 0 1 0 1 0 0	148
Non-zero address on packet	1 0 0 1 0 1 0 1	149
Double interrupt received from subnet	1 0 0 1 0 1 1 0	150
Unexpected interrupt confirm received from subnet	1 0 0 1 0 1 1 1	151
Restricted fast select only	1 0 0 1 1 0 0 0	152
Incompatible PVCs	1 0 0 1 1 0 0 1	153
Local window is negative	1 0 0 1 1 0 1 0	154
Fields are missing from the packet	1 0 0 1 1 0 1 1	155
The address length is bad	1 0 0 1 1 1 0 0	156
The facility length is bad	1 0 0 1 1 1 0 1	157
A field within the packet is incomplete	1 0 0 1 1 1 1 0	158
The throughput class specified is incompatible	1 0 0 1 1 1 1 1	159
with the options subscribed		
The hunt group is not activated	1 0 1 0 0 0 0 0	160
The hunt group is not available	1 0 1 0 0 0 0 1	161
The hunt group is disallowed	1 0 1 0 0 0 1 0	162
Data network address fail	1 0 1 0 0 0 1 1	163
To be specified	1 0 1 0 0 1 0 0	164
The format of the utility is bad	1 0 1 0 0 1 0 1	165
Non-zero utility on packet	1 0 1 0 0 1 1 0	166
Non-zero user data on packet	1 0 1 0 0 1 1 1	167

No national facility marker on packet	1 0 1 0 1 0 0 0	168
Call was blocked by the block same service option	1 0 1 0 1 0 0 1	169
Area code - DNIC table locked temporarily	1 0 1 0 1 0 1 0	170

2. Technical Interface Specifications for X.25 Service over a Bolt Bernack Newman (BBN) Platform

2.1. Introduction

This report specifies the attachment of an X.25 host to a Bolt Bernack Newman (BBN) Packet Switching Node (PSN). In particular, this report describes specific options and features of CCITT Recommendation X.25 (1980) and Federal Information Processing Standard (FIPS) 100/ Federal Standard (Fed. Std.) 1041 (July 1983). In some cases it describes the operation that a DTE can expect of a BBN PSN DEC, (Packet Switching Node) Data circuit terminating equipment while in others it specifies properties required of a host X.25 Data Terminal Equipment (DTE) implementation to enable that host to communicate with a BBN X.25 PSN. This report, on conjunction with FIPS 100/Fed. Std. 1041, should enable site managers or others planning to attach a host to the BBN packet network by means of X.25 to determine, first, whether or not the X.25 implementation of the host in question is adequate for operation wit the BBN PSN, and second, what options, parameter settings, etc. may be selected for operation with that network.

This report assumes that the reader is familiar with CCITT Recommendation X.25 and FIPS 100/Fed. Std. 1041. A copy of FIPS 100/Fed. 1041 is attached as Appendix C of this report.

In this document, the term, “Administration” refers to the organization, within BBN, responsible for the day-to-day management of X.25 network.

2.1.1. Recommendation X.25 and FIPS 100/Federal Standard 1041

The CCITT Recommendation X.25 describes the interface between host computers (data terminal) equipment, or DTEs) and data circuit-terminating equipment (DCEs, which effect communication with remote hosts over computer networks) for hosts operating in the packet mode on public data networks. The X.25 interface standard is defined as three independent architectural levels, following the Open Systems Interconnection (DSI) Reference Model. The three levels are:

Level 1:	The PHYSICAL level of the connection. The physical, electrical, function, and procedural characteristics to activate, maintain, and deactivate the physical link between the DTE and the DCE.
Level 2:	The LINK level of the connection. The link access procedure for data interchange across the link between the DTE and the DCE.
Level 3:	The PACKET level of the connection. The packet format and control procedures for the exchange of packets containing control information and user data between the DTE and the DCE, and between the DTE and a remote DTE.

CCITT Recommendation X.25 contains many options and implementation choices. FIPS 100/Fed. Std. 1041, which specifies the general use of X.25 for the Federal Government, defines some of the choices left open in X.25. BBN packet switches follow procedures that are in compliance with FIPS 100/Fed. Std. 1041 in areas where Recommendation X.25 allows a choice. In several areas when both of these documents allow a choice, a single choice not in conflict with FIPS 100/Fed. Std. 1041 is specified; in area which X.25 leaves unspecified, addressing in particular, conventions are specified that are consistent with restrictions specified in Recommendation X.25 and FIPS 100/Fed. Std. 1041. The address formats used by the BBN X.25 PSN are consistent with CCITT Recommendation X.121. The effect of this approach is to make X.25 service available to hosts in BBN's packet network in a way that requires no changes to a host DTE implementation that is compliant with FIPS 100/Fed. Std. 1041 and CCITT Recommendation X.25. By implementing extensions described in this specification, a host will be able to take advantage of additional BBN PSN features not required of X.25 networks.

This report specifies the BBN X.25 interface, with respect both to any mandatory features not yet implemented and to any optional or additional features already implemented. Future releases of the BBN PSN should not prevent proper operation of DTEs that comply with this specification.

The reader is referred to CCITT Recommendation X.25 and to FIPS 100/Fed. Std. 1041 for detailed information not provided in the body of this specification.

2.1.2. Compliance

2.1.2.1. Compliance with Recommendation X.25 and FIPS 100/Fed. Std. 1041

The BBN X.25 PSN Interface Specification is compliant with CCITT Recommendation X.25 and FIPS 100/Fed. Std. 1041. The BBN DCE supports most facilities specified and E (essential) by FIPS 100/Fed. Std. 1041, and some facilities specified as A (additional). Future releases of the BBN PSN will support all essential and most additional facilities. Section 2.4.2 contains a com-

plete list of all the X.25 facilities and indicates which are supported, or will be supported, by the BBN X.25 DCE.

X.25 DTEs attached to BBN X.25 DCEs may support any or all facilities specified as either E or A by FIPS 100/Fed. Std. 1041. X.25 DCEs attached to BBN X.25 DCEs must not use the facilities identified in Section 2.4.2 that are not supported by the BBN X.25 DCE. Calls requesting unsupported facilities will be cleared.

2.1.2.2. DTE Compliance with this Specification

This document specifies several areas in which the BBN X.25 DCE allows a choice of modes of operation. For example, Table 2.1 lists a number of signaling rates supported by the DCE. In such cases, an X.25 DTE must implement at least one of the options listed (or the set of options required of the FIPS 100/Fed. Std. 1041) but need not implement all of the options listed. Determining the adequacy of the options supported by a DTE vendor for meeting a host's requirements is the responsibility of the host administrator.

In addition to the CCITT Recommendation X.25 and FIPS 100/Fed. Std. 1041 requirements, X.25 DTEs attached to BBN PSNs may wish to take advantage of additional features that are compatible extensions to the public standards. Implementation of an additional feature by a host is required only if the host wishes to take advantage of the service or information provided by the feature. For example, a host, that wishes to establish calls only at the default priority level assigned to it need not implement the priority negotiation facility described in Section 2.5.4.2. However, a host that wishes to have flexibility in the priority of the calls it establishes must implement this facility.

Any deficiencies with respect to this specification in a vendor-supplied X.25 DTE implementation contemplated for use with the BBN X.25 DCE should be rectified so as to attain compliance with this specification. An X.25 DTE that is not compliant with this specification cannot be guaranteed and should not expect proper operation with a BBN PSN.

2.1.3. Summary of Features

The BBN PSN supports two physical interface standards, RS-232C and V.35, at clock rates from 9.6 to 64 kilobits per second (Kb/s). Physical line status is sampled using incoming status interchange circuits.

The BBN PSN link level interface supports LAPB procedures. Link level status monitoring during LAPB operation is accomplished using a transparent idle-link polling mechanism. DCE link level parameters are configurable.

The BBN PSN packet level interface supports both virtual call and permanent virtual circuit (PVC) services, using the full range of logical channel numbers of 1 to 4095. Most procedures,

including packet acknowledgment, CLEAR AND RESET, have end-to-end significance. Among the optional facilities supported by the BBN X.25 DCE are flow control parameter negotiation, call barring, one-way logical channels and fast select. Non-CCITT facilities include a flexible logical addressing facility which permits hunt groups, call redirection, multiple circuits to the same DTE and multiple DTEs with the same address.

Chapters 2, 3, and 4 describe the physical, link, and packet level interfaces to the BBN X.25 PSN, respectively. A full list of optional user facilities supported by the BBN X.25 PSN is given in Section 2.4.2. Chapter 5 contains conventions to be used to establish calls through networks via the BBN X.25 DCE, as well as complete descriptions of the private facilities available on BBN X.25 PSNs.

2.2. Physical Level Specifications

The BBN X.25 PSN physical level specification is in conformance with FIPS 100/Fed. Std. 1041 and CCITT Recommendation X.25. This section presents additional information.

A X.25 DTE attached to a BBN X.25 PSN is connected via an access line. The access line interface is defined by BBN packet switching 56, 19.2, and 9.6 KBPS synchronous interface specifications. Appendix B of this document describes in detail the choices of physical interface that are made available to a host DTE attached to a BBN X.25 PSN and the specifications for each type of interface. Table 3.1, below summarizes the physical interfaces available at each data rate supported by the BBN X.25 DCE.

An X.25 DTE may implement more that one signaling rate. At each signaling rate implemented, the DTE must offer at least one of the physical interface options listed as “A” (available) for that rate in Table 3.1. DTE implementors area encouraged to offer the widest variety of signaling

rates and physical interfaces practical to maximize the flexibility of use of their equipment with the BBN X.25 PSN.

	Signaling Rate in Kb/s		
Physical Interface	9.6	19.2	48 and above
RS-232-C (and equiv.)	A	A	-
CCITT V.35	-	-	A

Legend:
A = Available; - = Not Available.

(Taken from Appendix B, Table B-3)

Table 2-1 - BBN X.25 Physical Signaling Rates and Interfaces

2.3. Link Procedures

BBN X.25 link level procedures are as specified by CCITT Recommendation X.25 and FIPS 100/Fed. Std. 1041. This section presents additional information.

2.3.1. Link Level Parameters and Options

1. The default value of K, the maximum number of sequentially numbered I frames that the DCE will have outstanding (unacknowledged) at any given time, is seven. The Administration may configure a BBN X.25 DCE to have an optional value of K from one to seven.

2. The default value of N2, the maximum number of transmission and re-transmission of a frame by the DCE following the expiration of the T1 timer, is twenty. The Administration may configure a BBN X.25 DCE to have an optional value of N2 from one to 200.

3. The optional 32-bit Frame Checking Sequence (FCS) is not supported.

2.3.2. Timer T1 and Parameter T2

The period of the timer T1 used by the BBN X.25 DCE reflects assumptions about the processing speed of the DTE. The DCE assumes that parameter T2, the response latency of the DTE to a frame from the DCE, is no greater than 1/2 second. Likewise, the DCE guarantees that its

parameter T2, the latency in responding to frames from the DTE, is 1/2 second for signaling rates of 19.2 Kb/s or slower, and 1/4 second for faster links.

T1 may be computed to by 4x + T2, based on the assumptions that the link propagation time in negotiable, the worst-case frame is scheduled for output, that each frame is scheduled just as transmission of the previous frame starts, that frames are not aborted, and that each frame and its predecessor are of maximum length N1 = 8248 bits (see Section 2.3.3 below).

As an example, for a signaling rate of 9.6 Kb/s, this yields X = /86 sec. If T2 is .5 sec., the total time for the DTE to respond in the worst case should be 3.9 seconds. In fact, the DCE uses a T1 timer value of 4 seconds for a link speed of 9.6 Kb/s.

In no case does the DCE use a value for T1 smaller than 3 seconds. This means that, for faster links, the DTE's T2 parameter may be lengthened because the X term in the above formula is smaller.

The DTE may choose any value for T1 that is compatible with the DCE's T2 parameter values. The value of T1 used by the DTE may always be set longer than the formulas indicates, with the result that recovery form certain types of link errors will be slower. However, the DCE's parameter T2 cannot be reduced, so the formulas should be viewed as yielding a lower bound on the DTE's T1 timer.

2.3.3. Maximum I Frame Size

The maximum number N1 of bits in an I Frame is 8248, accommodating a data packet with up to 1024 data octets. The derivation of this number is shown in Table 3.1.

Field Name	X.25 Level	No. of Bits
Address	2	8
Control	2	8
General Format Identifier	3	4
Logical Channel Number	3	12
Packet Type	3	8
User Data	3	8192 (max)
Frame Check Sequence	2	16
TOTAL		8248 (max)

Table 3.1 - Derivation of Maximum I Frame Size

2.4. Packet Level Procedures

BBN X.25 packet level procedures are as specified by CCITT Recommendation X.25 and FIPS 100/Fed. Std. 1041. The following additional information is provided.

1. The maximum window size that may be negotiated is seven.

2. Modulo 128 packet level sequence numbering is not supported.

3. Maximum packet sizes of 16, 32, 64, 128, 256, 512, and 1024 octets may be negotiated.

4. The BBN X.25 DCE uses additional packet level diagnostic codes as specified in Table 4.1. X.25 DTEs attached to BBN's X.25 DCEs may, but are not required to, make use of the information conveyed by these codes.

5. The Qualifier bit (Q-bit) is passed transparently by the BBN X.25 DCE. DTEs may use the Q-bit in any way that is consistent with FIPS 100/Fed. Std. 1041.

6. The BBN X.25 DCE implements the diagnostic packet. It is sent under conditions specified in Annex D of CCITT Recommendation X.25. The DTE is not required to act on the information provided in diagnostic packets.

2.4.1. Exception-Handling Procedures

Certain of the exception- or error-handling procedures of the BBN X.25 DCE differ in detail from the procedures specified in FIPS 100/Fed. Std. 1041. These differences are described below. These variances in the procedures will not preclude satisfactory operation between the DCE and a DTE, provided the DTE operates in accordance with FIPS 100/Fed. Std. 1041.

2.4.1.1. Non-Octet-Aligned Data

Data packets received by the BBN X.25 DCE that are not aligned on an octet boundary are discarded at the link level. They are not passed to the DCE packet level, and no packet level diagnostic code is returned to the DTE.

2.4.1.2. Restart Request Packet

The BBN X.25 DCE will not discard, but will instead act upon a RESTART REQUEST packet that

1. is too long (unless it exceeds the maximum frame size for the link level) or,
2. contains a non-zero cause field.

2.4.1.3. Reset Request Packet

The BBN X.25 DCE will not discard, but will instead act upon, a RESET REQUEST packet that contains a non-zero reset cause field.

2.4.1.4. Clear Request Packet

The BBN X.25 DCE will not discard, but will instead act upon, a CLEAR REQUEST packet that contains a non-zero reset cause field.

2.4.2. BBN X.25 Optional User Facilities

Following is a list of facilities provided by the BBN PSN, together with an indication (E or A) showing its category in FIPS 100/Fed. Std. 1041. Private facilities are described in Chapter 5 below. Facilities that apply to both virtual call and PVC service are available for both if they are in this list:

E	Flow control parameter negotiation (both window size and packet size).
E	Incoming calls barred.
E	Outgoing calls barred.
E	One-way logical channel outgoing.
A	One-way logical channel incoming.
A	Fast select acceptance.
A	Fast select.
	Nonstandard default priority (Private).
	Communities of interest (Private).
	Priority negotiation (Private).

The following facilities are not supported by the BBN PSN. Support of facilities marked * is planned for future releases of the BBN X.25 PSN. FS = further study is required; DG = datagram-related facility, which is not required of DCEs by FIPS 100/Fed. Std. 1041. Datagram service is expected to be removed from Recommendation X.25 in the 1984 revision:

A*	Extended packet sequence numbering.
A*	Non-standard default window sizing.
A*	Non-standard defualt packet sizes 16, 32, 64, 256, 512, 1024.
A*	Default throughput class assignment.
E*	Throughput class negotiation.
A	Packet retransmission (FIPS 100/Fed. Std. 1041 specifies that packet retransmission shall not be used).
E*	Closed user group.
A	Closed user group with outgoing access.
A*	Closed user group with incoming access.
A*	Incoming calls barred within a closed user group.
A*	Outgoing calls barred within a closed user group.
A	Bilateral closed user group.
A	Bilateral closed user group with outgoing access.
A*	Reverse charging acceptance.
DG	Datagram queue length selection.
DG	Datagram service signal logical channel.
DG	Datagram non-delivery confirmation.
DG	Datagram delivery confirmation.
A*	D Bit Modification.
A*	Closed user group selection.
A	Bilateral closed user group selection.
A*	Reverse charging.

A*	RPOA Selection.
FS	Abbreviated address calling.
*	Call accounting (Private).
*	Nonstandard default accounting (Private).
*	Accounting negotiation (Private).

2.4.3. Additional Diagnostic Codes

The BBN X.25 DCE will provide additional information to DTEs in RESTART, RESET, CLEAR INDICATION, AND DIAGNOSTIC packets by means of diagnostic codes that are extensions to the set of diagnostic codes given in Annex E of CCITT Recommendation X.25. These codes are taken from the set of codes “reserved for network specific diagnostic information,” and are thus not in conflict with code assignments made in Annex E. The values of these codes, and their meanings, are given in Table 4.1

Code Value	Meaning
128	PSN is unavailable. The packet-forwarding mechanisms of the network are unavailable to the DCE. Sent in RESET, CLEAR and RESTART packets.
130	Link level came up. Sent in RESTART and RESET packets.
131	Link level went down at remote DTE. Sent in CLEAR and RESET packets.
132	Remote DTE restarted. Sent in CLEAR and RESET packets.
133	Local resources not available for call establishment. The local DCE has too few resources to establish another call. Sent in CLEAR and DIAGNOSTIC packets.
134	Remote resources not available for call establishment . th remote DCE has too few resources to establish another call. Sent in CLEAR packets.
136	Remote host dead. The link to the remote DTE is down. Sent in CLEAR and RESET packets.
137	Remote PSN dead. The PSN to which the remote DTE is attached is down. Sent in CLEAR and RESET packets.
138	Logical subnetwork access barred. The remote DTE cannot be reached because of a communities -of-interest prohibition. Sent in CLEAR and RESET packets.
139	Connection lost. An internal error has occurred at either the remote or the local DCE which has made their virtual circuit data structures inconsistent. Sent in CLEAR and RESET packets.

