INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

Provisional Recommendations X.3, X.25, X.28 and X.29 on packet-switched data transmission services

Geneva 1978

INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

Provisional Recommendations X.3, X.25, X.28 and X.29 on packet-switched data transmission services

Geneva 1978

ISBN 92-61-00591-8

TABLE OF CONTENTS

Note: – Provisional Recommendations contained in this publication are those provisionally approved in October, 1977 in accordance with Resolution No. 2 of the VIth Plenary Assembly of the CCITT (Geneva, 1976).

Provisional Recommendation X.3 *(Geneva, 1977)*

PACKET ASSEMBLY/DISASSEMBLY FACILITY (PAD) IN A PUBLIC DATA NETWORK

Contents

Preface

The establishment in various countries of public data networks providing packet-switched data transmission services creates a need to produce standards to facilitate access from the public telephone network, circuit- switched public data networks and leased circuits.

The CCITT,

considering,

a) that Recommendations X.1 and X.2 define the user classes of service and user facilities in public data networks, Recommendation X.95 defines network parameters, Recommendation X.96 defines call progress signals, Recommendation X.29 defines the procedures for a packet-mode DTE to access the PAD, Recommendation X.28 defines the DTE/DCE interface for a start-stop mode DTE accessing the PAD;

b) that the logical control links for packet-switched data transmission services are defined in Recommendation X.92, and that in particular Recommendation X.92 allows for the incorporation of a PAD;

c) the urgent need to allow interworking between a start-stop mode DTE on a public-switched telephone network, a public switched data network or a leased circuit, and a packet-mode DTE using the virtual call facility of the packet-switched data service;

d) that DTEs operating in the start-stop mode will send and receive network control information and user information in the form of characters;

e) that DTEs operating in the packet-mode will send and receive network control information and user information in the form of packets in accordance with Recommendation X.25;

f) that the packet-mode DTE shall not be obliged to use the control procedures for PAD functions, but that some packet-mode DTEs may wish to control specific functions of the PAD;

unanimously declares the view

i) that the functions performed by and operational characteristics of the PAD for the start-stop mode DTE are described below in 1. *Description of the basic functions and user selectable functions of the PAD*;

ii) that the operation of the PAD for the start-stop mode DTE should depend on the possible values of internal variables known as PAD parameters which are described below in 2. *Characteristics of PAD parameters*;

iii) that the PAD parameters for the start-stop mode DTE and their possible values should be those which are listed below in 3. *List of PAD parameters and possible values*;

iv) that the PAD features described in 1., 2. and 3. below could be expanded by future studies to allow interworking with non-packet mode DTEs other than start-stop mode DTEs.

1. *Description of the basic functions and user selectable functions of the PAD*

1.1 The PAD performs a number of functions and exhibits operational characteristics. Some of the functions allow either or both the start-stop mode DTE and the packet-mode DTE to configure the PAD so that its operation is adapted to the start-stop mode DTE characteristics, and possibly to the application.

1.2 The operation of the PAD depends on the values of the set of internal variables called PAD parameters. This set of parameters exists for each start-stop mode DTE independently. The current value of each PAD parameter defines the operational characteristics of its related function.

1.3 *Basic functions of the PAD*

These basic functions include:

- assembly of characters into packets destined for the packet- mode DTE;
- disassembly of the user data field of packets destined for the start-stop mode DTE;
- handling of virtual call set-up and clearing, resetting and interrupt procedures;
- generation of service signals;
- a mechanism for forwarding packets when the proper conditions exist, e.g. a packet is full or an idle timer expires;
- a mechanism for transmitting data characters, including start, stop and parity elements as appropriate, to the start-stop mode DTE;
- a mechanism for handling a *break signal* from the start-stop mode DTE.

1.4 *User selectable functions which may be provided by the PAD*

These functions concern:

- management of the procedure between the start-stop mode DTE and the PAD;
- management of the assembly and disassembly of packets;
- a limited number of additional functions related to the operational characteristics of the start-stop mode DTE.

The method for the control of these functions is specified in Recommendation X.28 for start-stop mode DTE and in Recommendation X.29 for the packet-mode DTE.

1.4.1 *PAD recall by escaping from the data transfer state*

This function allows the start-stop mode DTE to initiate an escape from the *data transfer state* of a virtual call in order to send *PAD command signals.*

1.4.2 *Echo*

This function provides for all characters received from the start-stop mode DTE to be transmitted to the start-stop mode DTE as well as being interpreted by the PAD.

1.4.3 *Recognition of data forwarding signals*

This function allows the PAD to recognize defined character(s) or the *break signal* received from the start-stop mode DTE as an indication to complete the assembly and forward a packet as defined in Recommendation X.25.

1.4.4 *Selection of idle timer delay*

This function allows the PAD to terminate the assembly of a packet and to forward it in the event that the interval between successive characters received from the start-stop mode DTE exceeds a selected value.

1.4.5 *Ancillary device control*

This function allows for flow-control between the PAD and the start-stop mode DTE. The PAD indicates whether it is ready or not to accept characters from the start-stop mode DTE by transmitting special characters. These characters are those which in International Alphabet No. 5(IA5) are used to switch an ancillary transmitting device on and off.

1.4.6 *Suppression of PAD service signals*

This function provides for the suppression of all *PAD service signals* to the start-stop mode DTE.

1.4.7 *Selection of operation of PAD on receipt of the break signal*

This function allows the selection of the operation of the PAD after the receipt of a *break signal* from the start-stop mode DTE.

1.4.8 *Discard output*

This function provides for a PAD to discard the contents of a user data field in packets rather than disassembling and transmitting these to the start-stop mode DTE.

1.4.9 *Padding after carriage return*

This function provides for the automatic insertion by the PAD of padding characters in the character string transmitted to the start-stop mode DTE after the occurrence of a *carriage return* character. This allows for the printing mechanism of the start-stop mode DTE to perform the carriage return function correctly.

1.4.10 *Line folding*

This function provides for the automatic insertion by the PAD of appropriate format effectors in the character string transmitted to the start-stop mode DTE. The predetermined maximum number of graphic characters per line may be set.

1.4.11 *Flow control of the PAD by the start-stop mode DTE*

This function allows for flow-control between the start-stop mode DTE and the PAD. The start-stop mode DTE indicates whether it is ready or not to accept characters from the PAD by transmitting special characters. These characters are those which in IA5 are used to switch an ancillary transmitting device on and off.

2. *Characteristics of PAD parameters*

2.1 In this Recommendation parameters are identified by decimal reference numbers.

2.2 In this Recommendation the possible values of the parameters are represented by decimal numbers.

2.3 Specific procedures, described in Provisional Recommendations X.28 and X.29 are available for initializing, reading and changing the values of PAD parameters.

2.4 *Determination of the values of PAD parameters*

2.4.1 *Initial values of PAD parameters*

On initialization the initial value of each PAD parameter is set according to a predetermined set of values called a "standard profile".

2.4.2 *Current values of PAD parameters*

The current values of PAD parameters at a given time are the values resulting from possible modifications by the start-stop mode DTE and/or the packet-mode DTE.

3. *List of PAD parameters and possible values*

3.1 *PAD recall by escaping from the data transfer state*

Reference 1

The parameter will have the following selectable values:

not possible – represented by decimal 0;

possible – represented by decimal 1.

3.2 *Echo*

Reference 2

The parameter will have the following selectable values:

no echo – represented by decimal 0;

echo – represented by decimal 1.

3.3 *Selection of data forwarding signal*

Reference 3

The parameter will have the following selectable values:

no data forwarding signal – represented by decimal 0;

carriage return – represented by decimal 2;

all characters in columns 0 and 1 and character 7/15 (DEL) of International Alphabet No. 5 – represented by decimal 126.

Forwarding by other characters, or sets of characters, and the appropriate decimal representation is for further study.

3.4 *Selection of idle timer delay*

Reference 4

The parameter will have the following selectable values:

any number from 0 to 255 – represented by the respective decimal number.

The value 0 will indicate that no data forwarding on time-out is required; a value between 1 and 255 will indicate the value of the delay in twentieths of a second.

3.5 *Ancillary device control*

Reference 5

The parameter will have the following selectable values:

no use of X-ON (DC1) and X-OFF (DC3)	– represented by decimal 0;
use of X-ON and X-OFF	– represented by decimal 1.

3.6 *Suppression of PAD service signals*

Reference 6

The parameter will have the following selectable values:

no service signals are transmitted to the start-stop mode DTE	– represented by decimal 0;
service signals are transmitted	– represented by decimal 1.

3.7 *Selection of operation of PAD on receipt of break signal from the start-stop mode DTE*

Reference 7

This parameter is represented by the following encoding of basic functions, each having a decimal value as shown below:

nothing	– represented by decimal 0;
send to packet mode DTE an *interrupt packet*	– represented by decimal 1;
reset	– represented by decimal 2;
send to packet-mode DTE an *indication of break PAD message*	– represented by decimal 4;
escape from data transfer state	– represented by decimal 8;
discard output to start-stop mode DTE	– represented by decimal 16.

Only the following functions and combinations of functions will be selectable: 0, 1, 2, 8 and 21 (1+4+16). The use of other values is for further study.

Note: The decimal representation of individual values of this parameter allows coding to represent a single function or combination of functions.

3.8 *Discard output*

Reference 8

The parameter will have the following selectable values:

normal data delivery to the start-stop mode DTE	– represented by decimal 0;
discard output to the start-stop mode DTE	– represented by decimal 1.

3.9 *Padding after carriage return*

Reference 9

The parameter will have the following selectable values:

any number from 0 to 7	– represented by the respective decimal number.

A value between 0 and 7 will indicate the number of padding characters to be generated by the PAD after a carriage return character is transmitted to the start-stop mode DTE.

When parameter 9 is 0, PAD service signals will contain a number of padding characters according to the data rate of the start-stop mode DTE.

3.10 *Line folding*

Reference 10

The parameter will have the following selectable values:

no line folding	– represented by decimal 0;
any value between 1 and 255 characters per line	– represented by the respective decimal number.

3.11 *Binary speed*

This parameter is a read-only parameter and cannot be changed by either of the DTEs. It enables the packet-mode DTE to access a characteristic of the start-stop mode DTE which is known by the PAD.

Reference 11

The parameter will have the following values:

50 bit/s	– represented by decimal 10;
100 bit/s	– represented by decimal 9;
110 bit/s	– represented by decimal 0;
134.5 bit/s	– represented by decimal 1;
200 bit/s	– represented by decimal 8;
300 bit/s	– represented by decimal 2.

Only values 0, 2 and 8 are for use at this time. The provision of other speeds and the appropriate decimal representation is for further study.

3.12 *Flow control of the PAD by the start-stop mode DTE*

Reference 12

The parameter will have the following selectable values:

no use of X-ON (DC1) and X-OFF (DC3) for flow control	– represented by decimal 0;
use of X-ON and X-OFF	– represented by decimal 1.

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR TERMINALS OPERATING IN THE PACKET MODE ON PUBLIC DATA NETWORKS

(Geneva, 1976, amended at Geneva, 1977)

The establishment in various countries of public data networks providing packet-switched data transmission services creates a need to produce standards to facilitate international interworking.

The CCITT,

considering

a) that Recommendation X.1 includes specific user classes of service for data terminal equipments operating in the packet mode, Recommendation X.2 defines user facilities, Recommendations X.21 and X.21 *bis* define DTE/DCE interface characteristics, Recommendation X.95 defines network parameters, and Recommendation X.96 defines call progress signals;

b) that the logical control links for packet-switched data transmission services are defined in Recommendation X.92;

c) the need for defining an international recommendation for the exchange between DTE and DCE of control information for the use of packet-switched data transmission services;

d) that data terminal equipments operating in the packet mode will send and receive network call control information and user information in the form of packets;

e) that the necessary elements for an interface recommendation should be defined independently as:

Level 1 – The physical, electrical, functional and procedural characteristics to establish, maintain and disconnect the physical link between the DTE and the DCE.

Level 2 – The link access procedure for data interchange across the link between the DTE and the DCE.

Level 3 – The packet format and control procedures for the exchange of packets containing control information and user data between the DTE and the DCE.

f) that certain data terminal equipments operating in the packet mode will use a packet interleaved, synchronous data circuit;

g) the desirability of being able to use a single data circuit to a DSE for all user facilities;

unanimously declares the view

that for data terminal equipments operating in the packet mode:

1. The physical, electrical, functional and procedural characteristics to establish, maintain and disconnect the physical link between the DTE and the DCE should be as specified in 1. below *Level 1 DTE/DCE interface characteristics*, see below.

2. The link access procedure for data interchange across the link between the DTE and the DCE should be as specified in 2. below *Link access procedure across the DTE/DCE interface (level 2)*, see below.

3. The packet level control procedures for the exchange of call control information and user data at the DTE/DCE interface should be as specified in 3. below *Description of the packet level DTE/DCE interface for virtual call and permanent virtual circuit facilities (level 3)*, see below.

4. The format for packets exchanged between the DTE and the DCE should be as specified in 4. below *Packet formats for virtual call and permanent virtual circuit facilities*, see below.

5. Procedures and formats for optional user facilities should be as specified in 5. below *Procedures and formats for optional user facilities to be studied for virtual call and permanent virtual circuit facilities*, see below.

Note. – It is for further study whether alternative procedures for levels 2 and 3 of Recommendation X.25 would be advantageously introduced for cases where packet-switched facilities are accessed through circuit-switched connections.

INDEX TO RECOMMENDATION X.25

1. LEVEL 1 DTE/DCE INTERFACE CHARACTERISTICS

The DTE/DCE interface characteristics defined as the level 1 element shall be in accordance with Recommendation X.21 for user classes of service 8 to 11. For an interim period, some Administrations may offer a DTE/DCE interface at this level in accordance with Recommendation X.21 *bis*, for user classes of service 8 to 11.

Note. – The level 1 DTE/DCE interface also includes the failure detection and isolation procedures as defined in Recommendation X.21 or X.21 *bis*.

2. LINK ACCESS PROCEDURE ACROSS THE DTE/DCE INTERFACE (LEVEL 2)

2.1 *Scope and field of application*

2.1.1 The Link Access Procedure (LAP) described hereunder is used for data interchange between a DCE and a DTE operating in user classes of service 8 to 11 as indicated in Recommendation X.1.

2.1.2 The procedure uses the principle and terminology of the High Level Data Link Control (HDLC) procedure specified by the International Organization for Standardization (ISO).

Note. – Reference ISO documents IS 3309, IS 4335 plus approved amendments (TC 97/SC 6/N 1300 and 1445), and DP 6256.

2.1.3 The transmission facility is duplex.

2.1.4 DCE compatibility of operation with the ISO balanced class of procedure (Class BA, options 2, 8, 11 and 12) is achieved using the provisions found under the headings annotated as "applicable to LAPB" in this Recommendation.

A DTE may continue to use the provisions found under the headings annotated as "applicable to LAP" in this Recommendation, but for new DTE implementations, LAPB should be preferred.

Note. – Other possible applications for further study are, for example:

- two-way alternate, asynchronous response mode
- two-way simultaneous, normal response mode
- two-way alternate, normal response mode
- the need for and use of option 11.

2.2 *Frame structure*

2.2.1 All transmissions are in frames conforming to one of the formats of Table 1/X.25. The flag preceding the address field is defined as the opening flag.

TABLE 1/X.25 – Frame formats

Bit order of transmission	12345678	12345678	12345678	16 to 1	12345678
	Flag	Address	Control	FCS	Flag
	F 01111110	A 8-bits	C 8-bits	FCS 16-bits	F 01111110

FCS = frame checking sequence

Bit order of transmission	12345678	12345678	12345678		16 to 1	12345678
	Flag	Address	Control	Information	FCS	Flag
	F 01111110	A 8-bits	C 8-bits	I N-bits	FCS 16-bits	F 01111110

FCS = frame checking sequence

2.2.2 *Flag sequence*

All frames shall start and end with the flag sequence consisting of one 0 followed by six contiguous 1s and one 0. A single flag may be used as both the closing flag for one frame and the opening flag for the next frame.

2.2.3 *Address field*

The address field shall consist of one octet. The coding of the address field is described in 2.4.2 below.

2.2.4 *Control field*

The control field shall consist of one octet. The content of this field is described in 2.3.2 below.

Note. – The use of the extended control field is a subject for further study.

2.2.5 *Information field*

The information field of a frame is unrestricted with respect to code or grouping of bits except for the packet formats specified in 3. below.

See 2.3.4.10 and 2.4.11.3 below with regard to the maximum information field length.

2.2.6 *Transparency*

The DTE or DCE, when transmitting, shall examine the frame content between the two flag sequences including the address, control, information and FCS sequences and shall insert a 0 bit after all sequences of 5 contiguous 1 bits (including the last 5 bits of the FCS) to ensure that a flag sequence is not simulated. The DTE or DCE, when receiving, shall examine the frame content and shall discard any 0 bit which directly follows 5 contiguous 1 bits.

2.2.7 *Frame checking sequence (FCS)*

The FCS shall be a 16-bit sequence. It shall be the 1s complement of the sum (modulo 2) of:

1. the remainder of $x^k(x^{15} + x^{14} + x^{13} + \ldots + x^2 + x + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency, and
2. the remainder after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the content of the frame, existing between but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

As a typical implementation, at the transmitter, the initial remainder of the division is preset to all 1s and is then modified by division by the generator polynomial (as described above) on the address, control and information fields; the 1s complement of the resulting remainder is transmitted as the 16-bit FCS sequence.

At the receiver, the initial remainder is preset to all 1s, and the serial incoming protected bits and the FCS when divided by the generator polynomial will result in a remainder of 0001110100001111 (x^{15} through x^0, respectively) in the absence of transmission errors.

2.2.8 *Order of bit transmission*

Addresses, commands, responses and sequence numbers shall be transmitted with the low order bit first (for example the first bit of the sequence number that is transmitted shall have the weight 2^0).

The order of transmitting bits within the information field is not specified under 2. of this Recommendation. The FCS shall be transmitted to the line commencing with the coefficient of the highest term.

Note. – The low order bit is defined as bit 1, as depicted in Tables 1/X.25 to 4/X.25.

2.2.9 *Invalid frames*

A frame not properly bounded by two flags, or having fewer than 32 bits between flags, is an invalid frame.

2.2.10 *Frame abortion*

Aborting a frame is performed by transmitting at least seven contiguous 1s (with no inserted 0s).

2.2.11 *Interframe time fill*

Interframe time fill is accomplished by transmitting contiguous flags between frames.

2.2.12 *Link channel states*

2.2.12.1 *Active channel state*

A channel is in an active condition when the DTE or DCE is actively transmitting a frame, an abortion sequence or interframe time fill.

2.2.12.2 *Idle channel state*

A channel is defined to be in an idle condition when a contiguous 1s state is detected that persists for at least 15 bit times.

Note 1. – The action to be taken upon detection of the idle channel state is a subject for further study.

Note 2. – A link channel as defined here is the means of transmission for one direction.

2.3 *Elements of procedure*

2.3.1 The elements of procedure are defined in terms of actions that occur on receipt of commands at a DTE or DCE.

The elements of procedure specified below contain a selection of commands and responses relevant to the link and system configuration described in 2.1 above.

A procedure is derived from these elements of procedure and is described in 2.4 below. Together 2.2 and 2.3 form the general requirements for the proper management of the access link.

2.3.2 *Control field formats and state variables*

2.3.2.1 *Control field formats*

The control field contains a command or a response, and sequence numbers where applicable.

Three types of control field formats (see Table 2/X.25) are used to perform numbered information transfer (I frames), numbered supervisory functions (S frames) and unnumbered control functions (U frames).

TABLE 2/X.25 – **Control field formats**

Control field bits	1	2	3	4	5	6	7	8
I frame	0	N(S)			P/F	N(R)		
S frame	1	0	S		P/F	N(R)		
U frame	1	1	M		P/F	M		

N(S) = transmitter send sequence number (Bit 2 = low order bit)
N(R) = transmitter receive sequence number (Bit 6 = low order bit)
S = supervisory function bits
M = modifier function bits
P/F = poll bit when issued as a command, final bit when issued as a response. (1 = Poll/Final)

Information transfer format — I

The I format is used to perform an information transfer. The functions of N(S), N(R) and P/F are independent; i.e. each I frame has an N(S), an N(R) which may or may not acknowledge additional frames received by the DTE or DCE, and a P/F bit.

Supervisory format — S

The S format is used to perform link supervisory control functions such as acknowledge I frames, request retransmission of I frames, and to request a temporary suspension of transmission of I frames.

Unnumbered format — U

The U format is used to provide additional link control functions. This format contains no sequence numbers. The encoding of the unnumbered commands is as defined in Table 3/X.25.

2.3.2.2 *Control field parameters*

The various parameters associated with the control field formats are described below.

2.3.2.3 *Modulus*

Each I frame is sequentially numbered and may have the value 0 through modulus minus one (where "modulus" is the modulus of the sequence numbers). The modulus equals 8 and the sequence numbers cycle through the entire range.

2.3.2.4 *Frame variables and sequence numbers*

2.3.2.4.1 *Send state variable V(S)*

The send state variable denotes the sequence number of the next in-sequence I frame to be transmitted. The send state variable can take on the value 0 through modulus minus one. The value of the send state variable is incremented by one with each successive I frame transmission, but at the DCE cannot exceed N(R) of the last received I or S frame by more than the maximum number of outstanding I frames (k). The value of k is defined in 2.4.11.4 below.

2.3.2.4.2 *Send sequence number N(S)*

Only I frames contain N(S), the send sequence number of transmitted frames. Prior to transmission of an in-sequence I frame, the value of N(S) is updated to equal the value of the send state variable.

2.3.2.4.3 *Receive state variable V(R)*

The receive state variable denotes the sequence number of the next in-sequence I frame to be received. This receive state variable can take on the values 0 through modulus minus one. The value of the receive state variable is incremented by the receipt of an error free, in-sequence I frame whose send sequence number N(S) equals the receive state variable.

