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X.25 LEVEL 3 REVISION TO INCLUDE DATAGRAM INTERFACE PROCEDURES.(U)
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LEVEL III

TECHNICAL INFORMATION BULLETIN 79-4 CCITT RECOMMENDATION X.25 LEVEL 3 REVISION TO INCLUDE DATAGRAM INTERFACE PROCEDURES WORKING DRAFT

MARCH 1979

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER NCS TIB 79-4	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) X.25 Level 3 Revision to Include Datagram Interface Procedures		5. TYPE OF REPORT & PERIOD COVERED Interim
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) HAROLD C. FOLTS		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Communications System Office of Technology and Standards (NCS-TS) Washington, D.C. 20305		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS National Communications System Office of Technology and Standards (NCS-TS) Washington, D.C. 20305		12. REPORT DATE March 1979
		13. NUMBER OF PAGES 29
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Standards
Packet Switching
Virtual Circuit
X.25
CCITT
Datagram
ISO

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This TIB contains the United States of America Technical Contribution to the International Organization for Standardization, "Requirement for Datagram Service"

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NCS TECHNICAL INFORMATION BULLETIN 79-4

X.25 LEVEL 3 REVISION TO INCLUDE DATAGRAM INTERFACE PROCEDURES

March 1979

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FOREWORD

Among the responsibilities assigned to the Office of the Manager, National Communications System, is the management of the Federal Telecommunication Standards Program which is an element of the overall GSA Federal Standardization Program. Under this program, the NCS, with the assistance of the Federal Telecommunication Standards Committee, identifies, develops, and coordinates proposed Federal Standards which either contribute to the interoperability of functionally similar Federal telecommunication systems or to the achievement of a compatible and efficient interface between computer and telecommunication systems. In developing and coordinating these standards a considerable amount of effort is expended in initiating and pursuing joint standards development efforts with appropriate technical committees of the Electronic Industries Association, the American National Standards Institute, the International Organization for Standardization, and the International Telegraph and Telephone Consultative Committee of the International Telecommunication Union. This Technical Information Bulletin presents an overview of an effort which is contributing to the development of compatible Federal, national, and international standards in the area of data communication interface standards. It has been prepared to inform interested Federal activities of the progress of these efforts. Any comments, inputs, or statements of requirements which could assist in the advancement of this work are welcome and should be addressed to:

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BACKGROUND

Intense activity over the past several years is leading to a new generation of interface standards for the newly emerging public data networks being implemented in numerous countries around the world. These new data networks will offer a variety of service tailored to support the rapidly expanding computer and digital communications requirements. A summary of the public data network standards work is presented in NCS TIB 79-2.

The principle technology used for these new networks is packet-switching. In applying the packet-switching techniques the International Telegraph and Telephone Consultative Committee (CCITT) approved at their Sixth Plenary Assembly, September - October 1976, Recommendation X.25, Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for Terminals Operating in the Packet Mode on Public Data Networks. X.25 defines operation for virtual calls and permanent virtual circuits which effectively simulate dial-up end-to-end connections and dedicated end-to-end connections, respectively, using packet-switching techniques. For the details of the latest Working draft of X.25 for virtual circuit service, refer to NCS TIB 79-3. (AD A068562)

The virtual circuit mode of operation has proved effective for some applications but is not fully efficient for a large spectrum of requirements. As a result, efforts through the American National Standards Institute (ANSI) to CCITT and the International Organization for Standardization (ISO) by the USA have resulted in gaining acceptance for expansion of X.25 to include a datagram mode of operation. Datagrams will provide a fast, transport of small, independent units of data. Appendix 1 of this TIB presents a USA contribution to ISO which describes the features and requirements of datagram operation as a complement to virtual call operation.

As a result of a meeting of the CCITT Special Rapporteur on Datagram Service, Mr. H. Bertine of Bell Labs, USA, good acceptance of the Datagram concept was finally received from a number of participating countries. It was agreed that the test describing Datagram operation should be integrated into the level 3 part of the X.25 virtual call specification. Appendix 2 to this TIB presents a copy of this revised text. Where the proposed draft refers to paragraphs as being "unchanged" without indicating the text, reference should be made to the text in the Appendix of NCS TIB 79-3.

Further work will be done to complete the datagram work during further meetings in April and Autumn 1979. It is expected that a final X.25 covering both virtual circuit service and Datagram service will be approved by CCITT in 1980. At that time it is proposed that X.25 will be adopted as a Federal Standard. Any comments or input from Federal activities in the meantime will be welcome to help achieve a solution that will meet the Federal needs.

NCS TIB 79-4

A P P E N D I X 1

UNITED STATES OF AMERICA

TECHNICAL CONTRIBUTION TO THE

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

REQUIREMENT FOR DATAGRAM SERVICE

X3S37-77-85

ISO/TC 97/SC 6
DATE: October 1977

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ORGANISATION INTERNATIONAL de NORMALISATION

ISO/TC 97/SC 6

DATA COMMUNICATIONS

PROJECT: 15
SOURCE: United States of America
TITLE: Requirement for Datagram Service

1. Introduction

This document sets forth the USA requirement for datagram service to be supported by public data networks. It is specifically assumed that a public data network will offer virtual call service via the X.25 protocol recommendation. It is proposed that the X.25 specification be augmented to incorporate a datagram mode of operation at level 3 (packet level).

2. Historical Background

Packet communication networks are either in operation or under construction in at least 20 countries, and, in some countries, more than one network is to be found. Commercial interest in these networks is increasing and both public and private networks have been developed. A natural consequence of the development of these networks is the need and desire to establish standards for interfacing to them. Such standards would permit computer equipment manufacturers to build and support compatible software and hardware and could also, potentially, ease the ultimate task of interconnecting many of these networks to each other.

The USA recognizes that CCITT Recommendation X.25, in which the virtual call packet interface is defined, represents an important step in the development of standard service and interface specifications. However, for the reasons set forth below, the USA takes the position that an additional service, notably a datagram mode of operation, is needed to support public, private, and government requirements for efficient and reliable data communication. An interface Standard for such a service would be equally beneficial to all three sectors.

3. Datagram Service Definition

A detailed definition of a datagram interface (e.g., showing how it could be integrated into the level 3 part of CCITT Recommendation X.25) is beyond the scope of this paper, but a companion contribution offering a precise description of datagram procedures and formats is in preparation by the USA.

Datagram service can be thought of as a natural dual of virtual circuit service (as characterized in Recommendation X.25). Virtual circuit service is organized around the notion of providing service over a period of time during which one or more packets of information might be exchanged in a sequential fashion between DTE's. Datagram service is organized around <u>messages</u> which are complete in themselves and are unrelated (at least in the view of the transporting network) to any other messsages in transit between or among DTE's.