140	Response lost. A response from the remote DCE failed to arrive within a reasonable time. Sent in CLEAR and RESET packets.
141	Calling logical address not enabled or not authorized. Sent in CLEAR packets.
142	Calling logical name incorrect for this DTE. Sent in CLEAR packets.
143	Called logical name not authorized. Sent in CLEAR packets.
144	Called logical name not enabled. Sent in CLEAR packets.
145	Called logical name has no enabled DTEs. Sent in CLEAR packets.
147	Delcared logical name now in effect. Sent in CLEAR packets.
148	Declared logical name was already in effect. Sent in CLEAR packets.
149	Declared logical name is now disabled. sent in CLEAR packets.
150	Declared logical name was already disabled. Sent in CLEAR packets.
151	Incoming calls barred. Sent in CLEAR packets.
152	Outgoing calls barred. Sent in CLEAR packets.

Table 4.1 - Additional Packet Level Diagnostic Codes

2.5. Call Establishment Conventions

This section specifies X.25 call establishment conventions in networks consisting of BBN X.25 PSNs. The Call Establishment Conventions listed below will be adapted to Bell Core Research's (BCR) LADT addressing specification. The details of this specification are not finalized at this point but a brief explanation is covered in Section 2.6.

2.5.1. Addressing

Addresses are assigned to subscriber DTEs by the Administration. Two basic forms of address are supported: physical addresses, which correspond to the node number and DCE port number of the PSN to which the DTE is connected, and arbitrary addresses, which are mapped transparently in the BBN X.25 PSN into a corresponding physical network address. Each DTE port on a BBN PSN will be assigned one or more arbitrary addresses. A calling DTE need not be aware of whether a given address is a physical or arbitrary address, in order to establish a call to that address.

2.5.1.1. Address Formats and Fields

BBN X.25 DCEs utilize an address format that is consistent with CCITT Recommendation X.1211. Addresses have the following format:

2.5.1.1.1. Prefix

The Prefix field is used to tell the PSN whether or not to look for a DNIC in the following digits. If the prefix is supplied the PSN will assume that the four digits contain the DNIC of the called user. If no prefix digit is supplied then the PSN will assume that the call is an Intra-network call and that the first three digits contain the DNPA.

2.5.1.1.2. DNIC

The DNIC field is made up of a three digit Data Country Code followed by a Network Digit. The DNIC is issued via the FCC. BBN has not been issued a DNIC at this time. For now the DNIC field should be populated with zeros.

2.5.1.1.3. DNPA

The DNPA is the same as the corresponding voice NPA that the called data user resides in.

2.5.1.1.4. DCO - Data Central Office

The DCO is the same as the corresponding voice central office code that the called data user resides in.

2.5.1.1.5. End Point Number

The EPN serves two purposes: to specify the host port on the PSN and to provide network and customer PADs the capability to map an incoming call to a specific port or hunt group. As far as network routing is concerned we do not interrogate the last two digits in the EPN.

2.5.2. Arbitrary Addressing Facility

The Arbitrary Addressing Facility is based on CCITT recommendation X.121. The basic Inter-network/International Address contains a maximum of 14 digits. Intra-network routing is based upon the DNPA + DCO + first two digits of the End Point Number. These 8 digits arbitrarily map to a physical address within the BBN network. The last two digits of the End Point Number are not used by our network for routing to a X.25 port. The last two digits are made available to allow PAD vendors to use these digits to map a call to a particular asynchronous port. In any

case the entire 10 digit Intra-network address (DNPA + DCO + EPN) is issued by BBN and the number is a valid non-working telephone number in the serving LATA. It is up to the various PAD vendors to support the full range of 0-9 numerics in the last two digits of the EPN (i.e. NXX+NXX+XX95) may be mapped to any particular asynchronous port).

2.5.3. Supplying Missing Address Information

The BBN X.25 DCE incorporates a mechanism to supply missing address information in CALL REQUEST and CALL ACCEPTED packets received from an attached DTE. This mechanism is useful in DTE software testing and physical address determination.

If a DTE sends a CALL REQUEST packet with no calling address field, the local DCE will insert the physical calling DTE Address with no subaddress field. If a DTE sends a CALL REQUEST or CALL ACCEPTED packet with either or both calling or called addresses that contain zeros the local DCE will replace the DTE Address field with the physical address of the DTE.

DTE implementors are cautioned that use of this mechanism in accepting calls to a DTE's logical address (See Section 2.5.2) can result in confusion on the part of the calling DTE and is not advised.

2.5.4. PSN-Specific facilities Assigned by Administration

2.5.4.1. Communities of Interest

The X.25 PSN community of interest facility is a simple form of closed user group implemented independently from the CCITT closed user group facilities.

This facility permits the Administration to designate communities of interest which are groups of hosts interested in communicating with each other. Furthermore, the Administration is permitted to assign to any host membership in any set of these groups. The community of interest facility requires no negotiation or other activity on the part of the hosts.

PSNs contain a data base which contains, for each DTE, a list of the communities of interest to which it belongs. Whenever a DTE wishes to establish a virtual call, its membership list is compared to that of the called DTE, and the connection is not permitted unless there is at least one group in common between the two hosts.

This facility differs from the closed user group facility of CCITT Recommendation X.25 in the following ways:

- The facility is not the subject of call negotiation.

- The facility is always bidirectional, in the sense that all group members can either receive or make calls.

2.5.4.2. Extended User Data Fields

The BBN PSN allows user data fields to be contained in all CALL, CLEAR, INTERRUPT, and RESET packets. The limitation on total packet size is only the applied to DATA packets. Thus, for example, if the maximum packet data length is set at 1024 octets, a maximal data packet (including level 3 header) will be 1027 octets. The CALL, CLEAR, INTERRUPT, and RESET packets, then, are checked only for total lengths less than 1027 octets. For example, if a CALL packet requires a header of 18 octets, this feature would permit inclusion of a user data field of up to 1009 octets in the packet. This facility is a permanent part of the BBN PSN. No configuration option need be specified to request it.

2.5.5. BBN PSN-Specific Facilities Requested on a Per-Call Basis

BBN PSN-specific features are requested by means of “private” or non-CCITT facilities in CALL REQUEST and CALL ACCEPTED packets. If a private facility is requested in a CALL REQUEST or CALL ACCEPTED packet, it must follow all CCITT Recommendation X.25 facilities and must be preceded by a single facility market, which is two octets of zero.

2.5.5.1. Call Priority

All packets that cross the network indicate normal or high priority with respect to network resources required within the network. In particular, at every point where packets must be queued to await service, tow queues are maintained. The high priority queue receives service prior to the normal priority queue.

the Administration can select a priority to be used for all packets sent on a PVC.

The priority of a virtual call is negotiated by an X.25 DTE by means of a private facility two octets long, coded as:

00000100 000x0000

where X is the priority, 0 (normal priority) or 1 (high priority). If this facility is not used, the all will be established at the network default priority.

2.5.6. Logical Channel Assignment

The assignment of logical channels by the BBN X.25 DCE follows the requirements and guidelines of FIPS 100/Fed. Std. 1041 and Annex A of CCITT Recommendation X.25. Within the

guidelines of CCITT Recommendation X.25 Annex A, the range of logical channel numbers assigned to permanent virtual circuits, incoming, two-way, and outgoing virtual calls for a BBN X.25 DCE is configured by the Administration.

X.25 DTE's attached to BBN X.25 PSNs should follow the logical channel selection requirements of FIPS 100/Fed. Std. 1041.

2.6. PPSN Addressing

Complete finalized information concerning PPSN addressing is not available at this time but it will be added to this document when Bell Communications Research (BCR) formally releases the information. The basic details concerning BBN's arbitrary addressing is covered in Section 2.5 Call Establishment. The following information primarily covers BCR's recommendations for Inter-network addressing.

The basics of the PPSN addressing scheme is as follows:

BBN's network will support Arbitrary Network Addresses consisting of the digits of the form:

NXX - XXX - XXXX

X = 0 through 9

N = 2 through 9

LNAs in a PPSN (PUB54211) are permitted after the telephone dialing plan. The field of the first six digits uniquely identifies a packet switch (PS). The first three digit field of the PS identifier is the Data Numbering Plan Area (DNPA) code. The second three digit field is the Data Central Office (DCO) code. For the PPSN network. DNPAs are made identical to the Numbering Plan Areas (NPAs) in the DDD Network. The last four digit field called the End Point Number (EPN) identifies one or a group of PS ports.

BBN's network will also support X.121 International Data Numbers (IDNs) consisting of a digit decimal number of up to 14 digits in length. IDNs are used for internetwork calls.

A prefix of 1 will indicate the presence of a IDN to avoid confusing PPSN LNA's with DNSs of other PDNs which may be 10 digits in length.

2.6.1. Call Routing for PPSN

There are four types of PPSN calls, namely: intraLATA call, interLATA call, internetwork call, internetwork call via IC. The following elements are added to aid proper routing.

1. A ”1” may be prefixed to the called number, which instructs the network to interpret the digits following the 1-prefix as a DNIC. If the 1-prefix is not present then the PPSN DNIC is implicit, and the called address is taken to be a PPSN LNA.

2. If the originating LATA interfaces directly with the destination, non-PPSN data network, the calls are routed to the network by DNIC only.

3. The Recognized Private Operating Agancy (RPOA) facility of CCITT Recommendation X.25 is used to carry the DNIC of an IC to enable carrier selection for the interLATA and the internetwork-via-IC calls.

4. When an interLATA PPSN call is handled by the IC, the IC routes the call based on the DNPA-DCO pair of the LNA in conjunction with the PPSN DNIC. All the information is contained in the Call Request packet.

5. In a non-PPSN data network interfaces directly with the PPSN network, that network has to be able to interpret the DNPA-DCO pair in order to terminate a PPSN-bound call. If a network does not have this capability, it will rely on a IC to deliver the Call Request packet to the proper LATA.

With these additions, it should be evident that a call will be routed properly to its destination under all circumstances.

Appendix A

Alignment to Recommendation X.25

This appendix contains notes which help to clarify the functional characteristics of the BBN X.25 DCE. It is organized by reference to the relevant section of the CCITT Recommendation X.25. Numbers in square brackets indicate sections of that recommendation.

A.1. The Link Level DTE/DCE Interface

A.1.1. Scope and Field of Application (2.1)

The BBN PSN supports the LAPB class of procedures. Use of LAPB provides for superior error recovery and link monitoring procedures by the DCE.

A.1.2. Frame Structure (2.2)

The address and control fields consist of one octet each. BBN PSNs do not support the extension of either the control or the address fields. The frame is required by the implementation to consist of an integral number of octets. The BBN PSN maintains interfame time fill between

frames; detection of idle channel state by the DTE would imply that the DCE is not service the link.

A.1.3. Elements of Procedure (2.3)

A.1.3.1. Elements of Procedure (2.3)

A.1.3.1. Control Field Parameters - Modules (2.3.2.3)

I frames are numbered sequentially modulo 8. Extended numbering (modulo 128) is not supported.

A.1.3.2. Rejection condition (2.3.5.6)

After entering rejection condition by the transmission of a FRMR or CMDR frame, the DCE will retransmit the frame every T1 seconds. After N2 retries without a reset by the DTE, the DCE will reset the link by sending a SABM.

A.1.4. Procedures for the Use of the POLL/FINAL Bit (2.4.3)

The POLL/FINAL bit is used by the DCE in conjunction with the timer recovery condition.

The DCE starts timer T1 whenever it schedules for transmission a frame which requires a response from the DTE, and it is not already running. When timer T1 runs out before the needed response is received from the DTE, the DCE (re)enters the timer recovery condition and transmits an appropriate command with the POLL bit set to 1. The timer recovery condition is cleared when the DCE receives from the DTE a valid unnumbered or supervisory response with the FINAL bit set to 1.

The DCE also uses the T1 timer in connection with automatic transmit mode in the disconnected phase. In this mode, it will keep the T1 timer running and transmit a DM response to request a mode-setting command from the DTE each time it expires.

When the link is in the information transfer phase, the DCE will ensure in the absence of I frames that the DTE link level procedures are operable by periodic transmission of an S frame with POLL bit set to solicit a response from the DTE with the FINAL bit set. Failure of the DTE to respond to this command will initiate timer recovery procedures by the DCE. The DTE need make no special allowance for this procedure, since its procedures in responding to the S frame command are simply those it must employ according to Recommendation X.25.

A.1.5. Procedures for Link Setup and Disconnection (LAPB) (2.4.5)

A.1.5.1. Link Set-up (2.4.5.1)

If the DCE attempting to set-up or reset the link transmits a SABM command N2 times, its recovery action is to attempt to disconnect the link.

A.1.5.2. Link Disconnection (2.4.5.3)

If the DCE transmits a DISC command N2 times, its recovery action is to send a DM response and enter the disconnected phase.

A.1.5.3. Disconnected Phase (2.4.5.4)

The PSN will not initiate link set-up while in the disconnected phase. However, if it is in automatic transmit mode, it will indicate a request for a link set-up command by transmitting a DM response every T1 seconds.

The PSN in disconnected phase will react only to the frames listed below:

- SABM will initiate a link set-up, and selects LAPB procedures.
- FRMR received when the B variable is 1 (i.e., the last link set-up was by a SABM command) will be answered with a DM.
- DISC received when the B variable is 1 will be answered with a DM response.
- DM will cause the DCE to initiate a link set-up, by sending a SABM if the B variable is 1.
- Any other command received with the poll bit set will be answered with a DM response with the final bit set.

All other frames will be ignored.

A.1.6. Receiving an I Frame (2.4.6.2)

DCE behavior in regard to acknowledgment of I frames can be summarized as follows:

When an I frame is correctly received from the DTE, the DCE starts a timer associated with parameter T2, if it is not already running.

If K2 I frames have been received and not acknowledged, or if no I or S frames are available for transmission before the timer expires, the DCE will transmit and S frame response to carry the value of V (R).

The DCE will stop the timer whenever it sends out a frame containing a N(R), i.e., an S or I frame).

DCE busy condition may cause the I field of incoming I frames to be ignored; please refer to the following section for details. I frames containing zero length information fields are indicated to the packet level in the received frame. The DCE ignores frames containing a non-integral number of octets.

A.1.7. DCE Busy Condition (2.4.6.7)

The DCE has two levels of the busy condition in the first level, called slow mode, any received I frames are accepted by transmission of an RNR response. In the second level, called stop mode, the DCE will discard any I frames it receives from DTE until the DCE leaves the busy condition, and will continue to reply with RNR responses. The decisions to enter and leave the two modes of each DCE busy condition are controlled by three parameters, which describe the length of the queue of packets to level 3 in the DCE. Values for these parameters are given in Section A.1.11 below.

To clear the busy condition, the DCE will send a REJ or RR supervisory frame, depending upon whether or not it knowingly discarded any I frames.

A.1.8. Waiting Acknowledgment (2.4.6.8)

When the T1 timer runs out before a transmitted I frame is acknowledged by the DTE, the DCE will restart timer T1. The DCE will transmit an appropriate supervisory command (RR or RNR) with the POLL bit set to 1.

Upon N2 retransmissions of the S or I frame command without an appropriate response, the DCE will reset the link by transmission of a SABM command.

A.1.9. Procedures for Resetting (Applicable to LAPB) (2.4.9)

The DCE does start the T1 timer whenever it sends a FRMR response, and will retransmit the FRMR response each time it expires. After N2 retransmissions of the FRMR response, it will attempt to reset the link using a SABM command.

A.1.10. Rejection Conditions (Applicable to LAPB) (2.4.10)

A.1.10.1. Receiving DM or FRMR in Information Transfer Phase (2.4.10.2)

If the DCE receives a DM response during the information transfer phase, it will transmit a DM and enter the disconnected phase. If the DCE receives a FRMR

response during the information transfer phase, it will initiate a resetting procedure. If it receives a spurious UA response during the information transfer phase, the DCE will reset the link by sending a SABM command. Any unexpected frame, or frame with an unexpected final bit, will cause the DCE to enter frame rejection condition and transmit a FRMR response.

A.1.11. Level 2 Implementation-Specific System Parameters

The DCE has three parameters associated with the Busy Condition. The first, whose default value is four, indicates the number of I frames that may be queued awaiting packet level processing before the DCE enters the busy condition slow mode, in which received frames are acknowledged with an RNR response. When the number of items queued for Level 3 reaches the second parameter, whose default value is two, the DCE enters the busy condition stop mode, in which received I frames are discarded. When the number of items queued for Level 3 while in the busy condition falls to the third parameter, whose default value is one, the DCE leaves the busy condition. The Administration may configure each of these parameters for each BBN DCE to any value between one and seven.

When receiving I frames, the DCE never allows more than K2 frames to be received without sending a frame that carries N(R) (that is, an I or S frame). This is an attempt to keep the DTE's transmit window from closing. K2 must always be equal to or less than K, and should be reduced for lines that have long delay, such as satellite lines. The Administration may configure K2 independently for each BBN DCE to any value between one and seven; the default value is seven.