2.3.2.4.4 *Receive sequence number N(R)*

All I frames and S frames contain N(R), the expected sequence number of the next received I frame. Prior to transmission of a frame of the above types, the value of N(R) is updated to equal the current value of the receive state variable. N(R) indicates that the DTE or DCE transmitting the N(R) has correctly received all I frames numbered up to N(R) — 1.

2.3.3 *Functions of the poll/final bit*

The poll/final (P/F) bit serves a function in both command frames and response frames. In command frames the P/F bit is referred to as the P bit. In response frames it is referred to as the F bit.

The use of the P/F bit is described in 2.4.3 below.

2.3.4 *Commands and responses*

The following commands and responses will be used by either the DTE or DCE and are represented in Table 3/X.25.

TABLE 3/X.25 – Commands and responses

Format	Commands	Responses	1	2	3	4	5	6	7	8
Information transfer	I (information)		0	N(S)			P	N(R)		
Supervisory	RR (receive ready)	RR (receive ready)	1	0	0	0	P/F	N(R)		
	RNR (receive not ready)	RNR (receive not ready)	1	0	1	0	P/F	N(R)		
	REJ (reject)	REJ (reject)	1	0	0	1	P/F	N(R)		
Unnumbered	SARM (set asynchronous response mode)	DM (disconnected mode)	1	1	1	1	P/F	0	0	0
	SABM (set asynchronous balanced mode)		1	1	1	1	P	1	0	0
	DISC (disconnect)		1	1	0	0	P	0	1	0
		UA (unnumbered acknowledgement)	1	1	0	0	F	1	1	0
		CMDR (command reject) FRMR (frame reject)	1	1	1	0	F	0	0	1

Note 1. – The need for, and use of, additional commands and responses are for further study.

Note 2. – RR, RNR, and REJ commands are not transmitted by the DCE, but can be received from the DTE. DTEs do not have to implement both SARM and SABM. DTEs which do not implement SABM do not have to implement DM.

The commands and responses are as follows:

2.3.4.1 *Information (I) command*

The function of the information (I) command is to transfer across a data link sequentially numbered frames containing an information field.

2.3.4.2 *Receive ready (RR)*

The receive ready (RR) supervisory frame is used by the DTE or DCE to:

1) indicate it is ready to receive an I frame;

2) acknowledge previously received I frames numbered up to N(R) – 1.

RR may be used to clear a busy condition that was initiated by the transmission of RNR. The RR command with the P bit set to 1 may be used by the DTE to ask for the status of the DCE.

2.3.4.3 *Reject (REJ)*

The reject (REJ) supervisory frame is used by the DTE or DCE to request retransmission of I frames starting with the frame numbered N(R). I frames numbered N(R) – 1 and below are acknowledged. Additional I frames pending initial transmission may be transmitted following the retransmitted I frame(s).

Only one REJ exception condition for a given direction of information transfer may be established at any time. The REJ exception condition is cleared (reset) upon the receipt of an I frame with an N(S) equal to the N(R) of the REJ.

2.3.4.4 *Receive not ready (RNR)*

The receive not ready (RNR) supervisory frame is used by the DTE or DCE to indicate a busy condition; i.e., temporary inability to accept additional incoming I frames. I frames numbered up to N(R) – 1 are acknowledged. I frame N(R) and subsequent I frames received, if any, are not acknowledged; the acceptance status of these I frames will be indicated in subsequent exchanges.

An indication that the busy condition has cleared is communicated by the transmission of a UA, RR, REJ or SABM. The RNR command with the P bit set to 1 may be used by the DTE to ask for the status of the DCE.

2.3.4.5 *Set asynchronous response mode (SARM) command*

The SARM unnumbered command is used to place the addressed DTE or DCE in the asynchronous response mode (ARM) information transfer phase.

No information field is permitted with the SARM command. A DTE or DCE confirms acceptance of SARM by the transmission at the first opportunity of a UA response. Upon acceptance of this command the DTE or DCE receive state variable V(R) is set to 0.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

2.3.4.6 *Set asynchronous balanced mode (SABM) command*

The SABM unnumbered command is used to place the addressed DTE or DCE in the asynchronous balanced mode (ABM) information transfer phase.

No information field is permitted with the SABM command. A DTE or DCE confirms acceptance of SABM by the transmission at the first opportunity of a UA response. Upon acceptance of this command the DTE or DCE send state variable V(S) and receive state variable V(R) are set to 0.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

2.3.4.7 *Disconnect (DISC) command*

The DISC unnumbered command is used to terminate the mode previously set. It is used to inform the DTE or DCE receiving the DISC that the DTE or DCE sending the DISC is suspending operation. No information field is permitted with the DISC command. Prior to actioning the command, the DTE or DCE receiving the DISC confirms the acceptance of DISC by the transmission of a UA response. The DTE or DCE sending the DISC enters the disconnected phase when it receives the acknowledging UA response.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged.

2.3.4.8 *Unnumbered acknowledge (UA) response*

The UA unnumbered response is used by the DTE or DCE to acknowledge the receipt and acceptance of the U format commands. Received U format commands are not actioned until the UA response is transmitted. The UA response is transmitted as directed by the received U format command. No information field is permitted with the UA response.

2.3.4.9 *Disconnected mode (DM) response*

The DM response is used to report a status where the DTE or DCE is logically disconnected from the link, and is in the disconnected phase. The DM response is sent in this phase to request a set mode command, or, if sent in response to the reception of a set mode command, to inform the DTE or DCE that the DCE or DTE, respectively, is still in disconnected phase and cannot action the set mode command. No information field is permitted with the DM response.

A DTE or DCE in a disconnected phase will monitor received commands, and will react to SABM as outlined in 2.4.5 below and will respond DM to any other command received with the P bit set to 1.

2.3.4.10 *Command reject (CMDR) response* *Frame reject (FRMR) response*

The CMDR (FRMR) response is used by the DTE or DCE to report an error condition not recoverable by retransmission of the identical frame; i.e., one of the following conditions, which results from the receipt of a frame without FCS error:

1. the receipt of a command or response that is invalid or not implemented;
2. the receipt of an I frame with an information field which exceeds the maximum established length;
3. the receipt of an invalid N(R).

An invalid N(R) is defined as one which points to an I frame which has previously been transmitted and acknowledged or to an I frame which has not been transmitted and is not the next sequential I frame pending transmission.

An information field which immediately follows the control field, and consists of 3 octets, is returned with this response and provides the reason for the CMDR (FRMR) response. This format is given in Table 4/X.25.

TABLE 4/X.25 – **CMDR (FRMR) field format**

Information field bits

1 2 3 4 5 6 7 8	9	10 11 12	13	14 15 16	17	18	19	20	21	22	23	24
Rejected frame control field	0	V(S)	(see Note)	V(R)	W	X	Y	Z	0	0	0	0

– Rejected frame control field is the control field of the received frame which caused the command (frame) reject.
– V(S) is the current send state variable value at the DTE or DCE reporting the rejection condition (Bit 10 = low order bit).
– V(R) is the current receive state variable at the DTE or DCE reporting the rejection condition (Bit 14 = low order bit).
– W set to 1 indicates that the control field received and returned in bits 1 through 8 was invalid.
– X set to 1 indicates that the control field received and returned in bits 1 through 8 was considered invalid because the frame contained an information field which is not permitted with this command. Bit W must be set to 1 in conjunction with this bit.
– Y set to 1 indicates that the information field received exceeded the maximum established capacity of the DTE or DCE reporting the rejection condition. This bit is mutually exclusive with bit W above.
– Z set to 1 indicates that the control field received and returned in bits 1 through 8 contained an invalid N(R). This bit is mutually exclusive with bit W above.

Note. – Bits 9, 13, 21 to 24 shall be set to 0 for CMDR. For FRMR, bits 9, 21 to 24 shall be set to 0. Bit 13 shall be set to 1 if the frame rejected was a response, and set to 0 if the frame rejected was a command.

2.3.5 *Exception condition reporting and recovery*

The error recovery procedures which are available to effect recovery following the detection/occurrence of an exception condition at the link level are described below. Exception conditions described are those situations which may occur as the result of transmission errors, DTE or DCE malfunction or operational situations.

2.3.5.1 *Busy condition*

The busy condition results when a DTE or DCE is temporarily unable to continue to receive I frames due to internal constraints, e.g., receive buffering limitations. In this case an RNR frame is transmitted from the busy DCE or DTE. I frames pending transmission may be transmitted from the busy DTE or DCE prior to or following the RNR. Clearing of the busy condition is indicated as described in 2.3.4.4 above.

2.3.5.2 *N(S) sequence error*

The information field of all I frames whose N(S) does not equal the receive state variable V(R) will be discarded.

An N(S) sequence exception condition occurs in the receiver when an I frame received error-free (no FCS error) contains an N(S) which is not equal to the receive state variable at the receiver. The receiver does not acknowledge (increment its receive state variable) the I frame causing the sequence error, or any I frame which may follow, until an I frame with the correct N(S) is received.

A DTE or DCE which receives one or more I frames having sequence errors but otherwise error-free shall accept the control information contained in the N(R) field and the P bit to perform link control functions; e.g., to receive acknowledgement of previously transmitted I frames and to cause the DTE or DCE to respond (P bit set to 1). Therefore, the retransmitted I frame may contain an N(R) field and P bit that are updated from, and therefore different from, that contained in the originally transmitted I frame.

2.3.5.3 *REJ recovery*

The REJ is used to initiate an exception recovery (retransmission) following the detection of a sequence error.

Only one "sent REJ" exception condition from a DTE or DCE is established at a time. A sent REJ exception condition is cleared when the requested I frame is received.

A DTE or DCE receiving REJ initiates sequential (re-)transmission of I frames starting with the I frame indicated by the N(R) obtained in the REJ frame.

2.3.5.4 *Time-out recovery*

If a DTE or DCE, due to a transmission error, does not receive (or receives and discards) a single I frame or the last I frame in a sequence of I frames, it will not detect an out-of-sequence exception condition and therefore will not transmit REJ. The DTE or DCE which transmitted the unacknowledged I frame(s) shall, following the completion of a system specified time-out period (see 2.4.11.1 below), take appropriate recovery action to determine at which I frame retransmission must begin.

2.3.5.5 *FCS error*

Any frame received with an FCS error is not accepted by the receiver. The frame is discarded and no action is taken as the result of that frame.

2.3.5.6 *Rejection condition*

A rejection condition is established upon the receipt of an error free frame which contains an invalid command/response in the control field, an invalid frame format, an invalid N(R) or an information field which exceeds the maximum information field length which can be accommodated.

At the DCE, this exception is reported by a CMDR (FRMR) response for appropriate DTE action. Once a DCE has established a CMDR (FRMR) exception, no additional I frames are accepted, except for examination of the P bit and the N(R) field until the condition is reset by the DTE. The CMDR (FRMR) response is repeated at each opportunity until recovery is effected by the DTE.

2.4 *Description of the procedure*

2.4.1 *Procedure to set the mode variable B*

The DCE will maintain an internal mode variable B, which it will set as follows:

- to 1, upon acceptance of an SABM command from the DTE
- to 0, upon acceptance of an SARM command from the DTE.

Changes to the mode variable B by the DTE should occur only when the link has been disconnected as described in 2.4.4.3 or 2.4.5.3 below.

Should a DCE malfunction occur, the internal mode variable B will upon restoration of operation, but prior to link set-up by the DTE, be initially set to 1.

Whenever B is 1, the DCE will use the LAPB link set-up and disconnection procedure and is said to be in the LAPB (balanced) mode.

Whenever B is 0, the DCE will use the LAP link set-up and disconnection procedure, and is said to be in the LAP mode.

The following are applicable to both LAP and LAPB modes: 2.4.2, 2.4.3, 2.4.6, 2.4.11.

The following are applicable only to the LAP mode: 2.4.4, 2.4.7, 2.4.8.

The following are applicable only to the LAPB mode: 2.4.5, 2.4.9, 2.4.10.

2.4.2 *Procedure for addressing (applicable to both LAP and LAPB)*

Frames containing commands transferred from the DCE to the DTE will contain the address A.

Frames containing responses transferred from the DTE to the DCE shall contain the address A.

Frames containing commands transferred from the DTE to the DCE shall contain the address B.

Frames containing responses transferred from the DCE to the DTE will contain the address B.

A and B addresses are coded as follows:

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 action to be taken by the DCE following the receipt of an address other than A or B is for further study.

2.4.3 *Procedure for the use of the poll/final bit (applicable to both LAP and LAPB)*

The DCE receiving a SARM, SABM, DISC, supervisory command or an I frame with the poll bit set to 1, will set the final bit to 1 in the next response frame it transmits.

The response frame returned by the DCE to a SARM, SABM or DISC command with the poll bit set to 1 will be a UA (or DM) response with the final bit set to 1. The response frame returned by the DCE to an I frame with the poll bit set to 1 will be an RR, REJ or RNR response in supervisory format with the final bit set to 1.

The response frame returned by the DCE to a supervisory command frame with the poll bit set to 1 will be an RR or RNR response with the final bit set to 1.

The P bit may be used by the DCE in conjunction with the timer recovery condition (see 2.4.6.8 below).

Note. – Other use of the P bit by the DCE is a subject for further study.

2.4.4 *Procedure for link set-up (applicable to LAP)*

2.4.4.1 *Link set-up*

The DCE will indicate that it is able to set up the link by transmitting contiguous flags (active channel state).

The DTE shall indicate a request for setting up the link by transmitting a SARM command to the DCE.

Whenever receiving a SARM command, the DCE will return a UA response to the DTE and set its receive state variable V(R) to 0.

Should the DCE wish to indicate a request for setting up the link, or when receiving from the DTE a first SARM command as a request for setting up the link, the DCE will transmit a SARM command to the DTE and start Timer T1 (see 2.4.11.1 below). The DTE will confirm the reception of the SARM command by transmitting a UA response.

When receiving the UA response the DCE will set its send state variable to 0 and stop its Timer T1. If Timer T1 runs out before the UA response is received by the DCE, the DCE will retransmit a SARM command and restart Timer T1.

After transmission of SARM N2 times by the DCE, appropriate recovery action will be initiated.

The value of N2 is defined in 2.4.11.2 below.

2.4.4.2 *Information transfer phase*

After having both received a UA response to a SARM command transmitted to the DTE and transmitted a UA response to a SARM command received from the DTE, the DCE will accept and transmit I and S frames according to the procedures described in 2.4.6 below.

When receiving a SARM command, the DCE will conform to the resetting procedure described in 2.4.7 below. The DTE may also receive a SARM command according to this resetting procedure.

2.4.4.3 *Link disconnection*

During the information transfer phase the DTE shall indicate a request for disconnecting the link by transmitting a DISC command to the DCE.

Whenever receiving a DISC command, the DCE will return a UA response to the DTE.

During an information transfer phase, should the DCE wish to indicate a request for disconnecting the link, or when receiving from the DTE a first DISC command as a request for disconnecting the link, the DCE will transmit a DISC command to the DTE and start Timer T1 (2.4.11.1 below). The DTE will confirm reception of the DISC command by returning a UA response. After transmitting a SARM command, the DCE will not transmit a DISC command until a UA response is received for this SARM command or until Timer T1 runs out.

When receiving a UA response to the DISC command, the DCE will stop its Timer T1. If Timer T1 runs out before a UA response is received by the DCE, the DCE will transmit a DISC command and restart Timer T1. After transmission of DISC N2 times by the DCE, appropriate recovery action will be initiated. The value of N2 is defined in 2.4.11.2 below.

2.4.5 *Procedures for link set-up (applicable to LAPB)*

The DCE will indicate that it is able to set up the link by transmitting contiguous flags (active channel state).

2.4.5.1 *Link set-up*

Whenever receiving an SABM command, the DCE will return a UA response to the DTE and set both its send and receive state variable V(S) and V(R) to 0.

Note. – The possible use of the SABM command by the DCE is a subject for further study.

2.4.5.2 *Information transfer phase*

After having transmitted the UA response to an SABM command, the DCE will accept and transmit I and S frames according to the procedures described in 2.4.6 below.

When receiving an SABM command while in the information transfer phase, the DCE will conform to the resetting procedure described in 2.4.9 below.

2.4.5.3 *Link disconnection*

During the information transfer phase, the DTE shall indicate disconnecting of the link by transmitting a DISC command to the DCE.

When receiving a DISC command, the DCE will return a UA response to the DTE and enter the disconnected phase.

Note. – The possible use of the DISC command by the DCE is a subject for further study.

2.4.5.4 *Disconnected phase*

2.4.5.4.1 After having received a DISC command from the DTE and returned a UA response to the DTE, the DCE will enter the disconnected phase.

In the disconnected phase, the DCE will react to the receipt of an SABM command as described in 2.4.5.1 above and will transmit a DM response in answer to a received DISC command.

When receiving any other command frame with the poll bit set to 1, the DCE will transmit a DM response with the final bit set to 1.

Other frames received in the disconnected phase will be ignored by the DCE.

2.4.5.4.2 The DCE may also enter the disconnected phase after detecting error conditions as listed in 2.4.10 below, or exceptionally after recovery from an internal temporary malfunction. In these cases, the DCE will transmit DM and start its Timer T1 (see 2.4.11.1 below). If Timer T1 runs out before the reception of an SABM or DISC command from the DTE, the DCE will retransmit the DM response and restart Timer T1.

After transmission of the DM response N2 times by the DCE, the DCE will remain in the disconnected phase and will no longer transmit the DM response on time-out.

2.4.6 *Procedures for information transfer (applicable to both LAP and LAPB)*

The procedures which apply to the transmission of I frames in each direction during the information transfer phase are described below.

In the following, "number one higher" is in reference to a continuously repeated sequence series, i.e. 7 is one higher than 6 and 0 is one higher than 7 for modulo eight series.

2.4.6.1 *Sending I frames*

When the DCE has an I frame to transmit (i.e. an I frame not already transmitted, or having to be retransmitted as described in 2.4.6.5 below), it will transmit it with an N(S) equal to its current send state variable V(S), and an N(R) equal to its current receive state variable V(R). At the end of the transmission of the I frame, it will increment its send state variable V(S) by one.

If the Timer T1 is not running at the instant of transmission of an I frame, it will be started.

If the send state variable V(S) is equal to the last value of N(R) received plus k (where k is the maximum number of outstanding I frames – see 2.4.11.4 below) the DCE will not transmit any I frames, but may retransmit an I frame as described in 2.4.6.5 or 2.4.6.8 below.

Note. – In order to ensure security of information transfer, the DTE should not transmit any I frame if its send state variable V(S) is equal to the last value of N(R) it has received from the DCE plus 7.

When the DCE is in the busy or frame/command rejection condition it may still transmit I frames, provided that the DTE is not busy itself. If the frame rejection condition was caused by receipt at the DCE of an invalid N(R) (see 2.4.10.1 below), the DCE will stop transmitting I frames.

2.4.6.2 *Receiving an I frame*

2.4.6.2.1 When the DCE is not in a busy condition and receives with the correct FCS an I frame whose send sequence number is equal to the DCE receive state variable V(R), the DCE will accept the information field of this frame, increment by one its receive state variable V(R), and act as follows:

i) If an I frame is available for transmission by the DCE, it may act as in 2.4.6.1 above and acknowledge the received I frame by setting N(R) in the control field of the next transmitted I frame to the value of the DCE receive state variable V(R). The DCE may also acknowledge the received I frame by transmitting an RR with the N(R) equal to the value of the DCE receive state variable V(R).

ii) If no I frame is available for transmission by the DCE, it will transmit an RR with the N(R) equal to the value of the DCE receive state variable V(R).

2.4.6.2.2 When the DCE is in a busy condition, it may ignore the information contained in any received I frame.

2.4.6.3 *Incorrect reception of frames*

When the DCE receives a frame with an incorrect FCS, this frame will be discarded.

When the DCE receives an I frame whose FCS is correct, but whose send sequence number is incorrect, i.e., not equal to the current DCE receive state variable V(R), it will discard the information content of the frame and transmit an REJ response with the N(R) set to one higher than the N(S) of the last correctly received I frame. The DCE will then discard the information content of all I frames until the expected I frame is correctly received. When receiving the expected I frame, the DCE will then acknowledge the frame as described in 2.4.6.2 above. The DCE will use the N(R) and P bit indications in the discarded I frames.

2.4.6.4 *Receiving acknowledgement*

When correctly receiving an I or S frame (RR, RNR or REJ), even in the busy or command/frame rejection condition, the DCE will consider the N(R) contained in this frame as an acknowledgement for all the I frames it has transmitted with an N(S) up to the received N(R) minus one. The DCE will reset the Timer T1.

If there are outstanding I frames still unacknowledged, it will restart the Timer T1. If the Timer then runs out, the DCE will follow the retransmission procedure (in 2.4.6.5 and 2.4.6.8 below) in respect of the unacknowledged I frames.

2.4.6.5 *Receiving reject*

When receiving an REJ, the DCE will set its send state variable V(S) to the N(R) received in the REJ control field. It will transmit the corresponding I frame as soon as it is available or retransmit it. Retransmission will conform to the following:

i) If the DCE is transmitting a supervisory or unnumbered command or response when it receives the REJ, it will complete that transmission before commencing transmission of the requested I frame.

ii) If the DCE is transmitting an I frame when the REJ is received, it may abort the I frame and commence transmission of the requested I frame immediately after abortion.

iii) If the DCE is not transmitting any frame when the REJ is received, it will commence transmission of the requested I frame immediately.

In all cases, if other unacknowledged I frames had already been transmitted following the one indicated in the REJ, then those I frames will be retransmitted by the DCE following the retransmission of the requested I frame.

If the REJ frame was received from the DTE as a command with the P bit set to 1, the DCE will transmit an RR or RNR response with the F bit set to 1 before transmitting or retransmitting the corresponding I frame.

2.4.6.6 *Receiving RNR*

After receiving an RNR, the DCE may transmit the I frame with the send sequence number equal to the N(R) indicated in the RNR. If the Timer T1 runs out after the reception of RNR, the DCE will follow the procedure described in 2.4.6.8 below. In any case the DCE will not transmit any other I frames before receiving an RR or REJ.