Thus, the unit of operation, accounting, and control in the two services is different. Control in virtual circuit service is exercised per virtual circuit while in datagram service, it is exercised per datagram. It follows that this distinction leads to a differing, but complementary array of services, the requirement for which is discussed in the next section.

A working definition of datagram service can be offered in a few lines:

1. A datagram is self-contained, carrying sufficient information to be routed from source DTE to destination DTE without reliance on earlier exchanges between source or destination DTE and the transporting network.

2. A datagram is delivered in such a way that the receiver can determine the boundaries (i.e., beginning and end) of the datagram as it was entered by the source DTE. The simplest way to achieve this is to deliver the datagram intact as one unit to its destination, but other methods are not ruled out.

3. A datagram is delivered with high probability to the desired destination, but it may possibly be lost.

4. The sequence in which datagrams are entered into a network by a source DTE is not necessarily preserved upon delivery at a destination DTE.

5. If a datagram cannot be delivered to the destination or is detectably lost, the network will attempt to advise the source DTE through provision of a "non-delivery notice" which indicates, to the best of the network's knowledge, why the datagram could not be delivered. To distinguish among datagrams for the purpose of providing error indications, the network will employ a datagram identifier supplied by the source DTE in each datagram. Uniqueness of this identifier, if desired, is the responsibility of the source DTE and is not necessarily guaranteed.

There are many other details such as formats and DTE/DCE state diagrams which are set forth in the previously mentioned companion contribution on datagram interface specfication.

The quality of virtual circuits and datagrams can be easily seen by a few simple comparisons. Referring to the five definitional statements above, we can construct a parallel set of definitions for virtual circuits:

1. Any one virtual circuit is independent of all others.

2. The source and destination DTE's can distinguish the beginning and ending of a virtual circuit in time.

3. A virtual circuit remains "connected" with high probability for its required lifetime, but may possibly be "reset" prematurely.

4. Virtual circuits are not necessarily set-up in any particular order.

5. If a virtual circuit "breaks" the network attempts to advise the parties involved. Virtual circuits are identified by numbers which may be assigned by DTE or DCE, depending upon the circumstances of the virtual circuit set-up.

While the parallel is not exact, it is close enough to show clearly that virtual circuits are entities which have duration in time while datagrams have duration in the data space. The two notions lead to qualitatively different but complementary services.

4. Datagram Service Applications

4.1 Transaction Processing

The processing of short, self-contained transactions is typical of a variety of applications, notably point-of-sale systems; some classes of electronic funds transfer; query-response services such as credit checking, meter reading, reservation systems, directory look-up, stolen vehicle identification; inventory control; some aspects of process control; and a wide variety of communication and control functions such as tracking, position locations, distributed sensor systems and status reporting systems.

A datagram service matches these transaction processing requirements without the need for virtual circuit set-up and clearing. Depending on the application, the use of permanent virtual circuits may be prohibitively expensive (e.g., more permanent virtual circuits would be required than can be economically supported by the net or the subscriber) or the interface procedures for virtual call service (e.g., setting up and clearing down a virtual circuit for each transaction) may be intolerably high in overhead.

4.2 Real-time Applications

Because the datagram service would treat each datagram independently, subscribers would be free to construct protocols at level 4 which employ a variety of criteria for packet ordering and processing without the delay overhead of explicit sequencing by the public data network. This is particularly attractive in applications where it is not necessary for every packet to be delivered, but low delay for those packets which are delivered is important (real-time data sampling, tracking, process control and so on). Provision of virtual circuit service (reliable, sequenced delivery) can introduce undesirable delays for packet delivery which may render the data useless when it is finally delivered. This is particularly the case for real-time applications in which the data has very high time value which drops rapidly to zero (or is negative - i.e., a liability if old data interferes with delivery of fresh data!) in a short time. Many of these applications are more concerned about the age of incoming data than their order.

4.3 Network Flexibility

Datagram traffic can be freely routed, without regard to sequencing, across any available link to multi-homed hosts, through any series of internetwork gateways without the need to maintain state information relating datagram packets to each other at source or destination DCE's or at intermediate gateways. For those classes of subscriber applications not requiring network sequencing, networks would have a wider range of routing options and could enhance their transparency to intermediate failures (broken lines, DCE's, gateways and the like).

Interconnection of public data nets with private, local nets such as the Xerox Ethernet would be considerably simplified through the use of a public network datagram mode of operation. Since such private packet nets do not internally sequence packets, there would be no need for the gateways between these private nets and public nets to set up and clear virtual circuits if a public datagram mode were available. Indeed, it is not always clear, at such a gateway, when to set up or clear a virtual circuit. Use of datagram mode in this case would eliminate inefficiencies for both the public data net and private network subscribers.

5. Recommendation

In order to provide interface procedures for datagram service (specified in X.2 as an A facility for user classes 8-11), the USA recommends that a datagram mode of operation be incorporated at level 3 (packet level) of Recommendation X.25.

NCS TIB 79-4

APPENDIX 2

CCITT DOCUMENT COM VII NO 295-E

X.25 LEVEL 3 REVISION TO INCLUDE DATAGRAM INTERFACE PROCEDURES

International Telegraph and Telephone
Consultative Committee
(C.C.I.T.T.)

Period 1977 - 1980

Question: 14/VII

COM VII No. 295-E

Original: English

Date: January 1979

STUDY GROUP VII - CONTRIBUTION NO. 295

SOURCE: Special Rapporteur on Datagram Service - H. Bertine

TITLE: X.25 Level 3 Revision to Include Datagram Interface Procedures

INTRODUCTION

At the 30 November - 1 December 1978 Special Rapporteur's meeting on datagram service, it was agreed that the datagram interface procedures should be integrated into the text for X.25, level 3. Mr. Folts, USA, agreed to do the necessary editing. The resulting working draft is provided in the annex to this document and is based on the text of COM VII No. 217 as modified by the Special Rapporteur's meeting on X.25 level 3, 27-29 November 1978. The unchanged sections are noted accordingly, and marginal lines appear where changes have been made.

ANNEX

3. DESCRIPTION OF THE PACKET LEVEL DTE/DCE INTERFACE FOR VIRTUAL CALL, PERMANENT VIRTUAL CIRCUIT AND DATAGRAM FACILITIES (LEVEL 3)

This section of the Recommendation relates to the transfer of packets at the DTE/DCE interface. The procedures apply to packets which are successfully transferred across the DTE/DCE interface.

Each packet to be transferred across the DTE/DCE interface shall be contained within the link level information field which will delimit its length, and only one packet shall be contained in the information field.

NOTE: Possible insertion of more than one packet in the link level information field is for further study.