A.2. The Packet Level DTE/DCE Interface

A.2.1. Logical Channels (3.1)

In this document, a logical channel is taken to mean the 12-bit concatenation of the 4-bit logical channel group number and the 8-bit logical channel number fields of the packet. Logical channel numbers available in this implementation are in the range 1 to 4095. Logical channel 0 is reserved for packets that are associated with no particular virtual call or PVC, namely RESTART and DIAGNOSTIC packets. Each DCE can support any number of channels, subject to the availability of network resources.

Permanent virtual circuits, where configured, use channel numbers starting at 1 and ending at the configured maximum, which must be no more than 500.

A.2.2. Basic Structure of Packets (3.2)

The maximum length of any Level 3 packet is three more than the maximum length of the user data field; the maximum possible packet is therefore 1027 octets. Note that this is the only packet size limit imposed by the packet level DCE; in particular, all CALL, CLEAR, INTERRUPT, and RESET packets may carry user data fields subject only to the maximum packet length.

A.2.3. Effects of the Physical and Link Levels on the Packet level (3.5)

Changes in the operational states of the physical and/or link levels of the DTE/DCE interface affect the state of the packet level interface only if the DCE cannot reliably transmit or receive packets. The DCE packet level software responds to such changes by sending CLEAR INDICATION packets to the remote DTEs that have channels open to the DTE with the falling link, and RESET INDICATION packets to remote DTEs that have permanent virtual circuits to the DTE. When the link returns to an operational state, the DCE initiates a restarting procedure.

A.2.4. Data and Interrupt Transfer Procedures (4.3)

A.2.4.1. States for Data Transfer (4.3.1)

When a virtual call is cleared, data and interrupt packets may be discarded by the network. It is beyond the scope of the Level 3 software (and therefore it is not the responsibility of the DCEs) to define DTE-to-DTE protocols able to cope with the various circuit interruptions which may occur.

A.2.4.2 . User Data Field Length (4.3.2)

Maximum packet sizes are required to be the same for both directions of transmission for a given virtual call or permanent virtual circuit. The Administration can configure independently for each PVC a value of the maximum packet size.

A.2.4.3. Delivery Confirmation Bit (4.3.3)

The delivery Confirmation Bit (D-bit) is sent transparently through the network. No acknowledgments are generated locally by the DCEs, and all packets sent by a DTE on a virtual circuit are delivered in order to the destination DTE on that circuit. Thus, two DTEs could use the D-bit procedure themselves, although acknowledgments will always have end-to-end significance anyway.

A.2.4.4. More Data Mark and Qualifier Bit (4.3.4) (4.3.6)

Like the Delivery Confirmation Bit, the More Data Mark and the Qualifier Bit are passed transparently through the Network. The network will never fragment a packet nor aggregate packets.

A.2.4.5. Interrupt Procedure (4.3.7)

The DCEs monitor INTERRUPT and INTERRUPT CONFIRMATION packets on each logical channel, resetting each end of a virtual call or permanent virtual circuit if either DTE attempts to have more than one INTERRUPT packet outstanding in one direction of transfer at any time.

After a RESET procedure (during which interrupts in transmit are discarded) there is by definition no outstanding interrupt packet in either direction.

A.2.5. Flow Control Principles (4.4.1.3)

The Administration can configure each PVC independently to have a window size from 1 to 7. Window sizes must be equal in the two directions of transfer for each virtual call or PVC.

The DCE does not exert flow control or logical channels, but instead relies upon the network to deliver, rapidly and in order, all packets (including flow control packets) sent on a virtual call or PVC. Thus if one DTE wishes to exert flow control of a virtual call or PVC, the network will in turn exert control at the remote DTE. The DCE does enforce the window size. Window size errors result in resetting of virtual calls or PVCs.

A.2.6. Delivery Confirmation (4.4.1.4)

The DCE attaches no special significance to the D bit. All RR and RNR packets are passed transparently through the network, with the result that all acknowledgments have end-to-end significance. P(R)values contained in all data, RR, and RNR packets are always the same at both ends of the virtual call or permanent virtual circuit.

A.2.7. DTE and DCE Receive Not Ready (RNR) Packets (4.4.1.5)

The PSN passes RNR packets transparently through the network. Thus, once one DTE indicates its inability to accept further data, the DTE at the other end of the virtual call or permanent virtual circuit will eventually be asked to stop until the busy DTE can again accept data. The DCE never spontaneously enters a busy condition at the packet level.

A.2.8. Effects of Clear, Reset and Restart Procedures on the Transfer of Packets (4.5)

The packet layer DCE ignores all packet fields that have no significance to its procedures. Non-essential fields in packets traveling on a virtual call or PVC are generally passed through the network transparently. In particular, user data fields in CALL, CLEAR, RESET and INTERRUPT packets are delivered unmodified to the remote DTE, subject to the maximum packet size for the virtual circuit or PVC.

A.2.9. Packet formats (6.1)

The packet layer DCE ignores all packet fields that have no significance to its procedures. Non-essential fields in packets traveling on a virtual call or PVC are generally passed through the network transparently. In particular, user data fields in CALL, CLEAR, RESET, and INTERRUPT packets are delivered unmodified to the remote DTE, subject to the maximum packet size for the virtual circuit or PVC.

A.2.10. Call Set-up and Clearing Packets (6.2)

A.2.10.1. Call Request and Incoming Call Packets (6.2.1)

The called DTE address is required in call request packets. The DCE always ensures that the actual calling DTE address exists in INCOMING CALL packets, whether the calling DTE provided one or not.

If the calling DTE provides a calling DTE address, the DCE ensures that it is correct. If it is not provided, the DCE inserts the correct calling DTE address.

The Call User Data Field, if present, is passed transparently by the network and is otherwise ignored. It may have any length, provided the packet does not exceed the maximum packet size for the virtual call.

A.2.10.2. Call Accepted and Call Connected Packets (6.2.2)

The Call User Data Field, if present, is passed transparently by the network and is otherwise ignored. It may have any length, provided the packet does not exceed the maximum packet size for the virtual call.

A.2.10.3. Clear Request and Clear Indication Packets (6.2.2)

The clearing cause and diagnostic codes generated by the network are those listed in Table 6.3/X.25 and Annex 5, respectively, of CCITT, Recommendation X.25. In addition, DCEs may generate several network-specific diagnostics, which are

listed above in Table 4.1. The cause and diagnostic codes in CLEAR REQUEST packets are passed transparently through the network.

CLEAR REQUEST packets are passed on by the DCE as they were received. The Call User Data Field, if present, is passed transparently by the network and is otherwise ignored. It may have any length, provided the packet does not exceed the maximum packet size for the virtual call.

A.2.10.4. Clear Confirmation Packets (6.2.4)

CLEAR CONFIRMATION packets are passed on by the DCE as they were received. The Call User Data Field, if present, is passed transparently by the network and is otherwise ignored. It may have any length, provided the packet does not exceed the maximum packet size for the virtual call.

A.2.11. DCE and DTE Interrupt Confirmation Packets (6.3.3)

Interrupt confirmation packets may have a user field of any length, provided the packet does not exceed the maximum packet size for the virtual call.

A.2.12. Reset Request and Reset Indication packets (6.5.3)

The reset cause and diagnostic codes generated by the network are those listed in Table 6.5/X.25 and Annex 5, respectively, of CCITT Recommendation X.25. DCEs may also generate several network-specific diagnostics, as outlined in Table 4.1 above. The cause and diagnostic codes in RESET REQUEST packets are passed transparently through the network.

The Call User Data Field, if present, is passed transparently by the network and is otherwise ignored. It may have any length, provided the packet does not exceed the maximum packet size for the virtual call.

A.2.13. Restart Request and Restart Indication Packets (6.6.1)

The restart cause and diagnostic codes generated by the network are those listed in Table 6.6/X.25 and Annex 5, respectively, of CCITT Recommendation X.25. DCEs may also generate several network-specific diagnostics, as outlined in Table 4.1, above.

A.2.14. Formats for Optional User Facilities (7.4)

Appendix B

C.30 X.25 PSN Synchronous Physical Level Specification

B.1. Introduction

This section describes the functional, electrical, and mechanical connection (the level 1 connection) that is required when an X.25 host DTE is connected to a BBN X.25 PSN. Such hosts require a synchronous modem connection or the equivalent, which typically will be supplied by the Administration for use in the central office. The host will present the DTE interface along with the customer premise modem.

B.2. Supported Interfaces

BBN X.25 PSNs presently support two synchronous level 1 interfaces. They are:

1. EIA RS-232-C, CCITT V.28 & X.24, X.21 IS;

2. CCITT V.35.

Table B.1 is a dictionary of terms that relates the CCITT signal ID to the EIA signal ID and to the more common abbreviations.

Tables B.2 and B.3 list signal and pin names for the two supported physical interfaces.

Together, these tables and figures serve as a guide to level 1 interface selection. From these, most systems will be able to identify the most appropriate interface. However, this information is not all-inclusive, and BBN's physical interface extends beyond the basic interfaces of X.25. BBN has issued three synchronous interface specifications to our network, they are: 56 KBPS, 19.2 KBPS Limited Distance, and 9.6 KBPS synchronous interface specifications. Those specifications detail the customer's interface at a Telco four wire data termination. This type of interface specification is required because BBN can not define a interface beyond the four wire demarcation point.

EIA ID	CCITT ID	ABBREV NAME	NAME
AA	101	FG	Frame (Chassis/Protective) Ground
AB	102	SG	Signal/Supply Common
SC	102a	- -	RS-449 DTE Common
RC	102b	- -	RS-449 DCE Common
BA	103	TD	Transmit Data
BB	104	RD	Receive Data
CA	105	RTS	Request to Send
CB	106	CTS	Clear to Send
CC	107	DSR	Data Set Ready
CD	108.2	DTR	Data Terminal Ready
CF	109	DCD	Data Carrier Detect
CG	110	SQ	Signal Quality
CH	111	- -	Signal Rate Selector to DCE
CI	112	- -	Signal Rate Selector to DTE
DA	113	ETC	External Transmit Clock
DB	114	TC	Transmit Clock
DD	115	RC	Receive Clock
- -	116	- -	Select Standby
- -	117	- -	Standby Indicator
SBA	118	STD	Secondary Transmit Data
- -			

SBB	119	SRD	Secondary Receive Data
SCA	120	SRS	Secondary Request to Send
SCB	121	SCS	Secondary Clear to Send
SCF	122	SCD	Secondary Carrier Detect
SCG	123	SSQ	Secondary Signal Quality
- -	124	- -	Select Frequency Group
CE	125	RI	Ringing Indicator
- -	126	- -	Select Transmit Frequency
- -	127	- -	Select Receive Frequency
- -	128	- -	External Receive Clock
- -	129	RR	Request to Receive
- -	130	- -	Secondary Transmit Tone
- -	131	- -	Receive Character Timing
- -	132	- -	Return to Non-Data Mode
- -	133	RTR	Ready to Receive
- -	134	- -	Received Data Present
- -	136	- -	New Signal
- -	140	RL	Remote Loopback
- -	141	LL	Local Loopback
- -	142	TM	Test Status Monitor
- -	191	- -	Transmit Voice Answer
	192	- -	Receive Voice Answer

Table B.1 - EIA and CCITT Interchange Circuits

Signal Name	Abbrev	Pin No.	EIA ID	Signal Source
Frame Ground	FG	1	AA	DTE/DCE
Transmitted Data	TD	2	BA	DTE
Received Data	RD	3	BB	DCE
Request to Send	RTS	4	CA	DTE
Clear to Send	CTS	5	CB	DCE
Data Set Ready	DSR	6	CC	DCE
Signal Ground	SG	7	AB	DTE/DCE
Data Carrier Detect	DCD	8	CF	DCE
Transmit Clock	TC	15	DB	DCE
Receive Clock	RC	17	DD	DCE
Data Terminal Ready	DTR	20	CD	DTE
Ext. Transmit Clock	ETC	24	DA	DTE
Wired Spare	- -	18	- -	- - -
Wired Spare	- -	22	- -	- - -
Wired Spare	- -	25	- -	- - -
Required pins: 1, 2, 3, 4, 5, 6, 7, 8, 15, 17, 20, 24 Optional pins: 9, 10, 18, 22, 25				

Table B.2 - RS-232-C Interface

Signal Name	Abbrev	Pin No.	EIA ID	Signal Source
Frame Ground	FG	A	AA	DTE/DCE
Signal Ground	SG	B	AB	DTE/DCE
Transmit Data	TD	P / S	BA	DTE
Receive Data	RD	R / T	BB	DCE
Request to Send	RTS	C	CA	DTE
Clear to Send	CTS	D	CB	DCE
Data Set Ready	DSR	E	CC	DCE
Data Carrier Detect	DCD	F	CF	DCE
Local Loopback	LL	K	- -	DTE
Ext. Transmit Clock	ETC	U / W	DA	DTE
Transmit Clock	TC	Y / aa	DB	DCE
Receive Clock	RC	V / X	DD	DCE
Required pins: A; B; P/S; R/T; C; D; E; F; U/W; Y/aa; V/X Optional pins: K				

Table B.3 - V.35 Interface

Appendix C

Michigan Bell Telephone Packet Switched Network Dial-Up Users Guide

November, 1986

C.1. Introduction

This users guide is meant as a brief introduction to the dial-up procedures for asynchronous terminals to the Bolt Bernack Newman (BBN) packet switched network (PSN). Connection is made to the network via a Bolt, Beranek and Newman (BBN) Communications Corporation C/10 APAD (asynchronous packet assembler/disassembler).

To use the BBN PSN, a user will need access to an asynchronous terminal and either a Bell 103- or Bell 212-compatible modem. The user will also need:

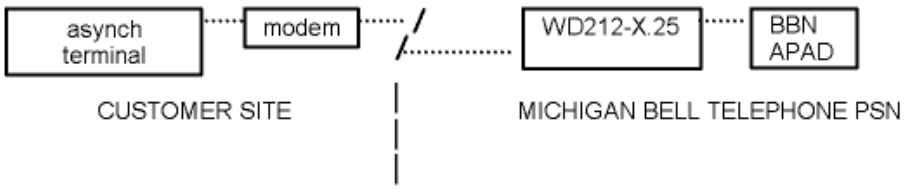
A. BBN PSN dial-up telephone number,

B. User identification and password for BBN PSN,

C. Network address of a host system (DTE), and

D. User identification and password for host system.

The following diagram is a general logic diagram of the user connection to a host system via the BBN pSN:



This document is intended to provide basic instructions for users that will utilize the BBN PSN. More detailed instructions may be found in the following manuals:

- C/10 APAD User Guide, BBN Communications Corp. (Use of APAD and APAD commands)
- Wolfdata WD212-X Series Reference Guide, Wolfdata, Inc. (use of modem)

In the examples in this guide, the following conventions apply:

A. Items that are underlined will be displayed on the terminal.

B. Items in UPPER-CASE indicate characters that should be typed as is by the user.

C. Items in lover-case indicate parameters that should be replaced by the user with the appropriate value.

D. Characters within angle brackets (<>) refer to specific keys on the keyboard. For example, <RET> and <ESC> refer to the RETURN and ESCAPE keys, respectively. A caret character (') refers to a <SHIFT-6>.

C.2 Modem Connection to Network

1. Turn on the terminal and be sure that the correct speed has been set. Supported speeds are 110 and 300 bps (Bell 103 mode) and 1200 bps (Bell 212 mode).

2. If using a modem that dials the telephone automatically, continue at step 3. If using a modem where the user must dial the phone:

    A. Dial the network access number.

    B. After the ringing (usually 2-3 rings), the high-pitched data tone will be heard.

    C. If using a DATA SET and telephone, push the DATA button and put down the telephone handset into the coupler.

    D. The remote modem will respond and a connection will be established with a PAD port. (Continue at step 4.)

3. If using an auto-dial modem, follow the modem's instructions to place a call to the BBN PSN. The following instructions are specific to using a Wolfdata WD212-X series modem:

    A. Reset mode. Type: AT Z <RET>

    B. Dial network: Type: AT D psn_phone_number <RET>

        NOTE: Wolfdata, and other manufacturers, provide a number of dial options. Most modems default to pulse dialing. If using a touch tone system, the user may use the dial command:

    AT D T psn_phone_number <RET>

    If calling from within a phone system where a "9" must be dialed prior to getting the dial tone (e.g., PBX or Centrex), use the dial command:

    AT D 9 psn_phone_number <RET>

C. When the modem detects the data tome form the PSN modem, the message **CONNECT** will be displayed.

4. After the remote modem connection has been made, the user should hit the <RET> key twice. (Wait about two seconds between striking the key.) This will establish the connection to the APAD and allow the APAD to detect the terminal's speed.

C.3. Connection to Host System

1. After making the connection to the APAD, the user must make its identity known. the APAD will accomplish this by asking the user for a user name and password. Note that the password will not be echoed on the screen:

   Please enter your user ID: user name <RET>

   Password: password <RET>

2. After accepting the user name and password, the PAD Herald Message will be displayed. This is a general greeting, usually indicating the date, port number, etc. It will look something line:

[BBN APAD / Version 6.015 - Jul 8 1985 / Port 19]

3. The APAD will indicate its willingness to accept commands by displaying the APAD prompt:

pad>

If the prompt does not appear, shut off the terminal and start over with section 2, above.

4. **(optional step)** A user profile contains values for the APAD parameters which control terminal - APAD communication. Before connecting to the host system (DTE), the user may want to check the user profile associated with this user name, to be sure that the parameters are set correctly. (See section 6, below, for more information on these parameters.)

   NOTE: In the steps below, the PROF command is used, which assumes that the user will be using standard X.28 PAD commands. If the PROF command does not work, substitute with the PROFILE command. Commands are discussed in more detail in section 5, below.

