INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

YELLOW BOOK

VOLUME VIII - FASCICLE VIII.2

DATA COMMUNICATION NETWORKS
SERVICES AND FACILITIES, TERMINAL EQUIPMENT AND INTERFACES

RECOMMENDATIONS X.1-X.29

VII[TH] PLENARY ASSEMBLY
GENEVA, 10-21 NOVEMBER 1980

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[1] "Telematic services" is used provisionally.

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[1] "Telematic services" is used provisionally.

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REMARKS

1 The Questions entrusted to each Study Group for the Study Period 1981-1984 can be found in Contribution No. 1 to that Study Group.

2 The status of annexes and appendices attached to the Series X Recommendations should be interpreted as follows:

- an *annex* to a Recommendation forms an integral part of the Recommendation;
- an *appendix* to a Recommendation does not form part of the Recommendation and only provides some complementary explanation or information.

CCITT NOTE

In this fascicle, the expression "Administration" is used for shortness to indicate both a telecommunication Administration and a recognized private operating agency.

FASCICLE VIII.2

Recommendations X.1 to X.29

DATA COMMUNICATION NETWORKS

SERVICES AND FACILITIES
TERMINAL EQUIPMENT AND INTERFACES

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PRINCIPLES GOVERNING THE COLLABORATION BETWEEN THE CCITT AND OTHER INTERNATIONAL ORGANIZATIONS IN THE STUDY OF DATA COMMUNICATIONS

Recommendation A.20 published in Volume I is reproduced below for the convenience of the reader of the Series X Recommendations.

Recommendation A.20

COLLABORATION WITH OTHER INTERNATIONAL ORGANIZATIONS OVER DATA TRANSMISSION

(Geneva, 1964; amended at Mar del Plata, 1968, and at Geneva, 1972, 1976 and 1980)

The CCITT,

considering

(a) that, according to Article 1 of the agreement between the United Nations and the International Telecommunication Union, the United Nations recognizes the International Telecommunication Union as the specialized agency responsible for taking such action as may be appropriate under its basic instrument for the accomplishment of the purposes set forth therein;

(b) that Article 4 of the International Telecommunication Convention (Malaga-Torremolinos, 1973) states that the purposes of the Union are:

"a) to maintain and extend international cooperation for the improvement and rational use of telecommunications of all kinds;

b) to promote the development of technical facilities and their most efficient operation with a view to improving the efficiency of telecommunication services, increasing their usefulness and making them, so far as possible, generally available to the public;

c) to harmonize the actions of nations in the attainment of those ends;"

(c) that Article 40 of the Convention states that, in furtherance of complete international coordination on matters affecting telecommunication, the Union shall cooperate with international organizations having related interests and activities;

(d) that in the study of data transmission the CCITT has to collaborate with the organizations dealing with data processing and office equipment and particularly the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC);

(e) that this collaboration has to be organized in a manner that will avoid duplication of work and decisions that would be contrary to the principles set out above;

unanimously declares the view

that international standards for data transmission should be established with the following considerations in mind:

(1) Clearly it will be the responsibility of the CCITT to lay down standards for *transmission channels*, i.e. aspects of data transmission which require a knowledge of telecommunication networks or affect performance of these networks.

(2) The standardization of signal conversion terminal equipment (modems) is the province of the CCITT; the standardization of the junction (interface) between modem and the data terminal equipment is a matter of agreement between the CCITT and the ISO or the IEC.

(3) Devices designed to detect and (or) correct errors must take account of:

- the error rate tolerable to the user;
- the line transmission conditions;
- the code, which has to meet the exigencies of the data alphabet and the requirements of error control (this must be such as to give an output satisfactory to the user), together with the requisite signalling (synchronism, repetition signals, etc.).

Standardization here may not come wholly within the CCITT's province, but the CCITT has very considerable interests at stake.

(4) The alphabet (definition given in [1]) is a "table of correspondence between an agreed set of characters and the signals which represent them".

The CCITT and the ISO reached agreement on an alphabet for general (but not exclusive) use for data and message transmission and have standardized a common alphabet which is known as International Alphabet No. 5 Recommendation V.3 [2]) (see also [3]).

Complementary study of some control characters of the alphabet should be effected cooperatively.

(5) Coding (definition given in [4]) is "a system of rules and conventions according to which the telegraph signals forming a message or the data signals forming a block should be formed, transmitted, received and processed". Hence, it consists of a transformation of the format of the signals in the alphabet for taking account of synchronous methods, and introduction of redundancy in accordance with the error control system. This is not a field in which the CCITT alone may be able to decide; however, no decision should be taken without reference to the Committee, because of the possible restrictions which transmission and switching peculiarities may impose on coding.

When the general switched network is used (telephone or telex) and when the error control devices are subject to restrictions (switching signals – reserved sequences), it is the CCITT which is in fact responsible for any necessary standardization in conjunction with other bodies.

(6) The limits to be observed for transmission performance on the transmission path (modem included) fall within the competence of the CCITT; the limits for the transmission performance of the sending equipment and the margin of terminal data equipment (depending on the terminal apparatus and the transmission path limits) should be fixed by agreement between the ISO and the CCITT.

(7) In all instances, the CCITT alone can lay down manual and automatic operating procedures for the setting-up, holding and clearing of calls for data communications when the general switched networks are used, including type and form of signals to be interchanged at the interface between data terminal equipment and data circuit terminating equipment.

(8) When a public data network is involved, the CCITT has the responsibility to provide the Recommendations which apply. Where these Recommendations have an impact on the basic design and features of data processing systems and office equipment [normally the Data Terminal Equipment (DTE)], they shall be the subject of consultation between CCITT and ISO and in some cases a mutual agreement may be desirable. Likewise when the ISO is developing or changing standards that may affect compatibility with the public data network there shall be consultation with the CCITT.

References

[1] CCITT Definition: *Alphabet (telegraph or data)*, Vol. X, Fascicle X.1, (Terms and Definitions).

[2] CCITT Recommendation *International Alphabet No. 5*, Vol. VIII, Fascicle VIII.1, Rec. V.3.

[3] *Seven-bit coded character set for information processing interchange*, ISO Standard No. 646-1973.

[4] CCITT Definition *Code (telegraph or data)*, Vol. X, Fascicle X.1, (Terms and Definitions).

SECTION 1

SERVICES AND FACILITIES

Recommendation X.1

INTERNATIONAL USER CLASSES OF SERVICE IN PUBLIC DATA NETWORKS

(Geneva, 1972; amended at Geneva, 1976 and 1980)

The establishment in various countries of public networks for data transmission creates a need to standardize user data signalling rates, terminal operating modes and call control signals to facilitate international interworking.

Recommendations in the V Series already standardize data signalling rates for synchronous data transmission in the general telephone network and modulation rates for modems. These rates are, however, not necessarily the most suitable for public networks devoted entirely to data transmission and this leads to the requirement for an additional Recommendation.

The CCITT,

bearing in mind

(a) the desirability of providing sufficient data signalling rates to meet users' needs,

(b) the requirement to optimize terminal, transmission and switching costs to provide an overall economic service to the user,

(c) the particular operating modes of users' data terminals,

(d) the users' need to transfer information consisting of any bit sequence and of any number of bits up to a certain amount,

(e) the interaction between users' requirements, technical limitations and tariff structure,

unanimously declares the view

that users' data transmission requirements via public data networks may best be served by defined user classes of service.

These user classes of service are shown in Table 1/X.1; they cater for three particular types of users' data terminals, namely:

- terminals operating in the start-stop mode (as typified by teleprinters used for message transfer) in classes 1 and 2,
- terminals operating in a synchronous mode in classes 3 to 7,
- terminals operating in the packet mode in classes 8 to 11.

TABLE 1/X.1

User classes of service for public data networks

a) *Terminal operating mode – start-stop* (See Notes 1 - 6)

User class of service	Data signalling rate and code structure	Call control signals
1	300 bit/s, 11* units/character, start-stop	300 bit/s, International Alphabet No. 5 (11 units/character)
2	50-200 bit/s, 7.5-11* units/character, start-stop	200 bit/s, International Alphabet No. 5 (11 units/character)

* Usage in accordance with Recommendation X.4.

b) *Terminal operating mode – synchronous* (See Note 6)

User class of service	Data signalling rate	Call control signals
3	600 bit/s	600 bit/s, International Alphabet No. 5
4	2 400 bit/s	2 400 bit/s, International Alphabet No. 5
5	4 800 bit/s	4 800 bit/s, International Alphabet No. 5
6	9 600 bit/s	9 600 bit/s, International Alphabet No. 5
7	48 000 bit/s	48 000 bit/s, International Alphabet No. 5

c) *Terminal operating mode – packet* (See Note 6)

User class of service	Data signalling rate	Call control signals
8	2 400 bit/s	2 400 bit/s — See Recommendation X.25 for user packet format
9	4 800 bit/s	4 800 bit/s — See Recommendation X.25 for user packet format
10	9 600 bit/s	9 600 bit/s — See Recommendation X.25 for user packet format
11	48 000 bit/s	48 000 bit/s — See Recommendation X.25 for user packet format

Note 1 — There is no user class of service for the data signalling rate of 50 bit/s, the transmission mode of 7.5 units/character start-stop and address selection and call progress signals at 50 bit/s, International Telegraph Alphabet No. 2. However, several Administrations have indicated that their telex service (50-baud, International Telegraph Alphabet No. 2) will be provided as one of the many services carried by their public data network.

Note 2 — Taking account of the existence of data terminal equipments operating in the start-stop mode at a data signalling rate of 300 bit/s and with a 10 unit/character code structure, some Administrations have indicated that their public data networks will accommodate such terminals. Other Administrations, however, have indicated that they cannot guarantee acceptable transmission if such terminals are connected to their networks. The implications of admitting such terminals in class 1 are for further study.

Note 3 — Class 2 will provide, in the data transfer phase, for operation at the following data signalling rates and code structures:

50 bit/s (7.5 units/character)
100 bit/s (7.5 units/character)
110 bit/s (11 units/character)
134.5 bit/s (9 units/character)
200 bit/s (11 units/character)

Call control signals would be at 200 bit/s, International Alphabet No. 5 (11 units/character) as indicated in a) of Table 1/X.1.

Note 4 — Some Administrations have indicated that, for certain of the data signalling rates listed in Note 3 above, they will permit users in class 2 to operate the same signalling rate and code structure for both data transfer and address selection and to receive call progress signals at these signalling rates and code structures. Where International Alphabet No. 5 is used for the call control signals the appropriate parts of Recommendation X.20 [1] or X.20 *bis* [2] shall apply. Procedures to be used with other alphabets are a matter for the discretion of individual Administrations.

Note 5 — For data terminals in user class of service 2, it should be noted that some public data networks may not be able to prevent two terminals working at different data signalling rates and code structures from being connected together by means of a circuit switched connection.

Note 6 — In a packet switched data transmission service it should be noted that terminals in different user classes of service may be connected together by means of a packet switched connection.

References

[1] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for start-stop transmission services on public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.20.

[2] CCITT Recommendation *Use on public data networks of data terminal equipment (DTE) which is designed for interfacing to asynchronous duplex V-series modems*, Vol. VIII, Fascicle VIII.2, Rec. X.20 *bis*.

Recommendation X.2

INTERNATIONAL USER SERVICES AND FACILITIES IN PUBLIC DATA NETWORKS

(Geneva, 1972; amended at Geneva, 1976 and 1980)

The CCITT,

bearing in mind

(a) the international user classes of service indicated in Recommendation X.1,

(b) the need to standardize user facilities in public data networks which should be made available on an international basis,

(c) the need to standardize additional user facilities which may be provided by Administrations and which may be available on an international basis,

(d) the impact which these user facilities could have on tariff structures,

unanimously declares the view that

(1) the user facilities should be standardized for each of the user classes of service indicated in Recommendation X.1 for each of the following:

i) circuit switched data transmission services;

ii) packet switched data transmission services;

iii) leased circuit data transmission services.

(2) the user facilities to be available on an international basis are as indicated in Table 1/X.2. Some of the user facilities are available on a per-call basis and others may be assigned for an agreed contractual period. In all cases the user has the option of requesting a given user facility.

TABLE 1/X.2

International user services and facilities in public data networks

a) *Circuit switched service* (see Notes 1 and 2)

User facility	All user classes
1. *Optional user facilities assigned for an agreed contractual period*	
1.1 Direct call	A
1.2 Closed user group	E
1.3 Closed user group with outgoing access	A
1.4 Closed user group with incoming access	A
1.5 Incoming calls barred within a closed user group	A
1.6 Outgoing calls barred within a closed user group	A
1.7 Calling line identification	A
1.8 Called line identification	A
1.9 Bilateral closed user group	A
1.10 Bilateral closed user group with outgoing access	A
1.11 Incoming calls barred	A
1.12 Reverse charging acceptance	A
1.13 Connect when free	A
1.14 Waiting allowed	A
1.15 Redirection of calls	A
1.16 On-line facility registration	A
1.17 DTE inactive registration	A
2. *Optional user facilities requested by the DTE on a per-call basis*	
2.1 Direct call	A
2.2 Abbreviated address calling	A
2.3 Multi-address calling	A
2.4 Reverse charging	A
2.5 RPOA selection	A
2.6 Charging information	A

b1) *Packet switching services* (see Notes 2 and 3)

Services	User classes of service		
	1 - 2	3 - 7	8 - 11
Virtual call service	E	FS	E
Permanent virtual circuit service	FS	FS	E
Datagram service (see Note 8)	FS	FS	A

b2) *Facilities of packet switched data networks* (see Notes 1 - 3)

	User facility	User classes of service					
		1 - 2 (see Notes 4 and 5)			8 - 11 (see Notes 4 and 5)		
		VC	PVC	DG	VC	PVC	DG
1.	*Optional user facilities assigned for an agreed contractual period*						
1.1	Extended packet sequence numbering (module 128)	—	—	—	A	A	A
1.2	Nonstandard default window sizes	—	—	—	A	A	A
1.3	Nonstandard default packet sizes 16, 32, 64, 256, 512, 1024	—	—	—	A	A	—
1.4	Default throughput class assignment	—	—	—	A	A	A
1.5	Flow control parameter negotiation	—	—	—	E	—	—
1.6	Throughput class negotiation	FS	FS	FS	E	—	—
1.7	Packet retransmission	—	—	—	A	A	A
1.8	Incoming calls barred	A	—	FS	E	—	E
1.9	Outgoing calls barred	A	—	FS	E	—	E
1.10	One-way logical channel outgoing	—	—	—	E	—	A
1.11	One-way logical channel incoming	—	—	—	A	—	A
1.12	Closed user group	E	—	E	E	—	E
1.13	Closed user group with outgoing access	A	—	A	A	—	A
1.14	Closed user group with incoming access	A	—	A	A	—	A
1.15	Incoming calls barred within a closed user group	A	—	A	A	—	A
1.16	Outgoing calls barred within a closed user group	A	—	A	A	—	A
1.17	Bilateral closed user group	A	—	A	A	—	A
1.18	Bilateral closed user group with outgoing access	A	—	A	A	—	A
1.19	Reverse charging acceptance	A	—	A	A	—	A
1.20	Fast select acceptance	A	—	—	A	—	—
1.21	Datagram queue length selection	—	—	A	—	—	A
1.22	Datagram service signal logical channel	—	—	FS	—	—	A
1.23	Datagram nondelivery indication	—	—	FS	—	—	E
1.24	Datagram delivery confirmation	—	—	FS	—	—	E
1.25	Multiple circuits to the same DTE	—	—	—	A	A	A
1.26	Charging information	A	—	FS	FS	—	FS
1.27	Direct call	A	—	FS	FS	—	FS
1.28	Multiple terminals with the same data number	A	—	FS	FS	—	FS
1.29	On-line facility registration	A	—	A	A	—	A
1.30	D-bit modification	—	—	—	A	A	—
2.	*Optional user facilities requested by the DTE on a per-call basis*						
2.1	Closed user group selection	E	—	E	E	—	E
2.2	Bilateral closed user group selection	A	—	A	A	—	A
2.3	Reverse charging	A	—	A	A	—	A
2.4	RPOA selection	A	—	A	A	—	A
2.5	Flow control parameter negotiation	—	—	—	E	—	—
2.6	Fast select	A	—	—	A	—	—
2.7	Throughput class negotiation	—	—	—	E	—	—
2.8	Abbreviated address calling	A	—	A	FS	—	A
2.9	Datagram nondelivery indication	—	—	E	—	—	E
2.10	Datagram delivery confirmation	—	—	E	—	—	E
2.11	Multi-address calling	A	—	FS	A	—	FS
2.12	Charging information	A	—	FS	FS	—	FS
3.	*Optional user facilities only applicable when a DTE in user classes 1 and 2 is communicating with a network-provided interworking unit, e.g., a PAD*						
3.1	Setting values of PAD parameters	E	—	FS	E	E	FS
3.2	Reading values of PAD parameters	E	—	FS	E	E	FS
3.3	Automatic detection of data rate, code and operational characteristics	A	—	—	—	—	—
3.4	Provision of PAD parameters (see Notes 6 and 7)						
3.4.1	National parameter separator	A	—	—	—	—	—
3.4.2	PAD recall	E	—	—	—	—	—
3.4.3	Echo	E	—	—	—	—	—
3.4.4	Selection of data forwarding signal	E	—	—	—	—	—
3.4.5	Selection of idle timer delay	E	—	—	—	—	—
3.4.6	Auxiliary device control	E	—	—	—	—	—
3.4.7	Suppression of PAD service signals	E	—	—	—	—	—
3.4.8	Selection of operation of PAD on receipt of break	E	—	—	—	—	—
3.4.9	Discard output	E	—	—	—	—	—
3.4.10	Padding after carriage return	E	—	—	—	—	—
3.4.11	Line folding	E	—	—	—	—	—
3.4.12	Binary speed (read only)	E	—	—	—	—	—
3.4.13	Flow control of PAD by start-stop mode DTE	E	—	—	—	—	—
3.4.14	Linefeed insertion (see Note 9)	A	—	—	—	—	—
3.4.15	Linefeed padding (see Note 9)	A	—	—	—	—	—
3.4.16	Editing functions (see Note 9)	A	—	—	—	—	—
3.4.17	Parity functions	A	—	—	—	—	—
3.4.18	Code conversion	A	—	—	—	—	—
3.5	Standard profile selection	A	—	—	—	—	—

c) *Leased circuit service* (see Notes 1 and 2)

User facility	User classes of service	
	1 - 2	3 - 7
1. Point-to-point	E	E
2. Centralized multipoint	A	A

E An essential user service or facility to be made available internationally
A An additional user service or facility which may be available in certain data networks and may also be available internationally
FS For further study
— Not applicable
DG Applicable when the datagram service is being used
VC Applicable when the virtual call service is being used
PVC Applicable when the permanent virtual circuit service is being used

Note 1 — It is assumed that terminals have an interface to only one of the three transmission services identified.

Note 2 — The subject of interworking between data terminals having interfaces to different data transmission services is for further study.

Note 3 — It is assumed in b) of Table 1/X.2 that all terminals are directly connected to a packet-switched network and may make use of one or more of the services of this network (e.g., virtual call, permanent virtual circuit, datagram).

Note 4 — The use of a PAD facility is assumed for virtual call service (see Recommendation X.3). Its applicability for permanent virtual circuit service and datagram service is for further study.

Note 5 — The classification "E" listed for datagram service facilities applies only to those networks which provide a datagram service.

Note 6 — PAD parameters are available for use on a per-call basis and during a call to allow the operating characteristics of the start-stop mode DTE to be adapted to suit the user application. Both the start-stop mode DTE and the packet mode DTE may set, set and read, and read the current values of PAD parameters by using the procedures in Recommendations X.28 [1] and X.29 [2] respectively.

Note 7 — The values of PAD parameters which are available in all networks are given in Recommendation X.3.

Note 8 — Datagram service does not embrace the concept of a "call" or a "connection". Facilities using these or similar terms in their titles or definitions should be appropriately interpreted when they apply to the datagram service (e.g., "calls" should be interpreted as "datagrams").

Note 9 — These optional user facilities are only available during the data transfer state (see Recommendations X.3 and X.28) [1].

Note 10 — The optional user facilities in this table are applicable to those requested by the DTE on a per-call basis and to those provided for an agreed contractual period.

References

[1] CCITT Recommendation *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,* Vol. VIII, Fascicle VIII.2, Rec. X.28.

[2] CCITT Recommendation *Procedures for the exchange of control information and user data between a packet assembly/disassembly facility (PAD) and a packet mode DTE or another PAD,* Vol. VIII, Fascicle VIII.2, Rec. X.29.

Recommendation X.3

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

(provisional, Geneva, 1977; amended at Geneva, 1980)

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.96 [1] defines call progess signals, Recommendation X.29 [2] defines the procedures between a packet assembly/disassembly facility (PAD) and a packet mode DTE or another PAD, Recommendation X.28 [3] 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 [4], 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 or another start-stop 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 [5];

(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

(1) 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;*

(2) 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;*

(3) 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;*

(4) 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;
- disassembly of the *user data* field of packets;
- 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. when 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;
- editing of *PAD command* signals.

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 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 [3] for the start-stop mode DTE and in Recommendation X.29 [2] for the packet mode DTE or for another PAD.

Table 1/X.3 shows details of the valid values and combination of values of PAD parameters standardized by CCITT. Other values and combinations of values are for further study.

1.4.1 *PAD recall using a character*

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 back to the start-stop mode DTE as well as being interpreted by the PAD.

1.4.3 *Selection of data forwarding signals*

This function allows the selection of defined sets of character(s) received from the start-stop mode DTE to be recognized by the PAD as an indication to complete the assembly and forward a packet as defined in Recommendation X.25 [5].

1.4.4 *Selection of idle timer delay*

This function allows the selection of the duration of an interval between successive characters received from the start-stop mode DTE which, when exceeded, will cause the PAD to terminate the assembly of a packet and to forward it as defined in Recommendation X.25 [5].

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 *Control of PAD service signals*

This function provides the start-stop mode DTE with the ability to decide whether or not PAD service signals are transmitted.

1.4.7 *Selection of operation of the 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 content of user sequences 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.

1.4.12 *Linefeed insertion after carriage return*

This function provides for the automatic insertion by the PAD of a linefeed character after any carriage return character transmitted or echoed to the start-stop DTE. This function applies only in the *data transfer* state.

1.4.13 *Padding after linefeed*

This function provides for the automatic insertion by the PAD of padding characters in the character stream transmitted to the start-stop DTE after the occurrence of a linefeed character. This allows for the printing mechanism of the start-stop mode DTE to perform the linefeed operation correctly. This function applies only in the *data transfer* state.

1.4.14 *Editing*

This function provides for character delete, line delete and line display editing capabilities in the PAD in the *PAD command signal* state and *data transfer* state for the start-stop mode DTE. During the *PAD command* state the editing function is always available.

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 Recommendations X.28 [3] and X.29 [2] 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 an *initial standard profile.* Table 2/X.28 [6] gives details of the initial values of parameters for transparent and simple standard profiles which have been agreed by CCITT.

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. The automatic change of the current values to the initial values when the virtual call is cleared is for further study.

3 List of PAD parameters and possible values

Restrictions on the permissible relationships between the values of the various parameters is a subject for further study. In particular, this study will include the means to ensure that when characters are used for parameter functions, they do not mutually conflict or interfere with other procedures in Recommendation X.28 [3].

3.1 *PAD recall using a character*

Reference 1

The parameter will have the following selectable values:

not possible – represented by decimal 0;

possible by character 1/0 (DLE) – represented by decimal 1;

possible by one of graphic characters defined by the user – represented by decimal 32-126.

A graphic character, defined by the user to escape from the *data transfer* state and to recall the PAD, is the binary representation of the decimal value in accordance with Recommendation V.3 [7].

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

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

no data forwarding character – represented by decimal 0;

alphanumeric characters (A-Z, a-z, 0-9) – represented by decimal 1;

character CR – represented by decimal 2;

characters ESC, BEL, ENQ, ACK – represented by decimal 4;

characters DEL, CAN, DC2 – represented by decimal 8;

characters ETX, EOT – represented by decimal 16;

characters HT, LF, VT, FF – represented by decimal 32;

all other characters in columns 0 and 1 not included in above – represented by decimal 64.

Note – The decimal representation of individual values of this parameter allows coding to represent a single function or combination of functions, see Table 1/X.3.

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.

Note 1 – Some PAD implementations may not offer all possible values of idle timer delay within the selectable range. In such cases where the value selected is not available, the PAD will assume the next higher available value in the range.

Note 2 – The effect of the idle timer delay on data forwarding may be subject to flow control constraints. (See [8].)

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 *Control of PAD service signals*

Reference 6

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

no service signals are transmitted to the start-stop mode DTE	–	represented by decimal 0;
service signals other than the prompt PAD service signal are transmitted	–	represented by decimal 1;
prompt PAD service signal is transmitted	–	represented by decimal 4.

Note – The decimal representation of individual values of this parameter allows coding to represent a single function or combination of functions, see Table 1/X.3.

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 or other PAD an *interrupt* packet	–	represented by decimal 1;
reset	–	represented by decimal 2;
send to packet mode DTE or other PAD 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.

Note – The decimal representation of individual values of this parameter allows coding to represent a single function or combination of functions, see Table 1/X.3.

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 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, there will be no padding except that *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	–	represented by the respective decimal number.

A value between 1 and 255 will indicate the number of graphic characters per line after which the PAD will automatically insert appropriate format effectors.

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;
75	bit/s	–	represented by decimal 5;
100	bit/s	–	represented by decimal 9;
110	bit/s	–	represented by decimal 0;
134.5	bit/s	–	represented by decimal 1;
150	bit/s	–	represented by decimal 6;
200	bit/s	–	represented by decimal 8;
300	bit/s	–	represented by decimal 2;
600	bit/s	–	represented by decimal 4;
1 200	bit/s	–	represented by decimal 3;
1 800	bit/s	–	represented by decimal 7;
75/1 200	bit/s	–	represented by decimal 11;
2 400	bit/s	–	represented by decimal 12;
4 800	bit/s	–	represented by decimal 13;
9 600	bit/s	–	represented by decimal 14;
19 200	bit/s	–	represented by decimal 15;
48 000	bit/s	–	represented by decimal 16;
56 000	bit/s	–	represented by decimal 17;
64 000	bit/s	–	represented by decimal 18.

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)	–	represented by decimal 0;
use of X-ON and X-OFF	–	represented by decimal 1.

3.13 *Linefeed insertion after carriage return*

Reference 13

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

no linefeed insertion	–	represented by decimal 0;
insert linefeed after each carriage return in the data stream *to* the start-stop mode DTE	–	represented by decimal 1;

insert linefeed after each carriage return in the data stream *from* the start-stop mode DTE – represented by decimal 2;

insert a linefeed after each carriage return in the echo to the start-stop mode DTE – represented by decimal 4.

Note 1 – The decimal representation of individual values of this parameter allows coding to represent a single function or combination of functions, see Table 1/X.3.

Note 2 – This function applies only in the *data transfer* state.

3.14 *Linefeed padding*

Reference 14

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 linefeed character is transmitted to the start-stop mode DTE during the data transfer state.

3.15 *Editing*

Reference 15

The parameter will have the following selectable values:

no use of editing in the *data transfer* state – represented by decimal 0;

use of editing in the *data transfer* state – represented by decimal 1.

The use of value 1 suspends the following operations of the PAD:

a) Data forwarding on full packet until the editing buffer is full.

b) Forwarding on idle timer period expiry.

Note – The value of parameter 4 remains unchanged.