To enable simultaneous virtual calls, permanent virtual circuits and/or datagrams, logical channels are used. Each virtual call, permanent virtual circuit, and datagram channel is assigned a logical channel group number (less than or equal to 15) and a logical channel number (less than or equal to 255). For virtual calls a logical channel group number and a logical channel number are assigned during the call set-up phase. For permanent virtual circuits and datagram channels, logical channel group numbers and logical channel numbers are assigned in agreement with the Administration at the time of subscription to the service. The range of logical channels used for virtual calls is agreed with the Administration at the time of subscription to the service.

Annex 1 shows the state diagrams which give a definition of events at the packet level DTE/DCE interface for each logical channel. Figures 15/X.25, 16/X.25 and 17/X.25 apply to logical channels used for virtual calls; Figures 15/X.25 and 17/X.25 apply to logical channels used for permanent virtual circuits and datagrams.

Annex 2 gives details of the action taken by the DCE on receipt of packets in each state shown in Annex 1. Details of the actions which should be taken by the DTE are for further study. Tables 10/X.25-13/X.25 apply for virtual calls and Tables 11/X.25-13/X.25 apply for permanent virtual circuits and datagrams.

Packet formats are given in Section 4 of this Recommendation.

3.1 Procedures for Virtual Calls

(Delete the three paragraphs under Section 3.1; Subsections 3.1.1 through 3.1.12 are unchanged.)

3.2 Procedure for Permanent Virtual Circuits and Datagrams

For permanent virtual circuits and datagrams there is no call set-up or clearing.

A datagram packet includes the destination DTE address. The source address may also be used.

NOTE: A DTE address may be a DTE network address, an abbreviated address or any other DTE identification agreed for a period of time between the DTE and the DCE.

3.3 Procedures for Data and Interrupt Transfer

The data transfer procedure described in the following section applies independently to each logical channel existing at the DTE/DCE interface.

Normal network operation dictates that user data in data, interrupt and datagram packets are all passed transparently, unaltered through the network in the case of packet DTE to packet DTE communications. Order of bits of user data is preserved. Packet sequences are delivered as complete packet sequences for virtual call and permanent virtual circuit operation. DTE Diagnostic Codes are treated as described in Sections 4.2.3, 4.4.3 and 4.5.1.

3.3.1 States for Data Transfer

A virtual call logical channel is in the DATA TRANSFER state after completion of call establishment and prior to clearing or a restart procedure. Permanent virtual circuit and datagram logical channels are continually in the DATA TRANSFER state except during the restart procedure. Data, datagram, interrupt, flow control, datagram service signal, and reset packets may be transmitted and received by a DTE in the DATA TRANSFER state of a logical channel at the DTE/DCE interface. In this state, the flow control and reset procedures described in section 3.4 apply to data transmission on that logical channel to and from the DTE.

For virtual calls, data, interrupt, flow control and reset packets transmitted by a DTE will be ignored by the DCE when the logical channel is in the DCE CLEAR INDICATION state. When a virtual call is cleared, data and interrupt packets may be discarded by the network. (See section 3.6). Data, interrupt, flow control and reset packets that are in the network and destined for a DTE, the interface of which enters the DTE CLEAR REQUEST state (p6) may be delivered before the DCE CLEAR CONFIRMATION packet is sent to that DTE. Hence it is left to the DTE to define DTE to DTE protocols able to cope with the various possible situations that may occur.

3.3.2 Numbering of Packets

Each data, or datagram and datagram service signal packet transmitted at the DTE/DCE interface for each direction of transmission in a virtual call, permanent virtual circuit, or datagram channel is sequentially numbered.

The sequence numbering scheme of the packets is performed modulo 8. The packet sequence numbers cycle through the entire range 0 to 7. As an additional facility, some Administrations will provide a sequence numbering scheme for packets being performed modulo 128. In this case, packet sequence numbers cycle through the entire range 0 to 127. The modulo, 8 or 128, is the same for both directions of transmission and is common for all logical channels at the DTE/DCE interface.

Only data, datagram and datagram service signal packets contain this sequence number called the packet send sequence number P(S).

The first data, datagram, or datagram service signal packet to be transmitted across the DTE/DCE interface for a given direction of data transmission, when the logical channel is in the DATA TRANSFER state, has a packet send sequence number equal to 0.

A P (S) in a received data, datagram, or datagram service signal packet not containing the proper sequence number on a logical channel is considered by the DCE as a local procedure error (see Sections 3.4.2 and 4.4.3); the DCE then resets the logical channel.

3.3.3 User Data Field Length

The standard maximum User Data Field length is 128 octets for virtual calls, permanent virtual circuits and datagrams.

In addition, and in conjunction with optional user facilities, other maximum data field lengths may be offered by Administrations for virtual call and permanent virtual circuit operation.

If an optional maximum data field length is selected at subscription it becomes the default maximum data field length common to all virtual call and permanent virtual circuit logical channels at the DTE/DCE interface. The Administration may also permit selection of a maximum data field length on a per call basis for virtual calls (see Section 5.1.2).

Optional maximum data field lengths offered for virtual calls and permanent virtual circuits will be chosen by each Administration from the following list: 16, 32, 64, 256, 512 and 1024 octets.

The data field of data and datagram packets transmitted by a DTE or DCE may contain any number of bits up to the agreed maximum.

For virtual call and permanent virtual circuit operation, if a DTE or DCE wishes to indicate a sequence of more than one packet, it uses a MORE DATA mark as defined below:

(Remainder of 3.3.3 unchanged)

3.3.4 Qualifier Bit (Unchanged except add the following additional paragraph at end of section.)

For datagram operation, the qualifier bit is set to 0 in all datagram packets and is set to 1 in all datagram service signal packets.

3.3.5 Interrupt Procedure

The interrupt procedure applies only to virtual call and permanent virtual circuit operation. It allows a DTE to transmit data to the remote DTE, without following the flow control procedure applying to data packets (see section 3.4). The interrupt procedure can only apply in the FLOW CONTROL READY state (d1) within the DATA TRANSFER state (p4).

(Remainder of 3.3.5 unchanged)

3.3.6 Datagram Identification

Each datagram transmitted at the DTE/DCE interface for each direction of transmission may be uniquely numbered with a datagram identification number. Assignment of the values to the datagram identification is a DTE responsibility and may be assigned according to any algorithm. The network will not operate on the datagram identification except to return the information in the appropriate network generated datagram service signal packet.

3.3.7 Datagram Service Signals

The DCE will be capable of transferring to the DTE service signals as specified in Recommendation X.96. The datagram service signals will be carried in datagram service signal packets which will include the datagram identification and address information, if valid, associated with the original datagram for which the service signal applies. The original destination address is provided in the datagram service signal packet as the source address while the original source address is shown as the destination address, when present.