To check the user profile, use the PROF command:

pad PROF <RET>

The APAD parameter values will be listed. Changing the parameters may be accomplished by use of the SET command, which will be discussed in section 5 below.

The PROF command can also be used to select a different profile:

pad PROF profile_name <RET>

Finally, to determine the names of the available profiles, use the following command:

pad> PROF ? <RET>

The system manager of the DTE, or the network administrator, can provide the user with an appropriate profile.

5. To make a connection to a DTE, type:

pad> CONNECT host_address <RET>

For example, if the network address of the host system is 3137654321, use:

pad> CONNECT 3137654321 <RET>

If the connection is successful, the APAD will print an appropriate message, which will be followed by the appropriate messages from the host system:

Connection initiated....opened

APPROPRIATE HOST SYSTEM BANNER MESSAGE

Login:

The user is now ready to login to the host system, just as if the terminal had a direct connection to the host.

C.4. Terminating a Network Session

1. When finished with a session at a given host, the user should logout normally. If the host computer automatically clears the call after the user logs out, a message indicating that the call has been cleared will be displayed, control will return to the APAD, and the user will see the APAD prompt. If this happens, continue at step 3, below.

If the host does not clear the call after logging out, the connection to the host still exists. The user may login again, under the same or different user name.

2. When finished with a connection to a host that does not automatically clear calls after the user logs out, the user will have to clear the call between the APAD and the host. This is done by entering APAD command mode and sending a clear command:

   pad> CLEAR <RET>

   Cleared.

   pad>

3. When the call has been cleared, the user may place a call to another DTE, or hangup the telephone call to the APAD.

To hangup the telephone call, the user should follow the instructions pertaining to the modem type:

A. Acoustic coupler - hangup the telephone.

B. DATA SET - push the DATA button and hang up the telephone.

C. Autodial modem - Re-enter modem command mode form the APAD and hangup. The following example uses Wolfdata instructions:

```
pad    +++          (Recall modem)
AT H <RET>          (Hang up)
```

C.5. Entering APAD Commands

The BBN C/10 APAD responds to standard commands, defined by CCITT Recommendation X.28. Additionally, BBN has defined a PAD Command Language (PCL), which is a superset of X.28.

The section below lists some of the more useful PCL commands, their function(s), and their syntax. Examples, where appropriate, are also included. X.28 equivalents are indicated in square brackets ([ ]), Note that the syntax of PCL and X.28 may be very different, particularly in those commands that refer to parameters. (PCL refers to parameters by name, while X.28 refers to parameters by number.) Parameter 21 in the user profile indicates which command set

is being used; 0 indicates X.28 commands and 1 indicates PCL commands. PCL commands are shown here since they will probably be used more frequently.

PCL commands

CONNECT [CONNECT]
CALL [CONNECT]
Connects terminal to host system.
syntax: CONNECT host_address

CLEAR [CLR]
Disconnects terminal from host system.
syntax: CLEAR

PROFILE [PROF]
Check on user profile.
syntax: PROFILE

Sets a named profile to user terminal.
syntax: PROFILE profile_name

PCL commands

SET [SET]
Set terminal port parameter(s) to desired value.
syntax: SET parameter_name:value
examples: SET SPEED:9600
SET SPEED:9600, PARITY:OFF

SET-AND-VERIFY [SET?]

Set terminal port parameter(s) to desired value, and have APAD display the new value.
syntax: SET-AND-VERIFY parameter:value
examples: SET-AND-VERIFY SPEED:9600
speed:9600
SET-AND-VERIFY SPEED:9600, PAIRTY:OFF
speed:9600
parity:off

PARAMETERS [PAR?]
Display values of all APAD parameters.
syntax: PARAMETERS
PARAMETERS ALL

Display values of specified APAD parameters.
syntax: PARAMETERS parameters_list
examples: PARAMETERS SPEED
speed:9600

PARAMETERS SPEED, PARITY
speed:9600
parity:off

STATUS [STAT]
Print current status of the terminal. Reply will indicate one of four connection states; namesly, idle, accepting connections, active, or connectionin progress.
syntax: STATUS

A number of rules apply to the entry of PCL commands. Some of them will be briefly presented here.

Help character

The help character is, by default, a question mark (?). (The help-char parameter defines which character will be used for the help function.) The help character may be used to list all available commands or all commands that begin with certain characters. Examples follow:

```
pad>  ?  <RET>
Command, one of the following:
accept-connections      call                connect
local                   pad-information     parameters
port-information        profile             set
set-and-verify          status

pad     pa?  <RET>
Command, one of the following:
pad-information         parameters

pad>
```

The PCL commands that will be listed are those that are available depending upon the state of the connection. For example, the list above includes the CALL and CONNECT commands, but not clear; thus, it shows the idle state, where a call may be made but there is no call to clear. A different listing will occur during an open connection.

PAD recall

While connected to a host system, the user may wish to send a command to the APAD. To do this, the user must return to APAD command mode. This is accomplished by sending the PAD recall character, which is, by default, the caret (^) character (defined by the recall parameter). The user is allowed a single APAD command, after which control returns to the host system. (In the example below, the host system prompt character is the dollar sign ($).)

```
$                       (Recall APAD from host)

pad> status <RET>       (Enter APAD command)

$                       (Control returns to host)
```

Command completion character

The command completion character (<ESC>) allows the user to type in a partial command and have the APAD complete it automatically. This may be used with any command, command argument or port parameter. If not enough characters are given to uniquely identify the command, a bell will be sounded.

```
pad> c<ESC>  <BELL>     (Bell sounds since not enough characters are given.)

pad? c ? <RET>          (Get help on 'c' commands.)
Command, one of the following:
call                    connect

pad> co <ESC>nnect <RET> (APAD completes 'co' command)
```

Users are urged to review the C/10 APAD User's Guide for more information on the PCL and X.28 command structure. Your system administrator will advise users as to their profile and , particularly, which command language they will use.

C.6. PAD Parameters

The BBN C/10 APAD supports 21 PAD parameters while the X.28 command mode and 62 parameters while in PCL mode. The parameters are defined in Chapter 6 of the C/10 Users Guide. The following lists the 21 PAD parameters available in X.28 mode. The parameters are identified by X.3 number and BBN PCL name.

X.3	PCL NAME	PARAMETER FUNCTION
1	RECALL	Defines PAD recall character
2	ECHO-DATA	Sets echoing in data thrasfer mode
3	FORWARD-SET	Defines data forearding character
4	IDLE-DELAY	Defines idle delay timer value
5	TERMINAL-FLOW	Sets PAD flow control of terminal
6	SERVICE SIGNALS	Control sending PAD service signals
7	BREAK-HANDLING	Defines action upon <BREAK> input
8	DISCARD-OUTPUT	Controls PAD output to terminal
9	RETURN-PADDING	Defines carriage return padding
10	LINE-LENGTH	Defines folding long data lines
11	SPEED	Defines terminal speed (bps)
12	PAD-FLOW	Sets terminal flow control of PAD
13	INSERT-LF	Defines linefeed insertion by PAD
14	LINE-FEED-PADDING	Defines padding for linefeeds
15	EDITING	Sets editing in data transfer mode
16	DELETE-CHAR	Defines character-delete indicator
17	LINE-DELETE-CHAR	Defines line-delete indicator
18	REDISPLAY-CHAR	Defines drdisplay-line indicator
19	TERMINAL-TYPE	Defines CRT of hard copy device
21	ECHO-SET	Defines characters not to echo
21	COMMAND-MODE	Sets PCL or X.28 command mode

3. Technical Interface Specifications For X.25 Service over a Siemens Platform

3.1. Introduction

This technical reference describes the interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for terminals operating in the packet mode and connected to the Siemens Packet Network (PSN). The interface conforms to the 1980 International Telegraph and Telephone Consultative Committee (CCITT) Recommendations [1]. The Network is currently supporting 1980 Recommendations and selected 1984 Recommendations. Unless otherwise indicated, specific references to sections of CCITT Recommendations are per the 1980 issue. The information contained in this document is intended to be used within the text of those recommendations.

This document provides information including:

- values of X.25 parameters supported on the PSN,
- actions taken by the PSN in areas where CCITT Recommendation X.25 offers alternatives or does not fully specify actions,
- features supported by the PSN that CCITT Recommendation X.25 indicates are optional for a network to provide,
- features supported by the PSN that CCITT Recommendation X.25 does not address.

Section 3.2 provides an overview of the services and subscription facilities available on this interface. Section 3.3 discusses the physical, link, and packet level procedures supported by this interface. Optional services and facilities available on the PSN have been listed in the attached appendices for a convenient reference.

3.1.1. Reasons for Reissue

This document describes capabilities of the PSN X.25 interface that are available as of the issue date. Updates to this document may be issued as new capabilities become available. When this document is reissued, the reasons for reissue will be given in this section.

3.1.2. Terms

This section defines several relevant terms used in this technical reference. Please refer to Appendix A for additional terms and abbreviations.

- Network interface - the demarcation point between the network communications channel and user provided equipment.

- Data Circuit - Terminating Equipment (DCE) - equipment or functions on the network side of the interface that provide access to the PSN. The Siemens PSN will always act as the DCE unless otherwise specified in a special assembly arrangement.

- Data Terminal Equipment (DTE) - user equipment that connects to a communications channel as a data source and/or sink. The DTE begins at the communications interface unit on a host computer or terminal equipment.

- Packet Assembler/Disassembler (PAD) - a function of the PSN that performs X.25 operations on behalf of the asynchronous DTE.

- Public Packet Switched Network (PPSN) - A Bell Operating Company maintained and operated public packet switched data network.

- Network refers to the Siemens supported public packet switched network.

3.1.3. Companion Documentation

This specification references a number of national and international standards/recommendations. Please see Appendix 8 for a listing and description of these references.

3.2. INTERFACE SUBSCRIPTION OPTIONS

By subscribing to various optional services and facilities, and by selecting various parameter values, the user can tailor a particular interface to their particular needs. Siemens will configure the interface to provide the services, facilities, and parameter values that the user requests at service order (subscription) time. This section describes the subscription options that are available to the user.

3.2.1. General

All essential (E) services and facilities defined for DTE operating in synchronous mode using an X.25 interface (user classes of service 8.11) in CCITT Recommendation X.2 [2] are supported by the PSN. Certain additional (A) services and facilities listed in that recommendation are also supported. The services and facilities available to the user at subscription time are listed for convenient reference in Table 1 of Appendix C.

3.2.2. Virtual Call Service

Virtual circuits are logical connections across the PSN that emulate point-to-point circuits by ensuring data integrity, transparency, and data sequence. Virtual call service provides virtual circuits on a temporary basis to meet the short-term data transport needs of the user. The DTE initiates the call setup procedure when a virtual circuit is required to another DTE and initiates the call clearing procedure when the circuit is no longer needed.

A virtual call setup is initiated when the PSN receives a call request packet from the calling DTE that includes the network address of the called DTE. An incoming call packet is transmitted to the called DTE who may respond with a call accepted packet. The PSN then transmits a call connected packet to the calling DTE to establish the virtual call. The virtual circuit is then in the data transfer state and available to transmit data packets.

A virtual call is disconnected when the PSN receives a clear request packet from either the calling or called DTE. The PSN transmits a clear indication packet to the other DTE who may respond with a clear confirmation packet. The PSN then transmits a clear confirmation packet to the clearing DTE who requested the call be cleared.

Various service options, such as reverse charging, can be requested by the user via facilities contained in call setup packets. Parameters (other than the interface defaults) that apply to the call, such as throughput class, can also be established via facility requests. The facilities that can be requested on a per-virtual call basis are listed in Table 2 of Appendix B.

3.2.3. Permanent Virtual Call Service

The virtual circuit corresponding to the virtual call is a switched connection and the association only lasts for the duration of the call, whereas in a permanent virtual connection, the association is, by definition, a permanent one. To the subscribers who are connected, it resembles a point-to-point leased line and it is therefore unnecessary to go through the call establishment procedure. The permanent virtual connections are set up in the Data Network Management Center by a Siemens operator.

The procedures for the control of packets between the DTE and the DCE conform with the virtual call service in the data transfer state.

In error conditions the DCE indicates a reset with "local procedure error"; the distant DTE Is also informed of the reset by a Reset Indication packet with "remote procedure error".

If the link level fails, the Permanent Virtual Circuit (PVC) is set in the out-or-order state. After recovery of the link level the PVC is set automatically in the operational state.

The operator of the Network Control Center can establish or release a permanent virtual connection by an operator command.

3.2.4. Logical Channel Ranges

The PSN supports multiple logical channels on an interface to allow simultaneous virtual calls and PVCs on a single physical access lines. The number of logical channels and the services to which they are allocated is specified by the user at service order time.

Any number of logical channels up to the theoretical maximum values listed below may be selected for a particular interface. However, specific customer applications, configurations and desired throughput will be the determining factors in choosing the appropriate number of logical channels per access line:

Line Speed	Max. No. of Logical Channels
56 Kbps	<= 2048
9.6 Kbps	<= 512
4.8 Kbps	<= 256
2.4 Kbps	<= 128
1.2 Kbps	<= 64

Ranges of logical channels may be allocated to each of the following services: PVCs, one-way incoming virtual calls, one-way outgoing virtual calls, and two-way virtual calls. Logical channels are allocated to particular services as shown in Appendix D.

3.2.4.1. One-Way Logical Channel Incoming

One-way Logical Channel Incoming is a subscription facility that restricts the use of particular logical channels to incoming virtual calls. That is, virtual calls may be received but not originated on logical channels designated as one-way incoming. This service insures that one or more logical channels will be available for incoming virtual calls, regardless of the number of outgoing calls at the interface.

The user may specify a particular range of logical channels to be designated as one-way incoming. Logical channels not within this range are unaffected. One-way Incoming logical channels retain their full-duplex data transfer capability. If all logical channels allocated to virtual calls are designated as one-way incoming, the effect on the interface is equivalent to the Outgoing Calls Barred facility.

3.2.4.2. One-Way Logical Channel Outgoing

One-way Logical Channel Outgoing is a subscription facility that restricts the use of particular logical channels to outgoing virtual call service. That is, virtual calls may be originated but not received on logical channels designated as one-way outgoing. This service insures that one or more logical channels will be available for outgoing virtual calls, regardless of the number of incoming calls at the interface.

The user may specify a particular range of logical channels to which this facility applies. Logical channels not within this range are unaffected. A one-way outgoing logical channel retains its full-duplex data transfer capability. If all logical channels allocated to virtual calls are designated one-way outgoing, the effect on the interface is equivalent to the Incoming Calls Barred facility.

3.2.4.3. Incoming Calls Barred

Incoming Calls Barred is a subscription facility that limits virtual call service on an interface to outgoing calls only. That is, this facility causes the PSN to block any call setup attempts addressed to the interface. Virtual calls may still be originated on any logical channel on the interface that is allocated for virtual calls. The interface may still be configured for PVCs. All logical channels on the interface retain their full-duplex data transfer capability. The DTE may not place a virtual call to itself for testing purposes when this facility is subscribed.

3.2.4.4. Outgoing Calls Barred

Outgoing Calls Barred is a subscription facility that limits virtual call service on an interface to incoming virtual calls only. This is, this facility causes the PSN to block any call setup attempts originated on that interface. Virtual calls may still be received on logical channels allocated to virtual cell service. The interface may still be configured for PVCs. All logical channels on the interface retain their full-duplex data transfer capability. The DTE may not place a virtual call to itself for testing purposes when this facility is subscribed.

3.2.5. Packet Level Parameters

At service order time, the values of various packet level parameters must be selected by the user. These parameters are throughput class, window size and packet size. They control the flow of data across a virtual circuit. The default values of these parameters established during service order apply to all virtual circuits allocated to virtual calls. The window sizes and maximum packet sizes that apply to PVCs are the same default values selected for virtual calls.

The user may choose the PSN default values of these parameters. The PSN network default values of these parameters are:

Parameter	Value
Throughput Class	- 48 kbps for 56 kbps line.
Window Size	- Line Speed Otherwise
Maximum Packet Size	2
	256 octets

Other values may be selected at service order time by subscribing to the default throughput classes assignment facility, nonstandard default window sizes facility and the nonstandard default packet sizes facility (discussed below).

The user may select from among the following values:

Parameter	Values
Throughput Class	5 (300 bps) 9 (4800 bps) 7 (1200 bps) 10 (9600 bps) 8 (2400 bps) 12 (56000 bps)
Packet Sizes	128 or 256
Window Sizes	1 to 7 (Mode) 1 to 127 (Mode 128)

The capability to negotiate the throughput class, window size, and maximum packet size on a per-call basis may be authorized for the interface at service order time. This capability provides a degree of flexibility to the interface, so that the parameters specified at service order time can be altered for individual calls which may have different packet level requirements. This capability is made available by subscription to the flow control parameter negotiation or the throughput class negotiation facilities (discussed below).

3.2.5.1. Default Throughput Classes Assignment

Default throughput classes assignment is a subscription facility that allows the default throughput classes for the interface to be set to values other than the PSN default value. Different values may be selected for each direction of transmission. Values other than the interface default throughput classes may be selected for individual PVCs at service order time. Values other than the interface default throughput classes may be negotiated for a virtual call by means of the throughput class negotiation facility. The interface default throughput classes are

the maximum throughput classes which may be associated with any virtual call on the interface, therefore these values can only be negotiated **down**.

3.2.5.2. Nonstandard Default Window Sizes

Nonstandard default window sizes is a subscription facility that allows the level 3 default window sizes for the interface to be set to values other than the PSN default value of 2 (1-7 mod 8, 1-127 mod 128). However, specific customer applications, configuration and desired throughput will be the determining factors in choosing the appropriate window size. Different values may be selected for each direction of transmission. Different window sizes may be selected for each PVC at subscription time. Values other that the interface default window sizes may be negotiated on individual virtual calls by means of the flow control parameter negotiation facility.