2.4.6.7 *DCE busy condition*

When the DCE enters a busy condition, it will transmit an RNR response at the earliest opportunity. While in the busy condition, the DCE will accept and process S frames and return an RNR response with the F bit set to 1 if it receives an S or I command frame with the P bit set to 1. To clear the busy condition, the DCE will transmit either an REJ response or an RR response with N(R) set to the current receive state variable V(R) depending on whether or not it discarded information fields of correctly received I frames.

2.4.6.8 *Waiting acknowledgement*

The DCE maintains an internal retransmission count variable which is set to 0 when the DCE receives a UA or RNR, or when the DCE correctly receives an I or S frame with the N(R) higher than the last received N(R) (actually acknowledging some outstanding I frames).

If the Timer T1 runs out, the DCE will enter the timer recovery condition, add one to its retransmission count variable and set an internal variable x to the current value of its send state variable.

The DCE will restart Timer T1, set its send state variable to the last N(R) received from the DTE and retransmit the corresponding I frame with the poll bit set to 1.

The timer recovery condition is cleared when the DCE receives a valid S frame from the DTE, with the final bit set to 1.

If, while in the timer recovery condition, the DCE correctly receives a frame with an N(R) within the range from its current send state variable to x included, on or before clearing the timer recovery condition, it will not enter a rejection condition, and will set its send state variable to the received N(R).

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 2.4.7.3 or 2.4.9.3 below. N2 is a system parameter (see 2.4.11.2 below).

Note. – Although the DCE will implement the internal variable x, other mechanisms do exist that achieve the identical functions. Therefore, the internal variable x is not necessarily implemented in the DTE.

2.4.7 *Procedures for resetting (applicable to LAP)*

2.4.7.1 The resetting procedure is used to reinitialize one direction of information transmission, according to the procedure described below. The resetting procedure only applies during the information transfer phase.

2.4.7.2 The DTE will indicate a resetting of the information transmission from the DTE by transmitting an SARM command to the DCE. When receiving an SARM command, the DCE will return, at the earliest opportunity, a UA response to the DTE and set its receive state variable V(R) to 0. This also indicates a clearance of the DCE busy condition, if present.

2.4.7.3 The DCE will indicate a resetting of the information transmission from the DCE by transmitting an SARM command to the DTE and will start Timer T1 (see 2.4.11.1 below). The DTE will confirm reception of the SARM command by returning a UA response to the DCE. When receiving this UA response to the SARM command, the DCE will set its send state variable to 0 and stop its Timer T1. If Timer T1 runs out before the UA response is received by the DCE, the DCE will retransmit an SARM command and restart Timer T1. After transmission of SARM N2 times, appropriate recovery action will be initiated. The value of N2 is defined in 2.4.11.2 below.

The DCE will not act on any received response frame which arrives before the UA response to the SARM command. The value of N(R) contained in any correctly received I command frames arriving before the UA response will also be ignored.

2.4.7.4 When receiving a CMDR response from the DTE, the DCE will initiate a resetting of the information transmission from the DCE as described in 2.4.7.3 above.

2.4.7.5 If the DCE transmits a CMDR response, it enters the command rejection condition. This command rejection condition is cleared when the DCE receives an SARM or DISC command. Any other command received while in the command rejection condition will cause the DCE to retransmit this CMDR response. The coding of the CMDR response will be as described in 2.3.4.10 above.

2.4.8 *Rejection conditions (applicable to LAP)*

2.4.8.1 *Rejection conditions causing a resetting of the transmission of information from the DCE*

The DCE will initiate a resetting procedure as described in 2.4.7.3 above when receiving a frame with the correct FCS, with the address A (coded 1 1 0 0 0 0 0 0) and with one of the following conditions:

- the frame type is unknown as one of the responses used;
- the information field is invalid;
- the N(R) contained in the control field is invalid;
- the response contains an F bit set to 1 except during a timer recovery condition as described in 2.4.6.8 above.

A valid N(R) must be within the range from the lowest send sequence number N(S) of the still-unacknowledged frame(s) to the current DCE send state variable included, even if the DCE is in a rejection condition, but not if the DCE is in the timer recovery condition (see 2.4.6.8 above).

2.4.8.2 *Rejection conditions causing the DCE to request a resetting of the transmission of information from the DTE*

The DCE will enter the command rejection condition as described in 2.4.7.5 above when receiving a frame with the correct FCS, with the address B (coded 1 0 0 0 0 0 0 0) and with one of the following conditions:

- the frame type is unknown as one of the commands used;
- the information field is invalid.

2.4.9 *Procedures for resetting (applicable to LAPB)*

2.4.9.1 The resetting procedures are used to initialize both directions of information transmission according to the procedure described below. The resetting procedures only apply during the information transfer phase.

2.4.9.2 The DTE shall indicate a resetting by transmitting an SABM command. After receiving an SABM command, the DCE will return, at the earliest opportunity, a UA response to the DTE, and reset its send and receive state variables V(S) and V(R) to 0. This also clears a DCE and/or DTE busy condition, if present.

2.4.9.3 Under certain rejection conditions listed in 2.4.6.8 and 2.4.10.2, the DCE may ask the DTE to reset the link by transmitting a DM response.

After transmitting a DM response, the DCE will enter the disconnected phase as described in 2.4.5.4.2 above.

2.4.9.4 Under certain rejection conditions listed in 2.4.10.1 below, the DCE may ask the DTE to reset the link by transmitting a FRMR response.

After transmitting a FRMR response, the DCE will enter the frame rejection condition. The frame rejection condition is cleared when the DCE receives an SABM or DISC command or DM response. Any other command received while in the frame rejection condition will cause the DCE to retransmit the FRMR response with the same information field as originally transmitted.

2.4.10 *Rejection conditions (applicable to LAPB)*

2.4.10.1 The DCE will initiate a resetting procedure as described in 2.4.9.4 above, when receiving, during the information transfer phase, a frame with the correct FCS, with the address A or B, and with one of the following conditions:

- the frame is unknown as a command or as a response;
- the information field is invalid;
- the N(R) contained in the control field is invalid as described in 2.4.8.1 above.

The coding of the information field of the FRMR response which is transmitted is given in 2.3.4.10 above. Bit 13 of this information field is set to 0 if the address of the rejected frame is B. It is set to 1 if the address is A.

2.4.10.2 The DCE will initiate a resetting procedure as described in 2.4.9.3 above when receiving during the information transfer phase a frame with the correct FCS, with address A, and with one of the following conditions:

- it is a UA or DM response;
- it contains a final bit set to 1, except during a timer recovery condition as described in 2.4.6.8.

2.4.11 *List of system parameters (applicable to both LAP and LAPB)*

The system parameters are as follows:

2.4.11.1 *Timer T1*

The period of the Timer T1, at the end of which retransmission of a frame may be initiated according to the procedures described in 2.4.4 to 2.4.6 above, is a system parameter agreed for a period of time with the Administration.

The proper operation of the procedure requires that Timer T1 be greater than the maximum time between transmission of frames (SARM, SABM, DM, DISC or I) and the reception of the corresponding frame returned as an answer to this frame (UA, DM or acknowledging frame). Therefore, the DTE should not delay the response or acknowledging frame returned to the above frames by more than a value T2 less than T1, where T2 is a system parameter.

The DCE will not delay the response or acknowledging frame returned to a command by more than T2.

2.4.11.2 *Maximum number of transmissions N2*

The value of the maximum number N2 of transmission and retransmissions of a frame following the running out of Timer T1 is a subject for further study.

2.4.11.3 *Maximum number of bits in an I frame N1*

The maximum number of bits in an I frame is a system parameter which depends upon the maximum length of the information fields transferred across the DTE/DCE interface.

2.4.11.4 *Maximum number of outstanding I frames k*

The maximum number (k) of sequentially numbered I frames that the DCE may have outstanding (i.e. unacknowledged) at any given time is a system parameter which can never exceed seven. It shall be agreed for a period of time with the Administration.

Note. — As a result of the further study proposed in 2.2.4 above, the permissible maximum number of outstanding I frames may be increased.

3. DESCRIPTION OF THE PACKET LEVEL DTE/DCE INTERFACE FOR VIRTUAL CALL AND PERMANENT VIRTUAL CIRCUIT 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 and/or permanent virtual circuits, logical channels are used. Each virtual call or permanent virtual circuit 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 a logical channel group number and a logical channel number 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.

3.1 *Procedures for virtual calls*

Annex 1, Figures 15/X.25, 16/X.25 and 17/X.25 shows the state diagrams which give a definition of events at the packet level DTE/DCE interface for each logical channel used for virtual calls (Annex 2 defines the symbols used for the state diagrams).

Annex 3 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.

Packet formats are given in 4. below.

3.1.1 *Ready state*

If there is no call in existence, a logical channel is in the *Ready* state.

3.1.2 *Call request packet*

The calling DTE shall indicate a call request by transferring a *call request* packet across the DTE/DCE interface. The logical channel selected by the DTE is then in the *DTE Waiting* state (p2). The *call request* packet includes the called DTE address. (See 3.6 below).

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.

3.1.3 *Incoming call packet*

The DCE will indicate that there is an incoming call by transferring across the DTE/DCE interface an *incoming call* packet. This places the logical channel in the *DCE Waiting* state (p3) (see 3.6 below).

The incoming call packet will use the logical channel in the *Ready* state with the lowest number. The incoming call packet includes the calling DTE address.

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.

3.1.4 *Call accepted packet*

The called DTE shall indicate its acceptance of the call by the transferring across the DTE/DCE interface a *call accepted* packet specifying the same logical channel as that of the *incoming call* packet. This places the specified logical channel in the *Data transfer* state (p4).

3.1.5 *Call connected packet*

The receipt of a *call connected* packet by the calling DTE specifying the same logical channel as that specified in the *call request* packet indicates that the call has been established and the logical channel is then in the *Data transfer* state (p4).

3.1.6 *Call collision*

Call collision occurs when a DTE and a DCE simultaneously transfer a *call request* packet and an *incoming call* packet specifying the same logical channel. The DCE will proceed with the call request and cancel the incoming call.

3.1.7 *Clearing by the DTE*

The DTE may indicate clearing by transferring across the DTE/DCE interface a *clear request* packet. The logical channel is then in the *DTE Clear request* state (p6). When the DCE is prepared to free the logical channel, the DCE will transfer across the DTE/DCE interface a *DCE clear confirmation* packet specifying the logical channel. The logical channel is now in the *Ready* state (p1) (see 3.6 below).

It is possible that subsequent to transferring a *clear request* packet the DTE will receive other types of packet, dependent on the state of the logical channel, before receiving a *DCE clear confirmation* packet.

3.1.8 *Clearing by the DCE*

The DCE will indicate clearing by transferring across the DTE/DCE interface a *clear indication* packet. The logical channel is then in the *DCE Clear indication* state (p7). The DTE shall respond by transferring across the DTE/DCE interface a *DTE clear confirmation* packet. The logical channel is now in the *Ready* state (p1) (see 3.6 below).

3.1.9 *Clear collision*

Clear collision occurs when a DTE and a DCE simultaneously transfer a *clear request* packet and a *clear indication* packet specifying the same logical channel. The DCE will consider that the clearing is completed and will not transfer a *DCE clear confirmation* packet.

3.1.10 *Unsuccessful call*

If a call cannot be established, the DCE will transfer a *clear indication* packet specifying the logical channel indicated in the *call request* packet.

3.1.11 *Call progress signals*

The DCE will be capable of transferring to the DTE *clearing call progress signals* as specified in Recommendation X.96.

Clearing call progress signals will be carried in *clear indication* packets which will terminate the call to which the packet refers. The method of coding *clear indication* packets containing call progress signals is detailed in 4. below.

3.1.12 *Data transfer phase*

The procedures for the control of packets between DTE and DCE while in the *Data transfer* state are contained in 3.3 below.

3.2 *Procedures for permanent virtual circuits*

Annex 1, Figures 16/X.25 and 17/X.25 shows the state diagrams which give a definition of events at the packet level DTE/DCE interface for logical channels assigned for permanent virtual circuits (Annex 2 defines the symbols used in the state diagrams). Annex 3, Tables 11/X.25 and 12/X.25 give details of the action taken by the DCE on receipt of packets in each state shown in Annex 1, Figures 16/X.25 and 17/X.25. Details of the action which should be taken by the DTE are for further study.

For permanent virtual circuits there is no call set-up phase and the logical channel is permanently in the data transfer state (p4).

3.3 *Procedures for data and interrupt transfer*

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

3.3.1 *States for data transfer in virtual calls*

Data, interrupt, flow control 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 3.4 below apply to data transmission on that logical channel to and from the DTE. *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.

Data, interrupt, flow control and *reset* packets may also be received by a DTE when the interface is in the *DTE Clear request* state.

3.3.2 *Numbering of data packets*

Each *data* packet transmitted at the DTE/DCE interface for each direction of transmission in a virtual call or permanent virtual circuit 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.

Only *data* packets contain this sequence number called the *packet send sequence number* P(S).

The first data packet to be transmitted across the DTE/DCE interface for a given direction of data transmission after the virtual call or permanent virtual circuit has been established, has a *packet send sequence number* equal to 0.

3.3.3 *Data field length*

In the absence of an optional user facility, the maximum data field length applying to a given DTE is fixed at subscription time and is common to all logical channels at the DTE/DCE interface (however, see 5.1.3 below). The maximum data field length of data packets is 128 octets. Additionally some Administrations may support other maximum data field lengths from the following list of powers of two, i.e. 16, 32, 64, 256, 512 and 1024 octets or exceptionally 255 octets.

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

If a DTE wishes to indicate a sequence of more than one packet, it uses a *More data* mark as defined below:

In a full *data* packet a DTE may indicate that more data is to follow with a mark called *More data.* This indication has the effect that such a packet may be combined with the subsequent *data* packet within the network.

Two categories of *data* packets are defined:

Category 1	*a)* Packets which do not have the local maximum data field length. *b)* Packets having the local maximum data field length and no *More data* mark.
Category 2	Packets having the local maximum data field length and a *More data* mark.

Category 1 packets will not be combined with subsequent packets.

A complete packet sequence is defined as being composed of either a single category 1 packet or consecutive category 2 packets and a category 1 packet. The sequence shall not be preceded by a category 2 packet.

When transmitted by a source DTE, a complete packet sequence is always delivered to the destination DTE as a complete packet sequence.

Note. – A national network which provides a single maximum data field length need not take any action as a result of the *More data* mark.

3.3.4 *Data qualifier*

A packet sequence may be on one of two levels. If a DTE wishes to transmit data on more than one level, it uses an indicator called *Data qualifier.*

When only one level of data is being transmitted on a logical channel, the *Data qualifier* is always set to zero. If two levels of data are being transmitted, the *Data qualifier* in all packets of a complete packet sequence are all set to the same value, either zero or one. Within a complete packet sequence, different levels of data may not be intermixed. Packets are numbered consecutively regardless of their data level.

3.3.5 *Interrupt procedure*

The interrupt procedure allows a DTE to transmit data to the remote DTE, without following the flow control procedure applying to data packets (see 3.4 below). The interrupt procedure can only apply in the *Flow control ready* state (d1) within the *Data transfer* state (p4).

The interrupt procedure has no effect on the transfer and flow control procedures applying to the *data* packets on the virtual call or permanent virtual circuit.

To transmit an interrupt, a DTE transfers across the DTE/DCE interface a *DTE interrupt* packet. The DCE will then confirm the receipt of the interrupt by transferring a *DCE interrupt confirmation* packet. The DCE will ignore further *DTE interrupt* packets until the first one is confirmed with a *DCE interrupt confirmation* packet.

The DCE indicates an interrupt from the remote DTE by transferring across the DTE/DCE interface a *DCE interrupt* packet containing the same data field as in the *DTE interrupt* packet transmitted by the remote DTE. The DTE will confirm the receipt of the *DCE interrupt* packet by transferring a *DTE interrupt confirmation* packet.

3.4 *Procedures for flow control*

The following only applies to the data transfer phase and specifies the procedures covering flow control of *data* packets and reset on each logical channel used for a virtual call or a permanent virtual circuit.

3.4.1 *Procedure for flow control*

At the DTE/DCE interface of a logical channel used for a virtual call or permanent virtual circuit, the transmission of *data* packets is controlled separately for each direction and is based on authorizations from the receiver.

3.4.1.1 *Window description*

At the DTE/DCE interface of a logical channel used for a virtual call or permanent virtual circuit and for each direction of data transmission, a window is defined as the ordered set of W consecutive *packet send sequence numbers* P(S) of the *data* packets authorized to cross the interface.

The lowest sequence number in the window is referred to as the lower window edge. When a virtual call or permanent virtual circuit at the DTE/DCE interface has just been established, the window related to each direction of data transmission has a lower window edge equal to 0.

The *packet send sequence number* of the first *data* 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 data transmission at a DTE/DCE interface is common to all the logical channels and agreed for a period of time with the Administration for the DTE. The value of W does not exceed 7, or 127 when extended (see 5.1.2 below).

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 *data* packets. When transmittd across the DTE/DCE interface, a P(R) becomes the lower window edge. In this way, additional *data* packets may be authorized by the receiver to cross the DTE/DCE interface.

When the *sequence number* P(S) of the next *data* packet to be transmitted by the DTE is within the window, the DCE will accept this *data* packet. When the *sequence number* P(S) of the next *data* packet to be transmitted by the DTE is outside of the window, the DCE will consider the receipt of this *data* packet from the DTE as a procedure error and will reset the virtual call or permanent virtual circuit. The DTE should follow the same procedure.

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

The *packet receive sequence number,* P(R), is conveyed in *data, 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 to the *packet send sequence number* of the next *data* 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 virtual call or permanent virtual circuit. The DTE should follow the same procedure.

The only universal significance of a P(R) value is a local updating of the window across the packet level interface, but the P(R) value may be used within some Administrations' networks to convey an end-to-end acknowledgement.

3.4.1.3 *DTE and DCE Receive ready (RR) packets*

RR packets are used by the DTE or DCE to indicate that it is ready to receive the W *data* packets within the window starting with P(R), where P(R) is indicated in the *RR* packet.

3.4.1.4 *DTE and DCE Receive not ready (RNR) packets*

RNR packets are used by the DTE or DCE to indicate a temporary inability to accept additional *data* packets for a given virtual call or permanent virtual circuit. A DTE or DCE receiving an *RNR* packet shall stop transmitting *data* packets on the indicated logical channel.

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.

3.4.2 *Procedure for reset*

The reset procedure is used to reinitialize the virtual call or permanent virtual circuit and in so doing removes in each direction all *data* and *interrupt* packets which may be in 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 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 16/X.25. When entering state p4 the logical channel is placed in state d1. Annex 3, Table 11/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE.

When a virtual call or permanent virtual circuit at the DTE/DCE interface has just been reset, the window related to each direction of data transmission has a lower window edge equal to 0, and the numbering of subsequent data packets to cross the DTE/DCE interface for that direction of data transmission shall start from 0.

3.4.2.1 *Reset request packet*

The DTE shall indicate a request for reset by transmitting a *reset request* packet specifying the logical channel. This places the logical channel in the *DTE Reset request* state (d2) (see 3.6 below).

3.4.2.2 *Reset indication packet*

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, interrupt, RR* and *RNR* packets (see 3.6 below).

3.4.2.3 *Reset collision*

Reset collision can occur when a DTE and a DCE simultaneously transmit a *reset request* packet, and a *reset indication* packet. In such a case, the second one of both those packets crossing the interface is considered as a reset confirmation. This places the logical channel in the *Flow control ready* state (d1).

3.4.2.4 *Reset confirmation packets*

When the logical channel is in the *DTE Reset request* state, the DCE will confirm reset by transmitting to the DTE a *DCE reset confirmation* packet. This places the logical channel in the *Flow control ready* state (d1).

When the logical channel is in the *DCE Reset indication* state, the DTE will confirm reset by transmitting to the DCE a *DTE Reset confirmation* packet. This places the logical channel in the *Flow control* state (d1) (see 3.6 below).

3.5 *Procedure for restart*

The restart procedure is used to simultaneously clear all the virtual calls and reset all the permanent virtual circuits at the DTE/DCE interface.

Annex 1, Figure 17/X.25 gives the state diagram which defines the logical relationships of events related to the restart procedure.

Annex 3, Table 12/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE. Details of the action which should be taken by the DTE are for further study.

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 in the *Flow control ready* state (d1) (see 3.6 below).

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. In this state of the DTE/DCE interface, the DCE will ignore *data, 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 in the *Flow control ready* state (d1) (see 3.6 below).

3.5.3 *Restart collision*

Restart collision can occur when a DTE and a DCE simultaneously transfer a *restart request* and a *restart indication* packet. Under this circumstance, the DCE will consider that the restart is completed and will not expect a *DTE Restart confirmation* packet, neither will it transfer a *DCE Restart confirmation* packet.

3.6 *List of system parameters*

The system parameters applying under 3. are for further study. This study should include considerations of both time-outs and numbers of re-tries.

4. PACKET FORMATS FOR VIRTUAL CALL AND PERMANENT VIRTUAL CIRCUIT FACILITIES

4.1 *General*

The possible extension of packet formats by the addition of new fields is for further study.

Bits of an octet are numbered 8 to 1 where bit 1 is the low order bit and is transmitted first. Octets of a packet are consecutively numbered starting from 1 and are transmitted in this order.

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 and permanent virtual circuit facilities. Two other codes are used to identify the similar formats in the case where the 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, datagram facility or single access DTE procedures.

TABLE 5/X.25 – **General format identifier**

General format identifier		Octet 1 Bits 8	7	6	5
Data 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.

4.1.2 *Logical channel group number*

The logical channel group number appears in every packet except in restart packets (see 4.5 below) in bit positions 4, 3, 2 and 1 of octet 1. This field is binary coded and bit 1 is the low order bit of the logical channel group number.