3.16 *Character delete*

Reference 16

The parameter will have the following selectable values:

one character from IA5 – represented by decimal 0-127.

The character defined by the user for character delete is the binary representation of the decimal value in accordance with Recommendation V.3 [7].

3.17 *Line delete*

Reference 17

The parameter will have the following selectable value:

one character from IA5 – represented by 0-127.

The character defined by the user for line delete is the binary representation of the decimal value in accordance with Recommendation V.3 [7].

3.18 *Line display*

Reference 18

The parameter will have the following selectable values:

one character from IA5 – represented by 0-127.

The character defined by the user for line display is the binary representation of the decimal value in accordance with Recommendation V.3 [7].

TABLE 1/X.3

Possible values and combination of values of PAD parameters (see Note 1)

Parameter reference number	Parameter description	Selectable possible values		PAD parameter meaning	Remarks
		Mandatory	Optional (see Note 2)		
1	PAD recall using a character	0		Not possible	
		1		Character DLE	
			32-126	Possible; using one graphic character defined by user	
2	Echo	0		No echo	
		1		Echo	
3	Selection of data forwarding signals	0		No *data forwarding* signal	
		2		Character CR	
		126		All characters in column 0 and 1 and character DEL	Value formed by combination (2+4+8+16+32+64)
			6	Characters CR, ESC, BEL, ENQ, ACK	Value formed by combination (2+4)
			18	Characters CR, EOT, ETX	Value formed by combination (2+16)
4	Selection of idle timer delay	0 20 255	1-254 (see Note 3)	Value of idle timer delay in twentieths of a second	
5	Ancillary device control	0		No use of X-ON (DC1) and X-OFF (DC3)	
		1		Use of X-ON and X-OFF	
6	Control of PAD service signals	0		No *PAD service* signals are transmitted to the start-stop mode DTE	
		1		*PAD service* signals are transmitted	
			5	*PAD service* signals and the *prompt PAD service* signal are transmitted	Value formed by combination (1 + 4)
7	Selection of operation of PAD on receipt of break signal from the start-stop DTE	0		Nothing	
			1	Interrupt	
		2		Reset	
		8		Escape from *data transfer* state	
		21		Discard output, interrupt and indication of break	Value formed by combination (1+4+16)
8	Discard output	1		Discard output	
		0		Normal data delivery	

TABLE 1/X.3 *(continued)*

Parameter reference number	Parameter description	Selectable possible values: Mandatory	Selectable possible values: Optional (see Note 2)	PAD parameter meaning	Remarks
9	Padding after carriage return (CR)	0		No padding after CR (see Note 4)	
		1-7		Number of padding characters inserted after CR	
10	Line folding	0		No line folding	
		1-255		Number of graphic characters	
11 (read only)	Binary speed of start-stop mode DTE	0		110 bit/s	The values implemented in individual PADs depend on the range of DTE data transmission rates which are supported. The allocation of decimal values to all known rates is to avoid revision of the Recommendation in the future
			1	134,5 bit/s	
		2		300 bit/s	
			3	1 200 bit/s	
			4	600 bit/s	
			5	75 bit/s	
			6	150 bit/s	
			7	1 800 bit/s	
		8		200 bit/s	
			9	100 bit/s	
			10	50 bit/s	
			11	75/1 200 bit/s	
			12	2 400 bit/s	
			13	4 800 bit/s	
			14	9 600 bit/s	
			15	19 200 bit/s	
			16	48 000 bit/s	
			17	56 000 bit/s	
			18	64 000 bit/s	
12	Flow control of the PAD	0		No use of X-ON (DC1) and X-OFF (DC3)	
		1		Use of X-ON (DC1) and X-OFF (DC3)	
13 (see Notes 2 and 5)	Linefeed insertion after carriage return	0		No linefeed	
		1		Insert linefeed after transmission of CR	
		4		Insert linefeed after echo of CR to start-stop mode DTE	
		5		Insert linefeed after transmission to the start-stop mode DTE and after echo of CR	Combination (1 + 4)
		6		Insert linefeed in data stream after CR from start-stop mode DTE and after echo of a CR to the start-stop mode DTE	Combination (2 + 4)
		7		Insert linefeed in the data stream to and from the start-stop mode DTE and after echo of a CR to the start-stop mode DTE	Combination (1 + 2 + 4) *Note* – Applies only to *data transfer* state
14 (see Notes 2 and 5)	Padding after linefeed	0		No padding after linefeed	
		1-7		Number of padding characters inserted after linefeed	*Note* – Applies only to *data transfer* state

TABLE 1/X.3 *(continued)*

Parameter reference number	Parameter description	Selectable possible values		PAD parameter meaning	Remarks
		Mandatory	Optional (see Note 2)		
15 (see Notes 2 and 6)	Editing	0 1		No use of editing in the *data transfer* state Use of editing in the *data transfer* state	
16 (see Notes 2 and 6)	Character delete	(see Note 7)	0-127	One character from IA5	
17 (see Notes 2 and 6)	Line delete	 24	0-23 25-127	One character from range of IA5 Character 1/8 (CAN)	
18 (see Notes 2 and 6)	Line display	(see Note 7)	0-127	One character from IA5	

Note 1 — Other values and possible combination of values are for further study.

Note 2 — These parameter values provide additional user facilities which are not necessarily provide in all PADs.

Note 3 — Some PAD implementation may not offer all possible values of idle timer delay within the selectable range. In such cases where the value selected is not available, the PAD will assume the next higher value available.

Note 4 — There is no padding after CR except that *PAD service* signals will contain a number of padding characters according to the data signalling rate of the start-stop mode DTE.

Note 5 — When implemented, both parameters 13 and 14 and all of the "mandatory values" are provided.

Note 6 — When parameter 15 is implemented the values of parameters 16, 17 and 18 are either default values or are selectable from the optional range shown. The editing function is provided during the *PAD command* state whether parameter 15 is implemented or not. If parameters 16, 17 and 18 are implemented the editing characters during the *PAD command* state are defined by the appropriate values of these parameters.

Note 7 — The default values for parameters 16 and 18 are for further study.

References

[1] CCITT Recommendation *Call progress signals in public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.96.

[2] CCITT Recommendation *Procedures for the exchange of control information and user data between a packet assembly/disassembly facility (PAD) and a packet mode DTE or another PAD*, Vol. VIII, Fascicle VIII.2, Rec. X.29.

[3] CCITT Recommendation *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*, Vol. VIII, Fascicle VIII.2, Rec. X.28.

[4] CCITT Recommendation *Hypothetical reference connections for public synchronous data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.92.

[5] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for terminals operating in the packet mode on public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.25.

[6] CCITT Recommendation *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*, Vol. VIII, Fascicle VIII.2, Rec. X.28, Table 2/X.28.

[7] CCITT Recommendation *International Alphabet No. 5*, Vol. VIII, Fascicle VIII.1, Rec. V.3.

[8] CCITT Recommendation *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*, Vol. VIII, Fascicle VIII.2, Rec. X.28, § 4.4.a.

GENERAL STRUCTURE OF SIGNALS OF INTERNATIONAL ALPHABET No. 5 CODE FOR DATA TRANSMISSION OVER PUBLIC DATA NETWORKS [1)]

(Geneva, 1976; amended at Geneva, 1980)

The CCITT,

I *considering, firstly,*

the agreement between the International Organization for Standardization (ISO) and the CCITT on the main characteristics of a seven-unit alphabet (International Alphabet No. 5) to be used for data transmission and for telecommunications requirements that cannot be met by the existing five-unit International Telegraph Alphabet No. 2;

the interest, both to the users and to the telecommunication services, of an agreement concerning the chronological order of transmission of bits in serial working;

declares the view

that the agreed rank number of the unit in the alphabetical table of combinations should correspond to the chronological order of transmission in serial working on telecommunication circuits;

that, when this rank in the combination represents the order of the bit in binary numbering, the bits should be transmitted in serial working with the low order bit first;

that the numerical meaning corresponding to each information unit considered in isolation is that of the digit:

0 for a unit corresponding to condition A (travail = space), and

1 for a unit corresponding to condition Z (repos = mark),

in accordance with the definitions of these conditions for a two-condition transmission system;

II *considering, moreover,*

that it is often desirable, in data and messages transmission, to add an extra "parity" unit to allow for the detection of errors in received signals;

the possibility offered by this addition for the detection of faults in terminal equipment;

the need to reserve the possibility of making this addition during the transmission itself, after the seven information units proper have been sent;

declares the view

that signals of International Alphabet No. 5 code for data and messages transmission should in general include an additional "parity" unit;

that the rank of this unit and, hence, the chronological order of the transmission in serial working should be the eighth of the combination thus completed;

III *considering*

that, in start-stop systems working with electromechanical equipment, the margin of such equipment and the reliability of the connection are considerably increased by the use of a stop element corresponding to the duration of two-unit intervals of the modulation;

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1) See Recommendation V.4 [1] for data transmission over public telephone networks.

that for start-stop systems using International Alphabet No. 5 at modulation rates of 200 and 300 bauds, Recommendations X.1 and S.31 [2] specify that transmit devices should use a stop element lasting at least two units;

that the previously expressed preference for a two-unit stop element arises from a transmission point of view where anisochronous public data networks are concerned;

declares the view

that in start-stop systems using combinations of International Alphabet No. 5 normally followed by a parity unit, the first information unit of the transmitted combination should be preceded by a start element corresponding to condition A (space);

that the duration of this start element should be a one-unit interval for the modulation rate under consideration, at transmitter output;

that the combination of seven information units, normally completed by its parity unit, should be followed by a stop element corresponding to condition Z (mark);

that for public anisochronous data networks, data terminal equipment using International Alphabet No. 5 should comply with Recommendations X.1 and S.31 [2] and use a stop element lasting at least two units;

that the start-stop receivers should be capable of correctly receiving start-stop signals from a source which appears to have a nominal cycle of 10 units (i.e., with a nominal one-unit stop element). However, for certain electromechanical equipment the receivers may only be capable of correctly receiving signals when the stop element is not reduced below one unit (even in the presence of distortion);

IV *considering, finally,*

that the direction of the parity unit can only be that of the even parity on the perforated tapes, particularly owing to the possibility of deletion (combination 7/15 of the alphabet) which causes a hole to appear in all tracks;

that, on the other hand, the odd parity is considered essential in the equipment which depends on transitions in the signals to maintain synchronism [in cases where combination 1/6 (SYNC) of the alphabet does not permit of an economical solution];

declares the view

that the parity unit of the signal should correspond to the even parity in links or connections operated on the principle of the start-stop system;

that this parity should be odd on links or connections using end-to-end synchronous operation;

that arrangements should be made when necessary to reverse the direction of the parity unit at the input and output of the synchronous equipment connected either to apparatus working on the start-stop principle or receiving characters on perforated tape;

that the detection of a character out-of-parity may be represented by:

a) a reverse question mark graphic character or a representation of the capital letter SB (see ISO 2047 [3]) provided that this letter occupies a single character position on a screen or printer, and which could have been entered by a single key stroke. It is recognized that it may be difficult to achieve a legible "SB" character from some matrix printers or displays where the characters are printed; or

b) a recording of the 1/10 (SUB) character in the tape or other storage medium, where provided.

Where a SUB character occurs in a received transmisson, or is presented to a DTE via a storage medium, e.g. paper tape, then the reaction should be as in a) and b) above.

References

[1] CCITT Recommendation *General structure of signals of International Alphabet No. 5 code for data transmission over public telephone networks*, Vol. VIII, Fascicle VIII.1, Rec. V.4.

[2] CCITT Recommendation *Transmission characteristics for start-stop data terminal equipment using International Alphabet No. 5*, Vol. VII, Fascicle VII.2, Rec. S.31.

[3] *Information processing – Graphical representations for the control characters of the 7-bit coded character set*, ISO Standard No. 2047-1975.

DEFINITIONS OF TERMS CONCERNING PUBLIC DATA NETWORKS

(Geneva, 1980)

Note – This Recommendation contains only new and revised definitions of terms concerning public data networks which were elaborated by Study Group VII during the Study Period 1976-1980 and approved by the VIIth Plenary Assembly.

It should be noted that there also exist a large number of definitions in force concerning public data networks which have been published in the *List of essential telecommunication terms*, Part I (including its two Supplements), *Green Book*, Volume VIII and *Orange Book*, Volume VIII.2.

1 New terms and definitions

1.1 access barred

F: accès interdit

S: acceso prohibido

The state in which the calling DTE is not permitted to make a call to the DTE identified by the *selection* signals.

1.2 bilateral closed user group

F: groupe fermé d'usagers bilatéral

S: grupo cerrado de usuarios bilateral

A facility that allows communication between two users who have bilaterally agreed to communicate with one another, but prevents communication with other users. Communication is authorized by address registration in the network between the pair of users who have agreed to communicate. The individual user has responsibility for, and authority over, establishment of this communication partnership in conjunction with this facility. A user can belong to more than one bilateral group and also to one or more ordinary closed user groups.

1.3 call collision at the DTE/DCE interface

F: collision d'appel à l'interface ETTD/ETCD

S: colisión de llamadas en el interfaz ETD/ETCD

The occurrence of the simultaneous transmission of a *call request* signal from the DTE and an *incoming call* signal from the DCE so that neither equipment receives the expected responses.

1.4 call establishment

F: établissement de l'appel

S: establecimiento de la comunicación

The sequence of events for the establishment of a data connection.

1.5 call identifier

F: identificateur de communication

S: identificador de la llamada

A network utility which is an identifying name assigned by the originating network for each established or partially established virtual call and, when used in conjunction with the calling DTE address, uniquely identifies the virtual call over a period of time.

1.6 **call progress signal**

F: signal de progression de l'appel

S: señal de progresión de la llamada

A *call control* signal transmitted from the DCE to the calling DTE to inform it about the progression of a call or the reason why the connection could not be established or any other network condition.

Additionally for packet services, a control signal

- for the virtual call service to inform the calling and called DTEs the reason why the call has been cleared;
- for the permanent virtual circuit service, to inform the DTEs the reason why the permanent virtual circuit has been reset;
- for the datagram service, to inform the source DTE about the delivery or nondelivery of a specific datagram, or general operation of the DTE/DCE datagram interface or service.

Note – Definitions of specific *call progress* signals can be found in Recommendation X.96 [1].

1.7 **call request signal**

F: signal de demande d'appel

S: señal de petición de llamada

A signal in the call establishment phase which alerts the DCE that the DTE wishes to make a call.

1.8 **centralized multipoint facility**

F: service complémentaire de liaisons multipoints centralisées

S: facilidad de multipunto centralizado

A multipoint facility which enables a central DTE to transmit data simultaneously to two or more remote DTEs, and to receive data transmitted by the remote DTEs one at a time. Data transmitted by a remote DTE is not delivered to other remote DTEs.

1.9 **character alignment**

F: alignement de caractères

S: alineación de caracteres

The identification of groups of contiguous bits which constitute characters.

1.10 **charging information**

F: avis de taxation

S: información de tasación

A facility which gives a user, after completion of a call, information about the charge for that call or other information which makes it possible for the user to calculate the charge.

1.11 **connect when free facility**

F: service complémentaire de connexion quand la ligne devient libre

S: facilidad de conexión cuando se libere

A facility, when assigned to the called DTE, enabling the calling DTE having the *waiting allowed* facility to wait for the called DTE to become free if the called DTE is busy when the call attempt is made. The call is established when the called DTE becomes free.

1.12 **D-bit modification facility**

F: service complémentaire de modification du bit D

S: facilidad de modificación del bit D

An optional user facility agreed for a period of time which for an interim period permits DTEs to operate (within a national network or internationally when bilateral agreements apply) with end-to-end P(R) significance, without following the Recommendation X.25 [2] *delivery confirmation* (D-bit) procedures.

Note – This facility is only intended for existing DTEs implemented for public data networks which supported end-to-end P(R) significance prior to the introduction of the *delivery confirmation* procedure into Recommendation X.25 [2].

Note – This facility applies to all virtual calls and permanent virtual circuits at the DTE/DCE interface.

1.13 **data transfer**

F: transfert de données

S: transferencia de datos

The result of the transmission of data signals from a data source to data sink.

1.14 **datagram**

F: datagramme

S: datagrama

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

1.15 **datagram delivery confirmation**

F: confirmation de remise de datagramme

S: confirmación de entrega de datagrama

A facility which provides for a network generated *call progress* signal when a datagram has been accepted by the destination DTE.

1.16 **datagram nondelivery indication**

F: indication de non-remise de datagramme

S: indicación de no entrega de datagrama

A facility which provides for a network generated *call progress* signal when a datagram cannot be delivered to the destination DTE.

1.17 **datagram queue length selection**

F: choix de la longueur de la file d'attente de datagrammes

S: elección de longitud de cola para datagramas

A facility which allows selection of the DCE queue length for datagrams and/or datagram *call progress* signals destined to the DTE.

1.18 **datagram service**

F: service de datagrammes

S: servicio de datagramas

A service whereby a datagram is routed to the destination identified in its address field without reference by the network to any other datagram previously sent or likely to follow.

Note 1 – It is possible that datagrams may be delivered to a destination address in a different order from that in which they were inputted to the network.

Note 2 – It may be necessary for users to provide DTE-to-DTE procedures, e.g., to ensure delivery of datagrams to the destination address.

Note 3 – For a DTE/DCE interface operating in the packet mode, a datagram is conveyed as a single packet.

1.19 **datagram call progress signal logical channel**

F: voie logique pour les signaux de progression de l'appel en service de datagrammes

S: canal lógico de señales de progresión de la llamada de datagrama

A facility which provides a separate logical channel for delivery of datagram *call progress* signals.

1.20 **diagnostic code in Recommendation X.25** [2]

F: code de diagnostic dans l'Avis X.25

S: código de diagnóstico de la Recomendación X.25

A unique combination of symbols, such as the CCITT International Alphabet No. 5, binary of hexadecimal notation, used to convey information between the DTE and the DCE for the purpose of indicating errors, failures, or, inherent incompatibilities of a DTE with the network or with another DTE.

1.21 **DTE busy**

F: ETTD occupé

S: ETD ocupado

Status of DTE which is unavailable because it cannot accept an additional call.

1.22 **DTE controlled not ready**

F: ETTD non prêt commandé

S: ETD controlado, no preparado

Indicates that, although the DTE is operational, it is temporarily unable to accept incoming calls.

1.23 **DTE inactive registration facility**

F: service complémentaire d'enregistrement de l'état ETTD inactif

S: facilidad de registro de ETD inactivo

The *DTE inactive registration facility*, for circuit switched services, provides an optional (A) facility for a DTE to advise the network that it intends to be unavailable for service for a specified period of time. At the start of the inactive period, the DTE will register with the network the month, day, and hour (local) that it intends to return to normal service. During the inactive period, the network will issue a *call progress* signal in response to an incoming call, giving the time information. The appropriate *call progress* signal to be issued is for further study.

1.24 **DTE uncontrolled not ready**

F: ETTD non prêt automatique

S: ETD no controlado no preparado

Indicates that the DTE is unable to accept incoming calls, generally because of abnormal operating conditions.

1.25 **echoplex mode**

F: mode échoplex

S: modo ecoplex

A mode of operation whereby characters transmitted by a DTE are automatically returned to that DTE from some specified network mode.

1.26 **editing**

F: edition

S: edición

A function provided by a PAD, which allows the start-stop mode DTE user to edit characters sent to the PAD before action by the PAD and/or onward transmission.

1.27 **fast select**

F: sélection rapide

S: selección rápida

A facility applicable to virtual calls which allows a DTE to expand the possibility to transmit data in *call set-up* and *clearing* packets beyond the basic capabilities of a virtual call.

1.28 **fast select acceptance**

F: acceptation de la sélection rapide

S: aceptación de selección rápida

A facility applicable to virtual calls which autorizes the DCE to transmit data to the DTE in *call set-up* and *clearing* packets beyond the basic capabilities of a virtual call.

1.29 **flow control parameter selection/negotiation and indication for virtual call service**

F: sélection, négociation et indication des paramètres de contrôle de flux pour service de communication virtuelle

S: elección, negociación e indicación de parámetros de control de flujo para el servicio de llamada virtual

A user facility for the virtual call service which provides for the packet mode DTE in classes of service 8-11 to select and negotiate the packet and window size and the significance of the *receive packet sequence number* [P(R)] and permits the DCE to indicate the appropriate value of each parameter at the end of the call establishment phase.

1.30 **inactive character**

F: caractère inactif

S: carácter inactivo

A character that is sent in the data transfer phase as a filler which does not represent information.

1.31 **logical channel**

F: voie logique

S: canal lógico

In packet mode operation, a means of two-way simultaneous transmission across a *data link*, comprising associated send and receive channels.

Note 1 – A number of logical channels may be derived from a *data link* by packet interleaving.

Note 2 – Several logical channels may exist on the same *data link*.

1.32 **multiple circuits (multilines) to the same DTE**

F: circuit multiple (multiligne) à destination du même ETTD

S: múltiples circuitos (múltiples líneas) hacia el mismo ETD

A facility whereby one DTE may be connected to a public data network by more than one physical circuit but providing a single set of logical channels, for reliability or throughput purposes.

1.33 **multiple terminals with the same data number**

F: terminaux multiples ayant le même numéro pour la transmission de données

S: múltiples terminales con el mismo número de datos

A facility whereby several DTEs each connected to a public data network by one or more separate access circuits, may be assigned the same data number which results in incoming calls being offered to the next free access circuit.

Note – The applicability of this definition to classes 8-11 requires further study.

1.34 **multiplex interface**

F: interface multiplex

S: interfaz múltiplex

A DTE/DCE interface which conveys the bitstream of a number of subscriber channels by means of time division multiplexing.

1.35 **multiplex link**

F: liaison multiplex

S: enlace multiplexado

A means of enabling a DTE to have several access channels to the data network over a single circuit.

Note – Three likely methods have been identified:
a) packet interleaving,
b) byte interleaving,
c) bit interleaving.

1.36 **network failure**

F: défaillance du réseau

S: avería en la red

A circumstance occurring in a network which prevents a service from being offered because the network is not functioning correctly.

1.37 **network transfer delay**

F: temps de propagation sur le réseau

S: tiempo de transferencia de la red

The time which is required by the network to transfer an entity, offered at the originating DTE/DCE interface, to the destination DTE/DCE interface. Depending on the mode of operation the entity may be a bit, a packet or a message.

1.38 **network utility**

F: service inter-réseaux

S: servicio interredes

An internetwork administrative signalling mechanism in the call control procedure between switched public data networks.

1.39 network utility field

F: champ des services inter-réseaux

S: campo de servicios interredes

A field to transmit the service information for the network utility. The network utility field complements the user facility field and serves to distinguish user service signalling from network administrative signalling.

1.40 on-line facility registration facility

F: service complémentaire d'enregistrement en ligne de service complémentaire

S: facilidad de registro en línea de facilidad

A facility which enables DTEs to activate, de-activate or request status by using on-line procedures facilities assigned for an agreed contractual period which have been subscribed to by the DTEs, and also enables DTEs to change, by using on-line procedures, parameters regarding the facilities, or the characteristics of the DTE/DCE interface (such as time-outs, number of logical channels, etc.)

Note – Possible facilities to be applied are *bilateral closed user group, abbreviated addressing, connect when free*, and *redirection of calls.*

1.41 packet assembly/disassembly

F: assemblage-désassemblage de paquets

S: empaquetado/desempaquetado de datos

A user facility which permits nonpacket mode terminals to exchange data in the packet mode.

1.42 parity function

F: fonction de parité

S: función de paridad

A function provided by a PAD which allows the start-stop mode DTE and the packet mode DTE to select which of a range (as yet undefined) of operations should be undertaken by the PAD in relation to the parity bit of characters transmitted by the PAD and received by the PAD.

1.43 public data transmission service

F: service public de transmission de données

S: servicio público de transmisión de datos

A data transmission service established and operated by an Administration and provided by means of a public data network.

1.44 reverse charging acceptance

F: acceptation de la taxation à l'arrivée

S: aceptación de cobro revertido

The facility is provided at subscription time and enables a DTE to be offered calls that request *reverse charging.* In the absence of this facility, the network will not transmit to the DTE incoming packets which request *reverse charging.*

Note – The DTE may refuse an incoming call that requests *reverse charging.*

1.45 standard profile selection

F: choix du profil normalisé

S: elección de perfil normalizado

A user facility, agreed for a contractual period, whereby a user may choose which of a range of standard profiles the PAD will use when the start-stop mode DTE accesses the PAD.

1.46 **subscriber channel in a multiplexed DTE/DCE interface**

F: voie d'abonné à une interface multiplex ETTD/ETCD

S: canal de abonado en un interfaz ETD/ETCD múltiplex

A two-way path in a time division multiplexed link exclusively assigned in a multiplex DTE/DCE interface to carry call control information to the network and data between two subscribers.

1.47 **transit network identification**

F: identification du réseau de transit

S: identificación de la red de tránsito

A network utility that names each transit network controlling a portion of the established or partially established virtual circuit.

1.48 **transparent data transfer phase**

F: phase de transfert transparent de données

S: fase de transferencia transparente de datos

The phase of a call during which any bit sequence can be transmitted between DTEs.

1.49 **user class of service**

F: catégorie d'usagers du service

S: clase de servicio de usuario

A category of data transmission provided in a network in which the *data signalling, address selection* and *call progress* signals signalling rates and the terminal operating mode are standardized.

1.50 **waiting allowed facility**

F: service complémentaire d'attente autorisée

S: facilidad de espera permitida

A facility enabling a calling DTE to wait for a called DTE that is busy to become free, where the called DTE has the *connect when free* facility.

2 Revision of terms and definitions published in the Orange Book volume *Terms and Definitions*

2.1 **direct call**

F: appel direct

S: llamada directa

A facility which enables the establishment of a call without the need to convey address signals to the network.

When instructed, the network establishes a connection to a single or a number of destination addresses previously designated by the user.

The facility may be provided on a per call or contractual period basis.

Note – This facility may permit faster call set-up than usual. No special priority is implied over other users of the network in establishing a connection. The designated address is assigned for an agreed period.

2.2 **incoming calls barred**

F: interdiction des appels à l'arrivée

S: prohibición de llamadas entrantes

A facility which permits a DTE to make outgoing calls only.

Note – For packet switching this applies to all logical channels.

2.3 **public data network**

F: réseau public pour données

S: red pública de datos

A network established and operated by an Administration* for the specific purpose of providing data transmission services to the public. Circuit switched, packet switched and leased circuit data transmission services are feasible.

Note – Administration* refers to both an Administration and a Recognized Private Operating Agency (RPOA).

2.4 **redirection of calls**

F: réacheminement des appels

S: redireccionamiento de llamadas

A facility which permits a called user to request the network to transfer all calls to another predetermined address. The user should be able to activate and de-activate the facility.

2.5 **time-out**

F: temporisation

S: temporización

A parameter related to an enforced event designed to occur at the conclusion of a predetermined elapsed time.

Note – A time-out condition can be cancelled by the receipt of an appropriate time-out cancellation signal.

References

[1] CCITT Recommendation *Call progress signals in public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.96.

[2] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for terminals operating in the packet mode on public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.25.

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SECTION 2

INTERFACES

Recommendation X.20

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT TERMINATING EQUIPMENT (DCE) FOR START-STOP TRANSMISSION SERVICES ON PUBLIC DATA NETWORKS

(Geneva, 1972; amended at Geneva, 1976 and 1980)

The CCITT,

considering

(a) that Recommendations X.1 [1] and X.2 [2] define the services and facilities to be provided by a public data network,

(b) that Recommendation X.92 [3] defines the hypothetical reference connections for public synchronous data networks,

(c) that Recommendation X.96 [4] defines *call progress* signals,

(d) that the necessary elements for an interface Recommendation should be defined in architectural levels (under study, see Question 27/VII [5]),

(e) that it is desirable for characteristics of the interface between the DTE and DCE of a public data network to be standardized,

unanimously declares the view

that the interface between the DTE and DCE in public data networks for user classes of service employing start-stop transmission should be as defined in this Recommendation.