3.4 Procedures for Flow Control

This subsection only applies to the data transfer phase and specifies the procedures covering flow control of data, datagram and datagram service signal packets and reset on each logical channel.

For each direction of data transmission on a logical channel a throughput class can be identified which directly corresponds to the rate at which packets can be transmitted across the DTE/DCE interface. The throughput class indicates the throughput that does not need to be exceeded for that direction of traffic. Details on throughput classes are given in 3.4.1.3.

3.4.1 Procedure for Flow Control

At the DTE/DCE interface of a logical channel, the transmission of data, datagram and datagram service signal packets is controlled separately for each direction and is based on authorizations from the receiver. These three packet types are referred below as flow controlled packets.

3.4.1.1 Window Description

At the DTE/DCE interface of a logical channel, and for each direction of data transmission, a window is defined as the ordered set of W consecutive packet send sequence numbers of the flow controlled packets authorized to cross the interface.

The lowest sequence number in the window is referred to as the lower window edge. At the start of DATA TRANSFER, the window related to each direction of transmission has a lower window edge equal to 0.

The packet send sequence number of the first flow controlled packet not authorized to cross the interface is the value of the lower window edge plus W (modulo 8, or 128 when extended).

In the absence of an optional user facility, the window size W for each direction of transmission at a DTE/DCE interface is common to all the logical channels and agreed for a period of time between the DTE and the Administration. The value of W does not exceed 7, or 127 when extended (see Section 5.1.2).

3.4.1.2 Flow Control Principles

A number modulo 8, or 128 when extended, referred to as a packet receive sequence number P(R), conveys across the DTE/DCE interface information from the receiver for the transmission of flow controlled packets. When transmitted across the DTE/DCE interface, a P(R) becomes the lower window edge. In this way, additional flow controlled packets may be authorized by the receiver to cross the DTE/DCE interface.

When the sequence number P(S) of the next flow controlled packet to be transmitted by the DTE is within the window, the DCE will accept this flow controlled packet. When the sequence number P(S) of the next flow controlled packet to be transmitted by the DTE is outside of the window, the DCE will consider the receipt of this flow controlled packet from the DTE as a procedure error and will reset the logical channel. The DTE should follow the same procedure.

When the sequence number P(S) of the next packet to be transmitted by the DCE is within the window, the DCE is authorized to transmit this flow controlled packet to the DTE. When the sequence number P(S) of the next flow controlled packet to be transmitted by the DCE is outside of the window, the DCE shall not transmit a flow controlled packet to the DTE.

The packet receive sequence number, P(R), is conveyed in data, datagram, datagram service signal, RECEIVE READY (RR), and RECEIVE NOT READY (RNR) packets.

The value of a P(R) received by the DCE must be within the range from the last P(R) received by the DCE up to and including the packet send sequence number of the next flow controlled packet to be transmitted by the DCE. Otherwise, the DCE will consider the receipt of this P(R) as a procedure error and will reset the logical channel. The DTE should follow the same procedure.

The receive sequence number P(R) is less than or equal to the sequence number of the next expected flow controlled packet and implies that the DTE or DCE transmitting P(R) has accepted at least all flow controlled packets numbered up to and including P(R)-1.

The only universal significance of a P(R) value is a local updating of the window across the packet level interface. The P(R) value for virtual calls and permanent virtual circuits may be used within some Administration's networks to convey an end-to-end acknowledgement.

The network maintains a datagram queue for each destination DTE. The maximum length of this queue is agreed for a period of time between the DTE and the Administration. When the queue is full, additional arriving datagrams destined to this DTE are discarded. Datagram service signal packets have priority over other datagram packets and therefore are inserted at the beginning of the queue. This may lead to the DCE discarding the last datagram packet of the queue if the maximum queue length is exceeded.

By agreement for a period of time between the DTE and the Administration, a special datagram logical channel may be assigned for the transmission of service signals. In this case, the maximum length of the queues for datagrams and datagram service signals are independently agreed between the DTE and the Administration.

If the DTE flow controls the receipt of datagram service signal packets, the DCE cannot guarantee to store an indefinite number of service signals. Therefore, there is a possibility of loss of service signal packets at the DCE. A possible coupling mechanism to allow the DCE to regulate the number of datagrams generated by the DTE in relation to the capacity of the DCE to store the datagram service signals should be studied to determine whether such losses at the DCE should be prevented.

3.4.1.3 Throughput Class

A throughput class for one direction of transmission is an indication of the throughput that does not need to be exceeded on the logical channel. Thus, the network is asked to allocate such resources that the throughput class can normally be reached. However, due to the statistical sharing of transmission and switching resources, it is not guaranteed that the throughput class can be reached 100% of the time.

Depending on the network and the applicable conditions at the considered moment, the effective throughput may exceed the throughput class.

The throughput class may only be reached if the following conditions are met:

(a) the access data links of both ends of a virtual call or permanent virtual circuit are engineered for the throughput class;

(b) the receiving DTE of a virtual call or permanent virtual circuit is not flow controlling the DCE such that the throughput class is not reachable; and

(c) the transmitting DTE is sending packets which have the maximum data field length.

The throughput class is expressed in octets/second; at a DTE/DCE interface, a maximum data field length is specified, and thus the throughput class can be interpreted by the DTE as the number of full packets/second that the DTE does not have a need to exceed.

NOTE 1: The definition of throughput class in terms of quality of service is for further study.

NOTE 2: The need to link the datagram flow control with the flow control of information associated with virtual calls and permanent virtual circuits across the DTE/DCE interface is for further study.

3.4.1.4 <u>DTE and DCE Receive Ready (RR) Packets</u> (Unchanged)

3.4.1.5 <u>DTE and DCE Receive Not Ready (RNR) Packets</u>

RNR packets are used by the DTE or DCE to indicate a temporary inability to accept additional flow controlled packets for a given logical channel. A DTE or DCE receiving an RNR packet shall stop transmitting flow controlled packets on the indicated logical channel, but the window is updated by the P(R) value of the RNR packet. The receive not ready situation indicated by the transmission of an RNR packet is cleared by the transmission in the same direction of an RR packet or by a reset procedure being initiated.

The transmission of an RR after an RNR at the packet level is not to be taken as a demand for retransmission of packets which have already been transmitted but still are in the window indicated in the RR.

3.4.2 <u>Procedure for Reset</u>

The reset procedure is used to re-initialize the logical channel. When a logical channel at the DTE/DCE interface has just been reset, the window related to each direction of transmission has a lower window edge equal to 0, and the numbering of subsequent flow controlled packets to cross the DTE/DCE interface for that direction of transmission shall start from 0.