4.1.3 *Logical channel number*

The logical channel number appears in every packet except in *restart* packets (see 4.5 below) in all bit positions of octet 2. This field is binary coded and bit 1 is the low order bit of the logical channel number.

4.1.4 *Packet type identifier*

Each packet shall be identified in the octet 3 of the packet according to 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
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
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

Note. – A bit which is indicated as "X" may be set to either 0 or 1.

4.2 *Call set-up and clearing packets*

4.2.1 *Call request and incoming call packets*

Figure 1/X.25 illustrates the format of *call request* and *incoming call* packets.

Address lengths field

Octet 4 consists of field length indicators for the called and calling DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the called DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the calling 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

Octet 5 and the following octets consist of the called DTE address when present, then the calling 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 octet 5 and 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 *call request* and *incoming call* packets.

The coding of this facility field is defined in 5. below.

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.

Call user data field

Following the facility field, user data may be present. The call user data field has a maximum length of 16 octets. The contents of the field are passed unchanged to the called DTE.

4.2.2 *Call accepted and Call connected packets*

Figure 2/X.25 illustrates the format of *call accepted* and *call connected* packets.

4.2.3 *Clear request and Clear indication packets*

Figure 3/X.25 illustrates the format of *clear request* and *clear indication* packets.

Clearing cause field

Octet 4 is the clearing cause field and contains the reason for the clearing of the call.

The coding of the clearing cause field in *clear indication* packets is given in Table 7/X.25.

The bits of the cause field in *clear request* packets are set to 0.

TABLE 7/X.25 – Coding of clearing cause field in clear indication packet

	Bits 8	7	6	5	4	3	2	1
DTE Clearing	0	0	0	0	0	0	0	0
Number busy	0	0	0	0	0	0	0	1
Out of order	0	0	0	0	1	0	0	1
Remote procedure error	0	0	0	1	0	0	0	1
Number refuses reverse charging	0	0	0	1	1	0	0	1
Invalid call	0	0	0	0	0	0	1	1
Access barred	0	0	0	0	1	0	1	1
Local procedure error	0	0	0	1	0	0	1	1
Network congestion	0	0	0	0	0	1	0	1
Not obtainable	0	0	0	0	1	1	0	1

4.2.4 *DTE and DCE Clear confirmation packets*

Figure 4/X.25 illustrates the format of the *DTE* and *DCE Clear confirmation* packets.

4.3 *Data and Interrupt packets*

4.3.1 *DTE and DCE data packets*

Figure 5/X.25 illustrates the format of the *DTE* and *DCE data* packets.

Note. – In the event that the sequence numbering scheme is performed modulo 128 (see 3.3.1.2 above), this format is effected.

Data qualifier

Bit 8 in octet 1 is used for *Data qualifier.*

Packet receive sequence number

Bits 8, 7 and 6 of octet 3 are used for indicating the *packet receive sequence number* P(R). P(R) is binary coded and bit 6 is the low order bit.

More data indication

Bit 5 in octet 3 is used for *More data* indication: 0 for no more data and 1 for more data.

Packet send sequence number

Bits 4, 3 and 2 of octet 3 are used for indicating the *packet send sequence number* P(S). P(S) is binary coded and bit 2 is the low order bit.

User data field

Bits following octet 3 contain user data.

4.3.2 *DTE and DCE Interrupt packets*

Figure 6/X.25 illustrates the format of the *DTE* and *DCE interrupt* packets.

Interrupt user data field

Octet 4 contains user data.

4.3.3 *DTE and DCE interrupt confirmation packets*

Figure 7/X.25 illustrates the format of the *DTE* and *DCE interrupt confirmation* packet.

4.4 *Flow control and reset packets*

4.4.1 *DTE and DCE receive ready (RR) packets*

Figure 8/X.25 illustrates the format of the *DTE* and *DCE RR* packets.

Note. – In the event that the sequence numbering scheme is performed modulo 128 (see 3.3.1.2 above), this format is effected.

Packet receive sequence number

Bits 8, 7 and 6 of octet 3 are used for indicating the *packet receive sequence number* P(R). P(R) is binary coded and bit 6 is the low order bit.

4.4.2 *DTE and DCE receive not ready (RNR) packets*

Figure 9/X.25 illustrates the format of the *DTE* and *DCE RNR* packets.

Note. – In the event that the sequence numbering scheme is performed modulo 128 (see 3.3.1.2 above), this format is effected.

Packet receive sequence number

Bits 8, 7 and 6 of the octet 3 are used for indicating the *packet receive sequence number* P(R). P(R) is binary coded and bit 6 is the low order bit.

4.4.3 *Reset request and reset indication packets*

Figure 10/X.25 illustrates the format of the *reset request* and *reset indication* packets.

Resetting cause field

Octet 4 is the resetting cause field and contains the reason for the reset. The coding of the resetting cause field in a *reset indication* packet is given in Table 8/X.25.

Diagnostic code

Octet 5 is the diagnostic code and contains additional information on the reason for the reset when the cause field indicates a local procedure error.

The bits of the diagnostic code field in a *reset request* packet are unassigned and set to 0.

The bits of the diagnostic code field in a *reset indication* packet are all set to 0 when no specific reason for the reset is supplied. Other values are not specified at this time.

TABLE 8/X.25 – **Coding of resetting cause field in reset indication packet**

	Bits							
	8	7	6	5	4	3	2	1
DTE Reset	0	0	0	0	0	0	0	0
Out of order	0	0	0	0	0	0	0	1
Remote procedure error	0	0	0	0	0	0	1	1
Local procedure error	0	0	0	0	0	1	0	1
Network congestion	0	0	0	0	0	1	1	1

Note. – The bits of the resetting cause field in a *reset request* packet are set to 0.

4.4.4 *DTE and DCE Reset confirmation packets*

Figure 11/X.25 illustrates the format of the *DTE* and *DCE reset confirmation* packets.

4.5 *Restart packets*

4.5.1 *Restart request and restart indication packets*

Figure 12/X.25 illustrates the format of the *restart request* and *restart indication* packets. Bits 4, 3, 2 and 1 of the first octet and all bits of the second octet are set to 0.

Restarting cause field

Octet 4 is the restarting cause field and contains the reason for the restart.

The coding of the restarting cause field in the *restart indication* packets is given in Table 9/X.25.

The bits of the restarting cause field in *restart request* packets are set to 0.

TABLE 9/X.25 – **Coding of restarting cause field in restart indication packets**

	Bits							
	8	7	6	5	4	3	2	1
Local procedure error	0	0	0	0	0	0	0	1
Network congestion	0	0	0	0	0	0	1	1

4.5.2 *DTE and DCE restart confirmation packets*

Figure 13/X.25 illustrates the format of the *DTE* and *DCE restart confirmation* packets. Bits 4, 3, 2 and 1 of the first octet and all bits of the second octet are set to 0.

4.6 *Packets required for optional user facilities*

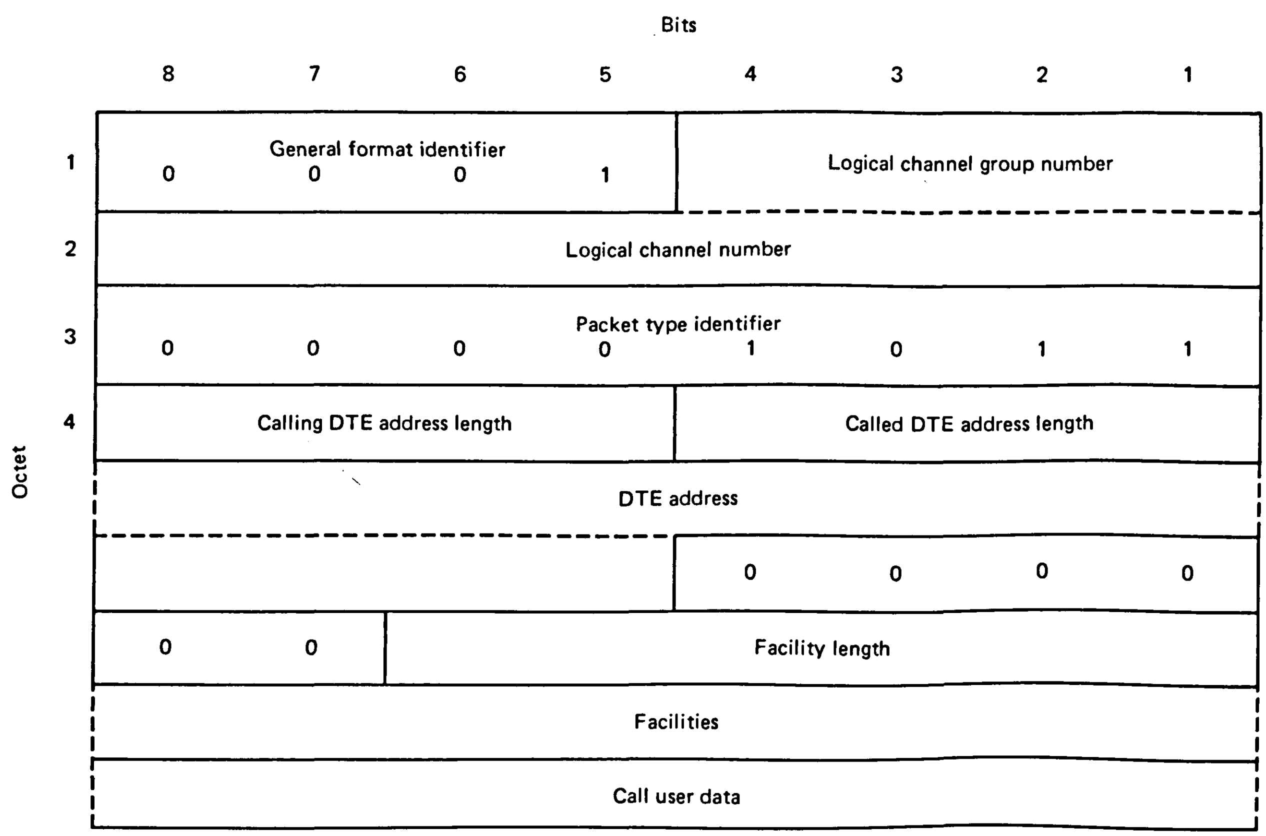
4.6.1 *DTE reject (REJ) packets*

Figure 14/X.25 illustrates the format of the *DTE REJ* packets, used in conjunction with the Packet Retransmission Facility described in 5. below.

Note. – In the event that the sequence numbering scheme is performed modulo 128 (see 3.3.1.2 above), this format is effected.

Packet receive sequence number

Bits 8, 7 and 6 of octet 3 are used for indicating the *packet receive sequence number* P(R). P(R) is binary coded and bit 6 is the low order bit.



Note. – The Figure assumes that a single address is present, consisting of an odd number of digits, and that the call user data field contains an integral number of octets.

FIGURE 1/X.25 – Call request and incoming call packet format

Octet	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
1	General format identifier: 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	Packet type identifier: 0	0	0	0	1	1	1	1

CCITT-8612-1

FIGURE 2/X.25 – Call accepted and call connected packet format

Octet	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
1	General format identifier: 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	Packet type identifier: 0	0	0	1	0	0	1	1
4	Clearing cause							

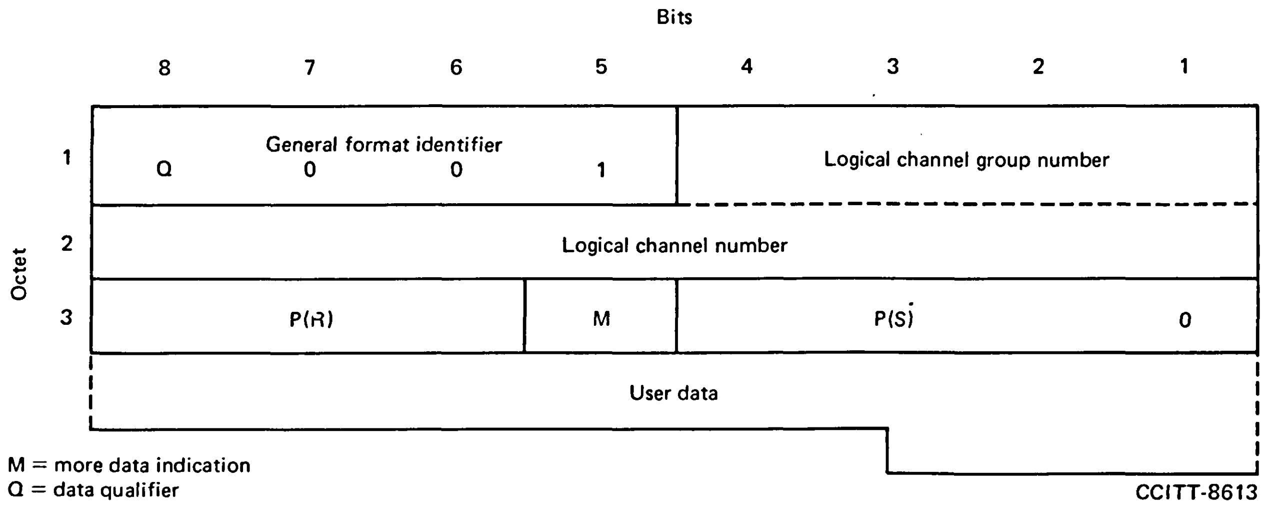
CCITT-8612-2

FIGURE 3/X.25 – Clear request and clear indication packet format

Octet	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
1	General format identifier: 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	Packet type identifier: 0	0	0	1	0	1	1	1

CCITT-8612-3

FIGURE 4/X.25 – DTE and DCE clear confirmation packet format



Note. – The Figure assumes that the user data field does not contain an integral number of octets.

FIGURE 5/X.25 – **DTE and DCE data packet format**

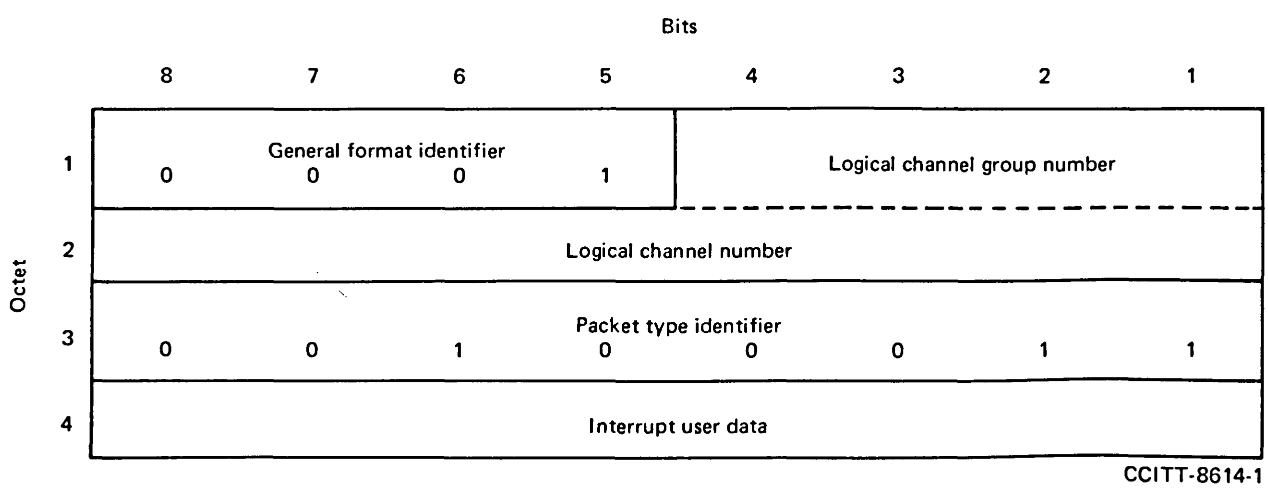


FIGURE 6/X.25 – **DTE and DCE interrupt packet format**

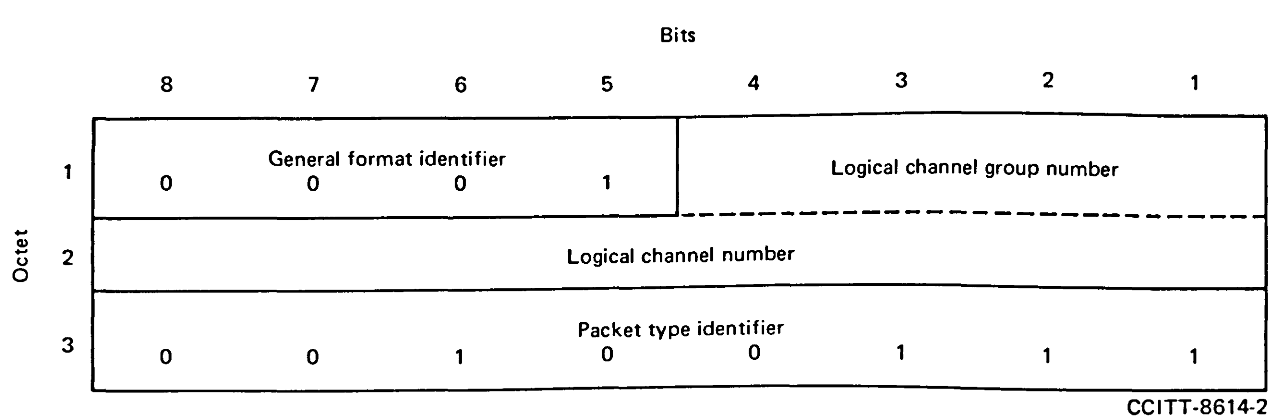


FIGURE 7/X.25 – **DTE and DCE interrupt confirmation packet format**

Bits

Octet	8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	P(R)			0	0	0	0	1

CCITT-8615-1

FIGURE 8/X.25 – DTE and DCE RR packet format

Bits

Octet	8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	P(R)			0	0	1	0	1

CCITT-8615-2

FIGURE 9/X.25 – DTE and DCE RNR packet format

Bits

Octet	8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	1	1	0	1	1
4	Resetting cause							
5	Diagnostic code							

CCITT-8616-1

FIGURE 10/X.25 – Reset request and reset indication packet format

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	1	1	1	1	1

CCITT-8616-2

FIGURE 11/X.25 – DTE and DCE reset confirmation packet format

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet type identifier 1	1	1	1	1	0	1	1
4	Restarting cause							

CCITT-8617-1

FIGURE 12/X.25 – Restart request and restart indication packet format

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet type identifier 1	1	1	1	1	1	1	1

CCITT-8617-2

FIGURE 13/X.25 DTE and DCE restart confirmation packet format

Octet	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	P(R)			0	1	0	0	1

CCITT-8617-3

FIGURE 14/X.25 – **DTE REJ packet format**

5. PROCEDURES AND FORMATS FOR OPTIONAL USER FACILITIES TO BE STUDIED FOR VIRTUAL CALL AND PERMANENT VIRTUAL CIRCUIT FACILITIES

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

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.

The Reverse Charging facility needs some indication in the *call request* and the *incoming call* packets.

5.1.2 *Flow Control Parameters Selection*

Flow Control Parameters Selection is an optional user facility agreed for a period of time; it can be used by a DTE for virtual calls.

This user facility allows a DTE to operate with a specific window size and/or maximum data field length depending on the throughput class requested for each direction, that is, the actual data transfer rate that the DTE does not have the need to exceed for this virtual call.

Specific throughput classes for a virtual call may be indicated to a called DTE using the optional user facility parameters in the *incoming call* packet.

If those throughput classes are not specified in the *incoming call* packet, the throughput classes considered at the DTE/DCE interface of the called DTE are the highest attainable one at this interface.

Specific throughput classes for virtual call may be selected by a calling DTE using the optional user facility parameters in the *call request* packet.

If those throughput classes are not specified in the *call request* packet, the throughput classes considered at the DTE/DCE interface of the calling DTE are the highest attainable one at this interface.

For each throughput class, a correspondence agreed with the Administration, for the DTE, for a period of time specifies either the window size, the maximum data field length, or both.

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 which request the Reverse Charging facility. In the absence of this facility, the DCE will not transmit to the DTE incoming calls which request the Reverse Charging facility.

5.1.4 *One-way Logical Channel*

One-way Logical Channel is an optional user facility agreed for a period of time.

This is a user facility which limits the use of a logical channel to either incoming or outgoing calls (incoming or outgoing access on logical channels).

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 *data* packets from the DCE (up to the window size) by transferring across the DTE/DCE interface a *DTE reject* packet specifying a logical channel number and a *sequence number* P(R).

When receiving a *DTE reject* packet, the DCE initiates on the specified logical channel retransmission of the *data* packets whose *packet send sequence numbers* start from P(R), where P(R) is indicated in the *DTE reject* packet. Until the DCE transfers across the DTE/DCE interface a *DCE data* 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 or permanent virtual circuit.

Additional *data* packets pending initial transmission may follow the retransmitted *data* 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 in 2. and 3. above.

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 packet or the incoming call packet.

The facility field contains a sequence of octet pairs. The first octet of each is a facility code field to indicate the facility or facilities requested and the second octet is the facility parameter field.

If any given user facility requires more than a single octet parameter field, several facility codes will be assigned to it. In the facility field, the octet pairs related to the same user facility are placed consecutively in the order specified for the parameters.

The facility code is binary coded. The coding of the facility parameter field is dependent on the facility being requested.

5.2.2 *Coding of facility field for particular facilities*

5.2.2.1 *Coding of Reverse Charging facility*

The coding of facility code field and parameters for Reverse Charging is the same in code request and incoming call packets.

Facility code field

The coding of the facility code field for Reverse Charging is:

bit:	8 7 6 5 4 3 2 1
code:	0 0 0 0 0 0 0 1

Facility parameter field

The coding of the facility parameter field is as follows:

bit 1 = 0 for Reverse Charging not requested

bit 1 = 1 for Reverse Charging requested

Note. – Bits 8, 7, 6, 5, 4, 3 and 2 could be used for user facilities other than for Reverse Charging; if not, they are set to 0.

5.2.2.2 *Coding of Flow Control Parameters Selection facility*

The inclusion of facility code and parameter fields for Flow Control Parameters Selection is optional.