1 Scope

1.1 This Recommendation defines the physical characteristics and call control procedures for a general purpose interface between DTE and DCE for user classes of service, as defined in Recommendation X.1 [1], employing start-stop transmission.

1.2 The formats and procedures for *selection, call progress* and *DCE provided information* are included in this Recommendation.

1.3 The provision for duplex operation is covered.

2 DTE/DCE physical interface elements

2.1 *Interchange circuits*

A list of the interchange circuits concerned is presented in Table 1/X.20. Definitions of these interchange circuits are given in Recommendation X.24.

TABLE 1/X.20

Interchange circuit	Interchange circuit name	Direction	
		to DCE	from DCE
G (see Note)	Signal ground or common return		
G_a	DTE common return	X	
G_b	DCE common return		X
T	Transmit	X	
R	Receive		X

Note – This conductor may be used to reduce environmental signal interference at the interface. In case of shielded interconnecting cable, the additional connection considerations are part of Recommendation X.24 and ISO 4903 [6].

2.2 *Electrical characteristics*

The electrical characteristics of the interchange circuits at the DCE side of the interface will comply with Recommendation X.26.

The electrical characteristics at the DTE side of the interface may be applied according to Recommendations X.26, X.27 (without cable termination in the load), or Recommendation V.28 [7].

For interworking between a V.28-DTE [7] and a X.26-DCE refer to Recommendation X.26 and ISO 4903 [6].

2.3 *Mechanical characteristics*

Refer to ISO 4903 [6] (15-pin DTE/DCE interface connector and pin assignment) for mechanical arrangements.

2.4 *Fault conditions of interchange circuits*

For the association of the receiver circuit-failure detection to particular interchange circuits in accordance with the type of failure detection, see Recommendation X.26, § 11 and Recommendation X.27, § 9.

2.4.1 *Circuit R in failure state*

The DTE should interpret a fault condition on circuit R as $r = 0$, using failure detection type 2. When the electrical characteristics are applied according to Recommendation V.28 [7], the DTE should interpret generator in power-off condition or open-circuited interconnecting cable as a binary 0.

2.4.2 *Circuit T in failure state*

The DCE will interpret a fault condition on circuit T as $t = 0$, using failure detection type 2.

3 **Call control characters and error checking**

All characters for call control purposes are selected from International Alphabet No. 5 according to Recommendation V.3 [8].

Even parity according to Recommendation X.4 [9] applies for IA5 characters interchanged for call control purposes.

4 **Elements of the call control phase for circuit switched service**

The state diagram provided in Figure A-1/X.20 shows the relationship between the various *call control* phase states as defined below, together with the recognized transactions between these states under normal operating conditions. Illustrated examples of the time sequence relationships between these states and associated time-out operation are provided in Figure B-1/X.20.

The *call control* phase can be terminated by either the DTE or the DCE by *clearing* as defined in § 6 below.

4.1 *Events of the call control procedures*

(See Figure A-1/X.20.)

4.1.1 *Ready (state 1)*

Circuits T and R show binary 0.

4.1.2 *Call request (state 2)*

The calling DTE shall indicate a request for a call by signalling steady binary condition t = 1 provided that it was previously signalling *DTE ready* (t = 0).

4.1.3 *Proceed-to-select (state 3)*

When the network is prepared to receive selection information the DCE will signal steady binary condition r = 1.

The *proceed-to-select* signal will start within 6 seconds of the *call request* being sent.

4.1.4 *Selection signal sequence (state 4)*

The *selection* signal sequence shall be transmitted by the DTE on circuit T.

The format of *selection* signal sequence is defined in § 4.6.1 below.

The information content and coding of the *selection* signal sequence is contained in Annex G and Recommendation X.121 [10].

The *selection* signal sequence shall start within 6 seconds of the *proceed-to-select* being received and shall be completed within 36 seconds.

The maximum permissible interval between individual selection characters is 6 seconds.

4.1.5 *DTE waiting (state 5)*

During *DTE waiting*, the DTE signals steady binary condition t = 1.

4.1.6 *Incoming call (state 8)*

The DCE will indicate an incoming call by signalling steady binary condition r = 1.

4.1.7 *Call accepted (state 9)*

The DTE shall accept the incoming call not later than 600 ms by signalling the steady state binary condition t = 1.

10-100 ms thereafter, the DTE transmits the call control character 0/6 (ACK).

4.1.8 *Call not accepted (state 18)*

If the DTE does not wish to accept the incoming call it shall signal this not later than 600 ms by changing circuit T to steady binary condition 1.

10-100 ms thereafter, the DTE shall transmit the call control character 1/5 (NAK) followed by *DTE clear request* (state 13).

4.1.9 *Call progress signal sequence (state 6)*

The *call progress* signal sequence will be transmitted by the DCE to the calling DTE on the R circuit when an appropriate condition is encountered by the network.

A *call progress* signal sequence will consist of one or more *call progress* signal blocks. A *call progress* signal block will consist of one or more *call progress* signals.

The format of the *call progress* signal sequence is defined in § 4.6.2 below.

The coding of *call progress* signals is provided in Annex E.

The description of *call progress* signals is provided in Recommendation X.96 [4].

A *call progress* signal sequence will be transmitted by the DCE within 60 seconds of: 1) the *end-of-selection* signal or 2) in case of *direct call*, the *proceed-to-select* signal being sent by the DTE. The *call progress* signal sequence, however, will not be sent by the DCE before the reception of the *end-of-selection* signal except in the case of expiration of time-outs described in § 4.1.4 where there may be a *call progress* signal sequence followed by the *clear indication.*

Note – When an error is detected in a received *call progress* signal sequence, the DTE may choose to either ignore the signal or attempt a new call after clearing.

4.1.10 *DCE provided information sequence (states 7 and 7 bis)*

The *DCE provided information* sequences will be transmitted by a DCE to the calling DTE (state 7) or a called DTE (state 7 *bis*) on circuit R.

A *DCE provided information* sequence will consist of 1 or more *DCE provided information* blocks. Each *DCE provided information* block will be limited to a maximum length of 128 characters.

The format of the *DCE provided information* sequences is defined in § 4.6.3 below.

The information content of *DCE provided information* is given in Annex G.

A *DCE provided information* sequence (state 10 *bis*) will be sent to the called DTE within 60 seconds of the *call accepted* signal being sent.

4.1.10.1 *Line identification*

Calling and *called line identification* is an optional additional facility.

The information content of *calling* and *called line identification* is provided in Annex G.

Calling and *called line identification* will be transmitted by the DCE on the R circuit during states 7 *bis* or 7 respectively.

When provided, *called line identification* (state 7) will be transmitted by the DCE to the calling DTE after all *call progress* signals, if any.

When provided, *calling line identification* (state 7 *bis*) will be transmitted by the DCE to the called DTE after *call accepted* has been sent by the DTE.

In the case where the *calling line identification* facility is not provided by the originating network, or the *called line identification* facility is not provided by the destination network, a *dummy line identification* shall be provided by the DCE to the DTE.

4.1.10.2 *Charging information*

Charging information is an optional additional facility provided during state 7 *bis.*

Upon completion of clearing the call for which *charging information* has been requested, the DCE will, within 100 ms after entering *ready* (state 1), establish an incoming call to the DTE for the purpose of giving *charging information.*

Note – The 100 ms value is tentative and a subject for further study.

Charging information will be transmitted by the DCE on circuit R.

The DCE will send *clear indication* (state 16) upon sending the last *charging information* block. The DTE should send *clear request* (state 13) when it has correctly received the *charging information* signal, if the DCE has not previously signalled the *clear indication.*

The format of *charging information* is defined in § 4.6.3 below.

4.1.11 *Connected (state 10)*

The DCE signals that the connection is being established by the transmission of the call control character 0/6 (ACK) on circuit R. Because of possible switching delays in the network, the DTE must keep circuit T in steady binary condition 1 during this state.

4.1.12 *Ready for data (state 11)*

20 ms after the reception of the call control character 0/6 (ACK) in state 10, the connection is available for data transfer between both DTEs.

4.2 *Unsuccessful call*

If the required connection cannot be established, the DCE will indicate this and the reason to the calling DTE by means of a *call progress* signal. Afterwards the DCE will signal *DCE clear indication* (state 16).

4.3 *Call collision (state 19)*

A *call collision* is detected by the DCE when it receives *call request* in response to an *incoming call*. The DCE may either accept the *call request* or may perform *DCE clearing*.

4.4 *Direct call*

For the *direct call* facility, *selection* signals (state 4) are always bypassed.

Note – The *direct call* facility can only be provided on a subscription basis and not on a per-call basis.

4.5 *Facility registration/cancellation procedure*

Registration/cancellation of optional user facilities shall be carried out by a DTE in accordance with normal call establishment procedures using the *selection* sequence, which is defined in § 4.6.1 below.

The format of the *facility registration/cancellation* signal is defined in § 4.6.1.3 below.

The *facility registration/cancellation* procedure shall not be combined with establishment of a normally addressed call, but shall be taken as an independent procedure.

In response to acceptance or rejection of the *facility registration/cancellation* procedure, the network will provide the appropriate *call progress* signal followed by *clear indication*.

4.6 *Selection, call progress and DCE provided information formats*

(See also Annex D for a syntactic description of the formats.)

4.6.1 *Format of selection sequence*

A selection sequence shall consist of a *facility request* block, or an *address* block, or a *facility request* block followed by an *address* block, or a *facility registration/cancellation* block.

4.6.1.1 *Facility request block*

A *facility request* block shall consist of one or more *facility request* signals.

Multiple *facility request* signals shall be separated by character 2/12 (" , ").

A *facility request* signal shall consist of a *facility request* code and may contain one or more *facility* parameters. The *facility request* code, *facility* parameter and subsequent *facility* parameters shall be separated by character 2/15 (" / "). For an interim period the 2/15 (" / ") separator will not be used in some networks.

The end of a *facility request* block shall be indicated by character 2/13 (" – ").

The coding of *facility request*, indicator and parameter is provided in Annex F.

4.6.1.2 *Address block*

An *address* block shall consist of one or more *address* signals.

An *address* signal shall consist of either a *full address* signal or an *abbreviated address* signal.

Start of an *abbreviated address* signal shall be indicated by a prefix character 2/14 (" . ").

Multiple *address* signals shall be separated by character 2/12 (" , ").

4.6.1.3 *Facility registration/cancellation block*

A *facility registration/cancellation* block shall consist of one or more *facility registration/cancellation* signals.

A *facility registration/cancellation* signal shall consist of up to four elements in order: *facility request* code, *indicator*, *registration* parameter, *address* signal.

The elements of a *facility registration/cancellation* signal shall be separated by character 2/15 (" / ").

If a *facility registration/cancellation* signal contains less than four of the elements, the elements should be eliminated in reverse order (e.g. a two-element *facility registration/cancellation* signal will contain the *facility request* code " / " *indicator*). If any element to be sent within the sequence is not required, a 0/3 ("0") character should be inserted in the position of each missing element (e.g. *facility request* code /0/0/*Address* signal).

Multiple *facility registration/cancellation* signals shall be separated by character 2/12 (" , ").

The end of a *facility registration/cancellation* block shall be indicated by character 2/13 ("−") followed by character 2/11 ("+").

4.6.1.4 *End of selection sequence*

The end of a selection sequence shall be indicated by character 2/11 ("+").

4.6.2 *Format of a call progress sequence*

A *call progress* block shall consist of one or more *call progress* signals.

Each *call progress* signal need not be repeated.

Multiple *call progress* signals shall be separated by characters 0/13 ("CR") and 0/10 ("LF").

The end of a *call progress* block shall be indicated by character 2/11 ("+").

4.6.3 *Formats of DCE provided information*

The following formats are specified for *DCE provided information* signals which have been identified.

The *DCE provided information* shall be preceded by the IA5 characters 0/13 ("CR"), 0/10 ("LF"), and except for *calling* and *called line identification*, by the IA5 character 2/15 (" / "). To distinguish between different types of *DCE provided information*, the prefix should be followed by one or more numerical characters followed by the character 2/15 (" / ") before the actual information is presented. The end of a *DCE provided information* block shall be indicated by character 2/11 ("+").

4.6.3.1 *Format of called and calling line identification*

Calling line identification block and *called line identification* block shall be preceded by character 2/10 (" * ").

When a *calling* or *called line identification* block contains Data Network Identification Codes (DNIC) or Data Country Codes (DCC), the blocks shall be preceded by 2 characters 2/10 (" ** ").

A *called line identification* block shall consist of one or more *called line identification* signals.

Multiple *called line identification* signals shall be separated by characters 0/13 ("CR") and 0/10 ("LF").

The end of *calling line identification* signal and *called line identification* block shall be indicated by character 2/11 ("+").

The *dummy line identification* block shall be indicated by character 2/10 (" * ") followed by 2/11 ("+").

4.6.3.2 *Format of charging information*

The *charging information* block will be preceded by characters 0/13 ("CR"), 0/10 ("LF"), and 2/15 (" / ") followed by a second IA5 numerical character (1 or 2 or 3) followed by character 2/15 (" / "). The end of the *charging information* block shall be indicated by character 2/11 ("+").

5 Data transfer phase

5.1 *Data transfer (state 12), circuit switched service*

The events during *data transfer* are the responsibility of the DTE.

5.2 *Data transfer, leased circuit service*

5.2.1 *Ready*

Circuits T and R show binary 1.

5.2.2 *Send data (state 12S)*

Data transmitted by the DTE on circuit T are delivered to the remote DTE on circuit R.

5.2.3 *Receive data (state 12R)*

Data transmitted by a distant DTE are received on circuit R.

5.2.4 *Data transfer (state 12)*

Data are transferred on circuits T and R.

5.2.5 *Termination of data transfer*

The termination of *data transfer* is the responsibility of the DTE.

6 Clearing phase

6.1 *Clearing by the DTE (states 13, 14, 15)*

The DTE should indicate clearing by signalling the steady binary condition t = 0, *DTE clear request* (state 13) for more than 210 ms.

The DCE will respond within 6 seconds by signalling the steady state condition r = 0, *DCE clear confirmation* (state 14), for more than 210 ms and will not reverse circuit R to binary 1 before *DCE ready* (state 1).

Within 210-490 ms after the beginning of DCE *clear confirmation* the DTE shall be ready to accept an *incoming call*, i.e. it shall be in the state 15, *DTE ready.*

6.2 *Clearing by the DCE (states 16, 17, 15)*

The DCE will indicate clearing to the DTE by signalling the steady binary condition r = 0, *DCE clear indication* (state 16) for more than 210 ms.

Within 210-490 ms after the beginning of *DCE clear indication*, the DTE should signify *DTE clear confirmation* (state 17) by signalling the steady binary condition t = 0 for more than 210 ms.

Within 490 ms after the beginning of the *DTE clear confirmation*, the DTE shall be ready to accept an *incoming call*, i.e. it shall be in the state 15, *DTE ready.*

6.3 *DCE ready (state 1)*

490 ms after the beginning of *DCE* or *DTE clear confirmation*, respectively, the DCE is ready to accept a new *call request.*

6.4 *Clear collision*

In case *DTE clear request* and *DCE clearing* occur at the same instant or during an overlapping time of 210 ms, the DTE shall proceed in its clearing procedure.

7 Test loops

The definitions of test loops are provided in Recommendation X.150 [11].

7.1 *Local test loop – loop 3*

In order to assist the test of the DTE, test loop 3 is provided in the DCE which causes signals on circuit T to be presented on circuit R.

Test loop 3 should be near the DCE/DTE interface. The DCE interface generator and receiver may be included in the test loop. The precise implementation of the test loop within the DCE is a national option.

Manual control should be provided on the DCE for activation of the test loop.

7.2 *Network test loop – loop 2*

For network maintenance purposes, a loop 2 is implemented in the DCE.

Loop 2 may be controlled manually on the DCE or automatically from the network. The control of the loop and the method used for the automatic control, when implemented, is a national option.

In the leased circuit service, loop 2 should not be activated prior to notifying the customer. Some Administrations may activate the loop without first informing the customer when an abnormal condition is detected in the network.

In the circuit switched service, loop 2 may be activated without the knowledge and agreement of the customer for periods which do not exceed one second. The loop shall not be activated when the DTE is engaged in a call.

In case of a collision between *call request* and the activation of the loop, the loop activation command will have priority.

When the test is in progress, the DCE will signal r = 0.

7.3 *DTE test loop – loop 1*

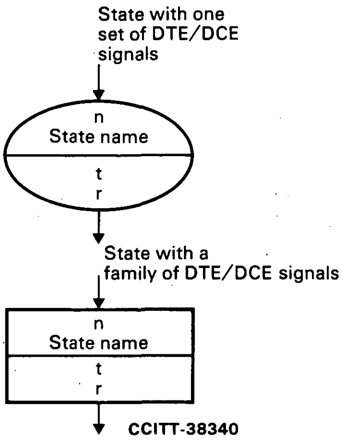
If loop 1 is implemented in the DTE and is activated, the DTE may present the same binary condition on circuit T as it was before the test. During the test, the DTE should monitor circuit R in order to detect an incoming call.

ANNEX A

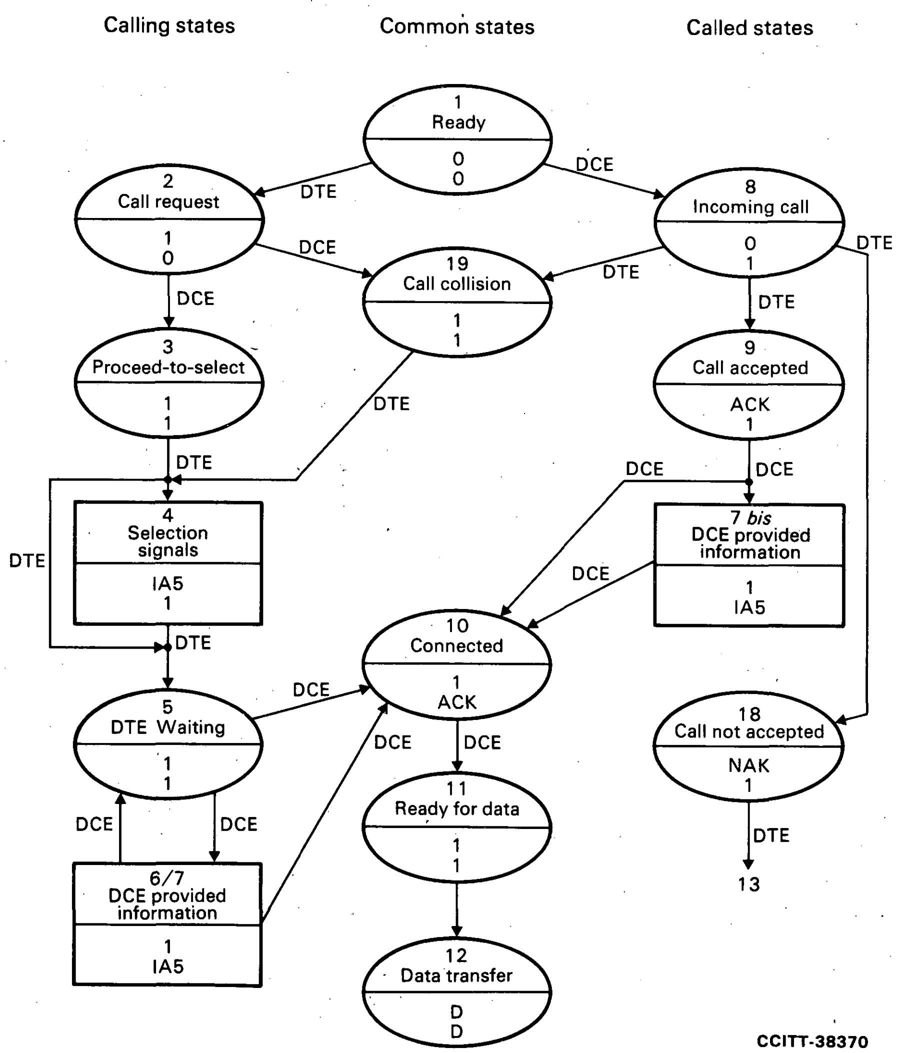
(to Recommendation X.20)

Interface signalling state diagrams

Definition of symbols used in state diagrams



n	State number
t	Signal on T circuit
r	Signal on R circuit
T	Transmit interchange circuit
R	Receive interchange circuit
D	DTE or DCE data signals
0 and 1	Steady binary conditions
X	Any value
IA5	Characters from International Alphabet No. 5 (Recommendations V.3 [8] and X.4 [9]
ACK	IA5 character 0/6
NAK	IA5 character 1/5
↓	Transition with indication of whether DTE or DCE is responsible for transition



Note – For simplification of the state diagram, state 6 *(call progress signals)* is merged with state 7 *(DCE provided information)*.

FIGURE A-1/X.20

Call control phase for circuit switched service

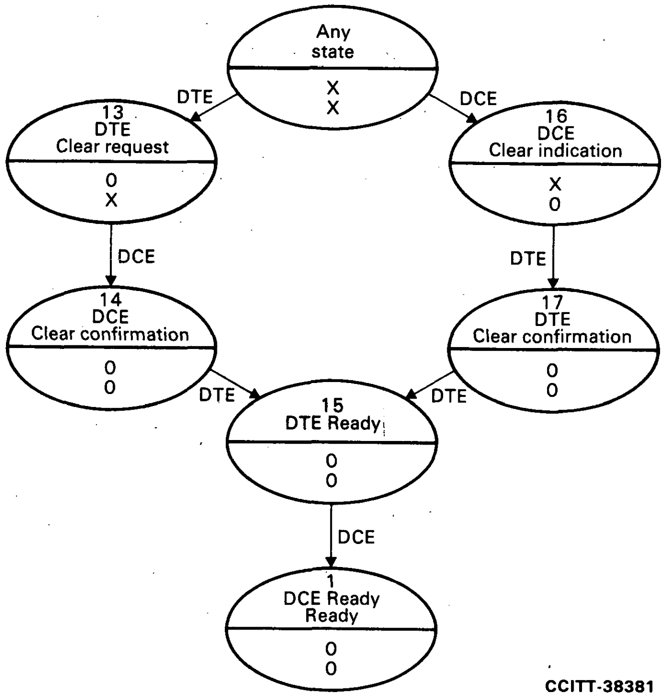


FIGURE A-2/X.20

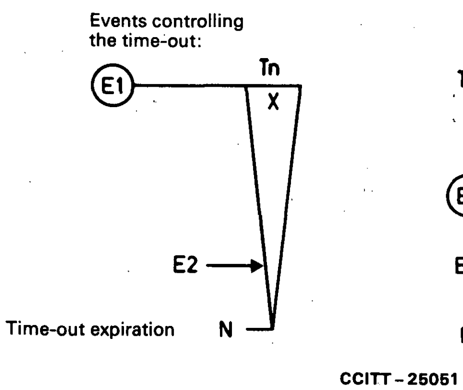
Clearing phase

ANNEX B

(to Recommendation X.20)

Interface signalling sequence diagrams and time-out operations

Definition of symbols used to illustrate time-out operation in the signalling sequence diagrams:



Tn Time-out number

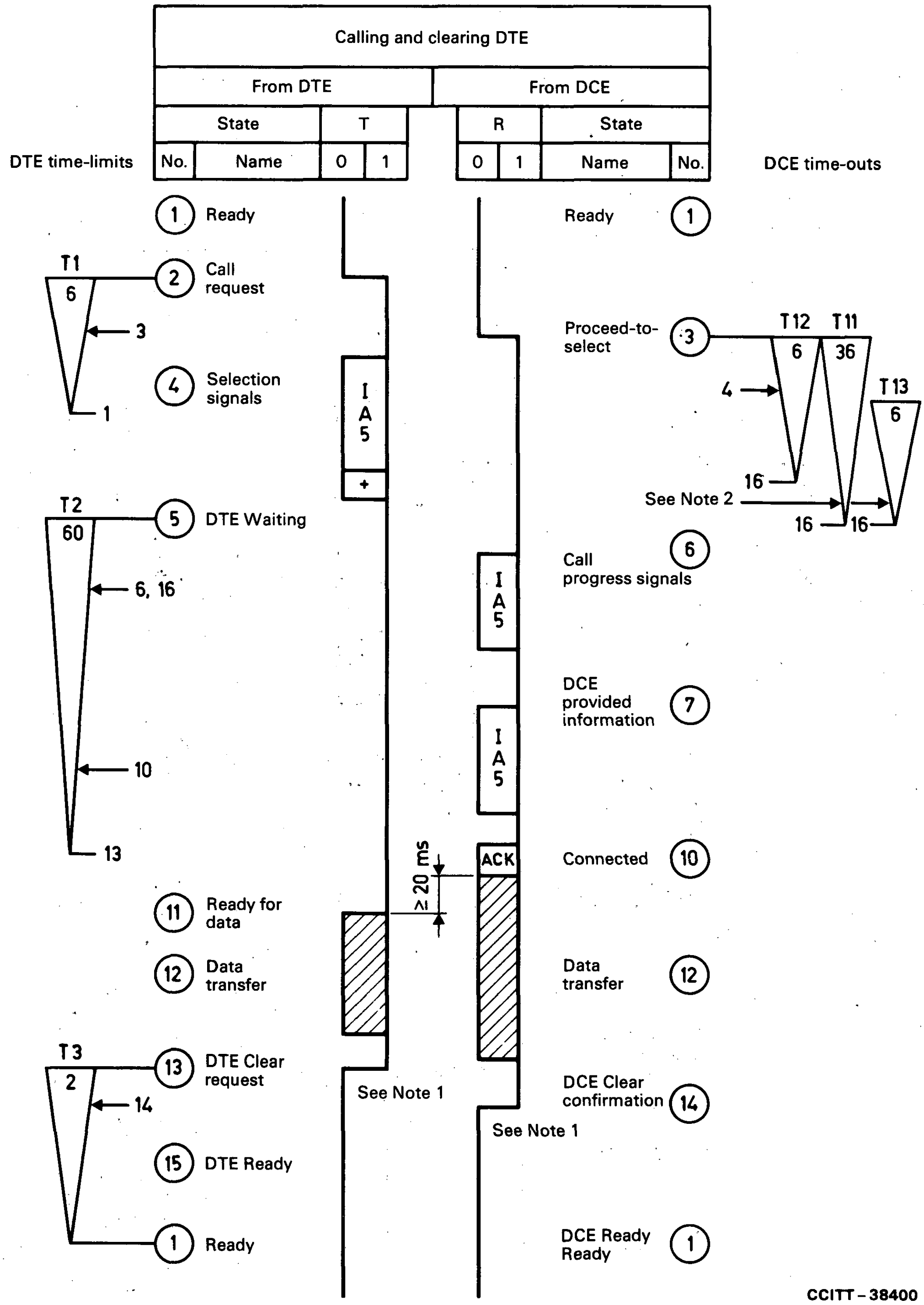
X Time-out figure in seconds

(E1) Start of time-out at event indicated

E2 Stop of time-out at event indicated

N Number of the state to be entered after expiration of time-out

Note – For additional alternative assignments of DTE time-limits or DCE time-outs not shown together with the signalling sequence diagrams, see Table C-1/X.20.