For virtual calls and permanent virtual circuits, the reset procedure removes in each direction all data and interrupt packets which may be in the network associated with that virtual call or permanent virtual circuit (See Section 3.6). For datagram channels, the reset procedure does not cause datagrams or datagram service signals to be purged within the network.

The reset procedure can only apply in the DATA TRANSFER state of the DTE/DCE interface. In any other state of the DTE/DCE interface, the reset procedure is abandoned. For example, when a clearing or restarting procedure is initiated, RESET REQUEST and RESET INDICATION packets can be left unconfirmed.

For flow control, there are three states d1, d2 and d3 within the DATA TRANSFER state (p4). They are FLOW CONTROL READY (d1), DTE RESET REQUEST (d2), and DCE RESET INDICATION (d3) as shown in the state diagram in Annex 1, Figure 17/X.25. When entering state p4 the logical channel is placed in state d1. Annex 2, Table 11/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE.

3.4.2.1 <u>Reset Request Packet</u> (Unchanged)

3.4.2.2 <u>Reset Indication Packet</u>

The DCE shall indicate a reset by transmitting to the DTE a RESET INDICATION packet specifying the logical channel and the reason for the resetting. This places the logical channel in the DCE RESET INDICATION state (d3). In this state, the DCE will ignore data, datagram, interrupt, RR and RNR packets. (See section 3.7).

3.4.2.3 <u>Reset Collision</u> (Unchanged)

3.4.2.4 <u>Reset Confirmation Packets</u> (Unchanged)

3.5 <u>Procedure for Restart</u>

The restart procedure is used to simultaneously clear all the virtual calls and reset all the permanent virtual circuits and datagram channels at the DTE/DCE interface. (See section 3.6).

(Remainder of this section unchanged)

3.5.1 Restart by the DTE

The DTE may at any time request a restart by transferring across the DTE/DCE interface a RESTART REQUEST packet. The interface for each logical channel is then in the DTE RESTART REQUEST state.

The DCE will confirm the restart by transferring a DCE RESTART CONFIRMATION packet placing the logical channels used for virtual calls in the READY state (p1), and the logical channels used for permanent virtual circuits and datagrams in the FLOW CONTROL READY state (d1).

The DCE RESTART CONFIRMATION packet can only be interpreted universally as having local significance. The time spent in the DTE RESTART REQUEST state (r2) will not exceed a network dependent limit.

3.5.2 Restart by the DCE

The DCE may indicate a restart by transferring across the DTE/DCE interface a RESTART INDICATION packet. The interface for each logical channel is then in the DCE RESTART INDICATION state (r3). In this state of the DTE/DCE interface, the DCE will ignore data, datagram, interrupt, call set-up and clearing, flow control, and reset packets.

The DTE will confirm the restart by transferring a DTE RESTART CONFIRMATION packet placing the logical channels used for virtual calls in the READY state (p1), and the logical channels used for permanent virtual circuits and datagrams in the FLOW CONTROL READY state (d1). (See section 3.7).

3.5.3 Restart Collision (Unchanged)

3.6 Effect of Clear, Reset and Restart Procedures on the Transfer of Packets

(Unchanged except add the following paragraph.)

For datagram channels, the reset procedure does not cause datagrams or datagram service signals to be purged within the network.

3.7 List of System Parameters (Unchanged)

3.8 Effects of Levels 1 and 2 on Level 3

Changes of operational states of level 1 and 2 of the DTE/DCE interface do not implicitly change the state of each logical channel at level 3. Such changes when they occur are explicitly indicated at level 3 by the use of restart, clear or reset procedures as appropriate.

A failure on levels 1 and/or 2 is defined as a condition in which the DCE cannot transmit and receive any frames because of abnormal conditions caused by for instance line fault between DTE and DCE.

When a failure on levels 1 and/or 2 is detected, the DCE will transmit to the remote end

(a) a reset indicating Out of Order for a permanent virtual circuit and

(b) a clear indicating Out of Order for an existing virtual call.

During the failure, the DCE will clear any incoming virtual calls and discard any incoming datagrams and datagram service signals.

When the failure is recovered on levels 1 and 2, the DCE will send a RESTART INDICATION packet indicating Network Operational to the local DTE and this will result in a reset indicating Remote DTE Operational to be transmitted to the remote end of each permanent virtual circuit.

In other out of order conditions on level 1 and/or 2, including transmission of a DISC command by the DTE, the behavior of the DCE is for further study.

4. PACKET FORMATS

4.1 General (Unchanged)

4.1.1 General Format Identifier

The General Format Identifier field is a four bit binary coded field which is provided to indicate the general format of the rest of the header. The General Format Identifier field is located in bit positions 8, 7, 6 and 5, of octet 1, and bit 5 is the low order bit (see Table 5/X.25).

Two of the sixteen possible codes are used to identify the formats for the DTE/DCE interface defined herein, which provide for virtual call, permanent virtual circuit, and datagram facilities. Two other codes are used to identify the similar formats in the case sequence numbering scheme of data packets is performed modulo 128. Other codes of the General Format Identifier are unassigned.

NOTE: It is envisaged that unassigned codes could identify alternative packet formats associated with other facilities or simplified access procedures, for example, single access DTE procedures.

TABLE 5/X.25

GENERAL FORMAT IDENTIFIER

GENERAL FORMAT IDENTIFIER		Octet 1 bits 8 7 6 5
Data, datagram and datagram service signal packets	Sequence numbering scheme modulo 8	X 0 0 1
	Sequence numbering scheme modulo 128	X 0 1 0
Call set-up and clearing, flow control, interrupt, reset and restart packets	Sequence numbering scheme modulo 8	0 0 0 1
	Sequence numbering scheme modulo 128	0 0 1 0

NOTE: A bit which is indicated as "X" may be set to either "0" or "1" as discussed in subsequent sections.

4.1.2 Logical Channel Group Number (Unchanged)

4.1.3 Logical Channel Number (Unchanged)

4.1.4 Packet Type Identifier

Each packet shall be identified in the octet 3 of the packet according to the following Table 6/X.25.