The coding in incoming call packets and in call request packets is the same.

Facility code field

The facility code field for Flow Control Parameters Selection is coded:

bit:	8 7 6 5 4 3 2 1
code:	0 0 0 0 0 0 1 0

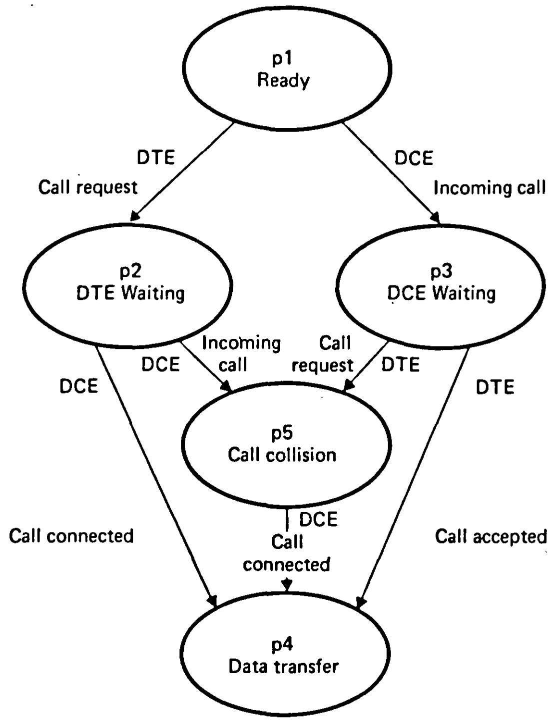
Facility parameter field

The throughput class for transmission from the calling DTE is indicated in bits 4, 3, 2, and 1. The throughput class for transmission from the called DTE is indicated in bits 8, 7, 6 and 5.

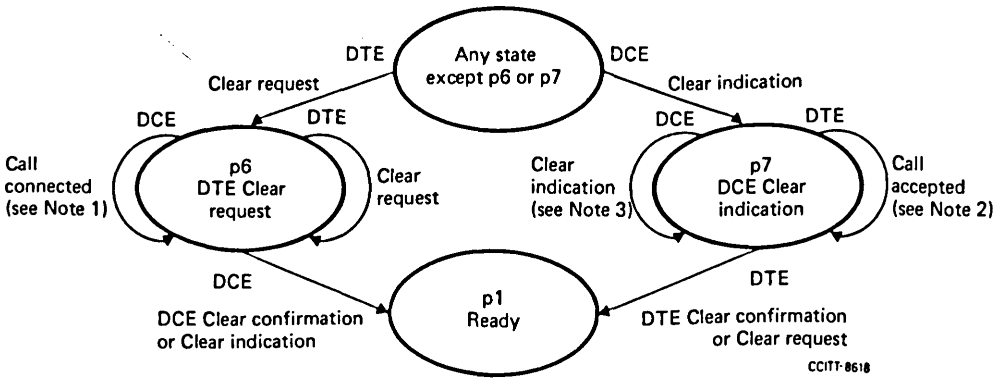
The four bits indicating each throughput class are binary coded and express the logarithm base 2 of the number of octets per second defining the throughput class. Bit 1 or 5 is the low order bit of each throughput class indicator.

ANNEX 1
(to Recommendation X.25)

Packet level DTE/DCE interface state diagram for a logical channel



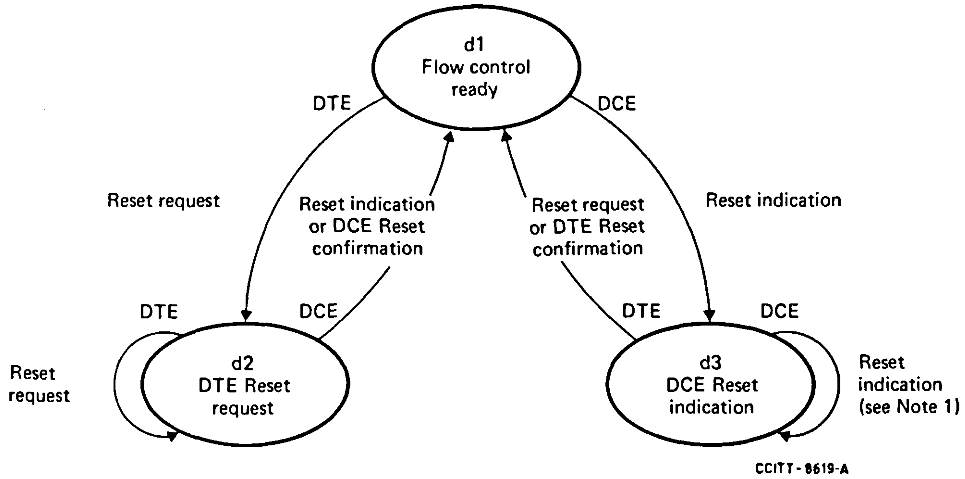
a) Call set-up phase



b) Call clearing phase

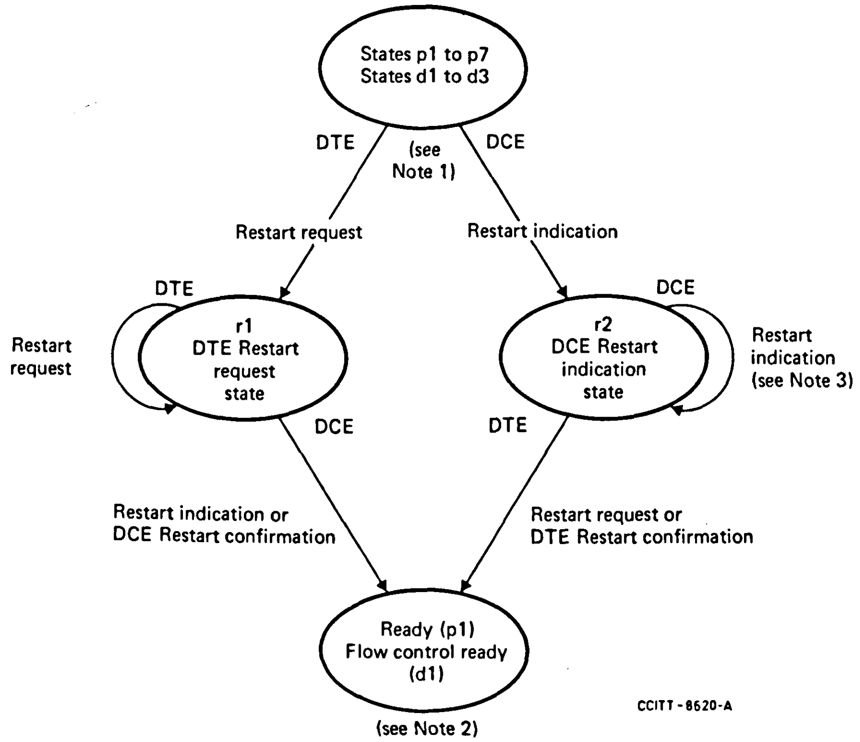
Note 1. – This transition is possible only if the previous state was *DTE Waiting* (p2).
Note 2. – This transition is possible only if the previous state was *DCE Waiting* (p3).
Note 3. – This transition will take place after a time-out in the network.

FIGURE 15/X.25



Note 1. – This transition will take place after a time-out in the network.

FIGURE 16/X.25 – Reset phase

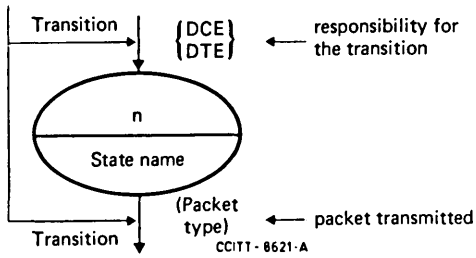


Note 1. – States p1 to p7 for virtual calls or states d1 to d3 for permanent virtual circuits.
Note 2. – State p1 for virtual calls or state d1 for permanent virtual circuits.
Note 3. – This transition will take place after a time-out in the network.

FIGURE 17/X.25 – Restart phase

ANNEX 2
(to Recommendation X.25)

Symbol definition of the state diagrams



Note 1. – Each state is represented by an ellipse wherein the state name and number are indicated.

Note 2. – Each state transition is represented by an arrow. The responsibility for the transition (DTE or DCE) and the packet it has successfully transmitted are indicated beside that arrow.

ANNEX 3
(to Recommendation X.25)

TABLE 10/X.25 – **Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface: call set-up and clearing**

State of the interface / Packet from the DTE	Ready p1	DTE Waiting p2	DCE Waiting p3	Data transfer p4	Call collision p5	DTE Clear request p6	DCE Clear indication p7
Call request	NORMAL	ERROR	NORMAL	ERROR	ERROR	ERROR	ERROR
Call accepted	ERROR	ERROR	NORMAL	ERROR	ERROR	ERROR	NORMAL
Clear request	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
DTE Clear confirmation	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	NORMAL
Data, interrupt, reset or flow control	ERROR	ERROR	ERROR	See Table 11/X.25	ERROR	ERROR	NORMAL

NORMAL: the action taken by the DCE follows the normal procedures as defined in 3. of the text.

ERROR: the DCE indicates a clearing by transmitting to the DTE a *clear indication* packet, with an indication of Local Procedure Error. If connected through the virtual call, the distant DTE is also informed of the clearing by a *clear indication* packet, with an indication of Remote Procedure Error.

TABLE 11/X.25 – **Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface: flow control and data transfer**

Packet from the DTE \ State of the interface	Data transfer (p4)		
	Flow control ready (d1)	DTE Reset request (d2)	DCE Reset indication (d3)
Reset request	NORMAL	NORMAL	NORMAL
DTE Reset confirmation	FLOW CONTROL ERROR	FLOW CONTROL ERROR	NORMAL
Data, interrupt or flow control	NORMAL	FLOW CONTROL ERROR	NORMAL

NORMAL: the action taken by the DCE follows the normal procedures as defined in 3. of the text.

FLOW CONTROL ERROR: the DCE indicates a reset by transmitting to the DTE a *reset indication* packet, with an indication of Local Procedure Error. The distant DTE is also informed of the reset by a *reset indication* packet, with an indication of Remote Procedure Error.

TABLE 12/X.25 – **Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface: restart**

Packet from the DTE \ State of the interface	Any state p1 to p7 and d1 to d3	DTE restart request state	DCE restart indication state
Restart request	NORMAL	NORMAL	NORMAL
DTE restart confirmation	ERROR	ERROR	NORMAL
Data, interrupt, call set-up and clearing, flow control or reset	See Note	ERROR	NORMAL

NORMAL: the action taken by the DCE follows the normal procedures as defined in 3. of the text.

ERROR: the DCE indicates a restarting by transmitting to the DTE a *restart indication* packet with an indication of Local Procedure Error.

Note. – See Table 10/X.25 for call set-up and clearing. See Table 11/X.25 for data, interrupt, flow control and reset.

Provisional Recommendation X.28 *(Geneva, 1977)*

DTE/DCE INTERFACE FOR A START-STOP MODE DATA TERMINAL EQUIPMENT ACCESSING THE PACKET ASSEMBLY/DISASSEMBLY FACILITY (PAD) IN A PUBLIC DATA NETWORK SITUATED IN THE SAME COUNTRY

Contents

The establishment in various countries of public data networks providing packet-switched data transmission services creates a need to produce standards to facilitate access from the public telephone network, circuit- switched public data networks and leased circuits.

Preface

The CCITT,

considering

a) that Recommendations X.1 and X.2 define user classes of service and user facilities provided by a public data network, Recommendation X.95 defines network parameters and Recommendation X.96 defines call progress signals,

b) that Provisional Recommendation X.29 defines procedures for a packet mode DTE to control the PAD,

c) that the logical control links for packet-switched data transmission services are defined in Recommendation X.92,

d) the need for defining an international recommendation for the exchange of control information between a start-stop mode DTE and a PAD,

e) that DTEs operating in the start-stop mode will send and receive network call control information and user information in the form of characters according to Recommendation V.3,

f) that the necessary elements for an interface recommendation should be defined independently as:

1. Procedures for the establishment of a national access information path between a start-stop mode DTE and a PAD.
2. Procedures for character interchange and service initialization between a start-stop mode DTE and a PAD.
3. Procedures for the exchange of control information between a start-stop mode DTE and a PAD.
4. Procedures for the exchange of user data between a start-stop mode DTE and a PAD,

unanimously declares the view

that start-stop mode DTE accessing the PAD should operate in accordance with this Recommendation.

1. *Procedures for the establishment of a national access information path between a start-stop mode DTE and a PAD*

1.1 *Access via a public switched telephone network or leased lines with V-Series interfaces*

1.1.1 *DTE/DCE interface*

The access information path will be provided by the use of modems standardized for use in the public switched telephone network or leased line operating at rates up to 300 bit/s (nominally at 200 bit/s), in accordance with Recommendation V.21.

The particular interchange circuits provided, and their operation, shall be in accordance with 8. of Recommendation V.21 and clamping of circuit 104 shall be implemented in accordance with 8.e)ii) of Recommendation V.21. The modem shall be set up for channel operation in accordance with 7.a) of Recommendation V.21.

Note. — The interface requirements for data signalling rates greater than 300 bit/s are for further study.

1.1.2 *Electrical characteristics*

The electrical characteristics of the DTE/DCE interface shall be in accordance with Recommendation V.28.

1.1.3 *Procedure for setting up and disconnecting the access information path*

1.1.3.1 *Setting up the access information path by the DTE*

The access information path shall be established in accordance with 6. of Recommendation V.25 for a manual data station calling an automatic answering station.

The mechanism for echo suppressor disablement may not be implemented in some national networks where the access information path does not include echo suppressors.

Subsequent to the completion of the above, both the DTE and the DCE shall transmit binary 1 on circuits 103 and 104.

1.1.3.2 *Disconnecting the access information path by the DTE*

The access information path shall be disconnected by:

i) reversion of the data circuit to the voice mode, or

ii) the DTE turning circuit 108/1 or 108/2 OFF for a period greater than Z. The value of Z is for further study.

1.1.3.3 *Setting up the access information path by the PAD*

The procedure for the PAD to establish an access information path is for further study.

1.1.3.4 *Disconnecting the access information path by the PAD*

Disconnection by the PAD will be indicated by the DCE turning circuit 106 and 109 OFF, while circuit 108 is ON.

Note. — Access information path clear indication to the DTE is not signalled by circuit 107 OFF. Not all DTEs allow circuit 107 to be turned OFF f circuit 108 has not been turned OFF previously.

1.2 *Access via a public switched data network or via leased lines with X-Series interfaces*

1.2.1 *DTE/DCE interface designed for start-stop transmission services on public data networks (Recommendation X.20)*

1.2.1.1 *Physical characteristics*

The physical characteristics of the DTE/DCE interface are defined in 2. of Recommendation X.20.

1.2.1.2 *Procedures for setting up and disconnecting the access information path (call control)*

The procedures and formats for call control of the public switched data network are described in 3. and 4. of Recommendation X.20.

1.2.2 *DTE/DCE interface designed for operation on telephone type networks (Recommendation X.20bis)*

In the case of DTEs with interfaces designed for operation on telephone type networks (V-Series interfaces), the access information path will be established by the use of DCEs standardized for start-stop transmission services on public data networks according to Recommendation X.20*bis* (V.21-compatible interface).

1.2.2.1 *Characteristics*

The characteristics of the interchange circuits are described in 2. of Recommendation X.20*bis*.

1.2.2.2 *Operational requirements*

The requirements for the operation of the interchange circuits 106, 107, 108, 109 and 125 are described in 3. of Recommendation X.20*bis*.

1.2.2.3 *Operational requirements for disconnecting the access information path by the DTE*

The access information path shall be disconnected either

manually by depressing the clearing key of the DCE

or

automatically by the DTE turning OFF circuit 108/1 or 108/2 for a period longer than 210 ms.

1.2.2.4 *Indication of disconnection by the PAD*

Disconnection by the PAD, i.e. DCE clearing, will be indicated by the DCE by turning OFF circuits 106 and 109. The DTE should then perform clear confirmation by turning OFF circuit 108.

1.2.2.5 *Setting up the access information path by the PAD*

The procedure for the PAD to establish an access information path is for further study.

1.2.2.6 *Operational constraints for maintaining the access information path during information transfer*

Some DTEs are equipped with a break key to allow signalling without loss of character transparency. The user should be advised that the transmission of a *break signal* longer than 200 ms may cause clearing in a public switched data network. Therefore, the transmission of a *break signal* in either direction should either be avoided or the timer of the circuit generating a *break signal* should be adjusted to a signal length being considerably shorter than 200 ms.

2. *Procedures for character interchange and service initialization between a start-stop mode DTE and a PAD*

2.1 *Format of characters interchanged*

2.1.1 The start-stop mode DTE shall generate and be capable of receiving characters in accordance with International Alphabet No. 5 as described in Recommendation V.3. The general structure of characters shall be in accordance with Recommendation X.4.

2.1.2 For an interim period, PADs provided by some Administrations act as described below.

The PAD will transmit and expect to receive 8-bit characters.

Whenever the PAD has to interpret a received character for a specific action different from or additional to the transfer of this data character to the packet-mode DTE, it will only inspect the first seven bits and will ignore the eighth bit (the last bit preceding the stop element). Whenever the PAD generates characters (e.g. service signals), they will be transmitted by the PAD with even parity.

The PAD will accept characters which have a single stop element and will transmit characters with at least two stop elements if the start-stop mode DTE is operating at 110 bit/s. If the DTE is operating at 200 bit/s or 300 bit/s the PAD will transmit and accept characters with a single unit stop element.

2.2 *Procedures for initialization*

The references to states in the following procedures correspond to the state diagrams, see Figures 1/X.28 and 2/X.28.

2.2.1 *Active link (state 1)*

After the access information path has been established, the start-stop mode DTE and PAD exchange binary 1 signals across the start-stop mode DTE/DCE interface and the interface is in the *active link state.*

2.2.2 *Service request (state 2)*

If the interface is in the *active link state,* the DTE shall transmit a sequence of characters to indicate *service request* and to initialize the PAD. The *service request signal* enables the PAD to detect the data rate and code used by the DTE and to select the *initial standard profile* of the PAD. The parameters of *initial standard profiles* are summarized in Table 1/X.28.

The format of the *service request signal* to be transmitted by the DTE is given in 3.5.18 below.

The information content of the *service request signal* is a subject for further study.

2.2.3 *DTE waiting (state 3A)*

Following the transmission of the *service request signal* the DTE shall transmit binary 1 and the interface will be in the *DTE waiting state.*

2.2.4 *Service ready (state 4)*

After receiving a *service request signal* the PAD will transmit a *PAD identification PAD service signal* at the data rate of the DTE, unless the value of parameter 6 is 0.

When the value of parameter 6 is 0, the interface will directly enter the *PAD waiting state* following receipt of a valid *service request signal.*

2.2.5 *Fault condition*

If a valid *service request signal* is not received by the PAD within Y seconds after the transmission of binary 1, it will perform PAD clearing by disconnecting the access information path.

The value of Y is for further study.

Note. – Some networks may allow states 2 to 4 to be bypassed. In these cases the condition described under 2.2.5 does not apply.

3. *Procedures for the exchange of control information between a start-stop mode DTE and a PAD*

3.1 *General*

3.1.1 *PAD command signals and PAD service signals*

The operation of the PAD depends on the current values of internal PAD variables which are known as PAD parameters. Initially PAD parameter values depend on the profile selected at the time of sending a *service request signal.* The values of *initial standard profiles* are summarized in Table 1/X.28.

PAD command signals (direction DTE to PAD) are provided for:

a) the establishment and clearing of a virtual call (see 3.2 below);

b) the selection of a set of preset values of PAD parameters known as a *standard profile* (see 3.3.1 below);

c) the selection of individual PAD parameter values (see 3.3.2 below);

d) requesting the current values of PAD parameters to be transmitted by the PAD to the DTE (see 3.4 below).

PAD service signals (direction PAD to DTE) are provided to:

a) transmit *call progress signals* to the calling DTE;

b) acknowledge *PAD command signals*;

c) transmit information regarding the operation of the PAD to the start-stop mode DTE.

The formats of *PAD command signals* and *PAD service signals* are given in 3.5 below.

The information content of *PAD command signals* and *PAD service signals* are summarized in the Annex.

3.1.2 *Break signal*

The *break signal* is provided to allow the start-stop mode DTE to signal to the PAD without loss of character transparency. The *break signal* can also be transmitted by the PAD to the start-stop mode DTE.

The *break signal* is defined as the transmission of binary 0 for more than 150 ms. The maximum permitted duration shall depend upon the type of access information path used (see, for example, 1.2.2.6 above).

A *break signal* shall be separated from any following start-stop character or other *break signal* by the transmission of binary 1 for greater than 100 ms.

3.2 *Procedures for virtual call control*

Figure 1/X.28 (Sequence of events at the interface) shows the procedures at the DCE/DTE interface during call establishment, data transfer and call clearing. Figure 2/X.28 shows the state diagram.

3.2.1 *Call establishment*

3.2.1.1 *Pad waiting (state 5)*

Following the transmission of a *PAD service signal* the interface will be in the *PAD waiting state* unless a virtual call is established or is being established. During the *PAD waiting state* the PAD will transmit binary 1.

Note. — In certain networks the *active link state* will lead directly to the *PAD waiting state* (see Note in 2.2 above).

3.2.1.2 *Network user identification (NUI)*

When used for security, billing and network management purposes, the network user shall transmit a *network user identification signal.* Some Administrations may not implement a *network user identification signal.*

The format and information content of the *network user identification signal* are for further study.

When *network user identification* is not used and the calling DTE is not identified by other means, the reverse charging facility will be used.

3.2.1.3 *PAD command (state 6)*

The DTE may transmit a *PAD command signal* when the interface is in the *PAD waiting state* (state 5) and enters the *PAD command state* at the start of a *PAD command signal.*

The DTE may also transmit *PAD command signals* after escaping from the *data transfer state* of a virtual call (see 4.9.1 below).