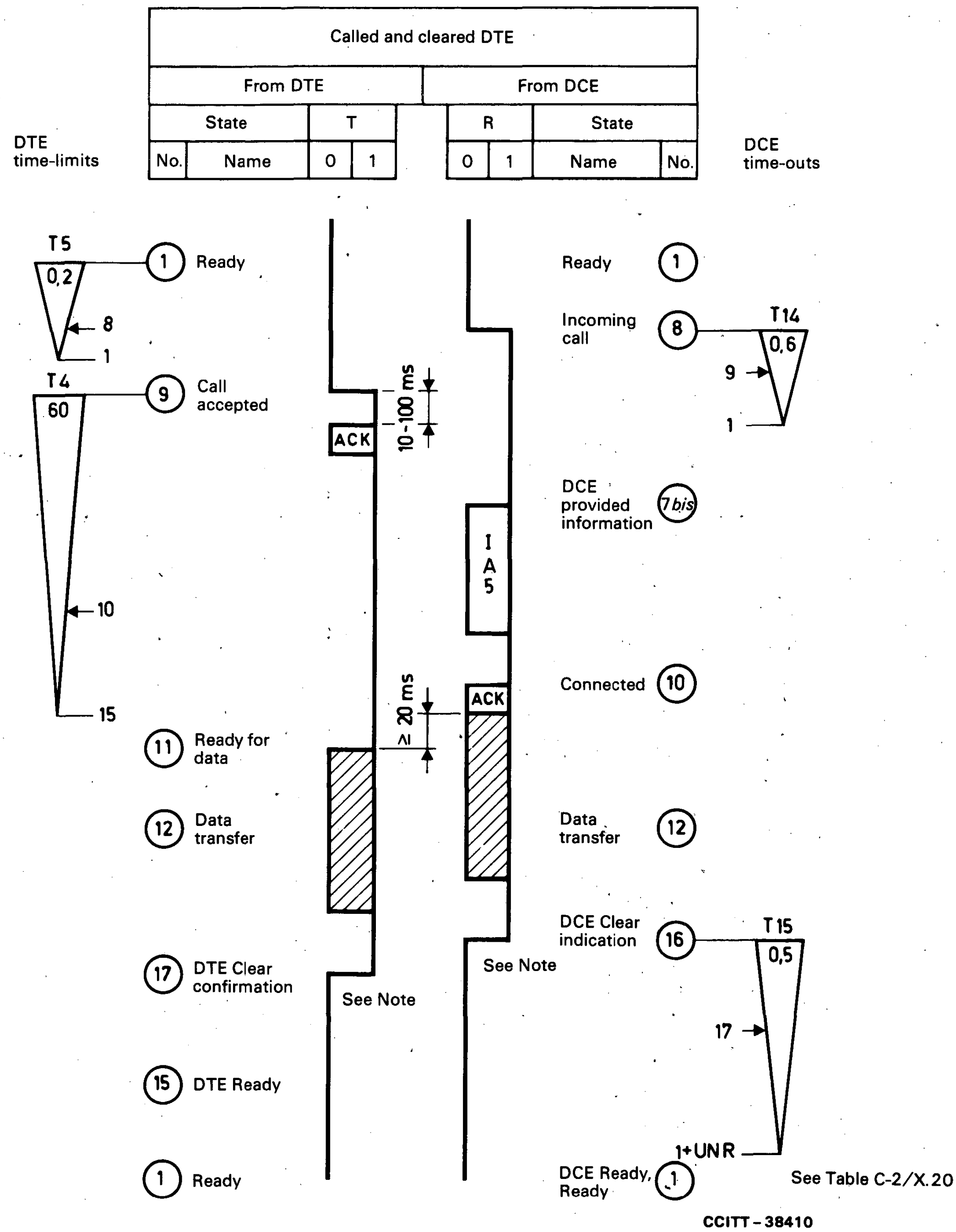


Note 1 – For proper detection, steady state conditions shall last at least 210 ms.

Note 2 – For additional alternative assignments of DTE time-limits or DCE time-outs not shown together with the signalling sequence diagrams, see Table C-1/X.20.

FIGURE B-1/X.20

Example of sequence of events: successful call and clear for circuit-switched service (calling and clearing DTE)



Note – For proper detection, steady state conditions shall last at least 210 ms.

FIGURE B-2/X.20

Example of sequence of events: successful call and clear for circuit-switched service (called and cleared DTE)

ANNEX C

(to Recommendation X.20)

DTE time-limits and DCE time-outs

C.1 *DTE time-limits*

Under certain circumstances this Recommendation requires the DCE to respond to a signal from the DTE within a stated maximum time. If any of these maximum times is exceeded, the DTE should initiate the action indicated in Table C-1/X.20. To maximize efficiency, the DTE should incorporate time-limits to send the appropriate signal under the defined circumstances summarized in Table C-1/X.20. The time-limits given in the first column are the maximum times allowed for the DCE to respond and are consequently the lower limits of the times a DTE must allow for proper network operation. A time-limit longer than the time shown may be optionally used in the DTE; for example, all DTE time-limits could have one single value equal to or greater than the longest time-limit shown in this table. However, the use of a longer time-limit will result in reduced efficiency of network utilization. The actual DCE response time should be as short as is consistent with the implementing technology and in normal operation should be well within the specified time-limit. The rare situation where a time-limit is exceeded should only occur when there is a failure in DCE operation.

TABLE C-1/X.20

DTE time-limits

Time-limit	Time-limit number	Started by	Normally terminated by	Preferred action to be taken when time-limit exceeded
6 s	T1	Signalling of *call request* (state 2)	Reception of *proceed-to-select* (state 3)	DTE signals *DTE ready* (state 1)
60 s	T2	Signalling *end-of-selection* or *DTE waiting* (direct call) (state 5)	Reception of *call progress* signals, DCE provided *information connected* or *DCE clear indication* (states 6, 7, 10 or 16), Reset by additional *call progress* signals (state 6)	DTE signals *DTE clear request* (state 13)
2 s	T3	Change of state to *DTE clear request* (state 13)	Change of state to *DCE clear confirmation* (state 14) or *DCE ready* (state 1)	DTE regards the DCE as DCE not ready and signals *DTE ready* (state 15)
60 s	T4	Change of state to *call accepted* (state 9)	Reception of connected or *DCE clear indication* (state 10 or 16), reset by *DCE provided information* (state 7 *bis)*	
200 ms	T5	Change of state to *ready* (state 1) when *charge information* has been requested	Reception of *incoming call* (state 8)	DTE returns to normal operation and may note absence of *charge information*

C.2 *DCE time-outs*

Under certain circumstances this Recommendation requires the DTE to respond to a signal from the DCE within a stated maximum time. If any of these maximum times is exceeded, a time-out in the DCE will initiate the actions summarized in Table C-2/X.20. These constraints must be taken into account in the DTE design. The time-outs given in the first column of the table are the minimum time-out values used in the DCE for the appropriate DTE response and are consequently the maximum times available to the DTE for response to the indicated DCE action. The actual DTE response time should be as short as is consistent with the implementing technology and in normal operation should be within the specified time-out. The rare situation where a time-out is exceeded should only occur when there is a failure in the DTE operation.

TABLE C-2/X.20

DCE Time-outs

Time-out	Time-out number	Started by	Normally terminated by	Action to be taken when time-out expires
36 s	T11 (see Note)	DCE signalling of *proceed-to-select* (state 3)	DCE reception of *end-of-selection* signal	DCE will signal *DCE clear indication* (state 16) or transmit appropriate call progress signal followed by *DCE clear indication* (state 16)
6 s	T12	DCE signalling of *proceed-to-select* (state 3)	DCE reception of first selection character or in the case of *direct call, DTE waiting* (state 5)	
6 s	T13 (see Note)	DCE reception of nth selection character (state 4)	DCE reception of (n+1)th selection character or *end-of-selection* signal	
600 ms	T14	DCE signalling of *incoming call* (state 8)	Change state to *call accepted* (state 9) or *call collision* (state 18)	The DTE is noted as not answering The DCE will signal *DCE ready* (state 1)
500 ms	T15	Change of state to *DCE clear indication* (state 16)	Change of state to *DTE clear confirmation* (state 17)	DCE will signal *DCE ready* and mark *DTE uncontrolled not ready*

Note – T11 and T13 do not apply in the case of a direct call.

ANNEX D

(to Recommendation X.20)

Formats of Selection, Call Progress, and DCE provided information signals

The following description uses Backus Normal Form as the formalism for syntactic description. A vertical line " | " separates alternatives.

<LF> : : = IA 5 character 0/10

<CR> : : = IA 5 character 0/13

<*> : : = IA 5 character 2/10

<+> : : = IA 5 character 2/11

< , > : : = IA 5 character 2/12

< – > : : = IA 5 character 2/13

< . > : : = IA 5 character 2/14

< / > : : = IA 5 character 2/15

<η> : : = IA 5 characters 3/1, 3/2 or 3/3

< : > : : = IA 5 character 3/10

<Facility request signal> : : = See Annex F

<Facility parameter> : : = See Annex F

<Full address signal> : : = See Recommendation X.121 [10]

<Abbreviated address signal> : : = National option

<Calling line identification signal> : : = See Annex G

<Called line identification signal> : : = See Annex G

<Charging information> : : = See Annex G

<Indicator> : : = See Annex F

<Facility request code> : : = See Annex F

<Registration parameters> : : = See Annex F

<Call progress signal> : : = See Annex E

The above signals are combined as follows:

<Address signal> : : = <Full address signal> | < . > <Abbreviated address signal>

<Address block> : : = <Address signal> | <Address block> < , > <Address signal>

<Facility registration/cancellation signal> : : = <Facility request code> < / > <Indicator> < / > <Registration parameter> < / > <Address signal>

<Facility registration/cancellation block> : : = <Facility registration/cancellation signal> | <Facility registration/cancellation block> < , > <Facility registration/cancellation signal>

<Facility request signal> : : = <Facility request code> | <Facility request signal> < / > <Facility parameter>

<Facility request block> : : = <Facility request signal> | <Facility request block> < , > <Facility request signal>

<Selection sequence> : : =	<Facility request block> < – > <Address block> < + > | <Facility request block> < – > < + > | <Address block> < + > | <Facility registration/cancellation block> < – > < + >
<Call progress block> : : =	<CR> <LF> <Call progress signal> < + > | <Call progress signal> < , > <Call progress block>
<Calling line identification> : : =	<CR> <LF> <*> <Calling line identification signal> < + >
<Calling line identification (with DNIC or DCC)> : : =	<CR> <LF> <**> <Calling line identification signal> < + >
<Called line identification> : : =	<CR> <LF> <*> <Called line identification block> < + >
<Called line identification block> : : =	<Called line identification signal> | <Called line identification block> <CR> <LF> <Called line identification signal>
<Called line identification (with DNIC or DCC)> : : =	<CR> <LF> <**> <Called line identification block> < + >
<Dummy line identification> : :=	<CR> <LF> <*> < + >
<Charging information block> : : =	<CR> <LF> < / > <η> < / > <Charging information signal> < + >

ANNEX E

(to Recommendation X.20)

Coding of call progress signals

TABLE E-1/X.20

Code group (see Note 1)	Code	Significance	Category
0	00 01 02 03	See Note 2 Terminal called Redirected call Connect when free	Without clearing
2	20 21 22 23	No connection Number busy Selection signals procedure error Selection signal transmission error	With clearing due to short-term conditions
4 and 5	41 42 43 44 45 46 47 48 49 51 52	Access barred Changed number Not obtainable Out of order Controlled not ready Uncontrolled not ready DCE power off Invalid facility request Network fault in local loop Call information service Incompatible user class of service	With clearing due to long-term conditions
6	61	Network congestion	With clearing due to network short-term conditions
7	71 72	Long-term network congestion RPOA out of order	With clearing due to network long-term conditions
8	81 82 83	Registration/cancellation confirmed Redirection activated Redirection deactivated	With clearing due to DTE-network procedure

Note 1 – From the DTE point of view group 0 means "wait"; groups 2 and 6 mean "try again, next try may result in a call set-up"; groups 4 and 5, and 7 mean "there is no reason for the DTE to try again because the answer will be the same for a longer period of time". Since group 8 results from a procedure between the DTE and the network, no special action is expected to be taken by the DTE.

Note 2 – Reserved for future use.

ANNEX F

(to Recommendation X.20)

Facility request, indicator and parameter coding (for use as appropriate request signals)

TABLE F-1/X.20

(see Annex D for formats and Note 1 below)

Facility request code	Facility parameter	Indicator	Registration parameter	Facility
0	—	—	—	Reserved for future use (may be combined with second character)
1	XX (see Note 2)	—	—	Closed user group (other than preferential)
2	—	—	—	Not yet assigned
3	—	—	—	Not yet assigned
4	—	—	—	Reserved
5	—	—	—	Not yet assigned
60	—	—	—	Multiple address calling
61	—	—	—	Charging information
62	—	—	—	Called line identification
63	—	1	—	Activation of redirection
63	—	2	—	Deactivation of redirection
63	—	3	—	Redirection status inquiry
7	—	—	—	Reserved
8	—	—	—	Reserved
9	—	—	—	Reserved

Note 1 – For an interim period, the 2/15 "/" separator will not be used in some networks.

Note 2 – XX is an index number, i.e., a key code for closed user groups other than the preferential. The index number shall be used to distinguish between parts or groups within one facility. The index number shall furthermore be chosen from International Alphabet No. 5, column 3, positions 3/0 – 3/9, giving a range of possible numbers from 00 to 99.

ANNEX G

(to Recommendation X.20)

Information content of DCE provided information

G.1 *Information content of calling and called line identification*

Two formats are defined:

i) *Calling* and *called line identification* consist of the international data number as defined in Recommendation X.121 [10] preceded by *two* prefixes 2/10 (" ** ").

In the case where the originating network does not provide *calling line identification,* only the Data Network Identification Code (DNIC) part of the international data number preceded by two prefixes 2/10 (" ** ") may be sent in place of the *dummy line identification.*

ii) Calling and called line identification consist of the National Number (NN) or Network Terminal Number (NTN) preceded by the prefix 2/10 (" * ").

G.2 *Information content of charging information*

The *charging information* will inform the subscriber of either the monetary charges for a call, the duration of the call, or the number of units used during the call.

When *charging information* is given in monetary charges for the call, n = 1 and the information shall consist of x number of integer digits optionally followed by a colon and two digits representing the fraction. The format applied is as follows:

< / > <1> < / > <X . . . > < + >

< / > <1> < / > <X . . . > < : > <yy> < + >

When the *charging information* is presented as the duration of a call, n = 2 and the information shall consist of x number of integer digits representing seconds. The format applied is as follows:

< / > <2> < / > <X . . . > < + >

When the *charging information* is presented as the number of units used, n = 3, and the information shall consist of x number of integer digits representing the units. The format applied is as follows:

< / > <3> < / > <X . . . > < + >

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.1.

[2] CCITT Recommendation *International user services and facilities in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.2.

[3] CCITT Recommendation *Hypothetical reference connections for public synchronous data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.92.

[4] CCITT Recommendation *Call progress signals in public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.96.

[5] CCITT Question 27/VII, Contribution COM VII-No. 1, Study Period 1981-1984, ITU, Geneva, 1981.

[6] *Data communication – 15-pin DTE/DCE interface connector and pin assignments*, ISO Standard No. 4903-1980.

[7] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.28.

[8] CCITT Recommendation *International Alphabet No. 5*, Vol. VIII, Fascicle VIII.1, Rec. V.3.

[9] CCITT Recommendation *General structure of signals of International Alphabet No. 5 code for data transmission over public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.4.

[10] CCITT Recommendation *International numbering plan for public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.121.

[11] CCITT Recommendation *DTE and DCE test loops for public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.150.

Recommendation X.20 *bis*

USE ON PUBLIC DATA NETWORKS OF DATA TERMINAL EQUIPMENT (DTE) WHICH IS DESIGNED FOR INTERFACING TO ASYNCHRONOUS DUPLEX V-SERIES MODEMS

(Geneva, 1976; amended at Geneva, 1980)

The CCITT,

considering that

(a) the interface between Data Terminal Equipment (DTE) and Data Circuit Terminating Equipment (DCE) for start-stop transmission on public data networks is specified in Recommendation X.20,

(b) several Administrations are planning to provide as an interim measure the connection to public data networks of start-stop DTEs which are designed for interfacing to V-Series modems for start-stop transmission, *unanimously declares the view*

that the interface between a V-Series type DTE and a DCE in public data networks for user classes of service employing start-stop transmission should be as defined in this Recommendation.

1 Scope

This Recommendation applies to the interface between a DTE designed for interfacing to duplex V-Series modems for start-stop transmission and a DCE on public data networks.

The operation is limited to start-stop transmission at data signalling rates and character structures specified for start-stop transmission in Recommendation X.1 [1].

The application comprises:

a) circuit switched service,

b) leased circuit service (point-to-point and centralized multipoint).

2 Interchange circuits

2.1 *Functional characteristics*

The functional characteristics of the interchange circuits concerned (see Table 1/X.20 *bis*) comply with Recommendation V.24 [2].

TABLE 1/X.20 *bis*

Interchange circuit	
Number	Designation
102	Signal ground or common return
103	Transmitted data
104	Received data
106	Ready for sending
107	Data set ready
108/1 a)	Connect data set to line
108/2 b)	Data terminal ready
109	Data channel received line signal detector
125 c)	Calling indicator
141 d)	Local loop back
142	Test indicator

a) Used in case of automatic control of the direct call facility.
b) Used in case of switched data network service.
c) Not provided in leased circuit service.
d) Not provided in those networks which do not provide automatic activation of of the test loops.

2.2 *Electrical characteristics*

The electrical characteristics of the interchange circuits comply with Recommendation V.28 [3], using the 25-pin interface connector and pin assignments in ISO 2110 [4].

3 Use of interchange circuits

3.1 *Operation of interchange circuit 107 – Data set ready*

This circuit is used to indicate the operational functions given in Table 2/X.20 *bis*.

TABLE 2/X.20 *bis*

Condition of circuit 107	Meaning in the data network
ON	Ready for data (see Note)
OFF	DCE clear indication
OFF	DCE clear confirmation

Note – Since no circuit 105 is operated, the ON condition on circuit 106 is applied 0 to 20 milliseconds after circuit 107 is turned ON.

3.2 *Use of interchange circuits 108/1 and 108/2*

3.2.1 *Circuit 108/1 – Connect data set to line*

This circuit is used alternatively to circuit 108/2. The operational functions given in Table 3/X.20 *bis* should be indicated.

TABLE 3/X.20 *bis*

Condition of circuit 108/1	Meaning in the data network
ON	Call request for direct call (see § 3.4.1)
ON	Call accepted
OFF	DTE clear request
OFF	DTE clear confirmation (see § 3.4.4)

3.2.2 *Circuit 108/2 – Data terminal ready*

This circuit is used alternatively to circuit 108/1. The operational functions given in Table 4/X.20 *bis* should be indicated.

TABLE 4/X.20 *bis*

Condition of circuit 108/2	Meaning in the data network
ON	Call accepted
OFF	DTE clear request
OFF	DTE clear confirmation (see § 3.4.4)

3.3 *Circuit 125 – Calling indicator*

The ON condition indicates *incoming call.* The circuit will be turned OFF as follows:

– in conjunction with circuit 107 turned ON, or

– *DCE ready* is received from the network, or

– *DCE clear indication* is received from the network.

3.4 *Operational requirements for circuits 106, 107, 108/1, 108/2 and 109*

3.4.1 *Call request for direct call*

For a *direct call* facility the DTE indicates a call request by turning circuit 108/1 ON. Circuit 108/2 cannot be used for this purpose.

3.4.2 *Call accepted*

A DTE receiving an *incoming call* should turn circuit 108/1 or 108/2 from OFF to ON within 500 ms to indicate *call accepted*, otherwise the call will be cleared. A DCE presenting an *incoming call* to a DTE which already has circuit 108/2 ON will regard the ON condition on circuit 108/2 as an indication of *call accepted.*

Optionally when a DTE does not provide circuit 108/1 or 108/2, the *call accepted* signal to the network would be generated within the DCE as an answer to the *incoming call* signal received from the network. However, it may also be possible to signal to the network a *DTE controlled not ready* by a manual action on the DCE.

3.4.3 *Operation of interchange circuits 109 and 106*

The DCE switches circuit 109 to ON together with circuit 107. Circuit 106 is put to ON 0 to 20 ms after the appearance of the ON condition on circuit 107.

The circuits 109 and 106 are switched to OFF either when circuit 108 is switched to OFF or when circuit 108 is ON and the DCE signals *DCE clear indication* (see § 3.4.4).

3.4.4 *DCE clear indication and DTE clear confirmation*

DCE clear indication is signalled to the DTE by turning circuit 107 OFF. The *DTE clear confirmation,* when implemented, should be given by the DTE turning OFF circuit 108/1 or 108/2 within 100 ms after the *DCE clear indication* is signalled on circuit 107. Otherwise, the DCE may consider the DTE as being *uncontrolled not ready* until circuit 108/1 or 108/2 is turned OFF or a *ready* signal is generated by a manual action on the DCE.

Circuit 108/1 should always be able to give *DTE clear confirmation.*

Optionally, when a DTE does not turn circuit 108/2 OFF for *DTE clear confirmation* this would be automatically generated within the DCE as an answer to the *clear indication* received from the network and the DTE will be considered in the *ready* condition.

In the case when the DTE expects to have circuit 107 OFF only as a response to circuit 108/1 or 108/2 OFF, the DCE will not turn circuit 107 OFF as a *DCE clear indication* and in this case the DCE indication will not be signalled to the DTE across the interface. The necessary *DTE clear confirmation* signal will then be automatically generated within the DCE as an answer to the *clear indication* signal received from the network. The DTE may be regarded as *uncontrolled not ready* until circuit 108/1 or 108/2 is turned OFF.

3.4.5 *Centralized multipoint operation*

As the circuits 106 and 109 are always in the ON condition, the transmission disciplines must be determined by end-to-end control procedures of the DTEs.

4 **Call progress signals and DCE provided information**

Call progress signals and *DCE provided information* cannot be handled by V-Series DTEs.

5 **Failure detection and isolation**

5.1 *Fault conditions of interchange circuits*

If the DTE or DCE is unable to determine the condition of circuits 107, 108/1 or 108/2 and possibly circuits 103 and 104, it shall interpret this as an OFF condition or binary 1 (circuits 103 and 104) as specified in the relevant electrical interface specifications.

5.2 *DCE fault conditions*

If the DCE is unable to provide service (e.g: loss of incoming line signal) for a period longer than a fixed duration it will turn circuit 107 to the OFF condition. The value of this duration is network dependent.

5.3 *Test loops*

The definitions of the test loops are provided in Recommendation X.150 [5].

5.3.1 *Local test loop – loop 3*

In order to assist the test of the DTE, test loop 3 is provided in the DCE where the signals transmitted on circuit 103 are presented on circuit 104.

Circuit 106 and circuit 107 should be ON. Additionally, circuit 142 should be ON whilst the loop is activated.

In the circuit-switched service, any existing connection with a remote station should be cleared by the DCE when the loop is activated.

The loop should be near the DCE/DTE interface. The DCE drivers and terminators may be included in the loop. The precise implementation of the loop within the DCE is a national option. Manual control should be provided on the DCE for activation of the loop.

5.3.2 *Network test loop – loop 2*

For network maintenance purposes loop 2 is implemented in the DCE.

The loop may be controlled manually on the DCE or automatically by the network. The control of the loop and the method used for the automatic control, when implemented, is a national option.

In the circuit switched service the loop should not be activated when the DTE is engaged in a call. The loop may be activated by the network without the knowledge and agreement of the DTE for periods which do not exceed one second.

In the leased circuit service the loop should not be activated before the customer has been informed of it. Some Administrations may activate the loop when abnormal conditions are detected in the network without first informing the customer.

When the test is in progress the DCE will turn circuits 107 and 109 in the OFF condition, circuit 104 in the binary 1 condition and circuit 142 in the ON condition.

In case of a collision between a *call request* and the activation of the loop, the loop activation command will have priority.

5.3.3 *DTE test loop – loop 1*

This loop may be used as a basic test on the operation of the DTE by returning transmitted signals to the DTE for checking. The loop should be set up inside the DTE as close as possible to the interface.

While the DTE is in the loop 1 test condition:

– transmitted data (circuit 103) is connected to received data (circuit 104) within the DTE;

– circuit 108/1 or 108/2 may be in the same condition as it was before the test;

– circuit 125 should continue to be monitored by the DTE so that an incoming call can be given priority over a routine loop test.

Interchange circuit 103 as presented to the DCE must be in the binary 1 condition.

The conditions of the other interchange circuits are not specified but they should, if possible, permit normal working.

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.1.

[2] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment*, Vol. VIII, Fascicle VIII.1, Rec. V.24.

[3] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.28.

[4] *Data communication – 25-pin DTE/DCE interface connector and pin assignments*, ISO Standard No. 2110-1980.

[5] CCITT Recommendation *DTE and DCE test loops for public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.150.

Recommendation X.21

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT TERMINATING EQUIPMENT (DCE) FOR SYNCHRONOUS OPERATION ON PUBLIC DATA NETWORKS

(Geneva, 1972; amended at Geneva, 1976 and 1980)

CONTENTS

Preface

The CCITT,

considering

(a) that Recommendations X.1 [1] and X.2 [2] define the services and facilities to be provided by a public data network,

(b) that Recommendation X.92 [3] defines the hypothetical reference connections for synchronous public data networks,

(c) that Recommendation X.96 [4] defines *call progress* signals,

(d) that the necessary elements for an interface Recommendation should be defined in architectural levels (under study, see Question 27/VII [5]),

(e) that it is desirable for characteristics of the interface between the DTE and DCE of a public data network to be standardized,

unanimously declares the view

that the interface between the DTE and DCE in public data networks for user classes of service employing synchronous transmission should be as defined in this Recommendation.

1 Scope

1.1 This Recommendation defines the physical characteristics and call control procedures for a general purpose interface between DTE and DCE for user classes of service, as defined in Recommendation X.1 [1], employing synchronous transmission.

1.2 The formats and procedures for *selection, call progress* and *DCE provided information* are included in this Recommendation.

1.3 The provision for duplex operation is covered.

1.4 The operation of the interface for half duplex operation when the data circuit interconnects with Recommendation X.21 *bis* DTEs is described in Annex E. Half duplex operation between X.21 DTEs is for further study when such new facilities are identified.

2 DTE/DCE physical interface elements

2.1 *Electrical characteristics*

2.1.1 *Data signalling rates of 9600 bit/s and below*

The electrical characteristics of the interchange circuits at the DCE side of the interface will comply with Recommendation X.27 without cable termination in the load. The electrical characteristics at the DTE side of the interface may be applied according to either Recommendation X.27 either with or without cable termination in the load, or Recommendation X.26. The B′ leads of receivers in an X.26 DTE must be brought out to the interface individually and not connected together. (See § 2.2 below.)

2.1.2 *Data signalling rates above 9600 bit/s*

The electrical characteristics of the interchange circuits at both the DCE side and the DTE side of the interface will comply with Recommendation X.27 with or without implementation of the cable termination in the load.

2.2 *Mechanical characteristics*

Refer to ISO 4903 (15-pin DTE/DCE interface connector and pin assignment) [6] for mechanical arrangements.

2.3 *Functional characteristics of interchange circuits*

Definitions of the interchange circuits concerned (see Table 1/X.21) are given in Recommendation X.24.

In this Recommendation, signal conditions on interchange circuits T, C, R, and I are designated by t, c, r, and i, respectively.

Signal conditions on circuit C *(Control)* and I *(Indication)* refer to continuous ON (significant level binary 0) and continuous OFF (significant level binary 1) conditions.