3.2.5.3. Nonstandard Default Packet Sizes

Nonstandard default packet sizes is a subscription facility that allows the default maximum packet sizes for the interface to be set to values other than the PSN default value of 256 octets. Different values may be selected for each direction of transmission. Maximum packet sizes other than the interface default values may be selected for individual PVCs. Values other than the interface default maximum packet sizes may be negotiated for a virtual call by means of the flow control negotiation facility.

3.2.5.4. Flow Control Parameter Negotiation

Flow control parameter negotiation is a subscription facility that permits negotiation on a per-call basis of the flow control parameters. The flow control parameters are the maximum packet sizes and level 3 window sizes for each direction of data transmission. This subscription facility allows the user to signal the flow control parameter negotiation facility field (see Section 3.3.3.9.4) in a call request or call accepted packet. If this facility is not subscribed for the Interface, the presence of the flow control parameter negotiation facility field in a call request of call accepted packet received on the interface will cause the PSN to clear the call.

The values of these parameters are negotiated for both directions of data transfer and at each of the DTE/DCE interfaces associated with the call. The PSN does constrain the maximum packet sizes to be the same in both directions. The PSN does not do packet splitting or combining, so the maximum packet size must be the same at both interfaces for a given direction.

The window sizes for a given direction may have different values for the interfaces at either end of the connection. Also, the value of the window size parameters may be different for each direction of transmission.

3.2.5.5. Throughput Class Negotiation

The throughput class negotiation subscription facility permits negotiation on a per-call basis of the throughput classes for each direction of transmission associated with a virtual call. It allows the throughput class negotiation facility field (see Section 3.3.3.9.6) to be signaled in a call request or call accepted packet on the interface. If this facility is not subscribed for the interface, the presence of the throughput class negotiation facility field in a call request or call accepted packet received on the interface will cause the PSN to clear the call.

The throughput class need not be the same at both interfaces for a given direction. Also, it is not required that the throughput classes be the same for both directions of transmission.

3.2.6. Privacy Service Options

The PSN supports several closed user group (CUG) facilities in accordance with CCITT Recommendation X.300 [3]. CUG facilities allow users to form private subnetworks using the shared resources for the PSN. CUG service works as follows:

Membership in one or more CUGs may be established at service order time for an interface. A two-digit index is assigned to each CUG. This index is used in facility fields of call setup packets sent over that interface to identify the particular CUG associated with a virtual call. The CUG index has significance on the particular interface only. Different indices may be used to select the same CUG on other interfaces. The PSN matches the different indices to a CUG interlock code that uniquely identifies the particular CUG to all networks involved with the virtual call. The interlock code is passed by the network(s) involved with the call to the destination DCE where it can be used to verify that the called DTE is a member of that CUG. The virtual call may be cleared if the called DTE is not a member of the particular CUG. The interlock call is used within the networks but is neither transmitted nor received by the user.

A preferential COG may be established for the interface at service order time. The preferential COG Is automatically selected by the PSN for any virtual call originated on the interface if a particular CUG is not requested by the user. Membership in a particular CUG must be authorized by the user membership authority responsible for that COG. It is the responsibility of the users of the CUG to establish membership authorities for their respective CUCS. When an interface is authorized to join a particular CUG by the appropriate membership authority, Its inclusion in this group Is performed by service order.

There are five types of COG service supported by the PSN. Each can be obtained by subscribing to one of the following facilities.

3.2.6.1. Closed User Group (CUG)

Closed user group is a subscription facility that enables users to form groups with different combinations of restrictions for access from or to users having one or more of these facilities. The closed user group may be requested by means of a facility request over the DTE/DCE network. The standard COG permits members to communicate with each other but precludes communication with non-members. The standard CUG feature may be modified to allow CUG members to communicate with other CUGs and to restrict calling within a CUG. These CUG modifications include:

- CUG with outgoing access only (CUG/OA)
- CUG with incoming access only (CUG/IA)
- CUG with outgoing calls barred
- CUG with incoming calls barred

3.2.6.2. Closed User Group with Outgoing Access (CUG/OA)

Closed user group with outgoing access is a subscription facility that permits members to communicate with one another and to originate virtual calls to users who do not belong to any CUGs or who belong to other CUGs with incoming access. Specification of a preferential CUG is optional. If no preferential CUG is specified, either the per-call CUG selection facility or the per-call CUG/OA selection facility may be signaled over the interface. If a preferential CUG is specified, only the CUG selection facility may be signaled.

3.2.6.3. Closed User Group with Incoming Access (CUG/IA)

Closed user group with incoming access is a subscription facility that permits members to communicate with one another and to receive calls from users who do not belong to any CUG or who belong to CUGs with outgoing access.

3.2.6.4. Closed User Group with Outgoing Calls Barred (within CUG)

Prohibits certain members from placing outgoing call to others within the same CUG.

3.2.6.5. Closed User Group with Incoming Calls Barred (within CUG)

Prohibits certain members from receiving incoming calls from others within the same CUG.

3.2.7. Special Call Service Options

Several special virtual call service options are supported by the PSN including RPOA (Registered Private Operating Agency) selection, fast select service, and call redirection.

Inter-LATA calls will utilize 14 digits which consist of a 10 digit network address preceded by a 4 digit DNIC. Via the RPOA selection feature, the user may specify a preferred transit network (e.g. interLATA carrier) which the PSN will route to in the case when a transit network is required to complete the call and no transit network is selected via a facility field in the call request packet (see Section 3.3.3.9.3).

Fast select service allows users to send and receive up to 128 octets of user data in call setup and call clear packets. In order to take advantage of this capability, the calling DTE must signal the fast select facility field in the call request packet (see Section 3.3.3.9.5) and the called interface must be configured for the fast select acceptance facility. In this case, the user data will be delivered to the called DTE in an incoming call packet. The called DTE may then respond with either a call accepted packet or clear indication packet containing up to 128 octets of user data. This data will be delivered to the calling DTE in a call connected or call clearing packet.

Call redirection service allows the PSN to redirect call requests addressed to a one interface to another interface to account for busy or out-of-order conditions.

3.2.7.1. RPOA Selection

RPOA selection is a subscription facility that allows the user to specify a preferred transit network for the interface. The PSN shall automatically route a virtual call request originated on the interface that requires a transit network to the preferred carrier unless another carrier is selected during call request. That is, the PSN will route to the preferred interLATA carrier if the following occurs:

- the call request packet does not contain the RPOA selection facility (see Section 3.3.3.9.3),
- the called address specifies a DTE that is neither on the PSN nor on a network that is directly connected to the PSN.

This facility is referred to in the 1984 version of CCITT Recommendations X.25 and X.2 as the RPOA Selection subscription facility although the details of how a network handles routing in the presence of this facility are not detailed.

3.2.7.2. Fast Select Acceptance

Fast select acceptance is a subscription facility that authorizes the PSN to transmit incoming call requests that contain the per-call fast select facility (see Section 3.3.3.9.5) over the interface. If this facility is not subscribed, the PSN will block any call setup attempt to the interface for which fast select is requested.

3.2.7.3. Call Redirection

Call redirection is a subscription facility that authorizes the PSN to redirect call requests addressed to a particular interface in case a busy or out-of-order condition exists. A network address of an alternate interface to which calls should be redirected is specified at service order time. Call requests will be redirected to the alternate interface in case there are not idle logical channels available for incoming virtual calls on the interface to which the call was originally destined.

This could occur under any of the following conditions:

- All logical channels authorized for incoming virtual call service are carrying virtual calls.
- The interface has been taken out-of-service by user request (made by telephone to Siemens).
- The PSN considers the interface to be out-of-order.

The PSN will indicate to the alternate DTE that the call has been redirected, the reason for the redirection, and the address of the originally called DTE by means of the call redirection notification facility (see Section 3.3.3.9.7) in the incoming call packet. The PSN will provide the address of the alternate DTE in the called address field of the call connected packet along with an indication that the address has been changed in the called line address modified notification facility (see Section 3.3.3.9.8) to the calling DTE.

Redirection is currently limited to the PSN of the originally called DTE. That is, both the original and alternate called interfaces must be on the same PSN.

3.2.8. Charging-Related Service Options

On the PSN, virtual calls may be normally charged (charged to the calling interface), charged to a Siemens calling card number, or reverse charged (charged to the called interface). Reverse charging or charging to a calling card number may be requested on a PSN interface via facility requests in the call request packet.

The user must decide at service order time whether the PSN should deliver incoming calls requesting reverse charging over an interface. The user may arrange for this by subscribing to the reverse charging acceptance facility. Otherwise, the PSN will clear all requests destined for the interface that request reverse charging.

The user may decide to subscribe to the network user identification (NUI) facility at service order time and be assigned a calling card number to which the user originated virtual calls may be charged. The subscriber may request charging of a virtual call to a calling card number by including it in an NUI facility field in the call request packet.

The user may decide at service order time to prevent virtual calls being charged to an interface. This is done by subscribing to the local charging prevention facility. This facility insures that all calls originated on the interface are either reverse charge or charged to a calling card number and that calls made to the interface are not reverse charged.

3.2.8.1. Reverse Charging Acceptance

Reverse charging acceptance is a subscription facility that authorizes the PSN to transmit incoming call packets requesting reverse charging over the interface. If this facility is not subscribed, the PSN will block any call request addressed to the interface for which reverse charging is requested. If this facility is subscribed, Siemens will charge the subscriber for a virtual call setup attempt when the PSN transmits an incoming call packet containing the reverse charging facility regardless of whether the subscriber accepts or clears the virtual call.

3.2.8.2. Network User Identification (NUI)

Network user identification is a subscription facility that allows a user to charge virtual calls to an Siemens calling card number when presented in a virtual call request (see Section 3.3.3.9.9).

3.2.8.3. Local Charging Prevention

Local charging prevention is a subscription facility that authorizes the PSN to block virtual call setup attempts on or to the interface for which the interface should be considered billable. This is accomplished by:

- The PSN selecting the per-call reverse charging facility on any call request received over the interface that does not already contain the reverse charging facility,
- The PSN not transmitting incoming calls that request reverse charging to the interface.

3.2.9. Addressing Options

The PSN numbering plan complies with the 1984 version of CCITT Recommendation X.121, which defines the international numbering plan for public data networks. This recommendation states that an international data number (IDN), which uniquely identifies a particular DTE, consists of a data network identification code (DNIC) followed by a network terminal number (NTN). The DNIC is a 4-digit code that uniquely identifies a network. The NTN is a sequence of up to 10 digits that is assigned to a particular interface or hunt group. All 10 digits must be present whenever an address is given in the address field of a packet.

The PSN NTNs are 10 digits in length and map closely to the existing voice network numbering plan. They are of the form:

NXX + NXX + XXXX (N = 2,...,9; X = 0,...,9)

The first 3 digits of an NTN are the data numbering plan area (DNPA) code which is the similar to the voice numbering plan area (NPA) code (DNPA = NPA + 80). The next 3 digits are the data central office (DCO)s code. Together, the codes uniquely identify a particular wire center served by the PSN. The last 4 digits of the NTN, the end point number (EPN), uniquely identify a particular interface or hunt group within a wire center.

Direct access interfaces on the PSN may be addressed by a 10-digit PSN NTN alone or a full IDN. DTEs on the other PPSNs may be addressed by a full IDN. Consistent with Recommendation X.121, which allows a prefix to be used to distinguish among different address formats used on a network, the prefix 1 will indicate an address other than a 10-digit PSN NTN. Thus, a full IDN (DNIC + NTN) is always preceded by the prefix 1.

3.2.9.1. Individual Line Addressing Options

Individual line address may represent:

- a single NTN
- multiple contiguous blocks of NTNs

3.2.9.2. Hunt Group

Hunt group is a subscription facility that allows a group of interfaces to be assigned one or more common addresses and causes the PSN to distribute incoming virtual calls containing one of those addresses across these interfaces. Selection of the particular interface within the hunt group is performed in such a way as to evenly distribute the number of virtual calls across the group. An incoming call is completed in case there is at least one ideal logical channel (for

which incoming virtual call service is authorized) available on any of the interfaces in the hunt group. Once a virtual call is established, it is handled like any other virtual call. Virtual call requests originated by the user on the interface are handled normally.

A multiple line hunt group is a grouping of access lines which can be called by DTEs using a single network address. The incoming calls are distributed across the available lines of the hunt group so that the number of virtual calls on each line are approximately equal. Hunt group sizes of up to 128 access lines are supported.

The hunt group performs an access line selection for an incoming call if there is at least one idle logical channel available for virtual calls (excluding one-way outgoing logical channels). The hunt group is considered busy when virtual calls are established on all logical channels available for virtual calls on all lines in the group.

Once a virtual call is assigned to a particular access line, it is treated as a regular call (e.g., if the access line rails, the virtual call is disconnected). All packets associated with an individual virtual call are routed over the same access line.

All access lines in a hunt group are treated as a single administrative unit when virtual call facilities are selected at service over time.

The following addressing options are available for a hunt group:

- a single NTN for the hunt group; individual lines within the hunt group are not individually addressed,
- a single NTN for the hunt group; one individual NTN assigned to each line in the hunt group,
- multiple contiguous blocks of NTNs assigned to the hunt group; individual lines within the hunt group cannot be separately addressed,
- multiple contiguous blocks of NTNs assigned to the hunt group; individual lines within the hunt group assigned NTNs by which they can be separately addressed.

3.3. X.25 INTERFACE PROTOCOL

This section describes the physical, link, and packet level procedures supported on the interface.

3.3.1. Physical Level

The PSN supports a variety of data signaling speeds for different user applications. Direct connections are provided to the PSN via a variety of private line channels. Please refer to the local

Siemens PSN services tariff (Section 3.3.3.1.F) for further information. Also, please refer to the Siemens Exchange Termination Compatibility Specifications in Appendix E for a cross reference of modems and data sets which are compatible with the Siemens PSN.

3.3.1.1. Speeds

The following data signal rates are available on the PSN:

0.3 kb/s

1.2 kb/s

2.4 kb/s

4.8 kb/s

9.6 kb/s

56 kb/s

3.3.2. Link Level

The link level protocol provides for data interchange between a DCE and a DTE over the single access link between them. It also provides for link error control, link error recovery, link initialization and termination, uniform flow control, recovery from procedural errors, transparency, and frame synchronization. Both information and control frames are transferred across the access link in transmission units called frames.

The link level protocol supported at the DTE/DCE interface conforms to CCITT Recommendation X.25 LAPB procedures and is based on the principles and terminology of the high level data link procedure specified by the International Organization for Standardization.

3.3.2.1. Parameters

The PSN default values of the link level parameters are:

Link Level Parameter	PSN Default Value
Window size (k)	7 (Mod 8)
Acknowledgement Timer (T1)	7 (Mod 128)
Response Timer (T2)	3 sec. (Dial-In)
Maximum no. of	2 sec. (Direct)
Retransmissions (N2)	0.3 sec.
Maximum no. of bits	10
in frame (N1)	2128 *

Values of the link level parameters other than the PSN defaults can be selected by the user at service order time. The selectable parameters and their values are:

Link Level Parameter	PSN Default Value
Acknowledgement Timer (T1)	5 ms to 35 sec.
Response Timer (T2)	<= 0.3 sec.
Maximum no. of	1 to 20
Retransmissions (N2)	

* Information Field of an I Frame or Test Frame should not exceed 2096 bits.

The following timer conditions will apply:

- The value of DCE Time T1 for the PSN network is between 5 ms and 35 seconds.
- The period of Timer T1, at the end of which retransmission of a frame may be initiated, will take into account whether T1 is started at the beginning or the end of the transmission of a frame. The period of Timer T1 is agreed to with the network service provider, and may be set in the above values with increments of 50 milliseconds.
- The proper operation of the procedure requires that Timer T1 be greater than the maximum time between transmission of frames (SABM, DISC, I or supervisory commands) and the reception of the corresponding frame returned as an answer

to this frame (UA, DM or acknowledging frame). Therefore, the DTE or DCE receiver should not delay the response or acknowledging frame returned to the above frame by more than a value T2 less than T1 where T2 is a parameter. The DCE will not delay the response or acknowledging frame returned to a command by more than T2.

- T2 should take into account the round-trip propagation delay of the access line plus any processing time in the DTE. The PSN network will not delay the response to a received frame by more than 0.3 seconds; this includes O.1 seconds for the worst case round trip propagation for an access line.

- The range of values for the number N2 of attempts made by the DTE to complete the successful transmission of a frame to the DCE is from 1 to 20.

- The maximum number of bits, N1, in the information field of an I frame or Test frame should not exceed 2096 bits (Level 3 Normal Mode).

3.3.2.2. Link Level Frame Structure

The PSN supports all aspects of the frame structure identified in Section 2.2 of X.25.

3.3.2.3. Link Level Procedural Elements

The PSN supports the LAPB elements of procedure specified in Section 2.3 of X.25. A summary of the link level commands and responses used at this interface follow:

1. Information Transfer (command)

    A. I (Information) Frame

2. Supervisory (commands and responses)

    A. RR (Receive Ready) Frame

    B. RNR (Receive Not Ready) Frame

    C. REJ (Reject) Frame

3. Unnumbered (Commands)

    A. SABM (Set Asynchronous Balanced Mode) Frame

    B. DISC (Disconnect) Frame

4. Unnumbered (responses)

    A. DM (Disconnected Mode) Frame

    B. UA (Unnumbered Acknowledgment) Frame

    C. FRMR (Frame Reject) Frame

3.3.2.4. Link Level Procedures

The procedural step for the setup, disconnect, reset, and transfer of information on this link are specified in the following sections. The user of the poll/final bit is discussed first because it may be used in any of these procedural steps.