If parameter 6 is set to 1, following the receipt of a *PAD command signal,* the PAD will ignore all characters received from the DTE until the associated *PAD service signal* or sequence of *PAD service signals* has been transmitted to the DTE by the PAD.

The formats of *PAD command signals* are given in 3.5 below.

The DTE may request the establishment of a virtual call by transmitting a *selection PAD command signal.* The information content of the *selection PAD command signal* is the subject of future recommendations.

3.2.1.4 *DTE waiting (state 3B)*

Following the transmission of a *PAD command signal* the DTE will transmit binary 1 and the interface will be in the *DTE waiting state.*

3.2.1.5 *Connection-in-progress (state 7)*

If parameter 6 is set to 1, on receipt of a valid *selection PAD command signal* the PAD will transmit an *acknowledgement PAD service signal* followed by binary 1 and will enter the *connection-in-progress state.* The interface will enter the *PAD service signal state* as necessary and the PAD will transmit the *connected PAD service signal* or a *clear indication PAD service signal* to the DTE. During this period the PAD will not accept any *PAD command signals.*

If the value of parameter 6 is 0, the PAD will not transmit *PAD service signals* to the start-stop mode DTE. Following the receipt of a valid *selection PAD command signal,* the interface shall remain in the *connection-in-progress state* until the virtual call has been established.

3.2.1.6 *PAD service signals (state 8)*

Following receipt by the DTE of a *PAD service signal* or a sequence of *PAD service signals* (in the case of call set-up) in response to a previously transmitted *PAD command signal,* the interface will be in either:

a) a *PAD waiting state* (state 5) if no virtual call is in progress, or

b) a *data transfer state* (state 9) if a virtual call is in progress.

Any *PAD service signal* arising from events within the packet network will not be transmitted until any *PAD service signal* outstanding from a previously received *PAD command signal* has been transmitted.

PAD service signals will not be transmitted if the value of parameter 6 is set to 0.

The format of *PAD service signals* is defined in 3.5 below.

A summary of *PAD service signals* is given in the Annex.

3.2.1.7 *Incoming calls*

The procedures for signalling an incoming call and the start-stop mode DTE responses are for further study.

3.2.2 *Clearing*

3.2.2.1 *Clearing by the start-stop mode DTE*

a) When parameter 6 is set to 1, DTE clearing shall be indicated by either:

i) transmitting a *clear request PAD command signal* after escaping from the *data transfer state* during a virtual call (see 4.9 below). The format of a *clear request PAD command signal* is given in 3.5.8 below. The PAD will transmit a *clear confirmation PAD service signal.* The format of the *clear confirmation PAD service signal* is given in 3.5.9 below. Following the transmission of the *clear confirmation PAD service signal,* the interface will be in the *PAD waiting state* and the DTE will be allowed to make a follow-on call;

or

ii) disconnecting the access information path.

b) When parameter 6 is set to 0, DTE clearing shall be indicated by disconnecting the access information path.

3.2.2.2 *PAD clearing*

a) When parameter 6 is set to 1, PAD clearing may be indicated by:

i) transmitting a *clear indication PAD service signal.* The format of a *clear indication PAD service signal* is given in 3.5.19 below. After transmitting a *clear indication PAD service signal,* the interface will be in the *PAD waiting state.* The DTE shall stop sending data on receipt of a *clear indication PAD service signal* and shall transmit binary 1;

or

ii) disconnecting the access information path.

b) When parameter 6 is set to 0, the PAD will not clear the access information path and the interface will enter the *PAD waiting state (state 3B).*

3.2.3 *Unsuccessful calls*

If a call is unsuccessful for any reason, the PAD will indicate the reason to the start-stop mode DTE by means of *PAD service signals.* If parameter 6 is set to 0, a *clear indication PAD service signal* is not transmitted.

After transmission of the *PAD service signals* the PAD will be in the *PAD waiting state.*

3.2.3.1 *Fault conditions*

a) *Failure to receive a PAD command signal*

If the first character of a *PAD command signal* is not received within X of the interface entering the *PAD waiting state,* the PAD will perform PAD clearing in accordance with 3.2.2.2 above. The value of X is for further study.

If following the first character of a *PAD command signal* a complete *PAD command signal* is not received within 30s, the PAD will transmit an *error PAD service signal,* if parameter 6 is set to 1, indicating that an error has occurred (see 3.5.21 below) and the interface will return to the *PAD waiting state.*

If the PAD received an unrecognized *PAD command signal,* it will transmit an *error PAD service signal,* if parameter 6 is set to 1, indicating that an error has occurred and the interface will return to the *PAD waiting state.*

b) *Failure to establish a virtual call*

If the interface enters the *PAD waiting state* more than N times after receiving a *service request signal* without a virtual call being established, the PAD will perform PAD clearing in accordance with 3.2.2.2 above. The value of N is for further study.

c) *Invalid clear request PAD command signal*

If the PAD receives a *clear request PAD command signal* while the interface is in the *PAD waiting state*, the PAD will transmit a *clear-in-error PAD service signal* and the interface returns to the *PAD waiting state*. The format of the *clear-in-error PAD service signal* is given in 3.5.10 below.

3.2.3.2 *Failure of the access information path*

If the access information path is disconnected for any reason, the call attempt or virtual call will be cleared by the PAD.

3.2.4 *Data transfer*

The procedures for data transfer are given in 4. below.

3.3 *Procedures for setting the values of PAD parameters*

These procedures may be used before the *selection PAD command signal* is sent and also after escaping from the *data transfer state*.

3.3.1 *Selection of a standard profile by the start-stop mode DTE*

The start-stop mode DTE may select a set of defined values of PAD parameters known as a *standard profile* [see 3.1.1b) above] by sending the *profile selection PAD command signal* which includes a profile identifier. This procedure is additional to the selecting of an *initial standard profile* by transmitting the *service request signal*.

The format of the *profile selection PAD command signal* is given in 3.5.5 below.

A list of the parameter values associated with the *transparent* and *simple standard profiles* is given in Table 1/X.28. Other *standard profiles*, their corresponding parameter values and their identifiers are subjects for further study.

When parameter 6 is set to 1, the PAD will acknowledge the *profile selection PAD command signal* by sending an *acknowledgement PAD service signal* to the start-stop mode DTE.

The format of the *acknowledgement PAD service signal* is defined in 3.5.3 below.

3.3.2 *Procedures for setting or changing one or several parameters by the start-stop mode DTE*

The start-stop mode DTE may change the values of one or several parameters by sending a *set or set and read PAD command signal* including the parameter reference(s) and value(s). The format of *PAD command signals* is defined in 3.5 below.

The PAD will respond to a valid *set and read PAD command signal* by transmitting a *parameter value PAD service signal* as described in 3.4 below, showing the newly set parameter values. The PAD will respond to a valid *set PAD command signal* by transmitting an *acknowledgement PAD service signal*. If at least one of the requested PAD parameters is invalid, the PAD will send a *parameter value PAD service signal* to the start-stop mode DTE to identify the invalid parameters. In this case the valid parameters will be accepted and invoked. Valid parameter references and values are given in Recommendation X.3.

The format of the *parameter value PAD service signal* is defined in 3.5.16 below.

3.4 *Procedure for reading the values of one or several parameters by the start-stop mode DTE*

These procedures may be used when parameter 6 is set to 1, before the *selection PAD command signal* is sent and also after escaping from the *data transfer state*.

The start-stop mode DTE may enquire about the current values of one or several PAD parameters by sending the *read PAD command signal* and the references of the required parameters. The format of the *read PAD command signal* is defined in 3.5.4 below.

The PAD will respond by sending a *parameter value PAD service signal* containing the requested parameter values. The format of the *parameter value PAD service signal* is defined in 3.5.16 below.

3.5 *Formats of PAD command signals and PAD service signals*

All characters in columns 2 to 7 of International Alphabet No. 5, excluding the characters 2/0 (SP), 7/15 (DEL) and 2/11 (+) will be recognized by the PAD as forming part of a *PAD command signal.* All other characters are not considered as part of a *PAD command signal* and those characters will be ignored. The *PAD command signal* delimiter is not part of the command.

All *PAD command signals* shall be terminated with the *PAD command signal delimiter.*

PAD service signals, other than the *acknowledgement PAD service signal,* will commence with and be followed by the *format effector.*

3.5.1 *Format of the PAD command signal delimiter*

The character 0/13 (CR) or character 2/11 (+) may be sent as a delimiter.

3.5.2 *Format of the format effector*

The characters 0/13 (CR), 0/10 (LF) will be sent by the PAD followed by, when parameter 9 is set to 0, two padding characters if the start-stop mode DTE operates at a data rate of 110 bit/s and four padding characters if the start-stop mode DTE operates at 200 bit/s or 300 bit/s.

If parameter 9 is not set to 0, then the number of padding characters transmitted after the character 0/10 (LF) will be equal to the current value of that parameter.

The format of the padding characters is given in 3.5.22 below.

3.5.3 *Format of the acknowledgement PAD service signal*

The *format effector* will be sent.

3.5.4 *Format of read PAD command signal*

The characters 5/0 (P) 4/1 (A) 5/2 (R) 3/15 (?) shall be sent followed by the decimal reference of the parameter to be read.

Note. — IA5 characters will be sent to represent both the parameter reference and parameter value, e.g. decimal value 12 would be sent as characters 3/1 (1) and 3/2 (2).

If no parameter reference number is indicated in the *read PAD command signal* then it applies implicitly to all the parameters.

When more than one parameter is required to be read by sending the *read PAD command signal,* the character 2/12 (,) shall be sent between the decimal references of the parameters.

Example: PAR?1,3,5

3.5.5 *Format of standard profile selection PAD command signal*

The characters 5/0 (P) 5/2 (R) 4/15 (O) 4/6 (F) shall be sent followed by a profile identifier which is for further study.

3.5.6 *Format of set PAD command signal and the set and read PAD command signal*

The characters 5/3 (S) 4/5 (E) 5/4 (T) shall be sent, followed by the decimal reference of the parameter to be set, followed by character 3/10 (":") and the value for the *set PAD command signal.* The characters 5/3 (S) 4/5 (E) 5/4 (T) 3/15 (?) shall be sent, followed by the decimal reference of the parameter to be set and read, followed by character 3/10 (:) and the value for the *set and read PAD command signal.*

If more than one parameter is to be set or set and read by the *PAD command signal,* the character 2/12 (,) shall be sent between a parameter value and the next parameter reference.

Example: SET2 :0,3 :2,9 :4

3.5.7 *Format of the reset PAD service signal*

The characters 5/2 (R) 4/5 (E) 5/3 (S) 4/5 (E) 5/4 (T) will be sent, followed by the character 2/0 (SP), followed by one of the following:

3.5.7.1 The characters 4/4 (D) 5/4 (T) 4/5 (E).

3.5.7.2 The characters 4/5 (E) 5/2 (R) 5/2 (R).

3.5.7.3 The characters 4/14 (N) 4/3 (C).

3.5.8 *Format of the clear request PAD command signal*

The characters 4/3 (C) 4/12 (L) 5/2 (R) shall be sent.

3.5.9 *Format of the clear confirmation PAD service signal*

The characters 4/3 (C) 4/12 (L) 5/2 (R) will be sent, followed by the character 2/0 (SP), followed by the characters 4/3 (C) 4/15 (0) 4/14 (N) 4/6 (F).

3.5.10 *Format of the clear-in-error PAD service signal*

The characters 4/3 (C) 4/12 (L) 5/2 (R) will be sent, followed by the character 2/0 (SP), followed by the characters 4/5 (E) 5/2 (R) 5/2 (R).

3.5.11 *Format of the status PAD command signal*

The characters 5/3 (S) 5/4 (T) 4/1 (A) 5/4 (T) will be sent.

3.5.12 *Format of the status engaged and status free PAD service signals*

The characters 4/5 (E) 4/14 (N) 4/7 (G) 4/1 (A) 4/7 (G) 4/5 (E) 4/4 (D) will be sent for status engaged. The characters 4/6 (F) 5/2 (R) 4/5 (E) 4/5 (E) will be sent for status free.

3.5.13 *Format of the reset PAD command signal*

The characters 5/2 (R) 4/5 (E) 5/3 (S) 4/5 (E) 5/4 (T) will be sent.

3.5.14 *Format of the interrupt PAD command signal*

The characters 4/9 (I) 4/14 (N) 5/4 (T) will be sent.

3.5.15 *Format of the interrupt and discard output PAD command signal*

The characters 4/9 (I) 4/14 (N) 5/4 (T) 4/4 (D) will be sent.

3.5.16 *Format of the parameter value PAD service signal*

The characters 5/0 (P) 4/1 (A) 5/2 (R) will be sent, followed by the decimal reference of the parameter, followed by the character 3/10 (:) and the appropriate parameter value. If the requested parameter's reference is invalid, the characters 4/9 (I) 4/14 (N) 5/6 (V) will be sent in place of the appropriate parameter value.

If more than one parameter value is contained in the *parameter value PAD service signal*, the character 2/12 (,) will be sent between a parameter value and the next parameter reference.

Example: PAR2 :1,3 :2,64 :INV

3.5.17 *Format of the selection PAD command signal*

A *selection PAD command signal* shall, in the following order, consist of a facility request block, or an address block, or both, optionally followed by a call user data field.

3.5.17.1 *Format of facility request block*

Characters representing the facility request code shall be sent. When more than one facility request code is to be sent, the character 2/16 (,) is sent to separate the facility request codes. The character 2/13 (–) shall be sent at the end of facility request block.

The format of the facility request code is for further study.

3.5.17.2 *Format of address block*

Characters representing a full address or an abbreviated address shall be sent. When an abbreviated address is sent, it shall be prefixed by character 2/14 (.). When more than one address, either full address or abbreviated address, is sent, the character 2/12 (,) is sent as a separator.

The format of the full address and the abbreviated address is for further study.

3.5.17.3 *Format of call user data field*

The character 5/0 (P) or the character 4/4 (D) shall be sent, followed by up to 12 characters of user data. Some networks may not make this field available to the user.

3.5.18 *Format of service request signal*

The format is for further study.

3.5.19 *Format of clear indication PAD service signals*

The characters 4/3 (C) 4/12 (L) 5/2 (R) 2/0 (SP) shall be sent, followed by one of the following character sequences:

3.5.19.1 The characters 4/15 (O) 4/3 (C) 4/3 (C).

3.5.19.2 The characters 4/14 (N) 4/3 (C).

3.5.19.3 The characters 4/9 (I) 4/14 (N) 5/6 (V).

3.5.19.4 The characters 4/14 (N) 4/1 (A).

3.5.19.5 The characters 4/5 (E) 5/2 (R) 5/2 (R).

3.5.19.6 The characters 5/2 (R) 5/0 (P) 4/5 (E).

3.5.19.7 The characters 4/14 (N) 5/0 (P).

3.5.19.8 The characters 4/4 (D) 4/5 (E) 5/2 (R).

3.5.19.9 The characters 5/0 (P) 4/1 (A) 4/4 (D).

Note. – The coding of these *PAD service signals* is provisional and may be the subject of another recommendation.

3.5.20 *Format of the PAD identification PAD service signal*

The characters that will comprise this *PAD service signal* will be network dependent, but would probably indicate the PAD identity and port identity.

3.5.21 *Format of the error PAD service signal*

The characters 4/5 (E) 5/2 (R) 5/2 (R) will be sent, followed by other characters which are for further study.

3.5.22 *Format of padding chararcters*

The padding character will be 0/0 (NUL) or the equivalent duration of binary 1 according to the particular network.

3.5.23 *Format of the connected PAD service signal*

The character 4/3 (C) 4/15 (0) 4/13 (M) or, as a network option, the character 0/6 (ACK), will be sent.

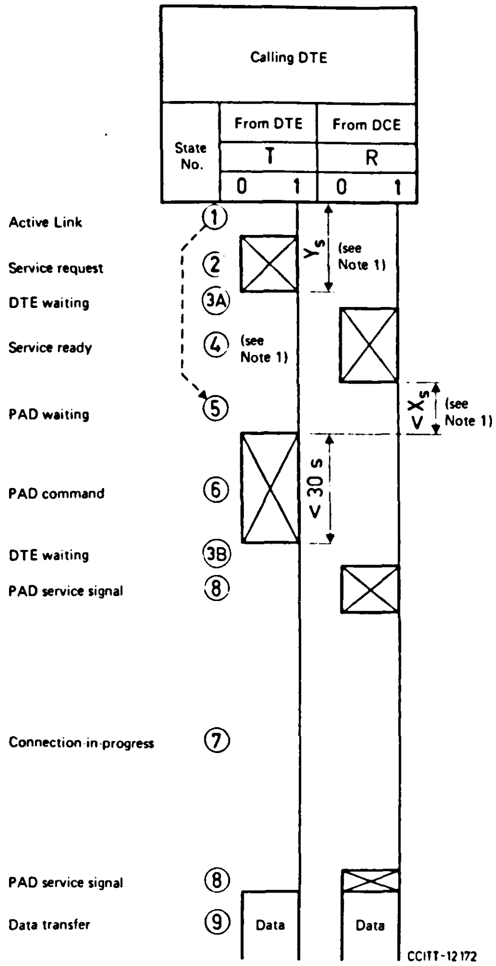


FIGURE 1a/X.28 – Sequence of events at the interface: call establishment

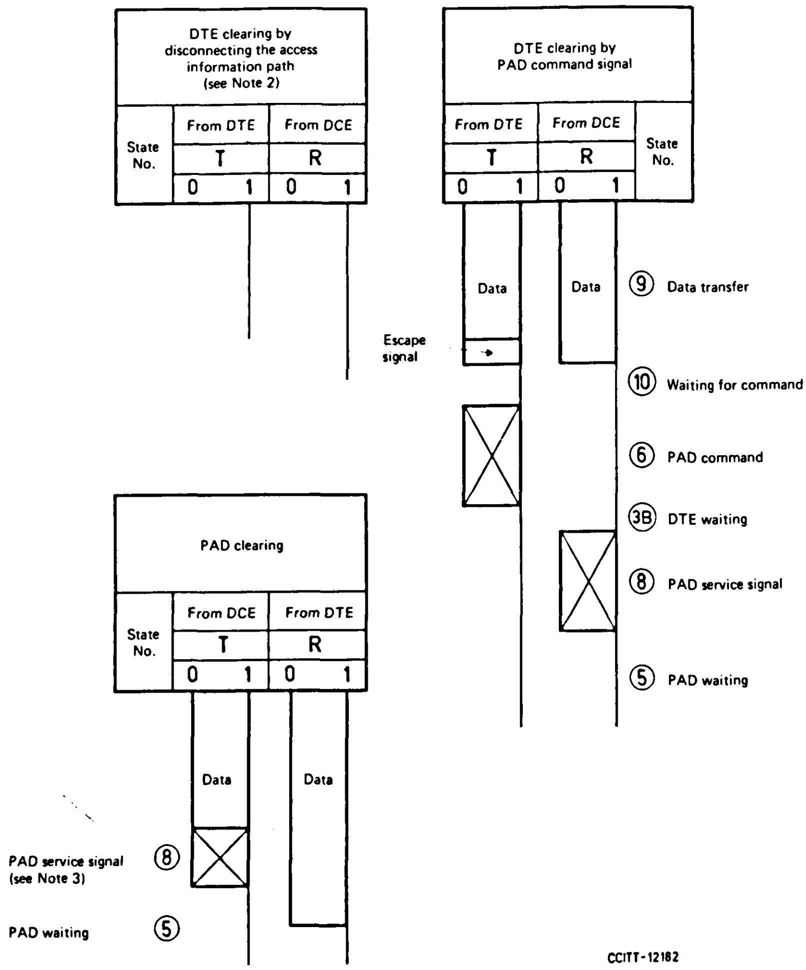
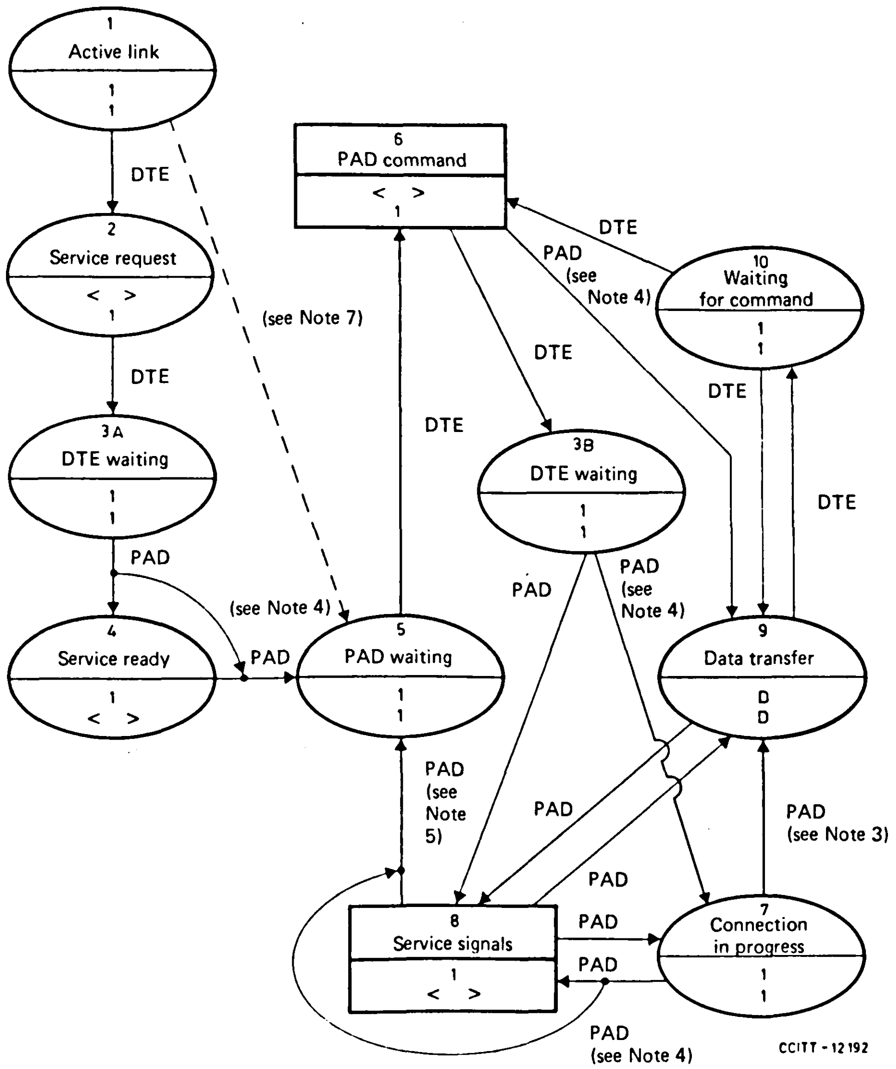


FIGURE 1b/X.28 – Sequence of events at the interface: call clearing

Note 1. – Some networks may allow states 2 to 4 to be bypassed. In these cases the time-outs X and Y do not apply.