TABLE 1/X.21

Interchange circuit	Name	Direction		Remarks
		to DCE	from DCE	
G	Signal ground or common return			See Note 1
Ga	DTE common return	X		
T	Transmit	X		
R	Receive		X	
C	Control	X		
I	Indication		X	
S	Signal element timing		X	See Note 2
B	Byte timing		X	See Note 3

Note 1 – This conductor may be used to reduce environmental signal interference at the interface. In the case of shielded interconnecting cable, the additional connection considerations are part of Recommendation X.24 and ISO 4903 [6].

Note 2 – Timing for continuous isochronous data transmission will be provided.

Note 3 – May be provided as an optional additional facility (see § 3.1.1 below).

2.4 *Physical link control conditions*

The DTE and DCE shall be prepared to send steady binary conditions 0 and 1 on circuit T or R, together with associated conditions on circuit C or I, for a period of at least 24 bit intervals. Detection of steady binary 0 or 1 on circuit R for 16 contiguous bit intervals with the associated condition on circuit I may be interpreted by the DTE as a steady state condition. In case of clearing, the steady state condition should apply for at least 16 contiguous bit intervals but not less than 10 ms to be interpreted as valid. If the DCE or DTE indicates on circuits R, I, or T, C that it has recognized the steady state, the DTE or DCE will not then be obliged to continue signalling the steady binary condition.

2.5 *Quiescent phase*

During the quiescent phase, the DTE and the DCE signal their ability to enter operational phases such as the call control phase or the data transfer phase as defined for the appropriate service. The basic quiescent signals of the DTE and the DCE can appear at the interface in various combinations which result in different interface states as defined below and shown in Figure A-1/X.21.

2.5.1 *DTE quiescent signals*

2.5.1.1 *DTE ready*

The DTE indicates its readiness to enter operational phases, according to the appropriate service, by signalling t = 1, c = OFF.

2.5.1.2 *DTE uncontrolled not ready*

The DTE indicates that it is unable to enter operational phases, according to the appropriate service, generally because of abnormal operating conditions, by signalling t = 0, c = OFF.

For leased circuit service point-to-point when the DTE enters *DTE uncontrolled not ready*, the remote interface may signal r = 0, i = OFF. Additional actions to be taken by the DCE are for further study.

For leased circuit-centralized multipoint when a DTE enters *DTE uncontrolled not ready*, no indication of this signal will be given at the other connected DTE/DCE interfaces.

2.5.1.3 *DTE controlled not ready*

DTE controlled not ready indicates that, although the DTE is operational, it is temporarily unable to accept incoming calls for circuit switched service. Use of *DTE controlled not ready* for other services is for further study.

This signal is indicated by t = 01 ... (alternate bits are binary 0 and binary 1), c = OFF. This signal shall persist for a minimum of 24 bit intervals.

Note 1 – *DTE controlled not ready* is normally entered from the *ready* state, as defined in § 2.5.3.1 below. In some networks, the DCE may not recognize the *DTE controlled not ready* signal if the DTE does not first signal *DTE ready* at the same time the DCE signals *DCE ready*.

2.5.2 *DCE quiescent signals*

2.5.2.1 *DCE ready*

The DCE indicates its readiness to enter operational phases, according to the appropriate service, by signalling r = 1, i = OFF.

2.5.2.2 *DCE not ready*

DCE not ready indicates that no service is available and will be signalled whenever possible during network fault conditions and when test loops are activated. This signal is indicated by r = 0, i = OFF.

2.5.3 *Quiescent states* (see Figure A-1/X.21)

2.5.3.1 *Ready (state 1)*

Ready is entered when the DTE and the DCE simultaneously signal *DTE ready* and *DCE ready*, respectively.

2.5.3.2 *State 14*

State 14 is entered when the DTE and the DCE simultaneously signal *DTE controlled not ready* and *DCE ready*, respectively.

2.5.3.3 *State 18*

State 18 is entered when the DTE and the DCE simultaneously signal *DTE ready* and *DCE not ready*, respectively.

2.5.3.4 *State 22*

State 22 is entered when the DTE and the DCE simultaneously signal *DTE uncontrolled not ready* and *DCE not ready*, respectively.

2.5.3.5 *State 23*

State 23 is entered when the DTE and the DCE simultaneously signal *DTE controlled not ready* and *DCE not ready*, respectively.

2.5.3.6 *State 24*

State 24 is entered when the DTE and the DCE simultaneously signal *DTE uncontrolled not ready* and *DCE ready*, respectively.

2.6 *Failure detection*

2.6.1 *Fault conditions of interchange circuits* [1)]

The DTE should interpret a fault condition on circuit R as r = 0, using failure detection type 2, a fault condition on circuit I as i = OFF, using failure detection type 1, and a fault condition on both circuits R and I as r = 0, i = OFF, *DCE not ready.* Alternatively, a fault condition on one of these circuits, R or I, may be interpreted by the DTE as *DCE not ready,* r = 0, i = OFF using failure detection type 3.

The DCE will interpret a fault condition on circuit T as t = 0, using failure detection type 2, a fault condition on circuit C as c = OFF, using failure detection type 1, and a fault condition on both circuits T and C as t = 0, c = OFF, *DTE uncontrolled not ready.* Alternatively, a fault condition on one of these circuits, T or C, may be interpreted by the DCE as *DTE uncontrolled not ready,* t = 0, c = OFF using failure detection type 3.

2.6.2 *DCE fault conditions*

If the DCE is unable to provide service (e.g., loss of alignment or loss of incoming line signal) for a period longer than a fixed duration, it will indicate *DCE not ready* by signalling r = 0, i = OFF see § 2.5.2.2 above. The value of that duration is network dependent. Prior to this *DCE not ready* signal, garbled signals may be delivered to the DTE.

2.6.3 *Signal element timing provision*

The signal element timing signal is delivered to the DTE on circuit S whenever possible, even when the DCE loses alignment or the incoming line signal. The signal element timing rate should in no case deviate from the nominal value by more than ± 1%.

3 **Alignment of call control characters and error checking**

All characters for call control purposes are selected from International Alphabet No. 5 according to Recommendation V.3 [7].

3.1 *Character alignment*

For the interchange of information between the DTE and the DCE for call control purposes, it is necessary to establish correct alignment of characters. Each sequence of call control characters to and from the DCE shall be preceded by two or more contiguous 1/6 (SYN) characters.

3.1.1 Certain Administrations will require the DTE to align call control characters transmitted from the DTE to either SYN characters delivered to the DTE or to signals on the byte timing interchange circuit.

Administrations who require this alignment shall provide the byte timing interchange circuit, but its use and termination by the DTE shall not be mandatory.

3.1.2 Certain Administrations will permit call control characters to be transmitted from the DTE independently of the SYN characters delivered to the DTE.

3.1.3 Additionally, for an intermediate period (see Note), Administrations will provide connection to the public data network of DTEs operating as described in § 3.1.2 above.

Note – The intermediate period would be determined by customer demand and other relevant factors as interpreted by individual Administrations.

3.2 *Error checking*

Odd parity according to Recommendation X.4 [8] applies for IA5 characters interchanged for call control purposes.

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1) For the association of the receiver circuit-failure detection to particular interchange circuits in accordance with the type of failure detection, see Recommendation X.26, § 11 and Recommendation X.27, § 9.

4 Elements of the call control phase for circuit switched service

The state diagram provided in Figure A-2/X.21, shows the relationship between the various *call control* phase states as defined below, together with the recognized transactions between these states under normal operating conditions. Illustrated examples of the time sequence relationships between these states and associated time-out operation are provided in Figures B-1/X.21 and B-2/X.21.

States which are indicated by an IA5 character on circuits T and R shall be entered and exited on a character boundary. At this time, in some networks, the transition from state 6 to state 11, or state 6 to state 12 may not be on a character boundary.

Once character alignment has been established by the DCE in response to an outgoing call request, or for presentation of an incoming call, the alignment will be maintained until entering *connection in progress*, state 11 or *ready for data* if state 11 is by-passed. This implies that all IA5 character sequences transmitted on circuit R, such as 2/11 ("+"), *call progress* signals, *DCE provided information*, etc., appear on the same character boundary even if they are separated by two or more SYN characters.

The call control phase can be terminated by either the DTE or the DCE by *clearing* as defined in § 6 below.

4.1 *Events of the call control procedures* (see Figure A-2/X.21)

4.1.1 *Call request (state 2)*

The calling DTE shall indicate a request for a call by signalling steady binary condition t = 0, c = ON, provided that it was previously signalling *DTE ready*.

The change of state from *ready* (t = 1, c = OFF) to *call request* (t = 0, c = ON) shall be such that the transition to t = 0 occurs within a maximum of 7 bit intervals of the transition to c = ON. Either transition may occur first.

Note – When optimizing the use of the byte timing circuit B, the transition to t = 0 shall occur within the same bit interval as the transition to c = ON. This might become a requirement for use with special user facilities which might arise from further study.

If the DTE signals *call request* (state 2) and the DCE simultaneously signals r = 0, i = OFF, the DCE will be assumed to be in state 19 *(DCE clear indication)*.

4.1.2 *Proceed to select (state 3)*

When the network is prepared to receive selection information the DCE will transmit continuously character 2/11 ("+") preceded by 2 or more contiguous characters 1/6 ("SYN") on the R circuit with i = OFF.

Proceed-to-select is maintained until receipt of the *end-of-selection* signal, or in the case of *direct call*, receipt of *DTE waiting*.

The *proceed-to-select* signal will start within 3 seconds of the *call request* being sent.

4.1.3 *Selection signal sequence (state 4)*

The *selection* signal sequence shall be transmitted by the DTE on the T circuit with c = ON and shall be preceded by two or more contiguous 1/6 ("SYN") characters with c = ON.

The format of the *selection* signal sequence is defined in § 4.6.1 below.

The information content and coding of the *selection* signal sequence is contained in Annex G and Recommendation X.121 [9].

The *selection* signal sequence shall start within 6 seconds of *proceed-to-select* being received and shall be completed within 36 seconds.

The maximum permissible interval between individual selection characters is 6 seconds.

The period, if any, between individual selection characters shall be filled by character 1/6 ("SYN") with c = ON.

4.1.4 *DTE waiting (state 5)*

During *DTE waiting*, the DTE signals steady binary condition t = 1, c = ON. (See also § 4.4 below for *direct call* conditions.)

4.1.5 *Incoming call (state 8)*

The DCE will indicate an incoming call by continuous transmission of character 0/7 ("BEL") preceded by two or more contiguous 1/6 ("SYN") characters on the R circuit with i = OFF.

If the DCE signals *incoming call* and the DTE simultaneously signals t = 0, c = OFF, the DTE will be assumed to be in state 16 *(clear request)*.

The connection of incoming calls will be inhibited when the DTE signals either *DTE uncontrolled not ready* or *DTE controlled not ready.*

4.1.6 *Call accepted (state 9)*

The DTE shall accept the incoming call as soon as possible by signalling the steady state binary condition t = 1, c = ON.

1) The DCE will return to *DCE ready* if the incoming call is not accepted within 500 milliseconds,

   or, where manual answering is permitted,

2) the DCE will return to *DCE ready* if the incoming call is not accepted within 60 seconds.

4.1.7 *DCE waiting (state 6A and state 6B)*

During *DCE waiting*, the DCE will signal two or more contiguous 1/6 ("SYN") characters on the R circuit with i = OFF. In the state diagram, Figure A-2/X.21, state 6A applies to calling procedures and state 6B applies to called procedures.

4.1.8 *Call progress signal sequence (state 7)*

The *call progress* signal sequence will be transmitted by the DCE to the calling DTE on the R circuit with i = OFF when an appropriate condition is encountered by the network.

A *call progress* signal sequence will consist of 1 or more *call progress* signal blocks. A *call progress* signal block will consist of 1 or more *call progress* signals.

The format of the *call progress* signal sequence is defined in § 4.6.2 below.

The coding of *call progress* signals is provided in Annex F.

The description of *call progress* signals is provided in Recommendation X.96 [4].

A *call progress* signal sequence will be preceded by two or more contiguous 1/6 ("SYN") characters sent during state 6A. The period between these blocks will also be filled by *DCE waiting* (state 6A).

A *call progress* signal sequence will be transmitted by the DCE within 20 seconds of: (1) the *end-of-selection* signal or (2) in the case of *direct call*, the *DTE waiting* signal being sent by the DTE. The *call progress* signal sequence, however, will not be sent by the DCE before the reception of the *end-of-selection* signal or *DTE waiting* signal is sent by the DTE, except in the case of expiration of time-out T11, T12, or T13 where there may be a *call progress* signal sequence followed by *clear indication.*

Note – When an error is detected in a received *call progress* signal sequence, the DTE may choose to either ignore the signal or attempt a new call after clearing.

4.1.9 *DCE provided information sequence (states 10 and 10 bis)*

The *DCE provided information* sequences will be transmitted by a DCE to the calling DTE (state 10) or a called DTE (state 10 *bis*) on circuit R with i = OFF.

A *DCE provided information* sequence will consist of 1 or more *DCE provided information* blocks. Each *DCE provided information* block will be limited to a maximum length of 128 characters.

The format of the *DCE provided information* sequences is defined in § 4.6.3 below.

The information content of *DCE provided information* is provided in Annex H.

The *DCE provided information* sequence will be preceded by two or more contiguous 1/6 ("SYN") characters. *DCE provided information* blocks within a *DCE provided information* sequence will be separated by 1/6 ("SYN") characters (the time between blocks to be filled by two or more SYN characters is for further study). In the case of a calling DTE (state 10), the preceding and separating SYN characters will be from *DCE waiting* (state 6A). In the case of a called DTE (state 10 *bis*), the preceding SYN characters and the separating SYN characters will be from *DCE waiting* (state 6B).

In certain circumstances, SYN characters may be inserted between characters within a *DCE provided information* block. Each insertion shall contain at least 2 SYN characters, and the inserted SYN characters will be counted as part of the maximum limit of 128 characters per block. In any case, the insertion of SYN characters should be rare and minimized.

A *DCE provided information* sequence (state 10 *bis*) will be sent to the called DTE within 2 seconds of the *call accepted* signal being sent. After reception of a *DCE provided information* block, the called DTE should reset time-limit T4.

4.1.9.1 *Line identification*

Calling and *called line identification* is an optional additional facility.

The information content of *calling* and *called line identification* is provided in Annex H.

Calling and *called line identification* will be transmitted by the DCE on the R circuit with i = OFF during states 10 *bis* or 10, respectively.

When provided, *called line identification* (state 10) will be transmitted by the DCE to the calling DTE after all *call progress* signals, if any.

When provided, *calling line identification* (state 10 *bis*) will be transmitted by the DCE to the called DTE after *call accepted* has been sent by the DTE.

In the case where the *calling line identification* facility is not provided by the originating network, or the *called line identification* facility is not provided by the destination network, a *dummy line identification* shall be provided by the DCE to the DTE. In some networks, when the *calling line identification* is not provided by the originating network, the DNIC will be provided by the DCE to the DTE in place of the *dummy line identification.*

4.1.9.2 *Charging information*

Charging information is an optional additional facility provided during state 10 *bis.*

Upon completion of clearing the call for which *charging information* has been requested, the DCE will, within 200 ms after entering *ready* (state 1), establish an incoming call to the DTE for the purpose of giving *charging information.*

Note – The DTE is advised not to signal *call request* or *not ready* during the above 200 ms period. If the DTE does, the *charging information* will not be transmitted to the DTE.

Charging information will be transmitted by the DCE on R circuit with i = OFF.

The DCE will send *clear indication* (state 19) upon sending the last *charging information* block. The DTE should send *clear request* (state 16) when it has correctly received the *charging information* signal, if the DCE has not previously signalled *clear indication.*

Note – A generalized procedure for error recovery, when needed, in state 10 and 10 *bis* is for further study.

The format of *charging information* is defined in § 4.6.3 below.

4.1.10 *Connection in progress (state 11)*

While the connection process is in progress, the DCE will indicate *connection in progress* (state 11) by signalling r = 1, i = OFF.

In some circumstances, *connection in progress* (state 11) may be bypassed.

4.1.11 *Ready for data (state 12)*

When the connection is available for data transfer between both DTEs, the DCE will indicate *ready for data* (state 12) by signalling r = 1, i = ON.

1) *Ready for data* will be indicated by the DCE to the calling DTE within 2 seconds of the last *call progress* signal or *DCE provided information* signals being received by the DTE or within 20 seconds of the *end-of-selection* signal being signalled by the DTE,

   or, when manual answering is permitted at the called DTE,

2) *ready for data* will be indicated by the DCE to the calling DTE within 60 seconds of the appropriate *call progress* signal being received or within 20 seconds of the *end-of-selection* signal being received.

   It will be indicated to the called DTE within 2 seconds of *call accepted* being signalled by the DTE or receipt of *DCE provided information* signal.

   Subsequent procedures are described in § 5 below, *data transfer* phase.

4.2 *Unsuccessful call*

If the required connection cannot be established, the DCE will indicate this and the reason to the calling DTE by means of a *call progress* signal. Afterwards the DCE will signal *DCE clear indication* (state 19).

4.3 *Call collision (state 15)*

A *call collision* is detected by a DTE when it receives *incoming call* in response to *call request*. The DTE shall not deliberately cause a *call collision* by responding to *incoming call* with *call request*.

A *call collision* is detected by a DCE when it receives *call request* in response to *incoming call*.

When a *call collision* is detected by the DCE, the DCE will indicate *proceed-to-select* (state 3) and cancel the incoming call.

4.4 *Direct call*

For a *direct call* facility, the entering of *DTE waiting* (state 5) directly upon receipt of *proceed-to-select* (state 3) indicates the request for the direct call. When the *direct call* facility is provided on a per-call basis, the DTE may choose either an addressed call by presenting *selection* signal (state 4) or a direct call by presenting *DTE waiting* (state 5). When the *direct call* facility only is provided on a subscription basis, *selection* signals (state 4) are always bypassed.

4.5 *Facility registration/cancellation procedure*

Registration/cancellation of optional user facilities shall be accomplished by a DTE using normal call establishment procedures using the *selection* sequence which is defined in § 4.6.1 below.

The format of the *facility registration/cancellation* signal is defined in § 4.6.1.3 below.

The *facility registration/cancellation* procedure shall not be combined with establishment of a normally addressed call, but shall be taken as an independent procedure.

In response to acceptance or rejection of the *facility registration/cancellation* actions, the network will provide the appropriate *call progress* signal followed by *clear indication*.

4.6 *Selection, call progress and DCE provided information formats*

(See also Annex D for a syntactic description of the formats.)

4.6.1 *Format of selection sequence*

A *selection* sequence shall consist of a *facility request* block, or an *address* block, or a *facility request* block followed by an *address* block, or a *facility registration/cancellation* block.

4.6.1.1 *Facility request block*

A *facility request* block shall consist of one or more *facility request* signals.

Multiple *facility request* signals shall be separated by character 2/12 (" , ").

A *facility request* signal shall consist of a *facility request* code and may contain one or more *facility* parameters. The *facility request* code, *facility* parameter and subsequent *facility* parameters shall be separated by character 2/15 (" / "). For an interim period the 2/15 (" / ") separator will not be used in some networks.

The end of a *facility request* block shall be indicated by character 2/13 ("–").

4.6.1.2 *Address block*

An *address* block shall consist of one or more *address* signals.

An *address* signal shall consist of either a *full address* signal or an *abbreviated address* signal.

Start of an *abbreviated address* signal shall be indicated by a prefix character 2/14 (" . ").

Multiple *address* signals shall be separated by character 2/12 (" , ").

4.6.1.3 *Facility registration/cancellation block*

A *facility registration/cancellation* block shall consist of one or more *facility registration/cancellation* signals.

A *facility registration/cancellation* signal shall consist of up to four elements in order: *facility request* code, *indicator*, *registration* parameter, *address* signal.

The elements of a *facility registration/cancellation* signal shall be separated by character 2/15 (" / ").

If a *facility registration/cancellation* signal contains less than four of the elements, the elements should be eliminated in reverse order (e.g., a two-element *facility registration/cancellation* signal will contain the *facility request* code " / " *indicator*). If any element to be sent within the sequence is not required, a 0/3 ("0") character should be inserted in the position of each missing element (e.g., *facility request* code /0/0/ *address* signal).

Multiple *facility registration/cancellation* signals shall be separated by character 2/12 (" , ").

The end of a *facility registration/cancellation* block shall be indicated by character 2/13 ("–") followed by character 2/11 ("+").

4.6.1.4 *End of selection sequence*

The end of *selection* sequence shall be indicated by character 2/11 ("+").

4.6.2 *Format of a call progress sequence*

A *call progress* block shall consist of one or more *call progress* signals.

Each *call progress* signal need not be repeated.

Multiple *call progress* signals shall be separated by character 2/12 (" , ").

The end of a *call progress* block shall be indicated by character 2/11 ("+").

4.6.3 *Formats of DCE provided information*

The following formats are specified for *DCE provided information* signals which have been identified.

The *DCE provided information* shall, except for *calling* and *called line identification*, be preceded by the IA5 character 2/15 (" / "). To distinguish between different types of *DCE provided information* the prefix should be followed by one or more numerical characters, followed by the character 2/15 (" / ") before the actual information is presented. The end of a *DCE provided information* block shall be indicated by character 2/11 ("+").

4.6.3.1 *Format of called and calling line identification*

Calling line identification block and *called line identification* block shall be preceded by character 2/10 (" * ").

When a *calling* or *called line identification* block contains Data Network Identification Codes (DNIC) or Data Country Codes (DCC), the blocks shall be preceded by 2 characters 2/10 (" ** ").

A *called line identification* block shall consist of one or more *called line identification* signals.

Multiple *called line identification* signals shall be separated by character 2/12 (" , ").

End of *calling line identification* block and *called line identification* block shall be indicated by character 2/11 (" + ").

The *dummy line identification* block shall be indicated by character 2/10 (" * ") followed by 2/11 ("+").

4.6.3.2 *Format of charging information*

The *charging information* block will be preceded by character 2/15 (" / ") followed by a second IA5 numerical character, followed by character 2/15 (" / "). The end of *charging information* block shall be indicated by character 2/11 ("+").

5 Data transfer phase

During the data transfer phase, any bit sequence may be sent by either DTE.

For the interchange of information between one DTE and another DTE during the data transfer phase, the DTEs will be responsible for establishing their own alignment.

The byte timing interchange circuit, when implemented, may be utilized by the DTEs for mutual character alignment.

5.1 *Circuit switched service*

All bits sent by a DTE after receiving *ready for data* and before sending *DTE clear request* will be delivered to the corresponding DTE after that corresponding DTE has received *ready for data* and before it has received *DCE clear indication* (provided that the corresponding DTE does not take the initiative of *clearing*).

All bits received by a DTE after receiving *ready for data* and before receiving *DCE clear indication* or receiving *DCE clear confirmation* were sent by the corresponding DTE. Some of those may have originated as *DTE waiting* before that corresponding DTE has received *ready for data*; those bits are binary 1.

During *data transfer* (state 13), c = ON, i = ON and data are transferred on circuits T and R.

Data transfer may be terminated by *clearing*, as defined in § 6 below, by either i) the DCE, or ii) any connected DTE.

The action to be taken when circuit C is turned OFF during *data transfer* (state 13), except when the DTE is signalling *DTE clear request* (state 16) by t = 0, c = OFF, is for further study except for the procedures for half-duplex operation which are described in Annex E.

5.2 *Leased circuit service – point-to-point (see Figure A-3/X.21)*

5.2.1 *Send data (state 13S)*

Data transmitted by the DTE on circuit T with c = ON are delivered to the remote DTE on circuit R with i = ON.

5.2.2 *Receive data (state 13R)*

Data transmitted by a distant DTE with c = ON are received on circuit R with i = ON.

5.2.3 *Data transfer (state 13)*

When c = ON, i = ON, data are transferred on circuits T and R.

5.2.4 *Termination of data transfer*

The DTE signals the termination of *data transfer* by signalling t = 1, c = OFF. The DCE indicates termination of *data transfer* by signalling r = 1, i = OFF.

Note – The action taken by the DCE when the DTE signals c = OFF and t does not equal 1, is for further study except for the *DTE uncontrolled not ready* procedures described in § 2.5.1.2 above.

5.3 *Leased circuit service – centralized multipoint (see Figure A-3/X.21)*

5.3.1 *Central DTE data transfer*

5.3.1.1 *Send data (state 13S)*

Data transmitted by the central DTE on circuit T with c = ON are delivered to all remote DTEs on circuit R with i = ON.

5.3.1.2 *Receive data (state 13R)*

Data transmitted by any remote DTE with c = ON (one at a time as determined by the data link protocol) during state 13S are delivered to the central DTE on circuit R with i = ON.

5.3.2 *Remote DTE data transfer*

Data transmitted by a remote DTE are not delivered to other remote DTEs.

Note – Transmission of data by two or more remote DTEs at the same time may result in unsatisfactory conditions.

5.3.2.1 *Send data (state 13S)*

Data transmitted by remote DTEs with c = ON (one at a time as determined by the data link protocol) are delivered to the central DTE on circuit R with i = ON.

5.3.2.2 *Receive data (state 13R)*

Data transmitted by the central DTE with c = ON are delivered to the remote DTE on circuit R with i = ON.

5.3.3 *Data transfer (state 13)*

When c = ON, i = ON data transmitted by the central DTE are delivered to all remote DTEs, and data transmitted by a remote DTE (one at a time as determined by data link protocol) are delivered to the central DTE. A remote DTE may send (one at a time as determined by the data link protocol) while the central DTE is sending to all remote DTEs.

6 **Clearing phase** (see Figure A-4/X.21)

6.1 *Clearing by the DTE (states 16, 17, 21)*

The DTE should indicate clearing by signalling the steady binary condition t = 0, c = OFF, *DTE clear request* (state 16).

The DCE will respond by signalling the steady state condition r = 0, i = OFF, *DCE clear confirmation* (state 17), followed by the steady binary condition r = 1, i = OFF, *DCE ready* (state 21). The *DCE ready* signal will be sent within 2 seconds after the receipt of the *DTE clear request* signal.

The DTE should respond to *DCE ready* within 100 milliseconds by signalling t = 1, c = OFF, *ready* (state 1).

6.2 *Clearing by the DCE (states 19, 20, 21)*

The DCE will indicate clearing to the DTE by signalling the steady binary condition r = 0, i = OFF, *DCE clear indication* (state 19).

The DTE should signify *DTE clear confirmation* (state 20) by signalling the steady binary condition t = 0, c = OFF, within 100 milliseconds. The DCE will signal r = 1, i = OFF, *DCE ready* (state 21) within 2 seconds of receiving *DTE clear confirmation.*

The DTE should respond to *DCE ready* within 100 milliseconds by signalling t = 1, c = OFF, *ready* (state 1).

7 Test loops

The definitions of test loops are provided in Recommendation X.150 [10].

7.1 *Local test loop – loop 3*

In order to assist the test of the DTE, test loop 3 is provided in the DCE which causes signals on circuit T to be presented on circuit R and signals on circuit C to be presented on circuit I.

Test loop 3 should be near the DCE/DTE interface. The DCE interface generators and receivers may be included in the test loop. The precise implementation of the test loop within the DCE is a national option.

Manual control should be provided on the DCE for activation of the test loop.

Consideration of automatic control is an item for further study.

7.2 *Network test loop – loop 2*

For network maintenance purposes, a loop 2 is implemented in the DCE.

Loop 2 may be controlled manually on the DCE or automatically from the network or automatically from the remote DTE. The control of the loop and the method used for the automatic control, when implemented, is a national option.