TABLE 6/X.25

PACKET TYPE IDENTIFIER

PACKET TYPE		OCTET 3 BITS
FROM DCE TO DTE	FROM DTE TO DCE	8 7 6 5 4 3 2 1
CALL SET-UP AND CLEARING		
INCOMING CALL	CALL REQUEST	0 0 0 0 1 0 1 1
CALL CONNECTED	CALL ACCEPTED	0 0 0 0 1 1 1 1
CLEAR INDICATION	CLEAR REQUEST	0 0 0 1 0 0 1 1
DCE CLEAR CONFIRMATION	DTE CLEAR CONFIRMATION	0 0 0 1 0 1 1 1
DATA AND INTERRUPT		
DCE DATA	DTE DATA	X X X X X X X 0
DCE INTERRUPT	DTE INTERRUPT	0 0 1 0 0 0 1 1
DCE INTERRUPT CONFIRMATION	DTE INTERRUPT CONFIRMATION	0 0 1 0 0 1 1 1
DCE DATAGRAM	DTE DATAGRAM	X X X X X X X 0
DATAGRAM SERVICE SIGNAL		X X X X X X X 0
FLOW CONTROL AND RESET		
DCE RR	DTE RR	X X X 0 0 0 0 1
DCE RNR	DTE RNR	X X X 0 0 1 0 1
	DTE REJ*	X X X 0 1 0 0 1
RESET INDICATION	RESET REQUEST	0 0 0 1 1 0 1 1
DCE RESET CONFIRMATION	DTE RESET CONFIRMATION	0 0 0 1 1 1 1 1
DCE RR (MODULO 128)*	DTE RR (MODULO 128)*	0 0 0 0 0 0 0 1
DCE RNR (MODULO 128)*	DTE RNR (MODULO 128)*	0 0 0 0 0 1 0 1
	DTE REJ (MODULO 128)*	0 0 0 0 1 0 0 1
RESTART		
RESTART INDICATION	RESTART REQUEST	1 1 1 1 1 0 1 1
DCE RESTART CONFIRMATION	DTE RESTART CONFIRMATION	1 1 1 1 1 1 1 1

* Not necessarily available on every network. Use of the DTE REJ packet is described in section 5.1.5.

NOTE: A bit which is indicated as "X" may be set to either "0" or "1" as discussed in subsequent sections.

4.2 Call Set-up and Clearing Packets (Unchanged)

4.3 Data, Interrupt, Datagram, and Datagram Service Signal Packets

4.3.1 DTE and DCE Data Packets (Unchanged)

4.3.2 DTE and DCE Interrupt Packets (Unchanged)

4.3.3 DTE and DCE Interrupt Confirmation Packets (Unchanged)

4.3.4 Datagram Packets

Figure 5 bis/X.25 illustrates the format of DTE and DCE datagram packets.

Qualifier Bit

Bit 8 in Octet 1 is the QUALIFIER bit and is always set to 0.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

Packet Send Sequence Number

Bits 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the Packet Send Sequence Number P(S). P(S) is binary coded and bit 2 is the low order bit.

Address Lengths Field

The octet following the sequence numbers consists of field length indicators for the destination and source DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the destination DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the source DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

Address Field

The octets following the Address Length Field consist of the destination DTE address when present, then the source DTE address when present.

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low-order bit of the digit.

Starting from the high order digit, the address is coded in consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The Address Field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

NOTE: This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as the coding of those facilities is for further study.

Facility Length Field

Bits 6, 5, 4, 3, 2 and 1 of the octet following the Address Field indicate the length of the Facility Field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

Bits 8 and 7 of this octet are unassigned and set to 0.

Facility Field

The Facility Field is present only when the DTE is using an optional user facility requiring some indication in the datagram packet.

The coding of this Facility Field is defined in Section 5.

The Facility Field contains an integral number of octets. The actual maximum length of this field depends on the facilities which are offered by the network. However this maximum does not exceed 62 octets.

User Data Field

Following the facility field, the user data field may be present and has a maximum length of 128 octets. The first two octets of the user data field are called the datagram identifier.

4.3.5 Datagram Service Signal Packets

Figure 5ter/X.25 illustrates the format of datagram service signal packets.

Qualifier Bit

Bit 8 of octet 1 is the QUALIFIER bit and is always set to 1.

Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used for indicating the Packet Receive Sequence Number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

Packet Send Sequence Number

Bit 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the Packet Send Sequence Number P(S). P(S) is binary coded and bit 2 is the low order bit.

Address Lengths Field

The octet following the sequence numbers consists of field length indicators for the destination and source DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the destination DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the source DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

Address Field

The octets following the Address Length Field consist of the destination DTE address when present, then the source DTE address when present (see Section 3.3.7).

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low-order bit of the digit.

Starting from the high order digit, the address is coded in consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The Address Field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

Datagram Identification Field

The datagram identification field contains the first two octets of the user data field from the original datagram to which the datagram service signal packet applies. If the user data field of the original datagram is less than two octets, the datagram identification field in the datagram service signal packet will be padded out to two octets by inserting the appropriate number of 0 bits.

Cause Field

The octet immediately following the datagram identification field is the cause field and contains the reason for the datagram Service Signal.

The coding of the Cause Field is given in Table ___/X.25.

Diagnostic Code

The octet immediately following the Cause Field contains additional information on the reason for the datagram service signal.

The bits of the Diagnostic Code in a datagram service signal packet are all set to zero when no specific additional information for the service signal is supplied. Other values are for further study.

NOTE: The contents of the diagnostic code field do not alter the meaning of the cause field. A DTE is not required to undertake any action on the contents of the diagnostic code field. Unspecified code combinations in the diagnostic code field shall not cause the DTE to not accept the cause field.

Network Information Field

Following the Diagnostic Field, the Network Information Field may be present and has a maximum length of 16 octets.

The information content of this field is for further study.

4.4 Flow Control and Reset Packets (Unchanged)

4.5 Restart Packets (Unchanged)

4.6 Packets Required for Optional User Facilities (Unchanged)

5. PROCEDURES AND FORMATS FOR OPTIONAL USER FACILITIES TO BE STUDIED

The following is a technical description of procedures and formats for user facilities which have been proposed for study for inclusion in Recommendation X.2, this being for further study.

NOTE: However, the closed user group facility is already mentioned in Recommendation X.2.

5.1 Procedures for Optional User Facilities

5.1.1 Reverse Charging

Reverse Charging is an optional user facility; it can be requested by a DTE for a given virtual call or for a datagram.

The reverse charging facility needs some indication in the CALL REQUEST, INCOMING CALL, DTE DATAGRAM AND DCE DATAGRAM packets.

5.1.2 Throughput Class Selection and Indication (Unchanged except add Note 3).

NOTE 3: Relating to datagram operation, the following has been identified for further study:

a. the attainment of throughput on a given datagram logical channel. The question of whether window size selection fulfills this requirement was raised.

b. the necessity of discriminating between throughput on datagram logical channels compared with logical channels used for virtual calls/permanent virtual circuits.

In addition, the relationship between throughput and priority/traffic class as possible further facilities needs to be studied.

5.1.3 Reverse Charging Acceptance

Reverse Charging Acceptance is an optional user facility agreed for a period of time.

This user facility, if subscribed to, authorizes the DCE to transmit to the DTE incoming calls or datagrams which request the Reverse Charging facility. In the absence of this facility, the DCE will not transmit to the DTE incoming calls or datagrams which request the Reverse charging facility.