Note 2. – The DTE clear is performed by disconnecting the access information path (see 1. of this Recommendation). The response from the DCE is PAD clearing which also disconnects the access information path.

Note 3. – PAD clearing may also be performed by disconnecting the access information path (see 1. of this Recommendation).



Note 1. – States 3A and 3B are represented in Figure 2/X.28 for convenience. They are functionally equivalent.

Note 2. – State 8 is used to represent a state during which all *PAD service signals* are transmitted.

Note 3. – When parameter 6 is set to 0, the change in state occurs when the PAD receives an indication that the virtual call to the packet-mode DTE has been established.

Note 4. – When parameter 6 is set to 0, states 4 and 8 are bypassed.

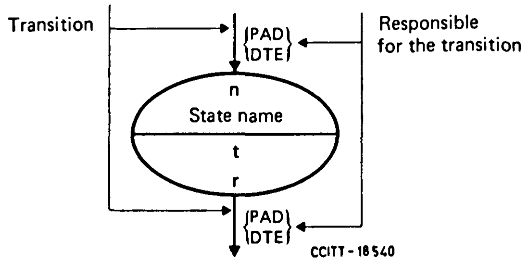
Note 5. – The PAD will permit entry to the *PAD waiting state* N times before performing PAD clearing.

Note 6. – Under certain circumstances DTE clearing is performed by disconnecting the access information path (see 1. of this Recommendation).

Note 7. – Some networks may allow states 2 to 4 to be bypassed.

Note 8. – See Figure 3/X.28 for the symbol definitions of the state diagram.

FIGURE 2/X.28 – **State diagram of call establishment and call clearing by PAD command and service signals**



D:	DTE to DTE data signal
0 and 1:	refer to steady binary conditions
< >:	an International Alphabet No. 5 character sequence
n:	state number
t:	value on interchange circuit 103 when access is via X.20*bis* or V.21; or on T interchange circuit when access is via X.20
r:	value on interchange circuit 104 when access is via X.20*bis* or V.21; or on R interchange circuit when access is via X.20

FIGURE 3/X.28 – Symbol definitions of the state diagrams

TABLE 1/X.28 – PAD parameter settings

The parameter references and values relate to Recommendation X.3

Parameter reference number	Parameter description	Parameter setting for the various profiles		
		Transparent profile	Simple profile	Values available in other (standard) profiles which are for further study (see Note 1)
1	PAD recall by escaping from the *data transfert state*	Set to *not possible* (value 0)	Set to *possible* (value 1)	Selectable, either *not possible* (value 0), or *possible* (value 1)
2	Echo	Set to *no echo* (value 0)	Set to *no echo* (value 0)	Selectable, either *no echo* (value 0), or *echo* (value 1)
3	Selection of *data forwarding signal*	Set to *no data forwarding signal* (value 0)	Set to *all characters in columns 0 and 1 and character 7/15 (DEL) of International Alphabet No. 5* (value 126)	Selectable, either *no data forwarding signal* (value 0) or *carriage return* (value 2) or *all characters in columns 0 and 1 and character 7/15 (DEL) of International Alphabet No. 5* (value 126)
4	Selection of *idle timer delay*	Set to *one second* (value 20)	Set to *no time out* (value 0)	Selectable, any time between *1 and 255* twentieths of a second, in increments of a twentieth of a second; or *no time out* (value 0)
5	*Ancillary device control*	Set to *no use of X-ON and X-OFF* (value 0)	Set to *use of X-ON and X-OFF* (value 1)	Selectable, either *no use of X-ON and X-OFF* (value 0), or *use of X-ON and X-OFF* (value 1)
6	Suppression of *PAD service signals*	Set to *no service signals sent to the start-stop mode DTE* (value 0)	Set to *service signals are sent* (value 1)	Selectable, either *no service signals sent to the start-stop mode DTE* (value 0) or *service signals are sent* (value 1)
7	Selection of operation of PAD on receipt of *break signal* from the start-stop mode DTE	Set to *reset* (value 2)	Set to *reset* (value 2)	Selectable, either *nothing* (value 0), or *interrupt* (value 1), or *reset* (value 2), or *escape from data transfer state* (value 8), or *discard output, interrupt and indication of break* (value 21)
8	*Discard output*	Set to *normal data delivery* (value 0)	Set to *normal data delivery* (value 0)	Set to *discard output* (value 1) by PAD and subsequently to *normal data delivery* (value 0) by the packet mode terminal
9	Padding after carriage return (CR)	Set to *no padding after CR* (value 0)	Set to *no padding after CR* (value 0)	Selectable, any number between *1 and 7* padding characters inserted after each CR character, or *no padding after CR* (value 0)
10	Line folding	Set to *no line folding* (value 0)	Set to *no line folding* (value 0)	Selectable, any number between *1 and 255* of characters per line, or *no line folding* (value 0)

TABLE 1/X.28 *(concluded)*

Parameter reference number	Parameter description	Parameter setting for the various profiles		
		Transparent profile	Simple profile	Values available in other (standard) profiles which are for further study (see Note 1)
11	Binary speed of start-stop mode DTE	Set as a result of automatic speed detection as either *110 bit/s* (value 0), or *200 bit/s* (value 8), or *300 bit/s* (value 2)	Set as a result of automatic speed detection as either *110 bit/s* (value 0), or *200 bit/s* (value 8), or *300 bit/s* (value 2)	Set as a result of automatic speed detection as either *110 bit/s* (value 0), or *200 bit/s* (value 8), or *300 bit/s* (value 2)
12	Flow control of the PAD by the start-stop mode DTE	Set to *no use of X-ON and X-OFF* (value 0)	Set to *use of X-ON and X-OFF* (value 1)	Selectable, either *no use of X-ON and X-OFF* (value 0) or *use of X-ON and X-OFF* (value 1)

Note 1. – When using any other profile besides the *transparent standard profile* and *simple standard profile*, the default value of any parameter is the value specified for the profile selected by the *service request signal.*

4. *Procedures for the exchange of user data between a start-stop mode DTE and a PAD*

The procedures described apply during the *data transfer state* for a start-stop mode DTE.

4.1 *Data transfer state*

After receipt of the *connected PAD service signal*, the start-stop mode DTE shall be in the *data transfer state* and will remain in that state, unless it escapes as described in 4.9 below, until the virtual call is cleared by the PAD or by the start-stop mode DTE as described in 3.2.2 above.

If parameter 1 is set to 0, during the *data transfer state* any character sequence may be transmitted by the start-stop mode DTE for delivery to the packet mode DTE. If parameter 1 is set to 1, the character 1/0 (DLE) can only be transferred to the packet-mode DTE by following the procedure described in 4.9.1.1 below.

The values of other parameters may affect the characters which may be transferred during the data phase.

4.2 *Data from the start-stop mode DTE received by the PAD*

Characters received from the start-stop mode DTE are defined as consisting of all the bits received between, but not including, the start and stop bits.

4.3 *Delivery of user data to the start-stop mode DTE*

Data received by the PAD for delivery to the start-stop mode DTE will be transmitted to the start-stop mode DTE at the data signalling rate appropriate to the start-stop mode DTE. Start and stop bits will be added to the data characters in accordance with Recommendation X.4.

4.4 *Packet forwarding conditions*

A packet will be forwarded whenever more than enough data has been received from the start-stop mode DTE to fill a packet after the last packet was forwarded.

In addition, the start-stop mode DTE may indicate to the PAD that a packet should be forwarded, subject to flow control, whenever it performs any one, or more of the following:

4.4.1 Allows the idle timer delay period (see Parameter 4 in Table 1/X.28), after the transmission of the previous character to the PAD, to elapse without sending a character.

If, due to flow control constraints, the packet cannot be forwarded, characters from the start-stop mode DTE will continue to be added to the packet until flow control permits the packet to be forwarded or the packet becomes full. The start-stop mode DTE will be advised (see 4.6 below) if this latter condition occurs.

4.4.2 Transmits one of the data forwarding characters (see Parameter 3 in Table 1/X.28). The character will be included in the data field of the packet it delimits before the packet is forwarded.

4.4.3 Transmits the *break signal* when parameter 7 is set to any value except 0.

4.4.4 Transmits the first character of a *PAD command signal* after the interface has entered a *waiting for command state* as described in 4.9.1 below.

4.5 *Procedure for the PAD to indicate to the start-stop mode DTE, by means of a PAD service signal, a temporary inability to accept additional information*

The procedure to enable the PAD to indicate a temporary inability to receive additional characters and to subsequently indicate that characters will be accepted, using PAD service signals, is for further study.

4.6 *Procedures for ancillary device control*

If parameter 5 is set to 1, the following procedure applies:

The PAD will send the *X-ON character* to the DTE as soon as the interface enters the *data transfer state*. The character 1/1 (DC1) will be transmitted by the PAD.

The PAD will send the *X-OFF character* to the start-stop mode DTE when it is incapable of receiving more than M characters from the ancillary device at the start-stop mode DTE and another character is received from that DTE. The PAD will also send the *X-OFF character* before the interface leaves the *data transfer state*. The character 1/3 (DC3) will be transmitted by the PAD.

When the PAD is again able to receive at least M + 1 characters from the start-stop mode DTE, it will send the *X-ON character* to that DTE.

The value of M is for further study.

4.7 *Procedures for reset*

4.7.1 *Start-stop mode DTE sending a reset PAD command signal*

The start-stop mode DTE shall send a *reset PAD command signal* to the PAD when it wishes to reset the virtual call to the packet mode DTE.

a) The *break signal* (see 3.1.2 above) will be recognized by the PAD as a *reset PAD command signal* if parameter 7 is set to 2.

b) Alternatively the start-stop mode DTE may request reset by escaping from the *data transfer state* and sending a *reset PAD command signal* according to the procedure of 4.9.2.3 below.

4.7.2 *Sending a reset PAD service signal to the start-stop mode DTE*

If the virtual call is reset by the packet mode DTE, or by the network, the PAD will send a *reset PAD service signal*, if the value of parameter 6 is set to 1, to the start-stop mode DTE. The *PAD service signal* will indicate the cause of the reset.

The following reset causes will be indicated to the start-stop mode DTE.

a) the remote DTE has reset the virtual call. The format is given in 3.5.7.1 above;

b) a local procedure error has occurred. The format is given in 3.5.7.2 above;

c) network congestion has occurred. The format is given in 3.5.7.3 above.

4.8 *Procedure for indication of break*

The PAD will inform the start-stop mode DTE that an incoming *indication of break PAD message* has been received from the packet mode DTE (see Recommendation X.29) by sending the *break signal (see 3.1.2 above).*

4.9 *Escape from the data transfer state*

4.9.1 During the *data transfer state*, the start-stop mode DTE may escape from that state by transmitting an *escape signal* to the PAD. On detection of the *escape signal*, the interface will enter the *waiting for command state*. On entering the *waiting for command state*, delivery of any data characters to the start-stop mode DTE will be delayed until the interface returns to the *data transfer state*.

If parameter 1 is set to 1, the PAD will recognize the character 1/0 (DLE) as the *escape signal* from the start-stop mode DTE.

On receipt of the next character from the start-stop mode DTE, the PAD will act in accordance with one of the following conditions:

4.9.1.1 If the character is the character 1/0 (DLE) the interface will immediately return to the *data transfer state*. This character will be treated as user data.

4.9.1.2 If the character received is the *PAD command signal delimiter* [characters 2/11 (+) or 0/13 (CR)] the PAD will not transfer it and the interface will return to the *data transfer state*.

4.9.1.3 If the character received is in columns 2 to 7 of International Alphabet No. 5, excluding the characters 2/0 (SP), 2/11 (+) [see 4.9.1.2 above] and 7/15 (DEL), the interface will enter the *PAD command state*. Characters 2/0 (SP) and 7/15 (DEL) will be ignored. Entering the *PAD command state* is a data forwarding condition and data will be sent to the packet mode DTE as described in 4.4 above.

If the complete *PAD command signal* is not received within 30s of entering the *PAD command state*, or an invalid *PAD command signal* is received, the PAD will transmit a *PAD service signal*, when parameter 6 is set to 1, indicating that an error has occurred. Following transmission of the *PAD service signal* the interface will be in the *data transfer state*.

If a valid *PAD command signal* is received the interface will, if parameter 6 is set to 1, subsequently enter the *PAD service signal state*, and on transmission of the last character of the *PAD service signal* will enter the *PAD waiting state* or the *data transfer state* as appropriate. If parameter 6 is set to 0, the interface will enter the *PAD waiting state* or the *data transfer state*, as appropriate, following the transmission of a *PAD command signal*.

If parameter 7 is set to 8, the *break signal* may be used as the *escape signal* from the *data transfer state*, allowing for escape from the *data transfer state* without loss of character transparency.

4.9.2 The ability to escape from the *data transfer state* allows a start-stop mode DTE to use the following *PAD command signals* and procedures:

4.9.2.1 *Clearing*

The procedure for clearing of the virtual call by the start-stop mode DTE sending a *clear request PAD command signal* is described in Section 3.2.2.1a)i).

4.9.2.2 *Request for status of the virtual call*

The start-stop mode DTE may, if parameter 6 is set to 1, enquire whether a virtual call is existing by sending the *status PAD command signal* to the PAD. The PAD will respond by sending the *status engaged* or *status free PAD service signal* to the DTE. The format of the *PAD command signal* and *PAD service signal* is given above in 3.5.11 and 3.5.12 respectively.

4.9.2.3 *Reset*

The start-stop mode DTE may request a resetting of the virtual call to the packet mode DTE by sending a *reset PAD command signal* to the PAD. The format of the *reset PAD command signal* is given in 3.5.13 above.

The PAD will acknowledge the *PAD command signal,* if parameter 6 is set to 1, by transmitting the *acknowledgement PAD service signal.*

4.9.2.4 *Interrupt*

The start-stop mode DTE may request that an interrupt be sent to the packet-mode DTE by sending an *interrupt PAD command signal* to the PAD. The format of the *interrupt PAD command signal* is given in 3.5.14 above.

The PAD will acknowledge the *PAD command signal,* if parameter 6 is set to 1, by transmitting the *acknowledgement PAD service signal.*

Note. – The use of the *interrupt and discard PAD command signal* is for further study.

4.9.2.5 *Setting, setting and reading, and reading PAD parameter values after having entered the data transfer state*

The start-stop mode DTE shall be able to send the following *PAD command signals* to set, set and read, and read PAD parameter values:

a) *profile selection PAD command signal;*

b) *set PAD command signal;*

c) *set and read PAD command signal;*

d) *read PAD command signal.*

The procedures for sending the above *PAD command signals* are described in 3.3 and 3.4 above.

4.10 *Echo*

If parameter 2 is set to 1, the following procedures will apply:

4.10.1 In the *data transfer state,* received characters will be echoed to the start-stop mode DTE prior to the transmission of data characters waiting for delivery at the time.

In the case where the PAD cannot handle and ignores a data character coming from the start-stop mode DTE, because of flow control constraints, the PAD will not echo the character.

4.10.2 In the *PAD waiting state,* all characters are echoed.

4.10.3 In the *PAD command state,* characters in *PAD command signals* are echoed, except the characters following the character P in a *selection PAD command signal,* which are not echoed.

4.10.4 In the *connection-in-progress state* and the *PAD service signal state,* characters are not echoed.

4.11 *Selection of the procedure on receipt of the break signal from the start-stop mode DTE*

The start-stop mode DTE, by means of parameter 7, will be able to select which procedure the PAD will perform when it receives the *break signal* from the start-stop mode DTE. The DTE may select any one of the following:

4.11.1 Take no action.

4.11.2 Send an *interrupt packet* to the packet mode DTE (see Recommendation X.29).

4.11.3 Reset the virtual call to the packet mode DTE (see Recommendation X.29).

4.11.4 Discard all data received for delivery to the start-stop mode DTE and send an *interrupt packet* to the packet mode DTE followed by an *indication of break PAD message* (see Recommendation X.29).

4.11.5 Escape from the *data transfer state* and enter the *waiting for command state.*

Other procedures which may be selected by the start-stop mode DTE are for further study.

4.12 *Selection of padding characters to be inserted after the character 0/13 (CR)*

The start-stop mode DTE, by means of parameter 9, will be able to select the number of padding characters that will be inserted after each character 0/13 (CR) transmitted or echoed to it. The value selected will also apply to the number of padding characters transmitted after the character 0/10 (LF) of the *format effector* as described in 3.5.2 above.

Other padding sequences and other padding rules are for further study.

4.13 *Selection of line folding*

The start-stop mode DTE, by means of parameter 10, will be able to select line folding and specify the maximum number (L) of graphic characters that the PAD may send as a single line to the start-stop mode DTE.

When line folding is requested, the PAD will maintain a count (C) which is incremented by 1 each time a graphic character is sent to the start-stop mode DTE.

The graphic characters are those shown in columns 2 to 7 of International Alphabet No. 5, excluding the character 7/15 (DEL).

If the value of C is equal to the value of L, the PAD will transmit to the start-stop mode DTE a format effector (see 3.5.2 above) and set the value of C to O.

The PAD will set the value of C to 0 when the PAD transmits the character 0/13 (CR) to the start-stop mode DTE.

When echo is provided, the PAD will increment the value of C by 1 each time a character is echoed.

Line folding also applies to *PAD service signals.*

4.14 *Selection of start-stop DTE flow control*

The start-stop mode DTE, by means of parameter 12, will be able to select to use or not flow control. When the use of flow control is selected it shall be achieved by use of the X-ON (DC1) and X-OFF (DC3) characters.

On entering the data transfer phase the PAD will be in the X-ON condition.

ANNEX
(to Recommendation X.28)
PAD command signals and PAD service signals

TABLE 1 – PAD command signals

PAD command signal format	Function	PAD service signal sent in response
STAT	To request status information regarding a virtual call connected to the DTE	FREE or ENGAGED
CLR	To clear down a virtual call	CLR CONF or CLR ERR (in the case of local procedure error)
PAR? List of parameter references	To request the current values of specified parameters	PAR [list of parameter references with their current values]
SET? List of parameter references and corresponding values	To request changing or setting of the current values of the specified parameters	PAR [list of parameter references with their current values]
•PROF [identifier]	To give to PAD parameters a standard set of values	Acknowledgement
RESET	To reset the virtual call or permanent virtual circuit	Acknowledgement
INT or INTD	To transmit an *interrupt packet* to the packet mode DTE	Acknowledgement
SET List of parameters with requested values	To set or change parameter values	Acknowledgement
Selection PAD command signal	To set-up a virtual call	Acknowledgement

TABLE 2 – PAD service signals

Format of the PAD service signal		Explanation
RESET	DTE	Indication that the remote DTE has reset the virtual call or permanent virtual circuit
	ERR	Indication of a reset of a virtual call or permanent virtual circuit due to a local procedure error
	NC	Indication of a reset of a virtual call or permanent virtual circuit due to network congestion
COM	–	Indication of call connected
CLR	See Table 3	Indication of clearing
PAD identification PAD service signal	The characters to be sent are network dependent and are for further study	
ERROR	ERR	Identification that a *PAD command signal* is in error

TABLE 3 – Clear indication PAD service signals

Clear indication PAD service signal	Possible mnemonics (see Note)	Explanation
Number busy	OCC	The called number is fully engaged in other calls
Network congestion	NC	Congestion conditions within the network temporarily prevent the requested virtual call from being established
Invalid call	INV	Facility invalid requested
Access barred	NA	The calling DTE is not permitted to obtain the connection to the called DTE. Incompatible closed user group would be an example
Local procedure error	ERR	The call is cleared because of a local procedure error
Remote procedure error	RPE	The call is cleared because of a remote procedure error
Not obtainable	NP	The called number is not assigned or is no longer assigned
Out of order	DER	The called number is out of order
Clearing after invitation	PAD	The PAD has cleared the call following the receipt of an invitation to clear from the packet mode DTE

Note. – The final coding of *clear indication PAD service signals* may be the subject of another Recommendation.

Provisional Recommendation X.29 *(Geneva, 1977)*

PROCEDURES FOR THE EXCHANGE OF CONTROL INFORMATION AND USER DATA BETWEEN A PACKET MODE DTE AND A PACKET ASSEMBLY/DISASSEMBLY FACILITY (PAD)

Contents

The establishment in various countries of public data networks providing packet-switched data transmission services creates a need to produce standards to facilitate international interworking.