In the leased circuit service, loop 2 should not be activated prior to notifying the customer. Some Administrations may activate the loop without first informing the customer when an abnormal condition is detected in the network.

In the circuit switched service, loop 2 may be activated without the knowledge and agreement of the customer for periods which do not exceed one second. The loop shall not be activated when the DTE is engaged in a call.

In case of a collision between *call request* and the activation of the loop, the loop activation command will have priority.

When the test is in progress, the DCE will signal r = 0, i = OFF.

A standard method of automatically operating the loop by a DTE in networks where this is permitted on point-to-point leased circuits is for further study.

Garbled signals may be delivered to the DTE on circuits R and I prior to the closing of the loop.

7.3 *DTE test loop – loop 1*

If loop 1 is implemented in the DTE and is activated, the DTE may present the same steady state conditions on circuits T and C as they were before the test. During the test, the DTE should monitor circuits R and I in order to detect an incoming call.

7.4 *Signal element timing provision*

The provision of signal element timing to the DTE is maintained when any of the loops, described above, are activated.

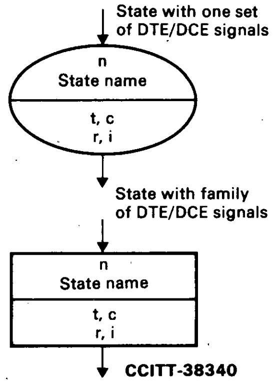
When test loops are activated, the signal element timing should in no case deviate from the nominal value by more than ± 1%.

ANNEX A

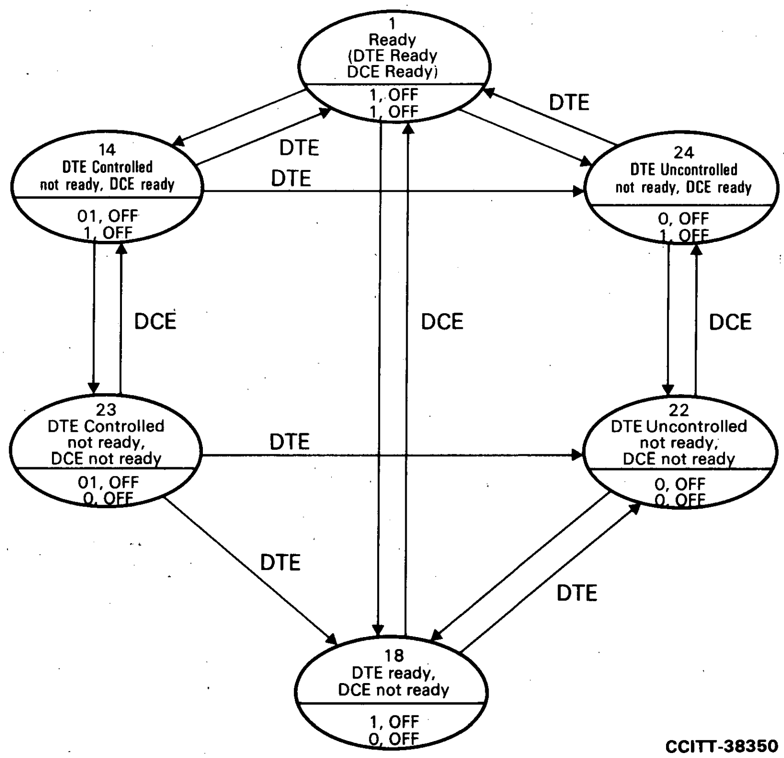
(to Recommendation X.21)

Interface signalling state diagrams

Definition of symbols used in the state diagrams



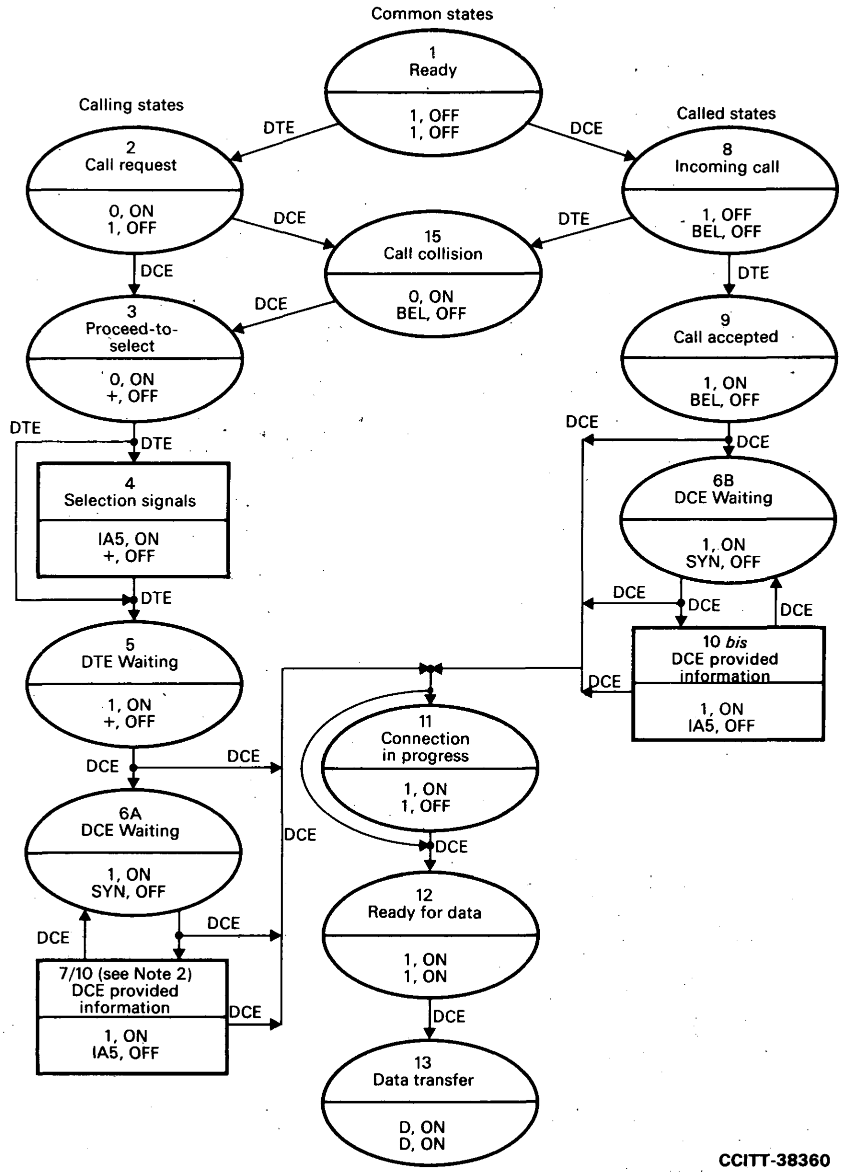
n	State number
t	Signal on T circuit
c	Signal on C circuit
r	Signal on R circuit
i	Signal on I circuit
T	Transmit interchange circuit
C	Control interchange circuit
R	Receive interchange circuit
I	Indication interchange circuit
D	DTE or DCE data signals
0 and 1	Steady binary conditions
01	Alternate binary 0 and binary 1
X	Any value
OFF	Continuous OFF (binary 1)
ON	Continuous ON (binary 0)
IA5	Characters from International Alphabet No. 5 (Recommendations V.3 [7] and X.4 [8])
+	IA5 character 2/11
BEL	IA5 character 0/7
SYN	IA5 character 1/6
↓	Transition with indication of whether DTE or DCE is responsible for transition



Note – This state diagram shows transitions that will be allowed by all Administrations. Other transitions are possible and may be allowed by some Administrations.

FIGURE A-1/X.21

Quiescent states

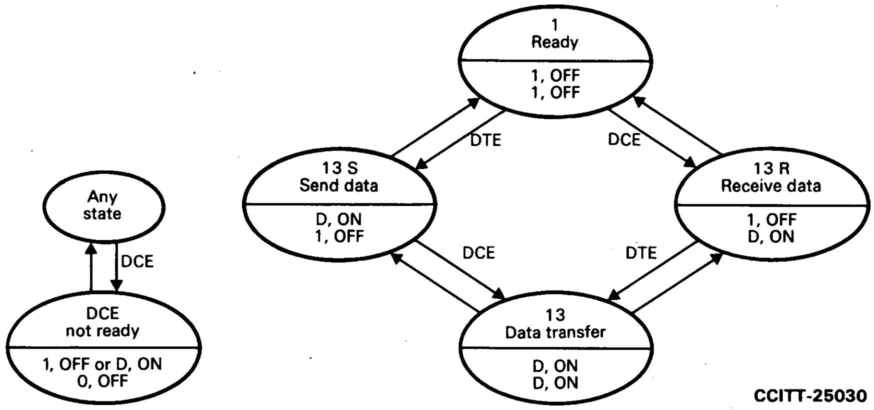


Note 1 – As indicated in Figure A-4/X.21, the DCE may enter state 19 from any state and the DTE may enter state 16 from any state except *ready*.

Note 2 – For simplification of the state diagram, state 7 (*call progress* signals) is merged with state 10 *(DCE provided information)*.

FIGURE A-2/X.21

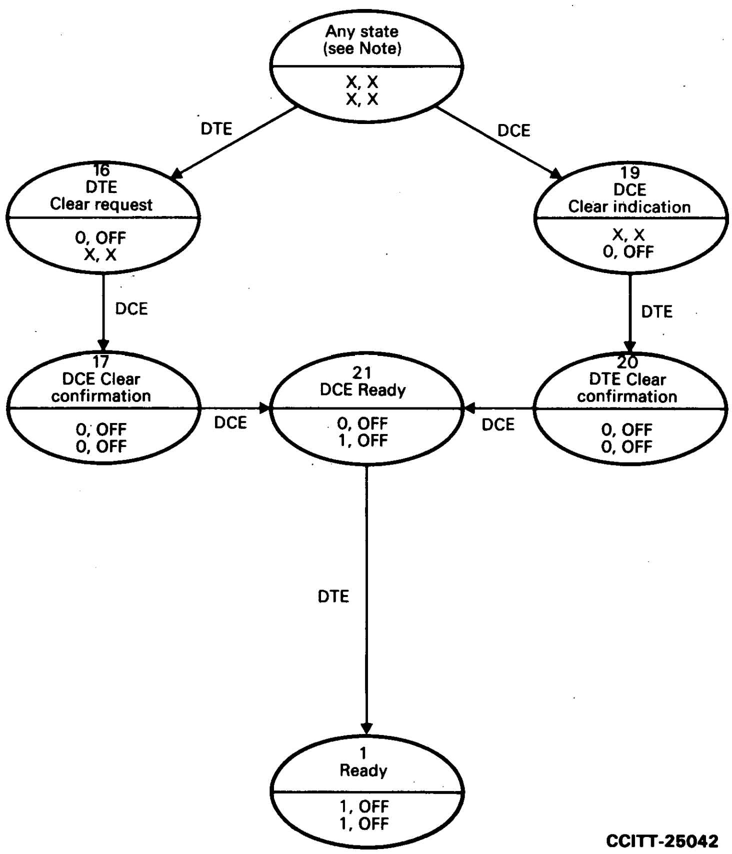
Call control phase for circuit-switched service



CCITT-25030

FIGURE A-3/X.21

Leased circuit service



CCITT-25042

Note – Any state in Figure A-2/X.21 except *ready.*

FIGURE A-4/X.21

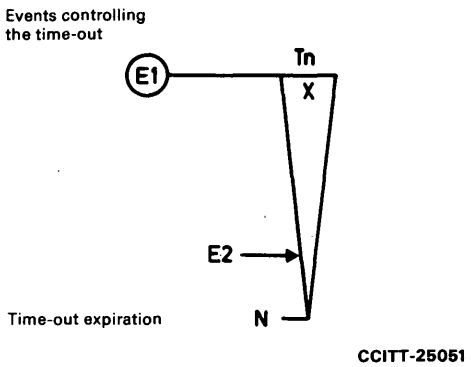
Clearing phase

ANNEX B

(to Recommendation X.21)

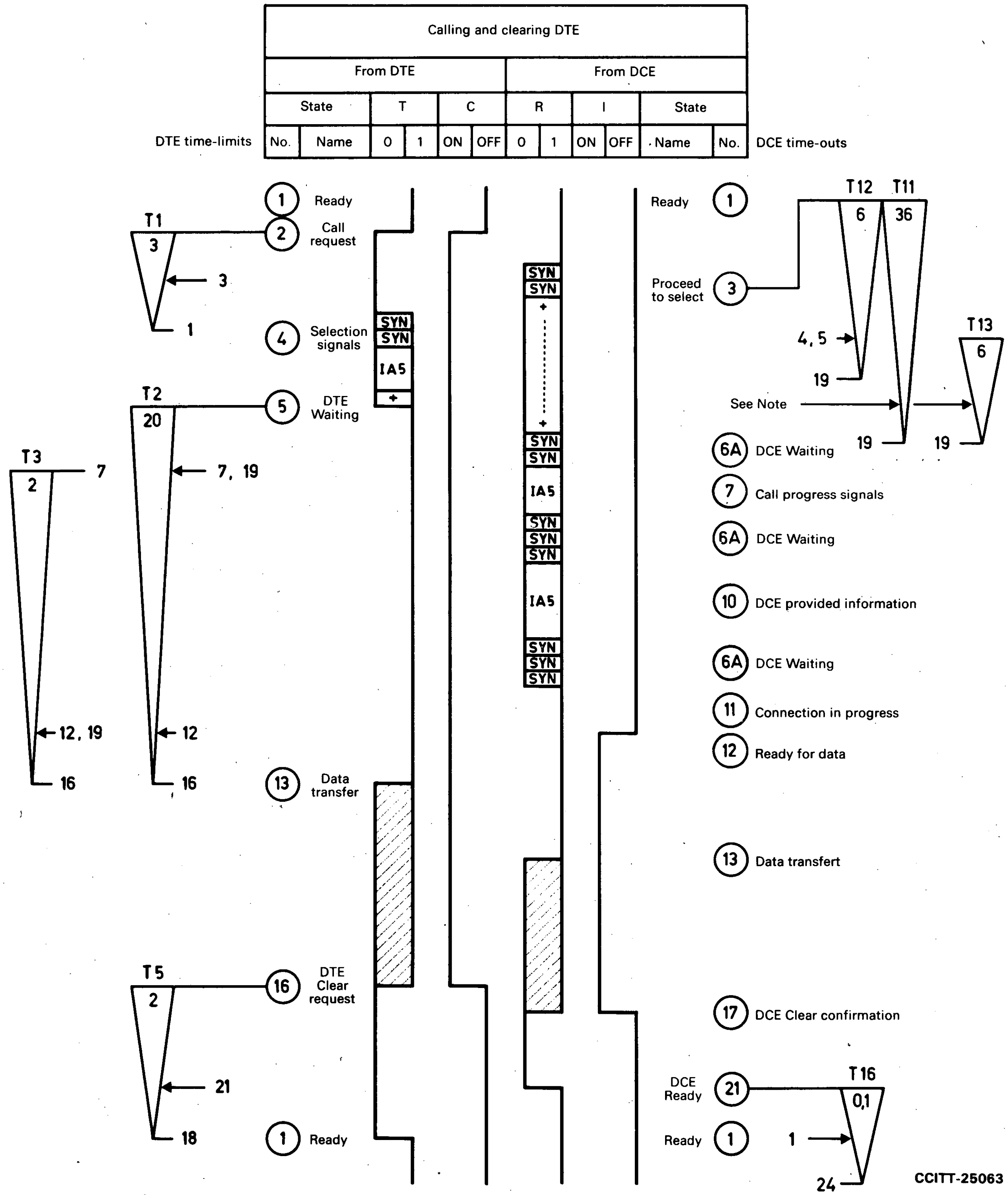
Interface signalling sequence diagrams and time-out operations

Definition of symbol used to illustrate time-out operation in the signalling sequence diagrams:



Tn	Time-out number
X	Time-out figure in seconds
(E1)	Start of time-out at event indicated
E2	Stop of time-out at event indicated
N	Number of the state to be entered after expiration of time-out

Note – For additional alternative assignments of DTE time-limits or DCE time-outs not shown together with the signalling sequence diagrams, see Table C-2/X.21.



Note – For additional alternative assignments of DTE time-limits or DCE time-outs not shown together with the signalling sequence diagrams, see Table C-2/X.21.

FIGURE B-1/X.21

Example of sequence of events: successful call and clear for circuit-switched service (calling and clearing DTE)

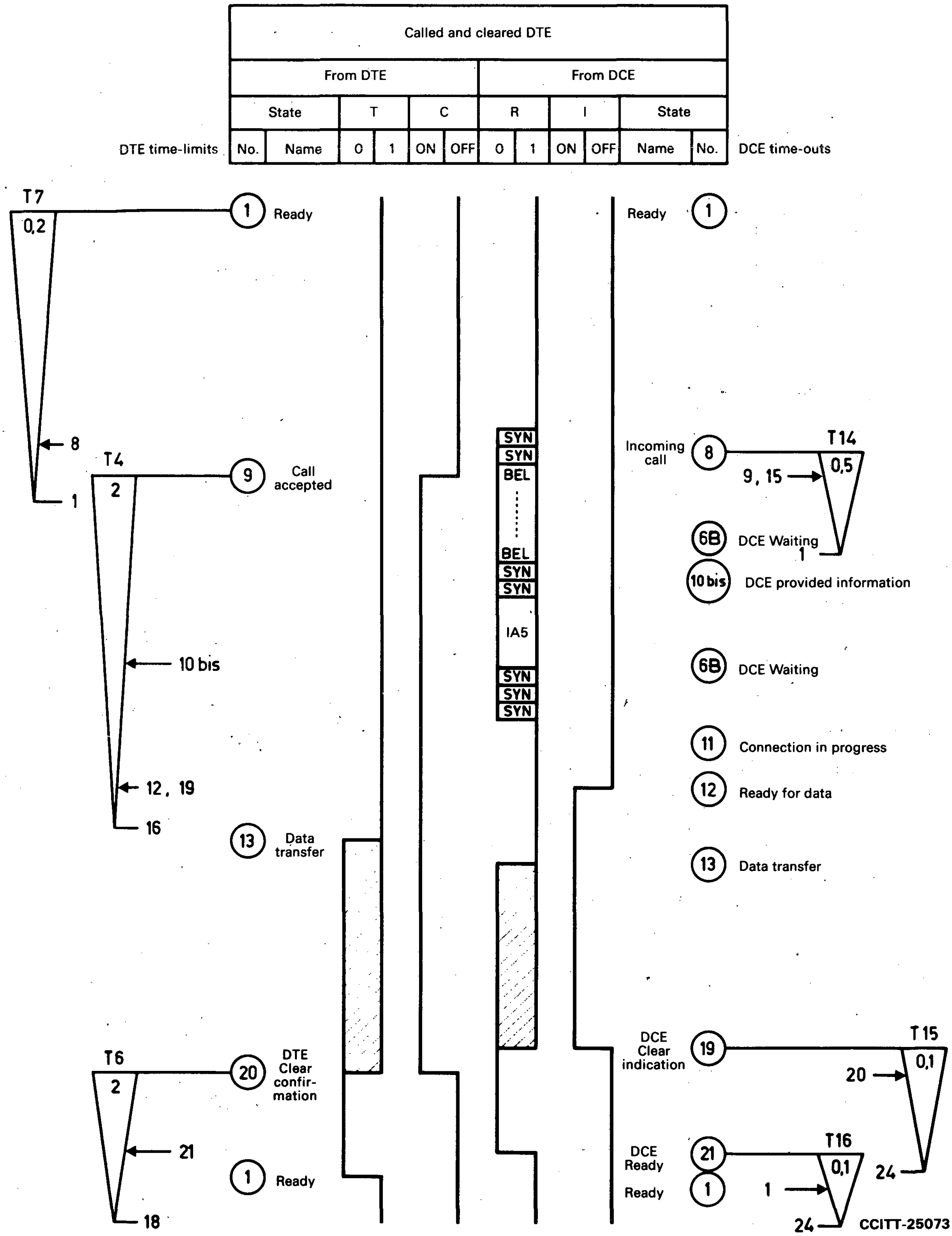


FIGURE B-2/X.21

Example of sequences of events: successful call and clear for circuit-switched service (called and cleared DTE)

ANNEX C

(to Recommendation X.21)

DTE time-limits and DCE time-outs

C.1 *DTE time-limits*

Under certain circumstances this Recommendation requires the DCE to respond to a signal from the DTE within a stated maximum time. If any of these maximum times is exceeded, the DTE should initiate the action indicated in Table C-1/X.21. To maximize efficiency, the DTE should incorporate time-limits to send the appropriate signal under the defined circumstances summarized in Table C-1/X.21. The time-limits given in the first column are the maximum times allowed for the DCE to respond and are consequently the lower limits of the times a DTE must allow for proper network operation. A time-limit longer than the time shown may be optionally used in the DTE; for example, all DTE time-limits could have one single value equal to or greater than the longest time-limit shown in this table. However, the use of a longer time-limit will result in reduced efficiency of network utilization. The actual DCE response time should be as short as is consistent with the implementing technology and in normal operation should be well within the specified time-limit. The rare situation where a time-limit is exceeded should only occur when there is a failure in DCE operation.

TABLE C-1/X.21

DTE time-limits

Time-limit	Time-limit number	Started by	Normally terminated by	Preferred action to be taken when time-limit exceeded
3 s	T1	Signalling of *call request* (state 2)	Reception of *proceed-to-select* (state 3)	DTE signals DTE *ready* (state 1)
20 s	T2	Signalling *end-of selection* or *DTE waiting* (direct call) (state 5)	Reception of *call progress* signals, *DCE provided information, ready for data* or *DCE clear indication* (states 7, 10, 12 or 19)	DTE signals *DTE clear request* (state 16)
2 s	T3A	Reception of *call progress* signals, or *DCE provided information* (states 7 or 10)	Reception of *ready for data* or *DCE clear indication* (state 12 or 19) Reset by additional *call progress* signals, or *DCE provided information* (states 7 or 10)	
60 s	T3B (see Note)	Reception of applicable *call progress* signals (state 7)		
2 s	T4	Change of state to *call accepted* (state 9)	Reception of *ready for data* or *DCE clear indication* (state 12 or 19) Reset by *DCE provided information* (state 10 *bis*)	
2 s	T5	Change of state to *DTE clear request* (state 16)	Change of state to *DCE ready* (state 21)	DTE regards the DCE as *DCE not ready* and signals *DTE ready* (state 18)
2 s	T6	Change of state to *DTE clear confirmation* (state 20)	Reception of *DCE ready* (state 21)	
200 ms	T7	Change of state to *ready* (state 1) when *charge information* (state 10 *bis*) has been requested	Reception of *incoming call* (state 8)	DTE returns to normal operation and may note absence of *Charge information* (state 10 *bis*)

Note – 60 s (T3B) applies for manual answering DTEs.

C.2 *DCE Time-outs*

Under certain circumstances this Recommendation requires the DTE to respond to a signal from the DCE within a stated maximum time. If any of these maximum times is exceeded, a time-out in the DCE will initiate the actions summarized in Table C-2/X.21. These constraints must be taken into account in the DTE design. The time-outs given in the first column of the table are the minimum time-out values used in the DCE for the appropriate DTE response and are consequently the maximum times available to the DTE for response to the indicated DCE action. The actual DTE response time should be as short as is consistent with the implementing technology and in normal operation should be within the specified time-out. The rare situation where a time-out is exceeded should only occur when there is a failure in the DTE operation.

TABLE C-2/X.21

DCE time-outs

Time-out	Time-out Number	Started by	Normally terminated by	Action to be taken when time-out expires
36 s	T11 (see Note 1)	DCE signalling of *proceed-to-select* (state 3)	DCE reception of *end-of-selection* signal	DCE will signal *DCE clear indication* (state 19) or transmit appropriate *call progress* signal followed by *DCE clear indication* (state 19)
6 s	T12	DCE signalling of *proceed-to-select* (state 3)	DCE reception of first selection character or in the case of *direct call, DTE waiting* (state 5)	
6 s	T13 (see Note 1)	DCE reception of nth selection character (state 4)	DCE reception of (n+1)th selection character or *end-of-selection* signal	
500 ms	T14A	DCE signalling of *incoming call* (state 8)	Change of state to *call accepted* (state 9) or *call collision* (state 15)	The DTE iss noted as not answering. The DCE will signal *ready* (state 1).
60 s (see Note 2)	T14B			
100 ms	T15	Change of state to *DCE clear indication* (state 19)	Change of state to *DTE clear confirmation* (state 20)	DCE will signal *DCE ready* and mark *DTE uncontrolled not ready* (state 24)
100 ms	T16	Change of state to *DCE ready* (state 21)	Change of state to *ready* (state 1)	DCE will mark *DTE uncontrolled not ready* (state 24)

Note 1 – T11 and T13 do not apply in the case of a direct call.

Note 2 – T14B will be provided when manual answering DTEs are allowed.

ANNEX D

(to Recommendation X.21)

Formats of Selection, Call progress, and DCE provided information signals

The following description uses Backus Normal Form as the formalism for syntactic description. A vertical line " | " separates alternatives.

<*> : : = IA 5 character 2/10

<+> : : = IA 5 character 2/11

<,> : : = IA 5 character 2/12

<–> : : = IA 5 character 2/13

<.> : : = IA 5 character 2/14

</> : : = IA 5 character 2/15

<η> : : = IA 5 characters 3/1, 3/2, or 3/3

<Facility parameter> : : = See Annex G

<Facility request signal> : : = See Annex G

<Full address signal> : : = See Recommendation X.121 [9]

<Abbreviated address signal> : : = National option

<Calling line identification signal> : : = See Annex H

<Called line identification signal> : : = See Annex H

<Charging information signal> : : = See Annex H

<Indicator> : : = See Annex G

<Facility request code> : : = See Annex G

<Registration parameter> : : = See Annex G

<Call progress signal> : : = See Annex F

The above signals are combined as follows:

<Address signal> : : = <Full address signal> | <.> <Abbreviated address signal>

<Address block> : : = <Address signal> | <Address block> <,> <Address signal>

<Facility registration/cancellation signal> : : = <Facility request code> </> <Indicator> </> <Registration parameter> </> <Address signal>

<Facility registration/cancellation block> : : = <Facility registration/cancellation signal> | <Facility registration/cancellation block> <,> <Facility registration/cancellation signal>

<Facility request signal> : : = <Facility request code> | <Facility request signal> </> <Facility parameter>

<Facility request block> : : = <Facility request signal> | <Facility request block> <,> <Facility request signal>

<Selection sequence> : : = <Facility request block> <–> <Address block> <+> | <Facility request block> <–> <+> | <Address block> <+> | <Facility registration/cancellation block> <–> <+>

<Call progress block> : : = <Call progress signal> <+> | <Call progress signal> <,> <Call progress block>

<Calling line identification> : : = <*> <Calling line identification signal> <+>

<Calling line identification (with DNIC or DCC)> : : = <**> <Calling line identification signal> <+>

<Called line identification block> : : = <Called line identification signal> | <Called line identification block> <,> <Called line identification signal>

<Called line identification> : : = <*> <Called line identification block> <+>

<Called line identification (with DNIC or DCC)> : : = <**> <Called line identification block> <+>

<Dummy line identification> : : = <*> <+>

<Charging information block> : : = </> <η> </> <Charging information signal> <+>

ANNEX E

(to Recommendation X.21)

Interworking between DTEs conforming to Recommendations X.21 and X.21 *bis*

It is recognized that interworking between V-Series DTEs connected to a public data network according to Recommendation X.21 *bis* at one end and Recommendation X.21 at the other end should always be possible for DTEs not using half-duplex operation.