- The idle channel state is not implemented in the PSN network.

3.3.2.4.1. Procedure for Using the Poll/Final Bit

In addition to the uses specified in Section 2.4.5.9 of X.25 (1984), the P/F bit will be used as follows.

- The DCE will restart Timer T1, set its send state variable to the last N(R) received from the DTE and transmit a RR or RNR command with the P bit set to 1 to the DTE,

- If, while in the timer recovery condition, the DCE receives correctly a supervisory frame with the F bit set to 0 and with an N(R) within the range from its current send state variable to X included, it will not clear the timer recovery condition,

- If the retransmission count variable is equal to N2, the DCE initiates a resetting procedure for the direction of transmission from the DCE as described in CCITT Recommendation X.25 (1984) Section 2.4.7.2 by sending a DISC. N2 is a system parameter. (See Paragraph 3.2.1),

- The Note in CCITT Recommendation X.25 (1984) Section 2.4.5.9 not apply to this network.

3.3.2.4.2. Link Level Setup

Procedures for the setup of the link level are as specified in Section 2.4.4.1 of X.25 (1984). Setup attempts are signaled using an SABM command and are acknowledged using a UA response. On receipt of the VA, the link is considered to be in the information transfer phase.

3.3.2.4.3. Information Transfer

The procedures used during the information transfer phase are as specified in Section 2.4.5 and 2.4.6 of X.25 (1984).

Additionally, when the DCE is in the busy condition, it does ignore the contents of the information field of a received I-frame, but it responds with an RNR at the earliest opportunity.

The PSN does inform the packet level procedures of a zero-length information field.

If the PSN receives a frame with a bad address field, the frame will be discarded.

If the DTE goes into the DTE busy state during the information transfer phase, the DCE will use the polling procedure discussed in Section 3.3.2.4.1 to deliver frames queued at the DCE.

3.3.2.4.4. Link Disconnection

During the information transfer phase, the frame reject condition or the disconnected phase, the CTE shall indicate disconnecting of the link by transmitting a DISC command to the DCE. When receiving a DISC command during the information transfer phase or the frame reject condition, the DCE will return a UA response to the DTE and enter the disconnected phase. When the DCE wishes to disconnect the link it will send the DISC command with the P bit set to 1 and start Timer T1. Upon reception of the UA or DM response, with F bit set to 1, from the DTE, the DCE will stop its Timer T1. Should Timer T1 expire before reception of the UA or DM responses from the DTE, the DCE will retransmit the DISC command and restart Timer T1. After transmission of the DISC command N2 times by the DCE, recovery action will be initiated.

The disconnected phase is implemented as specified in Section 2.4.4.4 of X.25.

3.3.2.4.5. Link Resetting

The link resetting procedures are as specified in Section 2.4.7 of X.25 (1984).

3.3.2.4.6. Link Level Address

The address field identifies a frame as either a command or a response. A command frame contains the address of the DCE or DTE to which the command is being sent. A response frame contains the address of the DCE or DTE sending the frame.

Frames containing commands transferred from the DCE to the DTE will contain the address A for the single link operation.

Frames containing responses transferred from the DCE to the DTE will contain the address B for the single link operation.

Frames contain commands transferred from the DTE to the DCE shall contain the address B for the single link operation.

Frames containing responses transferred from the DTE to the DCE shall contain the address A for the single link operation.

These addresses are coded as follows:

Single link operations	Address	1	2	3	4	5	6	7	8
	A	1	1	0	0	0	0	0	0
	B	1	0	0	0	0	0	0	0

NOTE: The DCE will discard all frames received with an address other than A or B (single link operation).

3.3.3. Packet Level

The packet level access protocol provides the interface procedures required to set up, maintain and clear virtual calls and maintain permanent virtual circuits between DTEs. The packet types, formats and procedures are those given in X.25 for Virtual Cell and Permanent Virtual Circuit services. These procedures apply to packets that have been successfully transferred across the DTE/DCE interface by the physical and link level protocol.

- Packet level interface attributes specified in X.25 include:
  - User data field length of 256 octets (optionally 128 octets)
  - Packet sequence number modulo 8
  - Packet level window size of 2
- Logical channels are identified by a four bit logical channel group number and an eight bit logical channel number. This allows a maximum of 4096 logical channels on the PS and 1024 logical channels on the PAD to be supported at the interface. Appendix D describes the logical channel number assignment process used in the PSN.

For each range of logical channels for virtual calls applying to an interface, the user must specify the logical channel number where the range begins and ends. If either the incoming/outgoing calls barred facility applies to an interface, the user must specify the logical channel number where the range begins and ends. For permanent virtual circuits, the user must specify the logical channel number for each permanent virtual circuit applying to an interface.

3.3.3.1. Basic Structure of Packet

The structure and type of packets implemented on the PSN are as specified in Section 3.2 (Table 4/X.25) of X.25.

3.3.3.2. Handling of Network Addresses

All 10 (or 14) digits must be present whenever an address is given in the address field of a packet.

The network will validate calling and called addresses as follows: When only one address is assigned to an access line, the network will consider the address to be valid if it is the one assigned to the access line. When multiple addresses are assigned to an access line, the network will consider the address to be valid if it is one of the addresses within the range of addresses assigned to the access line.

Network handling of addresses in Call Request, Incoming Call, Call Accepted, and Call Connected packets is as follows:

3.3.3.2.1. Call Request Packet

Call request packets should contain the called address. If the called address is not present in the Call Request packet, the network will clear the call with a cause of "not obtainable".

Call Request packets should contain the calling address if multiple addresses apply to the calling access line. If the calling address is not present, the network will accept the packet, insert the lowest address assigned to the access line, and process the call. If the calling address is present but is not one of the addresses assigned to the access line, the network will clear the virtual call with a cause code of "local procedure error".

Call Request packets may, but need not, contain the calling address when only one address applies to the calling access line. If the calling address is not present, the network will accept the packet, insert the calling address, and process the call. If the calling address is present but is not the one assigned to the calling access line, the network will clear the call with a cause code of "local procedure error".

3.3.3.2.2. Incoming Call Packet

The Incoming Call packet will contain both the calling address and the called address. In accordance with CCITT Recommendation X.87, the calling address signaled in the Incoming Call packet will have either been inserted of checked as valid by the network.

The PSN will transmit a 10-digit PSN NTN in the called address field of an incoming call packet sent across the interface. The calling address shall be a 10-digit PSN NTN in case the call originated on a PSN direct access interface. The calling address shall be a full IDN preceded by the prefix 1, in case the call originated on a non-PSN public data network. In case the call has been redirected, the address of the originally called DTE shall be present in the call redirection notification facility of the incoming call packet.

3.3.3.2.3. Call Accepted Packet

The Call Accepted packet may, but need not, contain the calling address or the called address. The network will accept a Call Accepted packet having one or both addresses, or having neither address. The network always inserts or substitutes the called address in the Call Accepted packet with the address assigned to the called line. If the called address in the Call Accepted packet from the called DTE is longer than the address assigned to the line, the network will append the extra digit(s) as sub-address to the end of the assigned address in the Call Accepted packet.

3.3.3.2.4. Call Connected Packet

If a calling address is present in the Call Request packet, the same address will be present in the Call Connected packet; otherwise, the calling address in the Call Connected packet will be the address assigned to the calling line. The called address in the Call Connected packet is the called address in the Call Accepted packet after validation and modification by the network. (see 3.3.2)

3.3.3.3. Octet Alignment of User Data Field Lengths

The standard User Data Field Length is 128 octets. However, the User Data Field of data packets transmitted by a DTE may contain any number of bytes up to the agreed maximum.

An octet aligned (any integral number of octets up to 128 or optional 256) User Data Field is supported.

If the User Data Field in a data packet exceeds the locally permitted maximum User Data field length, then the DCE will reset the virtual call or permanent virtual circuit with the resetting cause "local procedure error."

3.3.3.4. Transparency of User Data

All user data present in user data fields of X.25 packets is passed transparently by the PSN. This includes bits 8 and 7 of the first octet of the call user data field of call request and fast select call accepted packets.

Cause code fields supplied by the DTE in clear, reset, and restart request packets are passed transparently by the PSN, if the causecode is "DTE originated." Diagnostic fields supplied by the DTE in clear request packets are passed transparently by the PSN only if the associated cause code is "DTE originated".

3.3.3.5. Effects of Physical and Link Level Failures

A failure on the physical and/or link level is defined as a condition in which the DCE cannot transmit or cannot receive any frame because of abnormal conditions caused by, for instance, a line fault between DTE and DCE.

When a failure on the physical and/or link level is detected, the DCE will clear virtual calls and reset permanent virtual circuits.

In other out-of-order conditions on the physical and/or link level, the DCE will also clear virtual calls and reset permanent virtual circuits. An out-of-order condition on the link level includes receipt of a DISC command or transmission of a DISC command by the DCE, in the case of a single link procedure.

When a failure or out-or-order condition is recovered at physical and link levels, the DCE will send a restart indication packet with the cause "Network operational" to the local DTE.

When a failure at the physical and/or link level is detected, the DCE will transmit to the remote end:

1. a reset with the cause "Out of Order" for each permanent virtual circuit; and

2. a clear with the cause "Out of Order" for each existing virtual call.

During the failure:

A. the DCE will clear any incoming virtual call with the cause "Out of Order";

B. for any data or interrupt packet received from the remote DTE on a permanent virtual circuit, the DCE will reset the permanent virtual circuit with the cause "Out of Order";

C. a reset packet received from the remote DTE on a permanent virtual circuit will be confirmed to the remote DTE by either reset confirmation or reset indication packet.

When the failure is recovered on the physical and link levels, the restart procedure will be actioned and a reset with the cause "Remote DTE operational" will be transmitted to the remote end of each permanent virtual circuit.

3.3.3.6. Significance of Packet Types

The various packet types have different levels of significance. Packets that are referred to as having local significance only describe the state of the local DTE/DCE interface and provide no information about the remote DTE/DCE interface. Packets that are referred to as having end-to-end significance provide information on the end-to-end connection between the local DTE and remote DTE, including the local and remote DTE/DCE interface.

3.3.3.6.1. Significance of Call Accepted, Call Connected, and Interrupt Confirmation Packets

Call accepted, call connected, and interrupt confirmation packets have end-to-end significance.

3.3.3.6.2. Significance of Receive Ready, Receive Not Ready, and Date Packets

The packet sequence numbers P(S) and/or P(R), in the RR, RNR, and data packets transferred across the DTE/DCE interface normally have only local significance. The PSN does not necessarily transmit a packet level RR or RNR to the remote DTE, when it receives one from the local DTE.

If the D bit procedures are being used, the sequence numbers have end-to-end significance.

The user data in the data packets has end-to-end significance because it is passed transparently through the PSN.

3.3.3.6.3. Significance of DCE Clear, Reset, and Restart Confirmation Packets

DCE Clear, Reset, and Restart Confirmation packets have local significance. Local significance permits a confirmation packet to be sent as soon as the network has cleared or reset the logical channel, rather than after the remote DTE has confirmed the reset or clear indication.

If, after receiving the restart confirmation packet, the local DTE sends data on a PVC for which the remote DTE has yet to respond with a reset confirmation, the PSN will queue the data until the remote DTE confirms the reset. If the remote DTE is not operational, the DCE will transmit a reset indication with a cause of "network congestion" or "out of order" to the local DTE.

3.3.3.7. Flow Control Principles

The network follows the standard flow control principles specified in Section 4.4.1.3 of X.25. Namely, if the network receives a data packet containing a P(S) that is out of sequence but within the window, the network will reset the virtual circuit. The network will not pass these packets to the remote DTE. However, in the PSN, the P(R) acknowledgment is sent to the DTE by the local DCE when the corresponding data packet has been sent to the remote DTE by the remote DCE.

3.3.3.8. Support of D, M, and Q Bits

The PSN support of the Delivery Confirmation (D) Bit, More Data Mark (M) Bit, and Qualifier (Q) Bit is specified in the next three subsections.

3.3.3.8.1. Delivery Confirmation Bit

The Delivery Confirmation (D-bit) procedures are supported as specified in X.25. The DTE indicates whether it wishes to receive, by means of the packet receive sequence number P(R), an end-to-end acknowledgment (indicated by D = 1) or local acknowledgment (indicated by D = 0) of delivery for data it is transmitting.

3.3.3.8.2. More Data Mark (M Bit)

The More Data Mark (M-bit) may only be set to 1 in a full data packet. When it is set to 1 in a full data packet, it indicates that more data is to follow. The network does not perform fragmentation or recombination of packets since the maximum packet length is the same at both ends and equal to 128 octets. The network checks if a data packet with the M-bit set is a full data packet. If not, the DCE considers this as a "local procedure error" and will reset the call.

A sequence of data packets with every M-bit set to 1 except for the last one will be delivered as a sequence of data packets with the M-bit set to 1 except for the last one, when the original packets have M = 1 are full.

3.3.3.8.3. Qualifier Bit (Q Bit)

The network does not act on the value of the Qualifier Bit (Q-bit). The Q-bit should be set to the same value in all data packets of a -complete packet sequence (X.25 Section 4.3.6). If this is not the case, the network will still accept the packets and transfer the Q-bit values transparently.

3.3.3.9. Per-Call Facilities

This section describes the facilities that may optionally be selected on a per-call basis during call setup. Unless otherwise stated, the procedures, formats, and coding of these facilities are as specified in Section 7 of X.25.

3.3.3.9.1. Closed User Group Selection

Closed user group (CUG) selection is an optional facility that may be requested on a per-call basis. This facility may be requested or received by a user only if the interface is configured for the CUG, CUG/OA, or CUG/IA subscription facilities (see Section 3.2.6).

The CUG selection facility may be used by the calling DTE in a call request packet to specify a particular CUG associated with a virtual call. It may also be used in an incoming call packet to indicate to the called DTE the particular CUG selected for a virtual call.

The basic format of the CUG selection facility as defined in X.25 must be used.

3.3.3.9.2. Reverse Charging

The reverse charging facility may be signaled by a DTE for a given virtual call to request that the PSN charge all costs associated with the virtual call to the called DTE. This facility may be signaled on any interface.

3.3.3.9.3. RPOA Selection

RPOA selection is an optional user facility that may be signaled by a DTE in a call request packet to indicate that the call should be routed to a particular network. If this facility is signaled, the PSN will attempt to route to the indicated network based on the information in the RPOA selection facility field. If it cannot, the PSN will clear the call.

The RPOA selection facility field should contain the DNIC of a network that is directly connected to the PSN. It can be used to select a transit network (e.g., inter-LATA carrier) if one is required for the call.

Only the basic format of the RPOA selection facility as defined in X.25 may be used.

3.3.3.9.4. Flow Control Parameter Negotiation

Flow control parameter negotiation may be requested on a per-call basis on an interface that is configured for the flow control parameter negotiation subscription facility.

On an interface configured for the flow control parameter negotiation facility (see Section 3.2.5.4), a calling DTE may request, in the call request packet, pocket sizes and/or window sizes for both directions of data transmission of the virtual call. If either particular window sizes of packet sizes are not explicitly requested, the interface default values apply.

On an interface configured for the flow control parameter negotiation facility, an incoming call packet will indicate the packet and window sizes from which negotiation can start. The called DTE may request window sizes and/or packet sizes in the call accepted packet, otherwise the called DTE is assumed to have accepted the presented values.

On an interface configured for the flow control parameter negotiation facility, every call connected packet indicates the packet sizes and window sizes to be used at the interface for that call, or by the PSN in an incoming call packet. See X.25 for a description of the facility format.

The DTE may separately request, in a call request packet, maximum packet sizes and/or window sizes for both directions of transmission of a virtual call. If particular window or packet sizes are not explicitly requested, the PSN will assume that the default values for the interface (either the PSN default values or the non-standard default values see Section 3.2.5.3 and 3.2.5.4) apply.

3.3.3.9.5. Fast Select

Fast select is a per-call facility that allows a call setup packet to contain a call user data field of up to 128 octets. It is an optional facility that may be selected by a DTE in a call request packet.

The fast select facility in a call request packet may indicate either a restriction on response or no restriction on response. A restriction on response indicates that the virtual call should not be established (i.e., a call connected packet cannot be transmitted by the PSN).

If the fast select facility has been requested in a call request packet, an incoming call packet will only be delivered by the PSN if the called interface is configured for fast select acceptance (see Section 3.2.7).

The fast select facility may be requested by a DTE for a given virtual call on any PSN interface without prior agreement with the network service provider.

3.3.3.9.6. Throughput Class Negotiation

On an interface configured for throughput class negotiation (see Section 3.2.5.5), users may negotiate throughput classes different than the interface default values by means of the throughput class negotiation facility field in cell set-up packets. On such an interface, a calling DTE may request, in the call request packet, the throughput classes for both directions of data

transmission of the virtual call. If particular throughput classes are not explicitly requested, the interface default values will apply.

On such an interface, each incoming call packet will indicate the throughput classes from which negotiation may start. These values are always less than or equal to the values which negotiation may start. These values are always less than or equal to the values selected by the calling DTE. The called DTE may request, via a facility in the call accepted packet, the throughput classes that should finally apply to the virtual call. These classes must be less than or equal to the ones presented in the incoming call packet. If the called DTE does not make a request, it is assumed to have accepted the presented values.

On an interface configured for the throughput class negotiation facility, every call connected packet indicates the throughput classes finally applying to the call.

If the called interface is not configured for the throughput class negotiation facility, the throughput classes finally applying to the virtual call are less than or equal to both the values selected at the calling interface and the called interface default values.

3.3.3.9.7. Call Redirection Notification

Call redirection notification is a facility used by the PSN in an incoming call packet to indicate to the alternate DTE that a call has been redirected and to give the reason for the redirection and the address of the originally-called DTE.