5.1.4 One Way Logical Channel (unchanged)

5.1.5 Packet Retransmission

Packet Retransmission is an optional user facility agreed for a period of time.

This user facility allows a 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 a logical channel number and a sequence number P(R). The value of this P(R) should be within the range from the last P(R) received by the DCE up to, but not including, the P(S) of the next flow controlled packet to be transmitted by the DCE.

When receiving a DTE REJECT packet, the DCE initiates on the specified logical channel retransmission of the flow controlled packets; the Packet Send Sequence Numbers of which are starting from P(R) where P(R) is indicated in the DTE REJECT packet. Until the DCE transfers across the DTE/DCE interface a flow controlled packet with a Packet Send Sequence Number equal to the P(R) indicated in the DTE REJECT packet, the DCE will consider the receipt of another DTE REJECT packet as a procedure error and reset the virtual call, permanent virtual circuit or datagram channel.

Additional flow controlled packets pending initial transmission may follow the retransmitted packet(s).

A DTE receive not ready situation indicated by the transmission of RNR packet is cleared by the transmission of a DTE REJECT packet.

The conditions under which the DCE ignores a DTE REJECT packet, or considers it as a procedure error, are those described for flow control packets.

5.1.6 Closed User Group Facility

Closed User Group is an optional user facility agreed for a period of time between the Administration and a group of users.

This facility permits the users of the group to communicate with each other, but precludes communication with all other users.

A DTE may belong to more than the closed user group.

The calling/source DTE should specify the closed user group selected for a virtual call or datagram using the optional user facility parameters in the CALL REQUEST or DTE DATAGRAM packet.

The closed user group selected for a virtual call or datagram will be indicated to a called/destination DTE using the optional user facility parameters in the INCOMING CALL or DCE DATAGRAM packet.

When a DTE only belongs to one closed user group, this indication may not be present in the CALL REQUEST, INCOMING CALL, DTE DATAGRAM or DCE DATAGRAM packet.

5.1.7 Bilateral Closed User Group Facility

A Bilateral Closed User Group facility is an optional user facility which can be used for a period of time by a DTE for a virtual call or a datagram. This facility permits such users to communicate with each other, but precludes communication with all other users.

A DTE may belong to more than one bilateral closed user group.

The calling/source DTE should specify the bilateral user group selected for a virtual call or datagram using the optional user facility parameters in the CALL REQUEST or DTE DATAGRAM packet. The called/destination DTE address length shall be coded all zeros.

The bilateral closed user group for a virtual call or datagram will be indicated to a called/destination DTE using the optional user facility parameters in the INCOMING CALL or DCE DATAGRAM packet.

5.1.8 Abbreviated Addressing

Abbreviated addressing for datagrams is an optional user facility agreed for a period of time. This facility permits encoding of addresses into shorter representations as agreed between the Administration and DTE. Initially this facility is restricted to a 1:1 mapping of single addresses, but 1:N mapping for multiple addresses is for further study.

5.1.9 Datagram Service Signals

The following datagram service signals are optional user facilities which may be agreed for a period of time or selected on a per-datagram basis:

a. Non-delivery indication is provided by the network when a datagram cannot be delivered to the destination DTE.

b. Delivery confirmation is provided by the network after the datagram has been accepted by the destination DTE.

5.1.10 Datagram Service Signal Logical Channel

The datagram service signal logical channel is an optional user facility agreed for a period of time. A separate logical channel is designated for a DTE to receive only datagram service signals. This enables the DTE to separately flow control datagram service signal packets from the datagram packets

5.1.11 DCE Queue Length Selection

The DCE queue length per datagram logical channel is an optional user facility agreed for a period of time. This facility enables selection of the number of datagram and datagram service signal packets that will be stored in a queue by the destination DCE when the rate of arrival of packets at the destination DCE from other sources exceeds the rate of delivery of packets to the destination DTE.

5.1.12 Other Datagram Related Facilities Under Consideration

a. Priority
b. Traffic class
c. Broadcast
d. Datagram redirection
e. Interrupt datagram
f. Delayed delivery
g. Suppression of service signals

5.2 Formats for Optional User Facilities

5.2.1 General

The facility field is present only when a DTE is using an optional user facility requiring some indication in the CALL REQUEST, INCOMING CALL, DTE DATAGRAM or DCE DATAGRAM packet.

(Remaining paragraphs of this section unchanged except for last 3 paragraphs of this section).

The coding of the parameter field will be either all zeros or all ones depending on whether the facility requests following the marker refer to facilities offered by the calling/source or called/destination network, respectively. For intra-network virtual calls or datagrams, the parameter field should be all zeros.

Requests for facilities offered by the calling/source and called/destination networks may be simultaneously present within the facility field and in such cases two Facility Markers will be required with parameter fields coded as described above.

Within the facility field, requests for X.25 facilities will precede all requests for non-X.25 facilities and Facility Markers need only be included when requests for non-X.25 facilities are present.

5.2.2 Coding of Facility Field for Particular Facilities

5.2.2.1 Coding of Reverse charging Facility

The coding of the facility code and parameter fields for Reverse Charging is the same in CALL REQUEST, INCOMING CALL, DTE DATAGRAM, and DCE DATAGRAM packets.

(Remainder unchanged)

5.2.2.2 Coding of Throughput Class Selection and Indication Facility (Unchanged)

5.2.2.3 Coding of Closed User Group Facility

The coding of facility code field and parameters for Closed User Group is the same in CALL REQUEST INCOMING CALL, DTE DATAGRAM and DCE DATAGRAM packets.

(Remainder unchanged)

5.2.2.4 Coding of Bilateral Closed User Group Facility

The coding of facility code field and the format of the facility parameter field for Bilateral Closed User Group are the same in CALL REQUEST, INCOMING CALL, DTE DATAGRAM and DCE DATAGRAM packets.

(Remainder unchanged)

5.2.2.5 Coding of Other Datagram Related Facilities

For further study is the encoding of:

a. datagram service signal requests - non-delivery indication and delivery confirmation

b. other facilities as adopted from Section 5.1.12

Figures 1/X.25 through 5/X.25 unchanged

Figures 5bis/X.25 and 5ter/X.25 are new figures as attached

Figures 6/X.25 through 14/X.25 unchanged

Figure 15/X.25 revise Note 1 as follows:

at end of note add "and datagrams"

Figures 16/X.25 and 17/X.25 unchanged

Table 10 Add to note 5 the following:

"In the case of a datagram logical channel, the DCE discards the received packet and indicates a reset by transmitting an indication of Local Procedure Error."