Certain Administrations may provide facilities allowing interworking between DTEs operating in accordance with Recommendations X.21 and X.21 *bis* using half-duplex operation by switching circuit C, I and circuit 109, 105 during the data transfer phase in accordance with Figure E-1/X.21.

Those Administrations not providing this facility shall cause the Recommendation X.21 DCE to signal r = 1, i = ON when the Recommendation X.21 *bis* DTE signals circuit 105 OFF. This will permit half-duplex operation for those DTEs that do not require circuit 109 to be OFF before signalling circuit 105 ON.

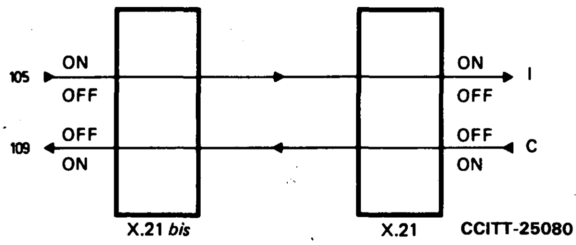


FIGURE E-1/X.21

ANNEX F
(to Recommendation X.21)

TABLE F-1/X.21

Coding of Call progress signals

Code group see Note 1	Code	Significance	Category
0	00 01 02 03	Note 2 Terminal called Redirected call Connect when free	Without clearing
2	20 21 22 23	No connection Number busy Selection signals procedure error Selection signals transmission error	With clearing due to short-term conditions
4 and 5	41 42 43 44 45 46 47 48 49 51 52	Access barred Changed number Not obtainable Out of order Controlled not ready Uncontrolled not ready DCE power off Invalid facility request Network fault in local loop Call information service Incompatible user class of service	With clearing due to long-term conditions
6	61	Network congestion	With clearing due to network short-term conditions
7	71 72	Long-term network congestion RPOA out of order	With clearing due to network long-term conditions
8	81 82 83	Registration/cancellation confirmed Redirection activated Redirection deactivated	With clearing due to DTE-network procedure

Note 1 – From the DTE point of view group 0 means "wait"; groups 2 and 6 mean "try again, next try may result in a call set-up"; groups 4 and 5, and 7 mean "there is no reason for the DTE to try again because the answer will be the same for a longer period of time". Since group 8 results from a procedure between the DTE and the network, no special action is expected to be taken by the DTE.

Note 2 – Reserved for future use.

ANNEX G

(to Recommendation X.21)

Facility request, indicator, and parameter coding
(for use as appropriate in Facility Request Signals and Facility Registration/Cancellation Signals)

TABLE G-1/X.21

(see Annex D for formats and Note 1 below)

Facility request code	Facility parameter	Indicator	Registration parameter	Facility
0	-	-	-	Reserved for future use (may be combined with second character)
1	XX (see Note 2)	-	-	Closed user group (other than preferential)
2	-	-	-	Unassigned
3	-	-	-	Unassigned
4	-	-	-	Reserved
5	-	-	-	Unassigned
60	-	-	-	Multiple address calling
61	-	-	-	Charging information
62	-	-	-	Called line identification
63	-	1	-	Redirection of call-activation
63	-	2	-	Redirection of call-cancellation
63	-	3	-	Redirection of call-status
7	-	-	-	Reserved
8	-	-	-	Reserved
9	-	-	-	Reserved

Note 1 – For an interim period, the 2/15 "/" separator in the formats will not be used in some networks.

Note 2 – XX is an index number, i.e., a key code for closed user group other than the preferential group. The index number shall be used to distinguish between parts or groups within one facility. The index number shall furthermore be chosen from IA5, column 3, positions 3/0–3/9, giving a range of possible numbers from 00 to 99.

ANNEX H

(to Recommendation X.21)

Information content of DCE provided information

H.1 *Information content of Calling and Called line identification*

Two formats are defined:

i) *Calling* and *called line identification* consist of the international data number as defined in Recommendation X.121 [8] preceded by *two* prefixes 2/10 (" ** "). In the case where the originating network does not provide *calling line identification*, only the data network identification code (DNIC) part of the International Data Number preceeded by two prefixes 2/10 (" ** ") may be sent in place of the *dummy line identification.*

ii) *Calling* and *called line identification* consist of the national number (NN) or network terminal number (NTN) preceded by the prefix 2/10 (" * ").

H.2 *Information content of Charging information*

The *charging information* will inform the subscriber of either the monetary charges for a call, the duration of the call, or the number of units used during the call.

When *charging information* is given in monetary charges for the call, n = 1 and the information shall consist of x number of integer digits optionally followed by a colon and two digits representing the fraction. The format applied is as follows:

< / > <1> < / > <X.....> <+>

< / > <1> < / > <X.....> <:> <yy>

When the *charging information* is presented as the duration of a call, n = 2 and the information shall consist of x number of integer digits representing seconds. The format applied is as follows:

< / > <2> < / > <X.....> <+>

When the *charging information* is presented as the number of units used, n = 3, and the information shall consist of x number of integer digits representing the units. The format applied is as follows:

< / > <3> < / > <X.....> <+>

ANNEX I

(to Recommendation X.21)

Reference and transition tables

TABLE I-1/X.21

Cross reference of interchange circuit signals, states, and reference section

T,	C	R,	I	State No.	Reference in the Recommendation (§)
1,	OFF	1,	OFF	1	2.5.3.1
1,	OFF	0,	OFF	18	2.5.3.3
0,	OFF	1,	OFF	21, 24	2.5.3.6
0,	OFF	0,	OFF	17, 20, 22	2.5.3.4
1,	OFF	BEL,	OFF	8	4.1.5
01,	OFF	1,	OFF	14	2.5.3.2
01,	OFF	0,	OFF	23	2.5.3.5
1,	OFF	D,	ON	13R	5.22, 5.3.1.2, 5.3.2.2
0,	OFF	1,	ON	16	6.1
0,	OFF	0,	ON	16	6.1
0,	OFF	D,	ON	16	6.1
1,	ON	1,	OFF	11	4.1.10
1,	ON	0,	OFF	19	6.2
0,	ON	1,	OFF	2	4.1.1
0,	ON	0,	OFF	19	6.2
1,	ON	BEL,	OFF	9	4.1.6
1,	ON	+,	OFF	5	4.1.4
1,	ON	SYN,	OFF	6A, 6B	4.1.7
1,	ON	IA5,[a]	OFF	7, 10, 10 *bis*	4.1.8, 4.1.9
0,	ON	BEL,	OFF	15	4.3
0,	ON	+,	OFF	3	4.1.2
IA5,	ON	+,	OFF	4	4.1.3
D,	ON	1,	OFF	13S	5.2.1, 5.3.1.1, 5.3.2.1
D,	ON	0,	OFF	19	6.2, Fig. A-3/X.21
1,	ON	1,	ON	12	4.1.1.1
D,	ON	D,	ON	13	5.1, 5.2.3, 5.3.3

[a] An IA5 character other than BEL.

TABLE I-2/X.21

Recognized transitions between states
(other transitions are not considered valid)

State No	Name	T,	C	R,	I	DTE transition to state No.	DCE transition to state No.	Time-out transition		
								To state No.	Time-out No.	Terminated by state No.
1	Ready	1,	OFF	1,	OFF	2, 13S, 14, 24	8, 13R, 18	1	T7	8
2	Call request	0,	ON	1,	OFF	–	3, 15	1	T7	3
3	Proceed-to-select	0,	ON	+,	OFF	4, 15	–	19	T11, T12	4, 5
4	Selection signal	IA5,	ON	+,	OFF	5	–	19	T13	End of selection (EOS)
5	DTE Waiting	1,	ON	+,	OFF	–	6A, 11, 12	16	T2	7, 10, 12, 19
6A	DCE Waiting	1,	ON	SYN,	OFF	–	7, 10, 11, 12	–	–	–
6B	DCE Waiting	1,	ON	SYN,	OFF	–	10 *bis*, 11, 12	–	–	–
7	Call progress signal	1,	ON	IA5,	OFF	–	6A, 10, 11, 12	16	T3A, T3B	7, 10, 12, 19
8	Incoming call	1,	OFF	BEL,	OFF	15, 9	–	1	T14A, T14B	9, 15
9	Call accepted	1,	ON	BEL,	OFF	–	6B, 11, 12	16	T4	10 *bis*, 12, 19
10	DCE provided information	1,	ON	IA5,	OFF	–	6A, 11, 12	–	–	–
10 *bis*	DCE provided information	1,	ON	IA5,	OFF	–	6B, 11, 12	–	–	–
11	Connection in progress	1,	ON	1,	OFF	–	12	–	–	–
12	Ready for data	1,	ON	1,	ON	–	13	–	–	–
13	Data transfer	D,	ON	D,	ON	13R	13S, DCE not ready	–	–	–
13R	Receive data	1,	OFF	D,	ON	13	1	–	–	–
13S	Send data	D,	ON	1,	OFF	7	13	–	–	–
14	DTE Controlled not ready, DCE Ready	01,	OFF	1,	OFF	1, 24	23	–	–	–
15	Call collision	0,	ON	BEL,	OFF	–	3	–	–	–
16	DTE Clear request	0, (see Note)	OFF	X	X	–	17	18	T5	21
17	DCE Clear confirmation	0,	OFF	0,	OFF	–	21	–	–	–
18	DTE Ready, DCE Not ready	1,	OFF	0,	OFF	22	1	–	–	–
–	DCE Not ready	D,	ON	0,	OFF	–	1, 13, 13S	–	–	–
19	DCE Clear indication	X (see Note)	X	0,	OFF	20	–	24	T15	20
20	DTE Clear confirmation	0,	OFF	0,	OFF	–	21	18	T6	21
21	DCE Ready	0,	OFF	1,	OFF	1	–	24	T16	1
22	DTE Uncontrolled not ready, DCE Not ready	0,	OFF	0,	OFF	18	24	–	–	–
23	DTE Controlled not ready, DCE Not ready	01,	OFF	0,	OFF	18, 22	14	–	–	–
24	DTE Uncontrolled not ready, DCE Ready	0,	OFF	1,	OFF	1	22	–	–	–
Any state (see Note)		X	X	X	X	16	19	–	–	–

Note – *DCE clear indication* (state 19) or *DTE clear request* (state 16) may be entered from any state except *ready* (state 1).

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.1.

[2] CCITT Recommendation *International user services and facilities in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.2.

[3] CCITT Recommendation *Hypothetical reference connections for public synchronous data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.92.

[4] CCITT Recommendation *Call progress signals in public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.96.

[5] CCITT Question 27/VII, Contribution COM VII-No. 1, Study Period 1981-1984, ITU, Geneva, 1981.

[6] *Data communication – 15-pin DTE/DCE interface connector and pin assignments*, ISO Standard No. 4903-1980.

[7] CCITT Recommendation *International Alphabet No. 5*, Vol. VIII, Fascicle VIII.1, Rec. V.3.

[8] CCITT Recommendation *General structure of signals of International Alphabet No. 5 code for data transmission over public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.4.

[9] CCITT Recommendation *International numbering plan for public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.121.

[10] CCITT Recommendation *DTE and DCE test loops for public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.150.

Recommendation X.21 *bis*

USE ON PUBLIC DATA NETWORKS OF DATA TERMINAL EQUIPMENT (DTE) WHICH IS DESIGNED FOR INTERFACING TO SYNCHRONOUS V-SERIES MODEMS

(Geneva, 1976; amended at Geneva, 1980)

The CCITT,

considering that

(a) the interface between Data Terminal Equipment (DTE) and Data Circuit terminating Equipment (DCE) for synchronous operation on public data networks is specified in Recommendation X.21;

(b) several Administrations are also planning to provide as an interim measure the connection to public data networks of synchronous DTEs which are designed for interfacing to synchronous V-Series modems;

unanimously declares the following view:

(1) The connection of DTEs with V-Series-type interface to public data networks allow for:

i) the leased circuit service (point-to-point and centralized multipoint),

ii) the *direct call facility*,

iii) the *address call facility*.

(2) This Recommendation specifies the operational modes and the optional features which apply when the data circuit interconnects V-Series DTEs. Interworking between V-Series DTEs and X.21 DTEs is described in Annex A.

1 The use of V-Series DTEs for leased circuit service

1.1 *General*

The use of V-Series DTEs utilizing the leased circuit service in public data networks is discussed in the following.

The data signalling rates are those defined in Recommendation X.1 [1] for user classes of service employing synchronous transmission.

1.2 *Use of interchange circuits*

The electrical characteristics of the interchange circuits at both the DCE side and the DTE side of the interface may comply either with Recommendation V.28 [2] using the 25-pin connector and pin allocation standardized by ISO 2110 [3] or with Recommendation X.26 using the 37-pin connector and pin allocation standardized by ISO 4902 [4]. Administrations may choose to offer only one of the interface options. Where the Administration permits interworking between V.28 [2] equipment on one side of the interface and X.26 equipment on the other side of the interface, refer to Recommendation X.26 and ISO 4902 [4]. (The onus is on the provider of X.26 equipment to supply the adaptor needed to interwork with the V.28 [2] equipment.)

For applications of the data signalling rate of 48 kbit/s, the connector and electrical characteristics at both the DCE side and the DTE side of the interface are given in the ISO standard for the assignment of the 34-pin interface connector ISO 2593 [5] and in Recommendation V.35 [6] respectively. Alternatively for the data signalling rate of 48 kbit/s, the connector and electrical characteristics at both the DCE side and the DTE side of the interface may use ISO 4902 [4] and Recommendations X.26/X.27 respectively as applied for Recommendation V.36 [7]. This alternative configuration will not interwork with the ISO 2593 [5] and Recommendation V.35 [6] configuration. Administrations may choose to offer only one of the interface options at 48 kbit/s.

Table 1/X.21 *bis* shows the use of interchange circuits for the leased circuit service.

TABLE 1/X.21 *bis*

V.24 [8] Interchange circuit No.	Designation
102	Signal ground or common return
103	Transmitted data
104	Received data
105	Request to send
106	Ready for sending
107	Data set ready (see Note 1)
108/1	Connect data set to line (see Notes 2 and 3)
109	Data channel received line signal detector
114	Transmitter signal element timing (DCE) (see Note 4)
115	Receiver signal element timing (DCE) (see Note 4)
140	Remote loopback for point to point circuits (see Note 5)
141	Local loopback (see Note 5)
142	Test indicator (DCE)

Note 1 – Circuit 107 shall go OFF only in cases of DCE power-off (normally the indeterminate state is interpreted as OFF), loss of service (see § 3.2 below) or when circuit 108/1, when implemented, is turned OFF.

Note 2 – Not required for V.29 [9], V.35 [6] and V.36 [7] compatible interfaces.

Note 3 – The DCE interprets the ON condition on circuit 108/1, when implemented, as an indication that the DTE is operational. If circuit 108/1 is not provided the DCE will consider the lack of circuit 108/1 as the ON condition. The DCE turns circuit 107 ON while circuit 108/1, if present, is ON and the circuit connection is available.

Note 4 – The DCE shall provide the DTE with transmitter and receiver signal element timings; this is done by feeding circuits 114 and 115 with the same timing signal from the DCE.

Note 5 – Not required in those networks which do not provide automatic activation of the loops.

All these circuit functions are in accordance with Recommendation V.24 [8] and the appropriate modem Recommendations (see also § 1.2.1 below).

1.2.1 *Operational requirements*

1.2.1.1 *Half-duplex operation*

In principle the data circuit provided has duplex transmission capability. However, when a remote response from circuit 105 to circuit 109 is required it may be provided on an optional basis (see also Annex A).

Note – Attention is drawn to the fact that, although circuit 105 can control circuit 109 at the other end, in case of the half-duplex facility, the detection of a line signal should be replaced by some other control mechanism.

1.2.1.2 *Response times*

The response time of the OFF to ON transition of circuit 106 as a response to circuit 105 OFF to ON should provisionally be between 30 and 50 ms for the 600 bit/s user rate, and 10 to 20 ms for the higher user rate.

1.2.1.3 *Clamping*

The following conditions apply:

- In the event of line failure (e.g. channel out of service, loss of alignment) the DCE shall clamp circuit 104 to steady binary 1 condition and circuit 109 to OFF condition.
- In all applications the DCE shall hold circuit 104 in binary 1 condition, when circuit 109 is in the OFF condition.
- In addition, when the half-duplex facility is provided, the DCE shall hold circuit 104 in the binary 1 condition and circuit 109 in the OFF condition when circuit 105 is in the ON condition.
- When circuit 105 or circuit 106 or both are OFF, the DTE shall maintain a binary 1 condition on circuit 103.

1.2.1.4 *Timing arrangements*

Timing signals on circuits 114 and 115 should always be maintained when the DCE is capable of generating them, disregarding the conditions of the other circuits. Circuits 114 and 115 should be held by the DCE in the OFF condition when the DCE is unable to generate the timing information.

2 The use of V-Series DTEs for direct call and address call facilities

2.1 *General*

The use of V-Series DTEs utilizing the *direct call* or the *address* facility in public data networks is discussed below.

The data signalling rates are those defined in Recommendation X.1 [1] for user classes of service employing synchronous transmission.

2.2 *Use of interchange circuits*

The electrical characteristics of the interchange circuits at both the DCE side and the DTE side of the interface may comply either with Recommendation V.28 [2] using the 25-pin connector and pin allocation standardized by ISO 2110 [3] or with Recommendation X.26 using 37-pin connector and pin allocation standardized by ISO 4902 [4]. Administrations may choose to offer only one of the interface options. Where the Administrations permit interworking between V.28 equipment on one side of the interface and X.26 equipment on the other side of the interface, refer to Recommendation X.26 and ISO 4902 [4]. (The onus is on the provider of the X.26 equipment to supply the adaptor needed to interwork with the V.28 [2] equipment.)

For applications of the data signalling rate of 48 kbit/s, the connector and electrical characteristics at both the DCE side and the DTE side of the interface are given in the ISO standard for the assignment of the 34-pin interface connector ISO 2593 [5] and in Recommendation V.35 [6] respectively. Alternatively for the data signalling rate of 48 kbit/s, the connector and electrical characteristics at both the DCE side and the DTE side of the interface may use ISO 4902 [4] and Recommendations X.26/X.27 respectively as applied for Recommendation V.36 [7]. This alternative configuration will not interwork with the ISO 2593 [5] and Recommendation V.35 [6] configuration. Administrations may choose to offer only one of the interface options at 48 kbit/s.

Table 2/X.21 *bis* shows the list of interchange circuits.

TABLE 2/X.21 *bis*

V.24 [8] Interchange circuit No.	Designation
102	Signal ground or common return
103	Transmitted data
104	Received data
105	Request to send
106	Ready for sending
107	Data set ready
108/1 or	Connect data set to line
108/2	Data terminal ready
109	Data channel received line signal detector
114	Transmitter request element timing (DCE)
115	Receiver signal element timing (DCE)
125	Calling indicator
141	Local loopback
142	Test indicator

For further definitions of the interchange circuits outlined below, refer to Recommendation V.24 [8] and the appropriate V-Series modem Recommendations.

2.2.1 *Call establishment and disconnection phases*

The following interchange circuits should be used for control signalling in the call establishment and disconnection phases:

Circuit 102 – Signal ground or common return

Circuit 107 – Data set ready

This circuit is used to indicate the following operational functions:

Condition of circuit 107	Function in the network (see § 2.2.1.1)
ON	Ready for data
OFF	DCE Clear indication
OFF	DCE Clear confirmation

Note – In duplex transmission when no circuit 105 operation is used by the DTE, circuit 106 will be set to ON with a delay from 0 to 20 ms with respect to the transition of circuit 107 to ON.

Circuit 108/1 – Connect data set to line

This circuit is used alternatively to circuit 108/2. The following operational functions should be indicated:

Condition of circuit 108/1	Function in the network (see § 2.2.1.1)
ON	Call request
ON	Call accepted
OFF	DTE Clear request
OFF	DTE Clear confirmation

Note – This circuit should not be operated when the DTE is connected to a modem which does not terminate this circuit.

Circuit 108/2 – Data terminal ready

This circuit is used alternatively to circuit 108/1. The following operational functions should be indicated:

Condition of circuit 108/2	Function in the network (see § 2.2.1.1)
ON	Call accepted
OFF	DTE Clear request
OFF	DTE Clear confirmation

Note – This circuit should not be operated when the DTE is connected to a modem which does not terminate this circuit.

Circuit 114 – Transmitter signal element timing (DCE)

Circuit 115 – Receiver signal element timing (DCE)

The DCE shall provide the DTE with transmitter and receiver element timings. This is done by feeding circuits 114 and 115 with the same timing signal from the DCE.

Circuit 125 – Calling indicator

The ON condition indicates *incoming call.* The circuit will be turned OFF as follows:

- in conjunction with circuit 107 turned ON, or
- *DCE ready* is received from the network, or
- *DCE clear indication* is received from the network.

Circuit 141 – Local loopback

Signals on this circuit are used to control the loop 3 test condition in the local DCE. Not required in those networks which do not provide automatic activation of the loops.

Circuit 142 – Test indicator

This circuit is used to indicate to the DTE the test-mode status of the DCE.

2.2.1.1 *Operational requirements*

2.2.1.1.1 *Call request*

For a *direct call facility* the DTE indicates a *call request* by turning circuit 108/1 ON. Circuit 108/2 cannot be used for this purpose.

2.2.1.1.2 *Call accepted*

A DTE receiving an *incoming call* should turn circuit 108/1 or 108/2 from OFF to ON within 500 ms to indicate *call accepted,* otherwise the call will be cleared. A DCE presenting an *incoming call* to a DTE which already has circuit 108/2 ON will regard the ON condition on circuit 108/2 as an indication of *call accepted.* Optionally when a DTE does not provide circuit 108/1 or 108/2, the *call accepted* signal to the network would be generated within the DCE as an answer to the *incoming call* signal received from the network. However, it may be also possible to signal to the network a *DTE controlled not ready* by a manual action on the DCE.

2.2.1.1.3 *DCE clear indication/DTE clear confirmation*

DCE clear indication is signalled to the DTE by turning circuit 107 OFF. The *DTE clear confirmation,* when implemented, should be given by the DTE turning OFF circuit 108/1 or 108/2 within 100 ms after the *DCE clear indication* is signalled on circuit 107. Otherwise, the DCE may consider the DTE as being *uncontrolled not ready* until circuit 108/1 or 108/2 is turned OFF or a *ready* signal is generated by a manual action on the DCE.

Circuit 108/1 should always be able to give *DTE clear confirmation.*

Optionally, when a DTE does not turn circuit 108/2 OFF for *DTE clear confirmation* this would be automatically generated within the DCE as an answer to the *clear indication* received from the network and the DTE will be considered in the ready condition.

In the case when the DTE expects to have circuit 107 OFF only as a response to circuit 108/1 or 108/2 OFF, the DCE will not turn circuit 107 OFF as a *DCE clear indication* and in this case the *DCE clear indication* will not be signalled to the DTE across the interface. The *DTE clear confirmation* signal will then be automatically generated within the DCE as an answer to the *clear indication* signal received from the network. The DTE may be regarded as *uncontrolled not ready* until circuit 108/1 or 108/2 is turned OFF.

2.2.1.1.4 *Line identification*

Calling and *called line identification* signals cannot be handled by V-Series DTEs.

2.2.1.1.5 *Call progress signals*

Call progress signals cannot be handled by V-Series DTEs. If automatic address calling is provided in accordance with Recommendation V.25 [10], the reception of negative *call progress* signals will be indicated to the DTE on circuit 205.

2.2.2 *Data transfer phase*

The interchange circuits shown in Table 3/X.21 *bis* should be used in the *data transfer* phase.

TABLE 3/X.21 *bis*

V.24 [8] Interchange circuit No.	Designation
102	Signal ground or common return
103	Transmitted data
104	Received data
105	Request to send
106	Ready for sending
109	Data channel received line signal detector
114	Transmitter signal element timing (DCE) (see Note)
115	Receiver signal element timing (DCE) (see Note)

Note – The DCE shall provide the DTE with transmitter and receiver element timings. This is done by feeding circuits 114 and 115 with the same timing signal from the DCE.

All the circuit functions are in accordance with Recommendation V.24 [8] and the appropriate modem Recommendations.

2.2.2.1 *Operational requirements*

2.2.2.1.1 *Half-duplex operation*

In principle the data circuit provided has duplex transmission capability. However, when a remote response from circuit 105 to circuit 109 is required it may be provided on an optional basis (see also Annex A).

2.2.2.1.2 *Response times*

The response time of the OFF to ON transition of circuit 106 as a response to circuit 105 OFF to ON should provisionally be between 30 and 50 ms for the 600 bit/s user rate, and 10 to 20 ms for the higher user rate.

2.2.2.1.3 *Clamping*

The following conditions shall apply:

– In the event of line failure (e.g. channel out of service, loss of alignment) the DCE shall clamp circuit 104 to steady binary 1 condition and circuit 109 to OFF condition.

– In all applications the DCE shall hold circuit 104 in binary 1 condition, when circuit 109 is in the OFF condition.

– In addition, when the half-duplex facility is provided, the DCE shall hold circuit 104 in the binary 1 condition and circuit 109 in the OFF condition when circuit 105 is in the ON condition.

– When circuit 105 or circuit 106 or both are OFF, the DTE shall maintain a binary 1 condition on circuit 103.

2.2.2.1.4 *Timing arrangements*

Timing signals on circuits 114 and 115 should always be maintained when the DCE is capable of generating them, disregarding the conditions of the other circuits. Circuits 114 and 115 should be held by the DCE in the OFF condition when the DCE is unable to generate the timing information.

Continuous isochronous operation should be used.

2.3 *Operational modes*

2.3.1 *Direct call facility*

The following operational modes may be provided for:

i) Automatic direct call and automatic disconnection from the DTE. Circuit 108/1 should be used. In this case manual disconnection from the DCE should not be used.

ii) Manual direct call from the DCE and automatic disconnection from the DTE. Circuit 108/2 should be used.

iii) Manual direct call and manual disconnection from the DCE; for DTEs not providing circuit 108 or unable to use circuit 108/2 for disconnection.

Only automatic call answering controlled by circuit 108/1 or 108/2 when provided, or automatically within the DCE itself, should be implemented. However in the last case it is possible to signal to the network *DTE controlled not ready* by a manual action on the DCE.

Note – Consideration of manual answering and the implications of manual *DTE clear confirmation* are for further study.

2.3.2 *Address call facility*

The following operational modes may be provided for:

i) Manual address calling from the DCE and automatic disconnection from DTE. Circuit 108/2 should be used.

ii) Manual address calling and manual disconnection from the DCE; for DTEs not providing circuit 108/1 or 108/2 or unable to use circuit 108/2 for disconnection.

Only automatic answering controlled by circuit 108/2 when provided, or automatically within the DCE itself, should be implemented. However in the last case it is possible to signal to the network *DTE controlled not ready* by a manual action on the DCE.

iii) Automatic address calling and automatic disconnection from DTE if provided, should use the 200 series interchange circuits and the Recommendation V.25 [10] relevant procedures. The spare and code positions on the digit signal circuits 206-209 may be used for special purposes during the selection sequence in public data networks. The relationship between control characters on circuits 206-209 and those of Recommendation X.21 is as shown in Table 4/X.21 *bis*.

TABLE 4/X.21 *bis*

Binary states 209	208	207	206	Corresponding X.21 control characters
1	1	0	0	+
1	1	0	1	,
1	1	1	1	/
1	1	1	0	.
1	0	1	0	–

For an interim period some Administrations may provide a relationship according to Table 5/X.21 *bis*.