3.3.3.9.8. Called Line Address Modified Notification

Called line address modified notification is a facility used by the PSN in a call connected or clear indication packet to indicate to the calling DTE that the called address has been changed from that specified in the call request packet and to give the reason for the change (see X.25).

3.3.3.9.9. Network User Identification

Network user identification (NUI) is a facility that can optionally be signaled by the DTE in a call request packet to provide information to the PSN for billing purposes. A calling card number can be placed in the NUI facility field and usage associated with the virtual call can be charged to that calling card number.

3.3.3.9.10. Closed User Group with Outgoing Access Selection

Closed user group with outgoing access selection is an optional facility that may be requested on a per-call basis. This facility may be requested or received by a user only if the interface is configured for either the CUG/OA or CUG/IA subscription facilities and no preferential CUG has been selected (see Section 3.2.6.2 and 3.2.6.3).

3.3.3.10. General Packet Level Procedures

The states referred to in this and the following sections are specified in X.25 (Annex B and C).

The precedence among packets to be delivered to the DTE from the PSN is:

1. Clear Indication
2. Reset Indication
3. Interrupt
4. Data

When a clear indication is transmitted, any reset indication, interrupt or data packets awaiting transmission are discarded by the PSN. When a reset indication is transmitted, any data or interrupt packets awaiting transmission are discarded by the PSN.

3.3.3.11. Call Setup Procedures

across either the local (calling) or remote (called) DTE/DCE interface. These packets, with the direction of their transmission specified in parentheses, are:

1. Call request (local DTE to DCE)
2. Incoming call packet (remote DCE to DTE)
3. Call accepted packet (remote DTE to DCE)
4. Call connected packet (local DCE to DTE).

3.3.3.11.1. Originating a Virtual Call

The DTE may initiate call setup by sending a call request packet across the DTE/DCE interface and by starting the call request response time (T21). The logical channel selected by the DTE for that call is then in the DTE waiting state (p2). Failure to receive a call connected packet or a clear indication packet before the expiration of T21 is considered an error. When T21 expires, the DTE packet level should clear the call with the cause "DTE originated" and the diagnostic "timer expired for call request."

The PSN will respond to a call request packet with a clear indication packet under the following circumstances:

1. Call request packet has an invalid format:

- Call user data field larger than maximum length
- Missing facility length field
- Value in the facility length field does not match the actual length of the facility field

2. Call unable to be completed:
   - Called address does not exist
   - Call collision
   - Invalid facility code or value
3. Remote DTE not responding
4. Network congestion
5. Remote DTE busy

3.3.3.11.2. Receiving an Indication of an Incoming Call

The DTE receives an indication of an incoming call when an incoming call packet is received from the DCE. The logical channel is then in the DCE waiting state (p3). The incoming call packet may contain an address field, facility fields, and user data. The call user data field (if any) of the call request packet will be placed in the call user data field of the incoming call packet and the PSN will not act on the content of this field.

3.3.3.11.3. Accepting a Virtual Call

The DTE receiving an incoming call packet may respond with a call accepted packet. This packet must specify the same logical channel as that of the incoming call packet. The specified logical channel is then in the flow control ready state (dl). The call accepted packet may contain user data if the incoming call packet indicates the fast select facility without restriction on response (see Section 3.3.3.9.5).

The PSN implements an internal timer that clears the requested call, if it does not receive the call accepted packet from the called DTE within T11 seconds after transmitting the incoming call packet.

3.3.3.11.4. Receiving a Call Connected Indication

The PSN transmits a call connected packet to the calling DTE specifying the same logical channel as that specified in the call request packet to indicate that the call has been accepted by the called DTE. The specified logical channel is then in the flow control ready state (dl).

3.3.3.11.5. Call Collision

If the DTE attempts to send a call request packet on the same logical channel as the one the incoming call packet is being sent on, that logical channel will go into the call collision state (p5). In this state, the call request packet is accepted as normal and the incoming call packet is assumed to have been discarded. The calling DTE that sent the original call request packet associated with the discarded incoming call packet will receive a clear indication packet with the cause code "DTE busy."

3.3.3.12. Procedures for Data and Interrupt Transfer

After the call setup procedure specified above is complete, the virtual call logical channel is in the data transfer state (p4) and stays in that state until either the PSN, the local DTE, or the remote DTE initiates a clearing or restarting. A PVC is continually in the flow control ready state except during a reset or restart procedure.

3.3.3.12.1. Data Transfer

The data packets sent and received will conform to the format specified in Section 6.3 of X.25. The procedures associated with transferring data packets will be consistent with Section 4.3 of X.25, augmented by additional information specified in Sections 3.3.3.7 and 3.3.3.8 of this document. Specifically, the use and significance of D, M, and Q bits in data packets are discussed in these sections. Also, note that the maximum size of a data packet allowed to be used by the DTE is controlled by the PSN default packet size, the DTE's subscribed nonstandard default packet size facility value, or the per-call result of the flow control parameter negotiation (maximum packet size). If the DTE attempts to send a data packet larger than this agreed on maximum, the virtual circuit will be reset with the cause code "procedure error."

3.3.3.12.2. Procedures for Interrupt Transfer

Using the DTE interrupt packet while in the data transfer (p4) or flow control ready (dl) state, the DTE is allowed to transfer up to 32 octets of user data to the remote DTE without following the flow control procedures applicable to data packets. The Interrupt data is delivered to the remote DTE at or before the point in the stream of data packets at which it was generated.

The remote DTE confirms the acceptance of this data packet by sending a DTE interrupt confirmation packet that is passed on to the local DTE using a DCE interrupt confirmation packet. The local DTE is not allowed to issue a second interrupt packet until it receives the DCE inter-

rupt confirmation packet associated with the first interrupt packet. If the DTE attempts to issue a second interrupt packet before the first one is acknowledged, the PSN will reset the virtual circuit with the cause code "procedure error. There is no internal PSN timer associated with the confirmation of interrupt packets. However, the PSN will clear the call if the remote DTE does not respond with an interrupt confirmation packet before the inactivity timer (an internal system parameter) expires.

During this period, the local DTE is also waiting for this confirmation, because it is not allowed to transmit any more interrupt packets until it receives this confirmation.

3.3.3.13. Procedures for Virtual Call Clearing

A call or call request may be cleared by any party at any time. The called or calling party may clear the call either normally, because of call completion, or abnormally, because of error detection.

3.3.3.13.1. Originating a Virtual Call Clearing

The DTE can use the clearing procedures to:

- Verify that a logical channel is in the ready state (clear while in ready state)
- Clear a virtual call that is in the process of setting up (clear before receiving call confirmation)
- Clear a virtual call that it does not want to accept (clear instead of call accepted packet)
- Clear a virtual call that is in progress (clear during data transfer or reset)

The DTE initiates clearing by sending a clear request packet specifying the logical channel across the DTE/DCE interface and by starting the clear request response timer (T23). The logical channel is then in the DTE clear request state. In this state, the only acceptable packets on the logical channel are clear confirmation or clear indication. Other types of packets should be ignored. Failure to receive a clear confirmation packet before T23 expires is considered an error.

The clearing is completed when the local DTE receives a clear confirmation packet from the local DCE.

The clear request packet may contain user data only in the DCE waiting state in response to an incoming call packet which has indicated the fast select facility (see Section 3.3.3.9.5).

3.3.3.13.2. Receiving an Indication of Virtual Call Clearing

When the DTE receives a clear indication packet, the specified logical channel enters the DCE clear indication state (p7). The DTE should complete the clearing by transmitting a clear confirmation packet on the logical channel. The logical channel would then be in the ready state (p1). A clear indication packet will specify the reason for clearing (clearing cause code and diagnostic code), and may contain user data and/or facilities.

3.3.3.13.3. Clear Collision

If the DTE transmits a clear request packet and then receives a clear indication packet on the same logical channel, the DTE should consider the clearing complete, and neither transmit nor expect to receive a clear confirmation packet. The logical channel is in the ready state (p1).

3.3.3.13.4. Clear Confirmation

The DTE may acknowledge a clear by transmitting a clear confirmation packet. The DTE that initiated a clearing procedure should consider the procedures completed when it receives a clear confirmation packet. When the clearing procedure is completed, the logical channel enters the ready state (p1).

3.3.3.13.5. Clearing Packet Formats

The formats used for clearing packets (clear request, clear indication, and clear confirmation) are specified in Sections 6.2.3 and 6.2.4 of X.25).

3.3.3.14. Reset

The reset procedure is used to reinitialize a virtual circuit and in so doing removes, in each direction, all data and interrupt packets that may be in the PSN. Resetting procedures apply to both virtual calls and PVCs.

A. Resetting by the DTE - The DTE initiates a reset by sending across the local DTE/DCE interface a reset request packet. The reset is completed when the local DTE receives a DCE reset confirmation packet from the local DCE. It is the DTE's responsibility to implement timer T22 to ensure the PSN responds to the reset request in an adequate amount of time. The reset confirmation can be assumed to have only local significance.

B. Resetting by the DCE - The DCE initiates a resetting procedure for several reasons including DTE procedure error. The PSN initiates a reset by sending a reset indication packet to the local DTE. Also at that time it starts timer T12. If the DTE responds with a DTE reset confirmation packet before the timer expires, the chan-

nel will be in the flow control ready state (dl). The PSN reaction to the expiration of timer T12 will be discussed in Section 3.3.4.4.

3.3.3.15. Restarting

When there is a need to reinitialize all the local channels at the DTE/DCE interface, the restart procedures may be used. This procedure clears all the logical channels supporting virtual calls, putting them into the ready (p1) state, and resets all the logical channels supporting PVCs, putting them into the flow control ready (dl) state.

3.3.3.15.1. DTE-Initiated Restarts

The DTE initiates a restart by sending a restart request on logical channel zero. The PSN will respond to this request by sending a restart confirmation at some time after receiving the request. At that time the local DTE may assume that all the PVC logical channels have been reset and are in the flow control ready state, and that all the virtual call logical channels have been cleared and are in the ready state.

When the PSN received the restart request above, it also sent a reset indication to the remote end of each restarting DTE's PVCs and sent a clear indication to the remote end of each of the restarting DTE's virtual calls. The restart is defined to be completed when the local DCE sends the restart confirmation packet to the local DTE. This happens regardless of the state of the remote DTEs.

If the remote end of a PVC is unavailable, the local DCE will respond to the restart request with a restart confirmation, followed by a reset request with cause code "out of order" on the PVC channel to the local DTE which sent the restart request.

If the remote end of the PVC does not confirm the reset before the restart is completed, the PSN will complete the restart at the local interface. The remote end of the PVC will be handled as will be discussed in Section 3.3.4.4.3.

If the remote end of a PVC confirms the reset indication and sends data before the restart is completed, this data will be queued and delivered to the local end of the PVC when the restart is completed.

If the local end of a PVC attempts to send any packets before the restart is completed (restart confirmation received), a procedure error will result. The DCE will send a restart indication packet to the local DTE with cause code "local procedure error."

Any incoming calls arriving at the local DCE during the restart process (before sending the restart confirmation) will not be queued in the PSN. Call indication packets are sent to the local DTE after the restart confirmation packet is sent.

3.3.3.15.2. DCE-Initiated Restart

A DCE-initiated restart is issued whenever...

- DTE line is put into service, as soon as the link enters the information transfer phase
- the DCE receives an unsolicited restart confirmation packet or
- the DTE attempts to send any packet immediately after sending a restart request, before a restart confirmation is received (see Section 3.3.3.15.1).

When the DCE starts this procedure by sending a restart indication packet to the local DTE, it also starts timer T1O. If the local DTE responds with a restart confirmation packet before the timer

expires, the interface will be in the packet level ready state (rl). The PSN reaction to expiration of time T10 will be discussed in Section 3.3.4.4.

3.3.4. Network-Defined Actions

The network will respond to the following conditions, which are either undefined in X.25, or have been left for further study.

3.3.4.1. Network Action on Improperly Formatted Packets

This section describes the PSN action on receipt of improperly formatted packets in states where receipt of these packet types is normal.

3.3.4.1.1. Improperly Placed Data Fields

The PSN will clear/reset/do nothing to the associated virtual call if a data field exists after the packet identifier of the following packages:

	PSN's Action
Clear Confirmation	do nothing
Reset Confirmation	do nothing
Interrupt Confirmation	reset with cause code "local procedure error"

Restart Confirmation	do nothing
Call Accepted	clear with cause code "local procedure error" except when the Call Accepted has been sent in response to an incoming call packet with fast select facility specified.

When reset/clear with cause code "local procedure error" is sent to the local DTE, a corresponding reset/clear indication packet is sent to the remote DTE with cause code "local procedure error." The presence of data in a clear request packet is only permitted under the conditions as specified in Section 3.3.3.13.1. If those conditions are not met and the clear packet contains user data, the PSN will send clear indication packets to both the local and remote DTEs with cause codes "local procedure error" and remote procedure error" respectively. The data field existing after the cause code and diagnostic field of a reset request packet is removed and is ignored by the PSN.

3.3.4.1.2. Improperly Formatted General Format Identifier

During a virtual call, packets with improperly formatted general format identifier are ignored and no action is taken by the PSN.

3.3.4.2. Network Action on Unexpected Packets

This section describes the PSN actions on receipt of properly formatted packets that are not expected. The actions discussed here are in addition to those cases discussed in procedural sections above.

3.3.4.2.1. Unsolicited DTE Confirmation Packets

The PSN will generate a restart indication packet to the local DTE on logical channel zero, with a cause code "local procedure error" on receipt of an unsolicited restart confirmation packet.

During a virtual call, the PSN will generate a reset indication packet to the local DTE with a cause code of "local procedure error’ on receipt of an unsolicited interrupt confirmation packet or an unsolicited reset confirmation packet. The above does not apply when DTE/DCE interface is in the reset indication state, in which case the unsolicited interrupt confirmation is discarded. It also does not apply when the DTE/DCE interface is in the clear indication state, in which case both the unsolicited interrupt confirmation and unsolicited interrupt confirmation and unsolicited reset confirmation packets are both discarded.

3.3.4.3. Network Action on Receipt of an Unauthorized Interrupt Packet

If the DTE attempts to send a subsequent interrupt packet before it receives confirmation of the previous interrupt packet, the PSN will reset the virtual circuit.

3.3.4.4. Network Action on Expiration of Timers

This section describes the actions taken by the PSN on expiration of the four packet level timers associated with an access line. The four timers and the packet that initiates the timer are:

1. T1O - started when DCE issues a restart indication packet
2. T11 . started when DCE issues an incoming call packet
3. T12 started when DCE issues a reset indication packet
4. T13 - started when DCE issues a clear indication packet

These timers are fixed in the PSN and cannot be altered on subscribed request.

3.3.4.4.1. Restart Indication Timer T10

Timer T10 is started when the PSN issues a restart indication packet. If timer T10 expires, DCE retransmits the restart indication with cause code changed to "local procedure error", restarts the T10 timer, and remains in start r3. If the restart procedure is not completed (neither a DTE restart confirmation packet nor a restart request packet is received by the DCE) after n retransmissions and after a period of (n+1) x T10 since the first transmission of the restart indication, the Restart Timer-Out Failure (rf) state will be entered. In the case of permanent virtual circuit the remote DTE will be informed by a reset indication packet with cause code "remote procedure error."

3.3.4.4.2. Incoming Call Timer T11

Timer T11 is started when the PSN issues an incoming call packet. If timer T11 expires, DCE enters the p7 state signaling a clear indication (local procedure error) to the called DTE, and the DCE enters the p7 state signaling a clear indication (remote procedure error) to the calling DTE.

3.3.4.4.3. Reset Indication Timer T12

Timer T12 is started when the PSN issues a reset indication packet. If timer T12 expires, DCE retransmits the reset indication with cause code changed to local procedure error", restarts the T12 timer, and remains in state d3. If the reset procedure is not completed (neither a DTE reset confirmation packet nor a reset indication packet is received by the DCE) after n retrans-

missions and after a period of (n+1) xTl2 since the first transmission of the reset indication, the logical channel will be placed in the Flow Control Reedy State (dl). The remote DTE will be informed by a reset indication packet with the cause code "remote procedure error", except when the original reset indication was caused by a reset "out of order" or reset "remote procedure error with diagnostic "reset indication time-out."

3.3.4.4.4. Clear Indication Timer T13

Timer T13 is started when the PSN issues a clear indication packet. If timer T13 expires, DCE retransmits the clear indication with cause code changed to "local procedure error", re-starts the T13 timer, and remains in state p7. If the clear procedure is not completed (neither DTE clear confirmation packet nor DTE clear indication packet is received by the DCE) after n retransmissions and after a period of (n+1) x T13 since the first transmission of the clear indication, the logical channel will be placed in the Ready State (p1).

3.3.4.5. Maintenance Procedures

If network operations initiates an action that results in a virtual call being cleared, a PVC being reset, or an access line being restarted, the cause code for the restart or the reset will be "network operational" and the cause code for the clear will be "network congestion. The diagnostic field for the restart, reset or clear is always "no additional information."