Table 11 - revise as follows:

In the first column, last two rows - "DATA, DATAGRAM, INTERRUPT, . . ." and "DATA and DATAGRAM PACKETS. . . "

2nd paragraph of explanation of flow control error - "... state d2 for permanent virtual circuits and datagram logical channels, the DCE ..."

Table 12 - revise as follows:

In the first column, fourth row - "DATA, DATAGRAM, INTERRUPT, . . . "

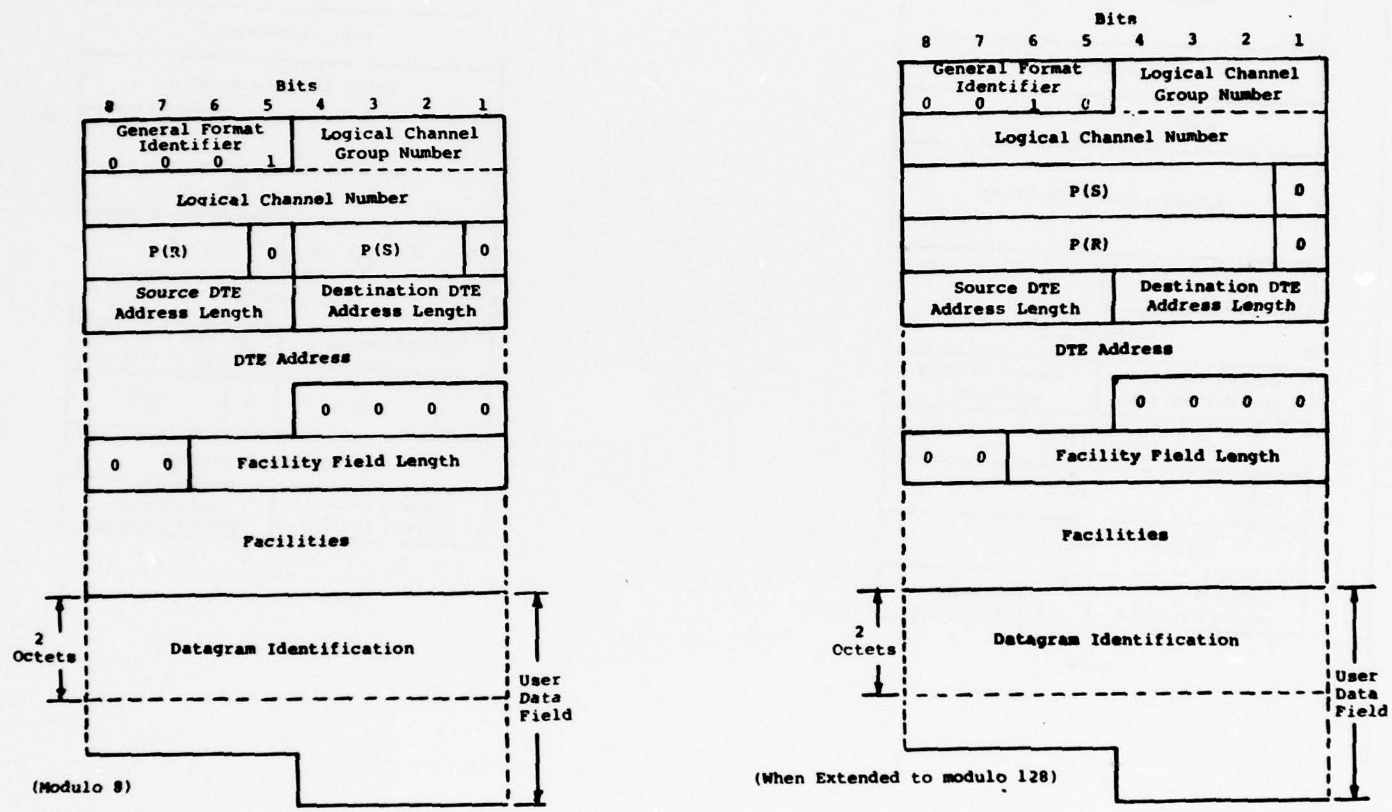
At the end of Note 2 add - "and datagrams."

TABLE /X.25

CODING OF CAUSE FIELD IN
DATAGRAM SERVICE SIGNAL PACKET

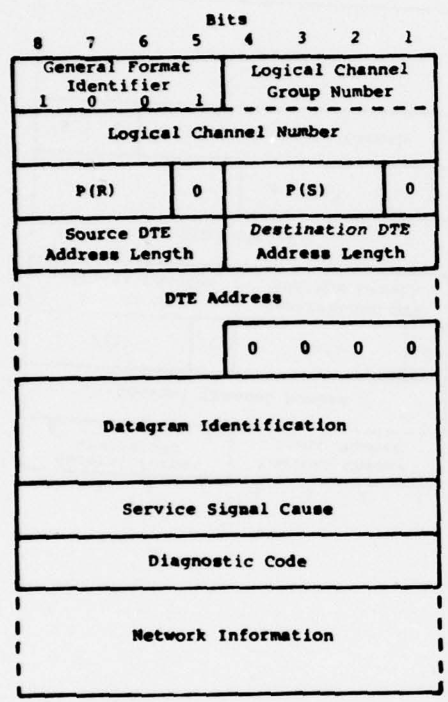
	8 7 6 5 4 3 2 1
Non-delivery Indication Delivery Confirmation	for further study

NOTE : Other causes are for further study.

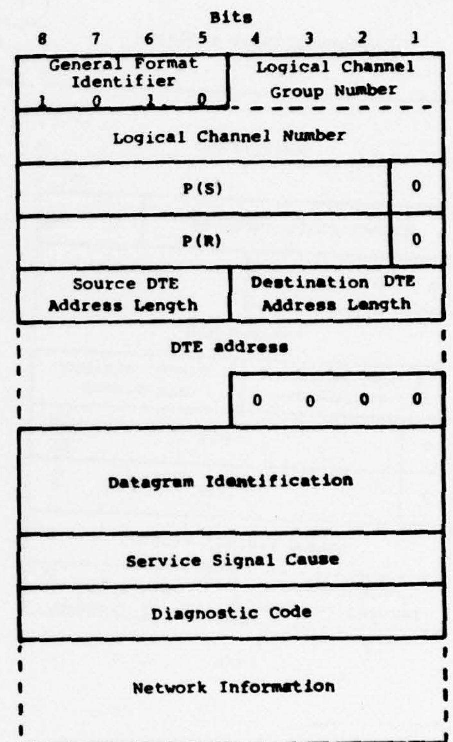


NOTE : The figure assumes that the user data field does not contain an integral number of octets.

Figure 5bis/X.25 - DTE and DCE datagram packet format



(Modulo 8)



(When extended to modulo 128)

Figure 5ter/X.25 - DCE datagram service signal packet format