Preface

The CCITT,

considering

a) that Recommendations X.1 and X.2 define the user classes of service and facilities in a public data network, Recommendation X.95 defines network parameters and Recommendation X.96 defines call progress signals;

b) that Recommendation X.25 defines the interface between the DTE and the DCE for DTEs operating in the packet mode in public data networks;

c) that Recommendations X.20, X.20 *bis*, X.21 and X.21 *bis* define the DTE/DCE interfaces in a public data network;

d) that Recommendation X.3 defines the PAD in a public data network;

e) that Recommendation X.28 defines the DTE/DCE interface for a start-stop mode DTE accessing the PAD in a public data network;

f) the need to allow interworking between a packet mode DTE and a non-packet mode DTE in the packet-switched transmission service;

g) the urgent need to allow interworking between a start-stop mode DTE in a public switched telephone network, public switched data network or a leased line and a packet mode DTE using the virtual call facility of the packet-switched transmission service;

h) that the packet mode DTE shall not be obliged to use the control procedures for PAD functions, but that some packet mode DTEs may wish to control specific functions of the PAD.

unanimously declares the view that:

1. the Recommendation X.29 procedures shall apply to the Recommendation X.25 interface between the DCE and the packet mode DTE;
2. the procedures be as specified below in 1. *Procedures for the exchange of PAD control information and user data*;
3. the manner in which user data is transferred between the packet mode DTE and the PAD be as specified below in 2. *User data transfer*;
4. the procedures for the control of the PAD via PAD messages be as specified below in 3. *Procedures for the use of PAD messages*;
5. the formats of the data fields which are transferable on a virtual call be as specified below in 4. *Formats.*

Note. – The following items are for further study:

– the possibility of a packet mode DTE establishing a virtual call to a non-packet mode DTE;

– the use of the permanent virtual circuit facility;

– interworking between non-packet mode DTEs in the packet-switched data transmission service;

– interworking between DTEs having interfaces to different data transmission services;

– operation of non-packet mode DTEs in other than start-stop mode.

1. *Procedures for the exchange of control information and user data*

1.1 The exchange of control information and user data between a PAD and a packet mode DTE is performed by using user data fields defined in Recommendation X.25.

1.2 The Appendix briefly describes some of the characteristics of virtual calls, as well as of the Recommendation X.25 interface as related to the PAD representation of a start-stop mode DTE to a packet mode DTE.

1.3 *Call user data*

The call user data field of *incoming call* packets to the packet mode DTE is comprised of two fields (see the Appendix):

a) the protocol identifier field, and

b) the call data field.

The protocol identifier field is used for protocol identification purposes and the call data field contains user data received by the PAD from the start-stop mode DTE during the call establishment phase.

1.4 *User sequences*

1.4.1 User sequences are used to exchange user data between the PAD and the packet mode DTE.

1.4.2 User sequences are conveyed in the user data fields of complete *data* packet sequences with Q = 0 (see the Appendix), and in both directions on a virtual call.

1.4.3 There will be only one user sequence in a complete *data* packet sequence.

1.5 *PAD messages*

1.5.1 *PAD messages* are used to exchange control information between the PAD and the packet mode DTE. A *PAD message* consists of a control identifier field and a message code field possibly followed by a parameter field (see 4.4 below).

1.5.2 *PAD messages* are conveyed in the user data fields of complete *data* packet sequences with Q = 1 (see the Appendix) and in both directions on a virtual call.

1.5.3 There will be only one *PAD message* in a complete *data* packet sequence.

1.5.4 The PAD will take into consideration a *PAD message* transmitted by a packet mode DTE only when it has been completely received.

1.5.5 In the case where a parameter reference (see 3. below) appears more than once in a *PAD message*, only the last appearance is taken into account.

1.5.6 In the direction from the PAD to the packet mode DTE, the data fields of *interrupt* packets (see the Appendix) are set to 0. The use of other values is for further study. In the direction from the packet mode DTE to the PAD, the PAD ignores the data fields of *interrupt* packets received. Other procedures are for further study.

1.5.7 *PAD messages from a packet mode DTE*

1.5.7.1 A packet mode DTE may request the PAD to set and/or read the current values of PAD parameters by sending a *PAD message* specifying the PAD parameters to be set and/or read. If PAD parameters are to be changed, the *PAD message* specifies the new values in the *PAD message* parameter field (see 3. below).

1.5.7.2 A packet mode DTE may send an *indication of break PAD message* to the PAD; a *break signal* will be sent to the start-stop mode DTE by the PAD (see Recommendation X.28). No parameter field is required.

1.5.7.3 The packet mode DTE may send an *invitation to clear PAD message*. This procedure is defined in 3. below. No parameter field is required.

1.5.8 *PAD messages to the packet-mode DTE*

1.5.8.1 On receipt of a *read* or *set and read PAD message*, the PAD will indicate, in a *parameter indication PAD message*, the state of some or all of the PAD parameters. This *PAD message* contains the control identifier field and a message code field followed by a parameter field (see 3. below).

1.5.8.2 When requested to do so by the start-stop mode DTE, the PAD will transmit an *indication of break PAD message* to the packet mode DTE consisting of a control identifier field, a message code field and a parameter field as defined in 3. below.

1.5.8.3 The PAD will transmit an *error PAD message* to the packet mode DTE in response to the receipt of a *PAD message* from the packet mode DTE which the PAD does not recognize as a valid *PAD message*. The parameter field of the *error PAD message* will define the type of error detected (see 3. below).

2. *User data transfer*

2.1 Packets will be forwarded from the PAD when a *set*, *read*, or *set and read PAD message* is received from a packet mode DTE, or under any of the other data forwarding conditions provided by the PAD (see Recommendation X.28).

2.2 The occurrence of a data forwarding condition will not cause the PAD to transmit empty data packets.

3. *Procedures for the use of PAD messages*

3.1 *Procedures for reading, setting, and reading and setting of PAD parameters*

3.1.1 A packet mode DTE may change and read the current values of PAD parameters by transmitting to the PAD a *set, read,* or *set and read PAD message.*

3.1.2 When the PAD receives a *set, read* or *set and read PAD message,* any data previously transmitted by the packet mode DTE will be delivered to the start-stop mode DTE before taking action on the *PAD message.* The PAD will also consider the arrival of such a *PAD message* as a data forwarding condition in the direction PAD to packet mode DTE.

3.1.3 The PAD will respond to a valid *read* or *set and read PAD message* by returning to the packet mode DTE a *parameter indication PAD message* with a parameter field containing a list of the current values, after any necessary modification, of the PAD parameters to which the message from the packet mode DTE referred.

3.1.4 The PAD will not return a *parameter indication PAD message* in response to a valid *set PAD message* received from the packet mode DTE.

3.1.5 Table 1/X.29 specifies the PAD's response to *set, set and read,* and *read PAD messages.*

TABLE 1/X.29 – PAD messages transmitted by the PAD in response to set, set and read, and read PAD messages from the packet mode DTE

PAD message received by the PAD		Action upon PAD parameters	Corresponding *parameter indication PAD message* transmitted to the packet mode DTE
Type	Parameter field		
Set	None	Reset all parameters to their initial values (corresponding to the initial profile)	None
	List of selected parameters with the desired values	Set the selected parameters to the given values: a) if no error is encountered b) if the PAD fails to modify the values of some parameters	a) None b) List of these invalid parameters with the error bit set
Set and read	None	Reset all parameters to their initial values (corresponding to the initial profile)	List all parameters, and their initial values
	List of selected parameters with the desired values	Set the selected parameters to the given values	List of these parameters with their new current values with the error bit set, as appropriate
Read	None	None	List of all parameters with their current values
	List of selected parameters	None	List of these parameters with their current values

3.2 *Procedures for inviting the PAD to clear*

3.2.1 The *invitation to clear PAD message* is used to request the PAD to clear the virtual call, after transmission to the start-stop mode DTE of all previously transmitted data.

Note. — The *clear indication* packet, which is transmitted to the packet mode DTE after delivery of the last data character to the start-stop mode DTE, will have a clearing cause field set to DTE clearing.

3.3 *Interrupt and discard procedures*

3.3.1 If parameter 7 is set to 21, the PAD will transmit an *interrupt* packet followed by an *indication of break PAD message* to indicate to the packet mode DTE that the PAD, at the request of the start-stop mode DTE, is discarding the user sequences received from the packet mode DTE. The *PAD message* will contain an indication in its parameter field that parameter 8 (see Recommendation X.3) has been set to 1 (*discard output*).

3.3.2 Before resuming data transmission to the PAD, the packet mode DTE shall respond to the *indication of break PAD message* by transmitting a *set* or *set and read PAD message*, indicating that parameter 8 should be set to 0 (*normal data delivery*).

3.4 *Procedure for resets*

The procedures defined in Recommendation X.25 are used. The effect of the resetting procedure on the value of PAD parameter 8 is to reset its value to 0 (normal data delivery). The current values of PAD parameters 1 to 7 and 9 to 12 are not affected.

3.5 *Error handling procedures by the PAD*

3.5.1 If the PAD receives a *set*, *read* or *set and read PAD message* from a packet mode DTE containing an invalid reference to a PAD parameter, the parameter field within the *parameter indication PAD message* returned to the packet mode DTE will contain an indication of that fact. The remaining valid references to PAD parameters are processed by the PAD.

Possible reasons for an invalid access to a PAD parameter are:

a) the parameter reference does not exist;

b) the parameter reference corresponds to an additional user facility which is not available;

c) the parameter is a read-only one: (set/set and read only);

d) the requested value is invalid: (set/set and read only).

3.5.2 The PAD will transmit an *error PAD message* containing the message code of an invalid *PAD message* received from the packet mode DTE under the following conditions:

a) if the PAD receives an unrecognizable message code;

b) if the parameter field following a recognizable message code is incorrect or incompatible with the message code;

c) if the parameter field following a recognizable message code has an invalid format.

3.5.3 The PAD will transmit an *error PAD message* if a *PAD message* containing less than 8 bits is received from the packet mode DTE.

4. *Formats*

4.1 *Introduction*

Bits of an octet are numbered 8 to 1 where bit 1 is the low order bit and is transmitted first. Octets of the call user data, of user sequences, of *PAD messages* and of interrupt user data are consecutively numbered starting from 1 and are transmitted in this order.

4.2 *Call user data format* (see Figure 1/X.29)

Octet	8	7	6	5	4	3	2	1	
1	0	0	0	0	0	0	0	1	Protocol identifier
2	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	
⋮									Call data
N									

4 ≤ N ≤ 16 octets

FIGURE 1/X.29 – **Call user data field format**

4.2.1 *Protocol identifier format*

The protocol identifier field consists of four octets.

The first octet is coded as follows:

bits 8 and 7	= 00	for CCITT use
	= 01	for national use
	= 10	reserved for international user bodies
	= 11	for DTE-DTE use

When bits 8 and 7 are equal to 00, bits 6 to 1 are equal to 000001 for indicating PAD messages relating to the packer assembly/disassembly facility for the start-stop mode DTE. Other coding of bits 6 to 1 is reserved for future standardization by the CCITT. The use of octets 2, 3 and 4 is reserved and all bits are set to 0. Octets 2, 3 and 4 are reserved as a future mechanism for providing the called PAD or packet mode DTE with additional information pertinent to the calling party.

4.2.2 *Call data format*

Octets of the call data field will contain the user characters received by the PAD from the start-stop mode DTE during the call establishment phase. The coding of these octets is similar to that of user sequences (see 4.3 below). The call data field is limited to 12 octets (see Figure 1/X.29).

4.3 *User sequence format*

4.3.1 The order of bit transmission to the packet mode DTE is the same as the order that bits are received from the start-stop mode DTE. The order of bit transmission to the start-stop mode DTE is the same as the order that bits are received from the packet mode DTE.

4.3.2 No maximum is specified for the length of a user sequence.

4.4 *Control message format*

4.4.1 The control identifier field (bits 8, 7, 6, 5 of octet 1) of all *control messages* is used to identify the facility, such as PAD, to be controlled. The control identifier field coding for a PAD for a start-stop mode DTE is 0000. Other codings of the control identifier field are reserved for future standardization.

Note. – The possiblity of extending the control identifier field is for further study.

4.4.2 When the control identifier field (see 4.4.1 above) is set to 0000, bits 4, 3, 2, 1 of octet 1 are defined as a message code field. The message code field is used to identify specific types of *PAD messages*, as given in Table 2/X.29.

TABLE 2/X.29 – Type and coding of octet 1 of PAD messages

Type	Message code
	Bits 4 3 2 1
Set PAD message	0 0 1 0
Read PAD message	0 1 0 0
Set and read PAD message	0 1 1 0
Parameter indication PAD message	0 0 0 0
Invitation to clear PAD message	0 0 0 1
Indication of break PAD message	0 0 1 1
Error PAD message	0 1 0 1

Note. – The possibility of extending the message code field is for further study.

4.4.3 All *PAD messages* consist of a control identifier field (bits 8, 7, 6, 5 of octet 1 equal to 0000) and a message code (bits 4, 3, 2, 1 of octet 1).

Set, read, set and read and *parameter indication PAD messages* consist of octet 1 which may be followed by one or more parameter fields. Each parameter field consists of a parameter reference octet and a parameter value octet.

The parameter value octets of the *read PAD message* contain the value 0.

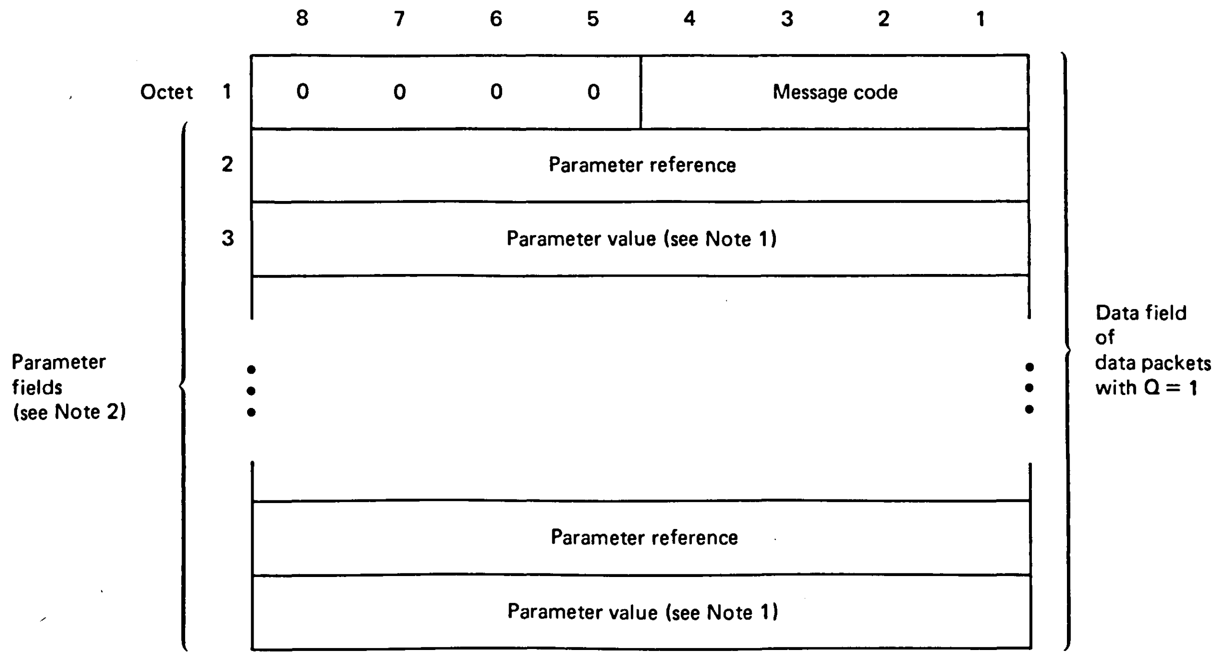
The *error PAD message* consists of octet 1 and one or two octets, giving the reason for the error.

The *indication of break PAD message* consists of octet 1 and one parameter field.

The *invitation to clear PAD message* consists of octet 1 only.

4.4.4 The maximum length is for further study.

4.4.5 *Parameter field for set, read, set and read, and parameter indication PAD messages* (see Figure 2/X.29)



Message code: 0010 – Set
0100 – Read
0110 – Set and read
0000 – Parameters indication

Note 1. – These octets contain all 0s in read PAD messages.

Note 2. – Parameter fields need not be present (see Table 1/X.29).

FIGURE 2/X.29 – Set, read, set and read, and parameter indication PAD message format

The parameter field of these *PAD messages,* when present, will consist of successive parts of reference fields and value fields. Each one of these fields will be one octet long.

4.4.5.1 A reference field consists of a parameter reference, identified as a decimal number in Recommendation X.3, and is binary coded in bits 7 to 1, where bit 1 is the low order bit. Reference fields need not be ordered by increasing parameter reference numbers.

4.4.5.2 In *PAD messages* received by the PAD, bit 8 of each octet will be ignored. In *parameter indication PAD messages,* bit 8 set to 1 will indicate an invalid access to the referred parameter as described in 3.5 above.

4.4.5.3 A parameter value field consists of a value of the parameter reference, identified as a decimal number in Recommendation X.3, and is binary coded in bits 8 to 1, where bit 1 is the low order bit. Value fields in *read PAD messages* are coded as all binary 0s. In *set* and *set and read PAD messages,* they will indicate the requested values of parameters. In *parameter indication PAD messages,* they will indicate the current values of PAD parameters, after modification if any. If bit 8 (error bit) is set to 1 in the preceding octet (i.e. reference field), they will be set to 0.

Note. – The coding 1111111 (decimal 127) in bits 7 to 1 of the reference field will be used for the extension of this field. Such coding will indicate that there is another octet following. The following octet is coded with the parameter reference of Recommendation X.3 minus 127.

4.4.6 *Parameter field for error PAD messages* (see Figure 3/X.29)

	8	7	6	5	4	3	2	1	
Octet 1	0	0	0	0	0	1	0	1	Data field of data packets with Q = 1
2	Error type (see Table 3/X.29)								
3	Invalid message code (see Note)								

Note. – Does not occur for error type 00000000.

FIGURE 3/X.29 – Error PAD message format

4.4.6.1 Octet 2 of the *error PAD message* will be coded as shown in Table 3/X.29.

TABLE 3/X.29 – Coding and meaning of octet 2 of error PAD messages

Case	Meaning	Coding Bits 8 7 6 5 4 3 2 1
a	Received *PAD message* contained less than eight bits	0 0 0 0 0 0 0 0
b	Unrecognized message code in received *PAD message*	0 0 0 0 0 0 0 1
c	Parameter field format of received *PAD message* was incorrect or incompatible with message code	0 0 0 0 0 0 1 0
d	Received *PAD message* did not contain an integral number of octets	0 0 0 0 0 0 1 1

4.4.6.2 In cases b, c and d in Table 3/X.29, octet 3 of an *error PAD message* will contain the message code of the received *PAD message.*

4.4.7 *Parameter field for indication of break PAD messages* (see Figure 4/X.29)

	8	7	6	5	4	3	2	1	
Octet 1	0	0	0	0	0	0	1	1	Data field of data packets with Q = 1
2	Parameter reference (see Note)								
3	Parameter value (see Note)								

Note. – PAD to packet mode DTE only.

FIGURE 4/X.29 – Indication of break PAD message format

4.4.7.1 When transmitted by the packet mode DTE, this *PAD message* will contain no parameter field.

4.4.7.2 When transmitted by the PAD, the parameter field will contain two octets (i.e. one reference field and one value field) and will be coded as follows: the reference field will be coded 00001000 (indicating parameter 8) and the value field will be coded 00000001 (indicating decimal 1).

4.4.8 *Parameter field for invitation to clear PAD message* (see Figure 5/X.29)

	8	7	6	5	4	3	2	1	
Octet 1	0	0	0	0	0	0	0	1	Data field of data packets with Q = 1

FIGURE 5/X.29 – **Invitation to clear PAD message format**

This *PAD message* will contain no parameter field.

APPENDIX

(to Recommendation X.29)

Characteristics of virtual calls and Recommendation X.25 as related to the PAD representation of a start-stop mode DTE to a packet mode DTE

1. *General interface characteristics*

1.1 The physical, electrical, functional and procedural characteristics to establish, maintain and disconnect the physical link between the DTE and the DCE will be in accordance with the level 1 procedures of Recommendation X.25.

1.2 The link access procedure for data interchange across the link between the DTE and the DCE will be in accordance with the level 2 procedures of Recommendation X.25.

1.3 The packet format and control procedures for the exchange of packets containing control information and user data between the DTE and the DCE will be in accordance with the level 3 procedures of Recommendation X.25.

2. *Interface procedures for virtual call control*

2.1 Incoming calls are indicated to the packet mode DTE as specified in 3.1.3 of Recommendation X.25. Any use of optional user facilities are indicated in accordance with 5. of Recommendation X.25.

2.2 The throughput classes used for the virtual call will correspond to the data rates used by the start-stop mode DTE.

2.3 The PAD and the packet mode DTE will use the clearing procedures specified in 3.1.7, 3.1.8 and 3.1.9 of Recommendation X.25.

3. *Interface procedures for data transfer*

3.1 Data transfer on a virtual call can only take place in the data transfer state and when flow control permits (see 3.4 of Recommendation X.25). The same is true for the transfer of *interrupt* packets (see 3.3 of Recommendation X.25).

3.2 *Interrupt* packets transmitted by the packet mode DTE will be confirmed by the PAD following the procedures in Recommendation X.25 (see 3.3.5 of Recommendation X.25).

3.3 The reset procedure may be used by the packet mode DTE or the PAD, to re-initialize the virtual call and will conform to the procedures described in 3.4.2 of Recommendation X.25.

3.4 A reset of the virtual call originated by the packet mode DTE or due to network congestion may be indicated by the PAD to the start-stop mode DTE.

3.5 A reset procedure initiated by the PAD may be due either to:

a) the receipt at the PAD of a request to reset from the non-packet mode DTE. The resetting cause contained in the reset indication packet will be *DTE reset*; or

b) a PAD or network failure.

4. *Virtual call characteristics*

4.1 *Resetting*

4.1.1 There may be a loss of data characters in any case of reset, as stated in Recommendation X.25. Characters generated by either of the DTEs prior to the reset indication or confirmation will not be delivered to the other DTE after the reset indication or confirmation.

4.2 *Interrupt transfer*

4.2.1 An *interrupt* packet is always delivered at or before the point in the data packet stream at which it was generated.

4.3 *Call clearing*

Data transmitted immediately before a *clear request* packet is sent may be overtaken within the network by the *clear request* packet and subsequently be destroyed.

Printed in Switzerland

ISBN 92-61-00591-8