3.3.4.6. Network-Defined Diagnostic Codes

DIAGNOSTICS	BITS 8 7 6 5 4 3 2 1	DECIMAL
Maintenance action	0 1 0 1 0 1 0 0	84
Resources not available	1 0 0 0 0 0 0 0	128
Node or line temporarily	1 0 0 0 0 0 0 1	129
out of service	1 0 0 0 0 0 1 0	130
Barred by operator	1 0 0 0 0 0 1 1	131
Format incompatible with	1 0 0 0 0 1 0 0	132
type code	1 1 1 1 1 1 1 1	255
RPOA required		
System error		

3.3.5. User Maintenance Capabilities

There are capability available to aid the user in operating and maintaining an access line. These capabilities apply to individual access lines, including access lines which are part of a hunt group. These capabilities are:

1. Access line takedown
2. User-initiated self-testing
3. DTE call redirection

3.3.5.1. Access Line Takedown

X.25 contains information on a restart capability, which allows the user to send a packet across the DTE/DCE interface (on logical channel 0) which will clear all virtual calls and reset all PVCs. The capability is commonly used when error conditions become prevalent on an access line, resulting in link level failure. It is automatically initiated by the link layer. At other times, the user may need to have control of a manual restart procedure so that he/she may take his/her access

line out of service for some period of time (e.g., to alter the configuration of the DTE ports). Two access line takedown procedures are available to users and are initiated by notifying Siemens.

3.3.5.1.1. Unconditional Access Line Takedown

A user may place a call to repair and request an unconditional takedown of an access line. The line is then taken out of service until the user requests that it be returned to service. The network will take the line out of service by clearing all virtual calls and resetting all permanent virtual circuits toward the remote DTES and by initiating the link level disconnect procedure on the local interface. For virtual calls, a Clear Indication packet will be transmitted to each remote DTE with a clearing cause code of "out of order." For permanent virtual circuits, a Reset Indication packet will be transmitted to each remote DTE with a cause code of "out of order." A DISC command frame will be transmitted to the local DTE.

Cause the diagnostic code settings for packets generated under the above conditions are as follows:

Packet Type	Cause Code	Diagnostic Code
Clear	Out of order	No additional info.
Reset	Out of order	No additional info.

Once the restart is completed, the network takes the link out of service by initiating the link level disconnect procedures specified in Section 3.3.2.4.4.

3.3.5.1.2. Conditional Access Line Takedown

This feature allows a user to take an access line gracefully out of service. The user calls, by standard voice telephone, to request a conditional takedown of an access line. Based on the user request, action is taken to prevent any new virtual calls from being set up on the designated access line. Existing virtual calls and permanent virtual circuits are unaffected. When the network operator detects that all virtual calls have been terminated, he/she will take the line out of service by initiating the link level disconnect procedure. The network will transmit a DISC command frame to the local DTE. For each permanent virtual circuit, and Reset Indication packet is sent to the remote DTE with a cause code of "out of order." The line will remain out of service until the user calls and requests its return to service.

Cause and diagnostic codes generated as a result of the above conditions are as follows:

Packet Type	Cause Code	Diagnostic Code
Reset	Out of order	No additional info.

3.3.5.2. User Self-Testing Capabilities

A DTE may place a virtual call to its own address. The PSN performs incoming call logical channel selection (and access line selection when a hunt group is employed) in the usual manner. Using this capability, users may perform tests on their DTE packet level procedures.

These self-test calls may be restricted by subscription to incoming/outgoing call restrictions.

References

1. “Interface between DTE and DCE for Terminals Operating in the Packet Mode on Public Data Networks”, CCITT Recommendation X.25, 1980.

2. “International User Services and Facilities in Public Data Networks”, CCITT Recommendation x.2, 1980.

3. “Interworking Between Networks”, CCITT Recommendation X.300, 1980.

Appendix A

Terms

This section lists relevant abbreviations used in this specification.

ANSI	American National Standards Industry
ASCII	American Standard Code for Information Interchange
BOC	Bell Operating Company
CCITT	International Telegraph & Telephone Consultative Committee
CO	Central Office
CPE	Customer Provided Equipment
CUG	Closed User Group
CUG/IA	CUG / Incoming Access
CUG/OA	CUG / Outgoing Access
DCE	Data Circuit-Terminating Equipment
DCO	Digital Central Office
DDD	Direct Distance Dialing
DDS	Direct Digital Service

DISC	Disconnect
DM	Disconnect Mode
DNIC	Data Network Identification Code
DNPA	Data Numbering Plan Area
DTE	Data Terminal Equipment
EIA	Electronic Industries Association
EPN	End Point Number
FRMR	Frame Reject
I	Information
IC	Interexchange Carrier
IDN	International Data Number
Kbps	Kilo bits per second
LAPB	Link Access Procedure Balanced
LATA	Logical Access & Transport Area
LC	Logical Channel
MLHG	Multi-Line Hunt Group
MTCE	Maintenance
NPA	Numbering Plan Area
NTN	Network Terminal Number (Also DTN or Data TN)
NUI	Network User Identification
OTC	Operating Telephone Company
PAD	Packet Assembler/Disassembler
PPSN	Public Packet Switched Network
PS	Packet Switch
PSN	Packet Switched Network
PVC	Permanent virtual Circuit
RES	Reset
RNR	Receiver Not Ready
RPOA	Registered Private Operating Company
RR	Receiver Ready (packets frames)

SABM	Set Asynchronous Balanced Mode
STE	Signaling Terminal Equipment
UA	Unnumbered Acknowledgement
VC	Virtual Call/Circuit
XOFF	Transmit Off
XON	Transmit On

Appendix B

Bibliography

This section lists information sources identified in this specification.

ANSI X.34	Denotes the code character set to be used for general interchange of information among information-processing systems, communications systems and associated equipment.
CCITT Recommendation V.3	International Alphabet No. 5
CCITT Recommendation X.1	International user classes of service in Public Data networks.
CCITT Recommendation X.2	International user services and facilities in Public Data Networks.
CCTT Recommendation X.3	Packet Assembler/Disassembler (PAD) facility in a Public Data Network.
CCITT Recommendation X.4	General Structure of Signals of International Alphabet No. 5 Code for data transmission over Public Data Networks.
CCITT Recommendation X.25	Interface between DTE and DCE for terminals operating in the packet mode on Public Data Networks.
CCITT Recommendation X.28	DTE/DCE interface for start-stop mode data terminal equipment assessing the PAD facility in a Public Data Network situated in the same country.
CCITT Recommendation X.29	Procedures for the exchange of control information and user data between a PAD facility and a packet mode DTE or another PAD.
CCITT Recommendation X.75	Terminal and transit call control procedures and data transfer system on international circuits between packets switched data networks.

CCITT Recommendation X.87	Principles and procedures for realization of international facilities and network utilities in Public Data Networks.
CCITT Recommendation X.92	Hypothetical reference connections for public synchronous data networks.
CCITT Recommendation X.96	Call progress signals in Public Data Networks.
CCITT Recommendation X.110	Routing principles for international public data services through Switched Public Data Networks.
CCITT Recommendation X.121	International numbering plan for Public Data Networks.
TR-TSY-000462*	X.25 Interface Description, June 1987
TR-TSY-000301*	Public Packet Switched Network Generic Requirements

* These TR's (Technical References) are available for a fee from:

Bell Communications Research

Information Operations center

60 New England Avenue

Piscataway, New Jersey 08854-4196

(201) 981-5800

Appendix C

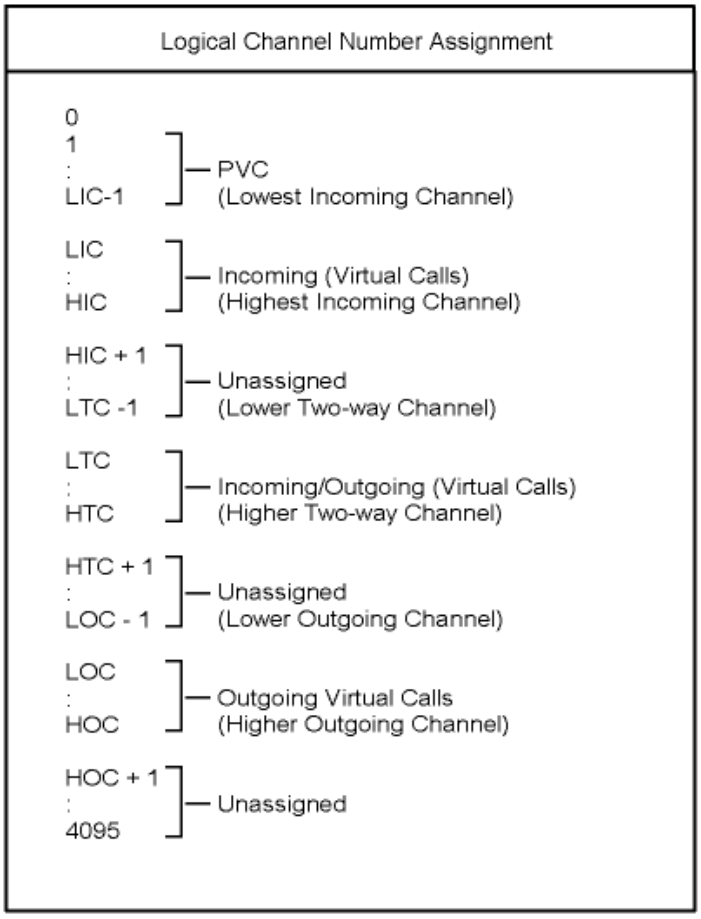
SIEMENS PSN OPTIONAL X.25 OPTIONAL FACILITIES

TABLE 1			
1. OPTIONAL USER FACILITIES ASSIGNED ON A PER SUBSCRIPTION BASIS			
		VC's	PVC's
1.1	On-line Facility Registration	NS	NS
1.2	Extended Packet Sequence Numbering (Modulo 128)	S	S
1.3	D-bit Modification	S	S
1.4	Packet Retransmission	NS	NS
1.5	Incoming Calls Barred	S	-
1.6	Outgoing Calls Barred	S	-
1.7	One-way Logical Channel Outgoing	S	-
1.8	One-way Logical Channel Incoming	S	-
1.9	Nonstandard Default Packet Sizes (256 Only)	S	S
1.10	Nonstandard Default Window Sizes	S	S
1.11	Default Throughput Classes Assignment	S	S
1.12	Flow Control Parameter Negotiation	S	-
1.13	Throughput Class Negotiation	S	-
1.14.1	Closed User Group (CUG)	S	-
1.14.2	CUG With Outgoing Access	S	-
1.14.3	CUG With Incoming Access	S	-
1.14.4	Incoming Calls Barred Within a CUG	S	-
1.14.5	Outgoing Calls Barred Within a CUG	S	-
			-

1.15.1	Bilateral Closed User Group (CUG)	NS	-
1.15.2	Bilateral CUG With Outgoing access	NS	-
1.16	Fast Select Acceptance	S	-
1.17	Reverse Charging Acceptance	S	-
1.18	Local Charging Prevention	S	-
1.19	Network User Identification (NUI)	S	S
1.20	Charging Information	S	-
1.21	RPOA Selection	S	-
1.22	Hunt Group	S	-
1.23	Call Redirection	S	-

TABLE 2			
1. OPTIONAL USER FACILITIES ASSIGNED ON A PER CALL BASIS			
		VC's	PVC's
1.1	Flow Control Parameter Negotiation	S	-
2.2	Throughput Class Negotiation	S	-
2.3	Closed User Group (CUG) Selection	S	-
2.4	CUG With Outgoing Access Selection	S	-
2.5	Bilateral CUG Selection	NS	-
2.6	Fast Select	S	-
2.7	Reverse Charging	S	-
2.8	Local Charging Prevention	S	-
2.9	Network User Identification (NUI)	S	-
2.10	Charging Information	S	-
2.11	RPOA Selection	S	-
2.12	Called Line Address Modified Notification	S	-
2.13	Call Redirection Notification	S	-
2.14	Transit Delay Selection & Indication	NS	-

Appendix D



The DTE uses the highest local channel from its allocation outgoing calls, while the DCE uses the lowest logical channel for incoming calls.

The following are the ranges of logical channels used for PVC connections.

I:	One-way, logical incoming channels. This range is restricted to incoming calls from the network to the subscriber.
I/O:	Incoming/Outgoing calls. This range of logical channels is used for incoming and outgoing calls.
O:	One-way, logical outgoing channels. This range is restricted to outgoing calls from the subscriber to the network.
Note:	The incoming or outgoing direction of a one-way logical channel can be defined in the line description.

Appendix E

EXCHANGE TERMINATION (MODEMS, DATA SETS)
COMPATIBILITY SPECIFICATIONS
FOR SIEMENS PACKETS SWITCHED NETWORK (PSN) SERVICES

PSN Port Termination			PSN Access		PSN Exchange Termination	
Access Types	Speed (BPS)	Protocol	Line Requirements	PSN Exchange Tariff Reference	Applicable Standards	Required Settings *
Public/ Private Dial In	300	Asynch	2 wire, Public Switched Telephone Network Service business/ residence), 1 party, no call waiting** (Note: may require additional circuit conditioning)	Sections 3.3.1.D and 3.3.1.E	Bell System (WECO) 103/113 compatible	Full duplex operation
Public/ Private Dial In	1200	Asynch	2 wire, Public Switched Telephone Network Service (business/residence), 1 party, no call waiting** (Note: may require additional circuit conditioning)	Sections 3.3.1.D and 3.3.1.E	Bell System (WECO) 212A compatible	Full duplex operation

* All other parameters should be set at the factory standard settings.
** The Call Waiting feature, when activated during a data call, may cause data calls to be cleared. Users should consider turning this feature off when making data calls.

EXCHANGE TERMINATION (MODEMS, DATA SETS)
COMPATIBILITY SPECIFICATIONS
FOR SIEMENS PACKETS SWITCHED NETWORK (PSN) SERVICES

PSN Port Termination			PSN Access	PSN Exchange Termination		
Access Types	Speed (BPS)	Protocol	Line Requirements	PSN Exchange Tariff Reference	Applicable Standards	Required Settings *
Direct	1200	Asynch	2 wire, dedicated analog, (Note: may require additional conditioning)	Section 3.3.1.F	Bell System (WECO) 212A compatible	Full duplex operation; mode selection = originate only; character length = 10 bits; transmit line signal level = 0 dBm; must conform to modulation spectrums of 212A data sets and be operational on private lines.
Direct	2400	Asynch	4 wire, dedicated analog, point-to-point or multi-drop	Section 3.3.1.F	Bell System (WECO) 201C-1D and CCITT V.26 type A or B encoding compatible	Full duplex operation, must be equipped with internal or external synchronous to asynchronous converter
Direct	4800	Asynch	4 wire, dedicated analog, point-to-point or multi-drop	Section 3.3.1.F	CCITT V.29 compatible	Fall back speed from 9600 bps; must also be equipped with internal or external synch. to asynch. converter. If fast polling is desired, must use Universal Data Systems (UDS) Model 9600 FP compatible modem.

EXCHANGE TERMINATION (MODEMS, DATA SETS)
COMPATIBILITY SPECIFICATIONS
FOR SIEMENS PACKETS SWITCHED NETWORK (PSN) SERVICES

PSN Port Termination			PSN Access	PSN Exchange Termination		
Access Types	Speed (BPS)	Protocol	Line Requirements	PSN Exchange Tariff Reference	Applicable Standards	Required Settings *
Direct	9600	Asynch	4 wire, dedicated analog, point-to-point or multi-drop	Section 3.3.1.F	CCITT V.29 compatible	Must be equipped with internal or external synch. to asynch. converter. If fast polling is desired, must use UDS Model 9600 FP compatible modem.
Direct	1200	X.25	2 wire, dedicated analog, (Note: may require additional circuit conditioning)	Section 3.3.1.F	Bell System (WECO) 212A compatible	Full duplex operation, mode selection = originate only, character length = 10 bits, transmit line signal level - 0 dbm, must conform to dodumation spectrums of 212A data sets and be operational on private lines.
Direct	2400	X.25	4 wire, dedicated analog, point-to-point on multi-drop	Section 3.3.1.F	Bell System (WECO) 201C-1D and CCITT V.26 type A or B encoding compatible	Full duplex operation

EXCHANGE TERMINATION (MODEMS, DATA SETS)
COMPATIBILITY SPECIFICATIONS
FOR SIEMENS PACKETS SWITCHED NETWORK (PSN) SERVICES

PSN Port Termination			PSN Access		PSN Exchange Termination	
Access Types	Speed (BPS)	Protocol	Line Requirements	PSN Exchange Tariff Reference	Applicable Standards	Required Settings *
Direct	4800	X.25	4 wire, dedicated analog, point-to-point or multi-drop	Section 3.3.1.F	CCITT V.29 compatible	Fall back speed from 9600 bps; if fast polling is desired, must use UDS 9600 FP compatible modem.
Direct	9600	X.25	4 wire, dedicated analog, point-to-point or multi-drop	Section 3.3.1.F	CCITT V.29 compatible	If fast polling is desired, must use UDS Model 9600 FP compatible modem.
Direct	2400	X.25	4 wire, dedicated digital	Section 3.3.1.F	500A DSU compatible	System Status = off Circuit Assurance = off *** (Note: see below)

*** If asynchronous, must be equipped with internal or external synch. to asynch. converter.

EXCHANGE TERMINATION (MODEMS, DATA SETS)
COMPATIBILITY SPECIFICATIONS
FOR SIEMENS PACKETS SWITCHED NETWORK (PSN) SERVICES

PSN Port Termination			PSN Access		PSN Exchange Termination	
Access Types	Speed (BPS)	Protocol	Line Requirements	PSN Exchange Tariff Reference	Applicable Standards	Required Settings *
Digital	4800	X.25 Asynch	4 wire, dedicated digital	Section 3.3.1.F	500 A DSU compatilbe	System Status = off Ciurcit Assurance = off ***
Digital	9600	X.25 Asynch X.75	4 wire, dedicated digital	Section 3.3.1.F	500A DSU compatible	System Status = off Circuit Assurance = off ***
Digital	56000	X.25 X.75	4 wire, dedicated digital	Section 3.3.1.F	500A DSU compatible	System Status = off Circuit Assurance = off

*** If asynchronous, must be equipped with internal or external synch. to asynch. converter.