For an interim period some Administrations may provide a relationship according to Table 5/X.21 *bis*.

TABLE 5/X.21 *bis*

Binary states 209	208	207	206	Corresponding X.21 control characters
1	0	1	1	+
1	1	0	0	,
1	1	1	1	/
1	1	1	0	.
1	1	0	1	–

3 Failure detection and isolation

3.1 *Indeterminate conditions on interchange circuits*

If the DTE or DCE is unable to determine the condition of circuits 105, 107, 108/1 or 108/2 and possibly circuits 103 and 104 as specified in the relevant electrical interfaces specifications, it shall interpret this as the OFF condition or binary 1 (circuits 103 and 104).

3.2 *DCE fault conditions*

If the DCE is unable to provide service (e.g. loss of alignment or of incoming line signal) for a period longer than a fixed duration it will turn circuit 107 to the OFF condition. The value of this duration is network dependent.

Moreover, as soon as the DCE detects this condition it turns circuit 109 in the OFF condition and circuit 104 in the binary 1 condition.

3.3 *Test loops*

The definitions of the loops are provided in Recommendation X.150 [11].

3.3.1 *DTE test loop – loop 1*

This loop may be used as a basic test on the operation of the DTE, by returning transmitted signals to the DTE for checking. The loop should be set up inside the DTE as close as possible to the interface.

While the DTE is in the loop 1 test condition:

- transmitted data (circuit 103) is connected to received data (circuit 104) within the DTE;
- circuit 108/1 or 108/2 may be in the same condition as it was before the test;
- circuit 105 must be in the OFF condition;
- circuit 125 should continue to be monitored by the DTE so that an incoming call can be given priority over a routine loop test.

Interchange circuit 103 as presented to the DCE must be in the binary 1 condition.

The conditions of the other interchange circuits are not specified but they should if possible permit normal working.

3.3.2 *DTE test loop – loop 3*

In order to assist the test of the DTE, test loop 3 is provided in the DCE where the signals transmitted on circuits 103 and 105 are presented on circuits 104 and 109 respectively. Circuit 106 should follow circuit 105 with or without the usual delay. Circuit 107 should be ON. Additionally, circuit 142 should be ON whilst the loop is activated.

In the circuit switched service, as described in § 2 above, any existing connection with a remote station should be cleared by the DCE when the loop is activated.

The loop should be near the DCE/DTE interface. The DCE drivers and terminators may be included in the loop. The precise implementation of the loop within the DCE is a national option. Manual control should be provided on the DCE for activation of the loop. The automatic activation of this loop, if provided, should be controlled by circuit 141.

3.3.3 *Network test loop – loop 2*

For network maintenance purposes loop 2 is implemented in the DCE. Signals incoming from the network towards circuits 104 and 109 are diverted from these circuits and looped back to the network in place of signals from circuits 103 and 105 respectively.

The loop may be controlled manually on the DCE or automatically by the network. The control of the loop and the method used for the automatic control, when implemented, is a national option. In the leased circuit service, customer control of the loop, if provided, should be by circuit 140.

In the circuit switched service the loop should not be activated when the DTE is engaged in a call. The loop may be activated by the network without the prior knowledge and agreement of the DTE for periods which provisionally do not exceed one second.

In the leased circuit service the loop should not be activated before the customer has been informed of it. Some Administrations may activate the loop when abnormal conditions are detected in the network without first informing the customer.

When the test is in progress the DCE will return circuits 107 and 109 in the OFF condition, circuit 104 in the binary 1 condition and circuit 142 in the ON condition.

In case of a collision between a *call request* and the activation of the loop, the loop activation command will have priority and the call request is ignored.

3.4 *Tolerance of the signal element timing signal under fault conditions*

The signal element timing signal is delivered to the DTE on circuits 114 and 115 whenever possible.

In particular, it is delivered to the DTE when one of the loops described in § 3.3 above is activated or when the DCE loses alignment or the incoming line signal. The tolerance of the signal element timing will be ± 1%.

ANNEX A

(to Recommendation X.21 *bis*)

Interworking between DTEs conforming to Recommendations X.21 and X.21 *bis*

It is recognized that interworking between V-Series DTEs connected to a public data network according to Recommendation X.21 *bis* at one end and Recommendation X.21 DTEs at the other end should always be possible for DTEs not using half duplex operation.

Certain Administrations may provide facilities allowing interworking between DTEs operating in accordance with Recommendation X.21 and Recommendation X.21 *bis* using half-duplex operation by switching circuits C, I and circuits 109, 105 during data transfer phase in accordance with Figure A-1/X.21 *bis*.

Those Administrations not providing this facility shall cause the X.21 DCE to signal r = 1, i = ON when the X.21 *bis* DTE signals circuit 105 OFF. This will permit half-duplex operation for those DTEs that do not require circuit 109 to be OFF before signalling circuit 105 ON.

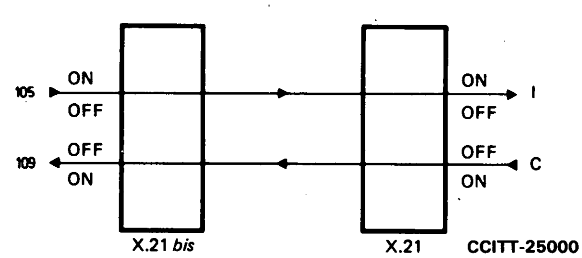


FIGURE A-1/X.21 *bis*

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.1.

[2] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.28.

[3] *Data communication – 15-pin DTE/DCE interface connector and pin assignments*, ISO Standard No. 2110-1980.

[4] *Data communication – 37-pin and 9-pin DTE/DCE interface connectors and pin assignments*, ISO Standard No. 4902.

[5] *Connector pin allocations for use with high-speed data terminal equipment*, ISO Standard No. 2593-1973.

[6] CCITT Recommendation *Data transmission at 48 kilobits per second using 60-108 kHz group band circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.35.

[7] CCITT Recommendation *Modems for synchronous data transmission using 60-108 kHz group band circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.36.

[8] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment*, Vol. VIII, Fascicle VIII.1, Rec. V.24.

[9] CCITT Recommendation *9600 bits per second modem standardized for use on point-to-point 4-wire leased telephone-type circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.29.

[10] CCITT Recommendation *Automatic calling and/or answering equipment on the general switched telephone network, including disabling of echo suppressors on manually established calls*, Vol. VIII, Fascicle VIII.1, Rec. V.25.

[11] CCITT Recommendation *DTE and DCE test loops for public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.150.

Recommendation X.22

MULTIPLEX DTE/DCE INTERFACE FOR USER CLASSES 3-6

(Geneva, 1980)

The CCITT,

considering

(a) that Recommendations X.1 [1] and X.2 [2] define the services and facilities to be provided by a public data network;

(b) that Recommendation X.21 defines the interface between a Data Terminal Equipment (DTE) and Data Circuit terminating Equipment (DCE) for synchronous operation on public data networks;

(c) that it is desirable for characteristics of the interface carrying a multiplexed bit stream between a DTE and a multiplex DCE of a public data network to be standardized;

unanimously declares the view

that the interface between the DTE and the DCE in a public data network using a multiplexed channel configuration employing synchronous transmission should be as defined in this Recommendation.

1 Scope

1.1 This Recommendation defines the interface between a DTE and a multiplex DCE, operating at 48 000 bit/s and multiplexing a number of Recommendation X.21 subscriber channels employing synchronous transmission.

1.2 The number of Recommendation X.21 subscriber channels is limited by the number of subscriber channels allowed in the network multiplex structure (see § 4).

1.3 The provision of all services supported by Recommendation X.21 is possible.

2 DTE/DCE physical interface elements (see Table 1/X.22)

2.1 *Electrical characteristics*

The electrical characteristics of the interchange circuits at both the DCE side and the DTE side of the interface will comply with Recommendation X.27 with implementation of the cable termination in the load.

2.2 *Mechanical characteristics*

Refer to ISO 4903 [3] (15-pin DTE/DCE interface connector and pin assignment) for mechanical arrangements.

2.3 *Functional characteristics of the interchange circuits*

Definitions of the interchange circuits to be implemented are given in Recommendation X.24 and in § 4.

TABLE 1/X.22

Interchange circuit	Name	Direction		Remark
		to DCE	from DCE	
G	Signal ground or common return			See Note
T	Transmit	X		
R	Receive		X	
C	Control	X		
I	Indication		X	
S	Signal element timing		X	
F	Frame start identification		X	

Note – This conductor may be used to reduce environmental signal interference at the interface. In the case of shielded interconnecting cable, the additional connection considerations are part of Recommendation X.24 and ISO 4903 [3].

2.4 *Call control and failure detection procedures*

Call control and *failure detection* procedures shall operate as specified in Recommendation X.21 on each subscriber channel independent of other subscriber channels.

2.4.1 *Quiescent states*

The quiescent states shall be in accordance with Recommendation X.21, § 2.5.

2.4.2 *Failure detection*

See the Recommendation cited in [4] for association of the receiver circuit failure detection types.

2.4.2.1 *Fault conditions on interchange circuits*

The DTE should interpret a fault condition on circuit R as r = 0 on all channels using failure detection type 2, a fault condition on circuit I as i = OFF on all channels using failure detection type 1, and a fault condition on both circuits R and I as r = 0, i = OFF *(DCE not ready)* on all channels.

Alternatively a fault condition on one of these circuits, R or I, may be interpreted by the DTE as r = 0, i = OFF *(DCE not ready)*, using failure detection type 3.

The DCE will interpret a fault condition on circuit T as t = 0 on all channels using failure detection type 2, a fault condition on circuit C as c = OFF on all channels using failure detection type 1, and a fault condition on both circuits T and C as t = 0, c = OFF on all channels *(DTE uncontrolled not ready)*.

Alternatively, a fault condition on one of these circuits, T or C, may be interpreted by the DCE as t = 0, c = OFF *(DTE uncontrolled not ready)*, using failure detection type 3.

2.4.2.2 *DCE fault condition*

Indication of the DCE failure condition shall be in accordance with Recommendation X.21, § 2.6.2.

A DCE failure condition may effect all subscriber channels at the DTE/DCE interface.

2.4.2.3 *Signal element timing provision*

The provision of signal element timing shall be in accordance with Recommendation X.21, § 2.6.3.

2.4.3 *Elements of the call control phase*

The elements of the call control phase, for each channel, shall be in accordance with Recommendation X.21, § 4 with the exception that byte timing is not used.

2.4.4 *Data transfer phase*

The data transfer phase, for each channel, shall be in accordance with Recommendation X.21, § 5.

2.4.5 *Clearing phase*

The clearing phase, for each channel, shall be in accordance with Recommendation X.21, § 6.

3 Alignment of call control characters and error checking

3.1 *Character alignment*

For the interchange of information between the DTE and the DCE for call control purposes, it is necessary to establish correct alignment of characters. Each sequence of call control characters to and from the DCE shall be preceded by two or more contiguous 1/6 ("SYN") characters.

3.1.1 Certain Administrations will require the DTE to align call control characters transmitted from the DTE to either SYN characters delivered to the DTE or to the signals on the *frame start identification* interchange circuit (F).

3.1.2 Certain Administrations will permit call control characters to be transmitted from the DTE independently of the SYN characters delivered to the DTE.

3.2 *Error checking*

Odd parity according to Recommendation X.4 [5] applies for the interchange of IA5 characters for call control purposes.

4 Multiplex structure

Depending on the multiplex structure used by the network, the structure of the multiplexed bit stream will be one of two different types.

4.1 *Multiplex structure in networks providing 6 bit-bytes*

The DCE shall deliver to and receive from the DTE a 6-bit byte interleaved multiplexed bit stream containing a number of subscriber channels. The allocation of the subscriber channels should be:

5 channels (phases)	of 9600 bit/s or
10 channels	of 4800 bit/s or
20 channels	of 2400 bit/s or
80 channels	of 600 bit/s or

an appropriate mix of channel data signalling rates having an aggregate bit rate of 48 kbit/s.

The multiplex structure is divided into five phases of 9600 bit/s, where each phase shall be homogeneous with regard to the subscriber data signalling rates.

4.1.1 *Interchange circuits and interface signalling scheme*

The interchange circuits between the DTE and the DCE are shown in Figure 1/X.22 and a timing diagram for the signals is given in Figure 2/X.22.

The signalling over the interchange circuits is as follows.

The transmit (T) and receive (R) circuits will convey in one time slot six consecutive user data bits for one subscriber channel (see Figure 2/X.22).

The control (C) and indication (I) circuits will convey the appropriate signal levels in accordance with Recommendation X.21 for the data channel which in the same time slot have bits conveyed over the respective data circuits.

The signal element timing (S) will operate for continuous isochronous transmission at 48 kbit/s.

The *frame start identification* circuit (F) will indicate the frame start with an OFF condition appearing in the last bit of each frame. For networks using Recommendation X.50 [6] division 2 multiplexing, the frame length will be 480 bits. For networks using Recommendation X.50 [7] division 3 multiplexing in which the user rate of 600 bit/s is not included, the frame length will be 120 bits.

4.2 *Multiplex structure in networks providing 8-bit bytes*

The DCE shall deliver to and receive from the DTE an 8-bit byte interleaved multiplexed bit stream containing a number of subscriber channels. The allocation of the subscriber channels should be:

5 channels (phases) of 9600 bit/s or
10 channels of 4800 bit/s or
20 channels of 2400 bit/s or
80 channels of 600 bit/s or

an appropriate mix of channel data signalling rates having an aggregate bit rate of 48 kbit/s.

The multiplex bit stream is divided into five phases of 9600 bit/s, where each phase shall be homogeneous with regard to the subscriber data signalling rates.

4.2.1 *Interchange circuits and interface signalling scheme*

The interchange circuits between the DTE and DCE are shown in Figure 1/X.22 and a timing diagram for the signals is given in Figure 3/X.22. The signalling over the interchange circuits is as follows.

The transmit (T) and receive (R) circuits will convey in one time slot eight consecutive user data bits for one subscriber channel (see Figure 3/X.22).

The control (C) and indication (I) circuits will convey the appropriate signal levels in accordance with Recommendation X.21 for the data channel which in the same time slot have bits conveyed over the respective data circuits.

The signal element timing (S) will operate for continuous isochronous transmission at 48 kbit/s.

The *frame start identification* circuit (F) will indicate the frame start with an OFF condition appearing in the position of the last bit of each 640-bit frame. As an optional facility each frame start could be followed by a code which will indicate the actual channel allocation. This facility is for further study.

5 Test loops

Establishment of test loops for DTE tests and network maintenance is for further study.

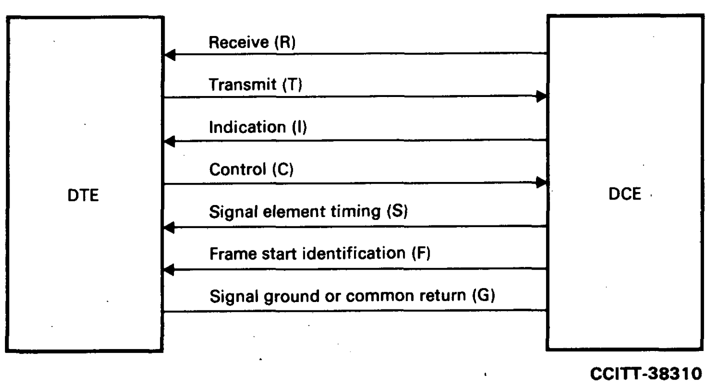
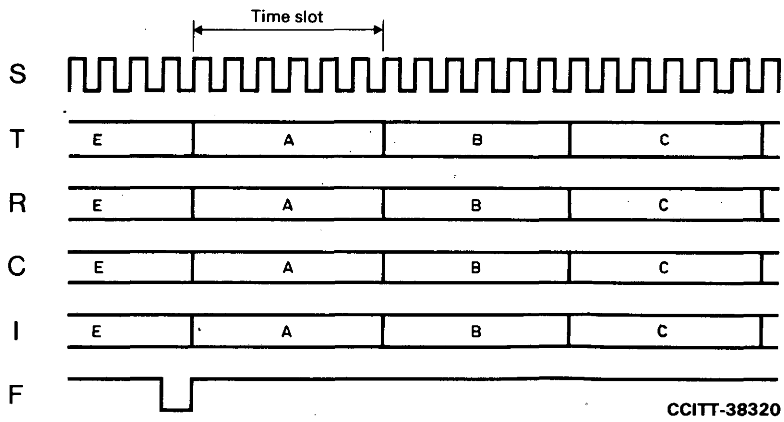


FIGURE 1/X.22

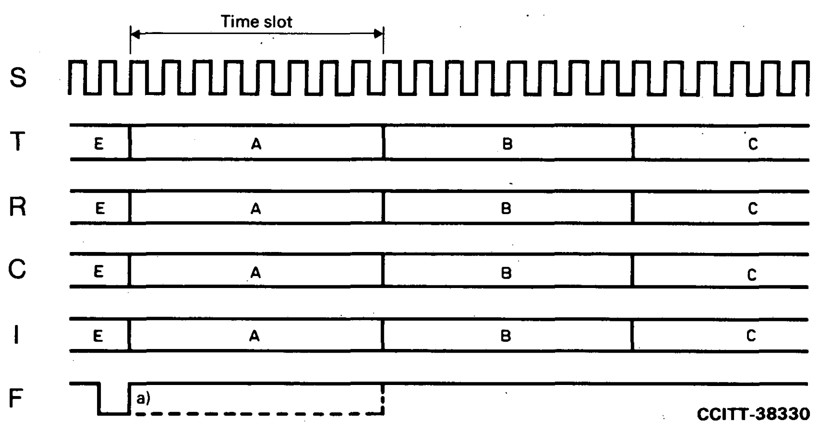
Interchange circuits in the multiplexed DTE/DCE interface



Note – This figure gives as an example the case of five 9600 bit/s subscriber channels labelled A, B, C, D and E.

FIGURE 2/X.22

Timing diagram for the interchange circuits when 6-bit bytes are used



a) Channel allocation code (for further study)

Note – The figure gives as an example the case of five 9600 bit/s subscriber channels labelled A, B, C, D and E.

FIGURE 3/X.22

Timing diagram for the interchange circuits when 8-bit bytes are used

References

[1] CCITT Recommendation *International user classes of service in public data networks,* Vol. VIII, Fascicle VIII.2, Rec. X.1.

[2] CCITT Recommendation *International user services and facilities in public data networks,* Vol. VIII, Fascicle VIII.2, Rec. X.2.

[3] *Data communication – 15-pin DTE/DCE interface connector and pin assignments,* ISO Standard No. 4903-1980.

[4] CCITT Recommendation *Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications,* Vol. VIII, Fascicle VIII.1, Rec. V.11 (X.27), § 9.

[5] CCITT Recommendation *General structure of signals of International Alphabet No. 5 code for data transmission over public data networks,* Vol. VIII, Fascicle VIII.2, Rec. X.4.

[6] CCITT Recommendation *Fundamental parameters of a multiplexing scheme for the international interface between synchronous data networks,* Vol. VIII, Fascicle VIII.3, Rec. X.50, § 2.

[7] *Ibid.,* § 3.

LIST OF DEFINITIONS FOR INTERCHANGE CIRCUITS BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT TERMINATING EQUIPMENT (DCE) ON PUBLIC DATA NETWORKS

(Geneva, 1976; amended at Geneva, 1980)

The CCITT,

considering that

(a) the interface between DTE and DCE on public data neworks requires, in addition to the electrical and functional characteristics of the interchange circuits, the definition of procedural characteristics for call control functions and selection of the facilities according to Recommendation X.2 [1];

(b) the functions of the circuits defined in Recommendation V.24 [2] are based on the requirements of data transmission over the general telephone network and are not appropriate for use at DTE/DCE interfaces in public data networks;

unanimously declares the view that

a Recommendation to include the list of definitions of interchange circuits for use in public data networks is required.

1 Scope

1.1 This Recommendation applies to the functions of the interchange circuits provided at the interface between DTE and DCE of data networks for the transfer of binary data, call control signals and timing signals.

For any type of practical equipment, a selection will be made from the range of interchange circuits defined in this Recommendation, as appropriate. The actual interchange circuits to be used in a particular DCE for a user class of service according to Recommendation X.1 [3] and defined user facilities according to Recommendation X.2 [1], are those indicated in the relevant Recommendation for the procedural characteristics of the interface, e.g., Recommendation X.20 or X.21.

To enable a standard DTE to be developed, the use and termination by the DTE of certain circuits even when implemented in the DCE are not mandatory. This is covered by the individual interface Recommendations.

The interchange circuits defined for the transfer of binary data are also used for the exchange of call control signals.

The electrical characteristics of the interchange circuits are detailed in the appropriate Recommendation for electrical characteristics of interchange circuits. The application of those characteristics for a particular DCE is specified in the Recommendation for the procedural characteristics of the interface.

1.2 The range of interchange circuits defined in this Recommendation is applicable to the range of services which could be offered on a public data network, e.g., circuit switching services (synchronous and start/stop), telex service, packet switching services, message registration and retransmission service and facsimile service.

2 Line of demarcation

The interface between DTE and DCE is located at a connector which is the interchange point between these two classes of equipment shown in Figure 1/X.24.

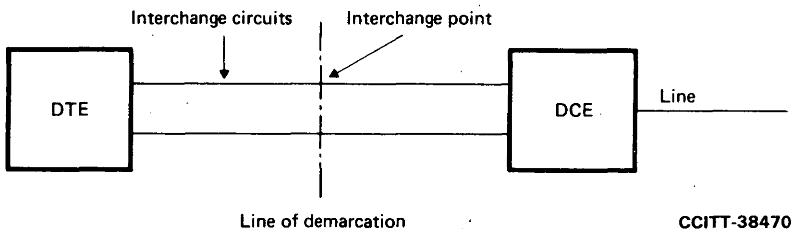


FIGURE 1/X.24

General illustration of interface equipment layout

2.1 The connector will not necessarily be physically attached to the DCE and may be mounted in a fixed position near the DTE. The female part of the connector belongs to the DCE.

2.2 An interconnecting cable will normally be provided together with the DTE. The cable length is limited by electrical parameters specified in the appropriate Recommendations for the electrical characteristics of the interchange circuits.

3 Definition of interchange circuits

A list of the data network series interchange circuits is presented in tabular form in Table 1/X.24.

TABLE 1/X.24

Data network interchange circuits

Interchange circuit designation	Interchange circuit name	Data		Control		Timing	
		From DCE	To DCE	From DCE	To DCE	From DCE	To DCE
G	Signal ground or common return						
Ga	DTE common return				X		
Gb	DCE common return			X			
T	Transmit		X		X		
R	Receive	X		X			
C	Control				X		
I	Indication			X			
S	Signal element timing					X	
B	Byte timing					X	
F	Frame start identification					X	

3.1 *Circuit G — Signal ground or common return*

This conductor establishes the signal common reference potential for unbalanced double-current interchange circuits with electrical characteristics according to Recommendation V.28 [4]. In the case of interchange circuits according to Recommendations V.10 [5] and V.11 [6], it interconnects the zero volt reference points of a generator and a receiver to reduce environmental signal interference, if required.

Within the DCE, this conductor shall be brought to one point, protective ground or earth, by means of a metallic strap within the equipment. This metallic strap can be connected or removed at installation, as may be required, to minimize the introduction of noise into electronic circuitry or to meet applicable regulations.

Note — Where a shielded interconnecting cable is used at the interface, the shield may be connected either to circuit G, or to protective ground in accordance with national regulations. Protective ground may be further connected to external grounds as required by applicable electrical safety regulations.

For unbalanced interchange circuits with electrical characteristics in accordance with Recommendation V.10 [5], two common-return conductors are required, one for each direction of signalling, each conductor being connected to ground only on the generator side of the interface. Where used, these shall be designated circuits Ga and Gb, and they are defined as follows:

Circuit Ga — DTE common return

This conductor is connected to the DTE circuit common and is used as the reference potential for the unbalanced X.26 [5] type interchange circuit receivers within the DCE.

Circuit Gb – DCE common return

This conductor is connected to the DCE circuit common and is used as the reference potential for the unbalanced X.26 [5] type interchange circuit receivers within the DTE.

3.2 *Circuit T – Transmit*

Direction: To DCE

The binary signals originated by the DTE to be transmitted during the data transfer phase via the data circuit to one or more remote DTEs are transferred on this circuit to the DCE.

This circuit also transfers the call control signals originated by the DTE, to be transmitted to the DCE in the call establishment and other call control phases as specified by the relevant Recommendations for the procedural characteristic of the interface.

The DCE monitors this circuit for detection of electrical circuit fault conditions, according to the specifications of the electrical characteristics of the interface. A circuit fault is to be interpreted by the DCE as defined in the Recommendation for the procedural characteristics of the interface.

3.3 *Circuit R – Receive*

Direction: From DCE

The binary signals sent by the DCE as received during the data transfer phase from a remote DTE, are transferred on this circuit to the DTE.

This circuit also transfers the call control signals sent by the DCE as received during the call establishment and other call control phases as specified by the relevant Recommendations for the procedural characteristics of the interface.

The DTE monitors this circuit for detection of electrical circuit fault conditions, according to the specifications of the electrical characteristics of the interface. A circuit fault is to be interpreted by the DTE as defined in the Recommendation for the procedural characteristics of the interface.

3.4 *Circuit C – Control*

Direction: To DCE

Signals on this circuit control the DCE for a particular signalling process.

Representation of a control signal requires additional coding of circuit T-*Transmit* as specified in the relevant Recommendation for the procedural characteristics of the interface. During the data phase, this circuit shall remain ON. During the call control phases, the condition of this circuit shall be as specified in the relevant Recommendation for the procedural characteristics of the interface.

Note – After appropriate selection of special user facilities (not yet defined), it might be required to change the ON condition after entering the data phase in accordance with the regulations for the use of these facilities. This subject is for further study.

The DCE monitors this circuit for detection of electrical circuit fault conditions, according to the specifications of the electrical characteristics of the interface. A circuit fault is to be interpreted by the DCE as defined in the Recommendation for the procedural characteristics of the interface.

3.5 *Circuit I – Indication*

Direction: From DCE

Signals on this circuit indicate to the DTE the state of the call control process.

Representation of a control signal requires additional coding of circuit R-*Receive*, as specified in the relevant Recommendation for the procedural characteristics of the interface. The ON condition of this circuit signifies that signals on circuit R contain information from the distant DTE. The OFF condition signifies a control signalling condition which is defined by the bit sequence on circuit R as specified by the procedural characteristics of the interface.

The DTE monitors this circuit for detection of electrical circuit fault conditions, according to the specifications of the electrical characteristics of the interface. A circuit fault is to be interpreted by the DTE as defined in the Recommendation for the procedural characteristics of the interface.

Note – For use with special user facilities (not yet defined) it might be required to use the OFF condition after entering the data transfer phase in accordance with the regulations for the use of these facilities. This subject is for further study.

3.6 *Circuit S – Signal element timing*

Direction: From DCE

Signals on this circuit provide the DTE with signal element timing information. The condition of this circuit shall be ON and OFF for nominally equal periods of time. However, for burst isochronous operations, longer periods of OFF condition may be permitted equal to an integer odd number of the nominal period of the ON condition as specified by the relevant procedural characteristics of the interface.

The DTE shall present a binary signal on circuit T-*Transmit* and a condition on circuit C-*Control*, in which the transitions nominally occur at the time of the transitions from OFF to ON condition of this circuit.

The DCE presents a binary signal on circuit R-*Receive* and a condition on circuit I-*Indication* in which the transitions nominally occur at the time of the transitions from OFF to ON condition of this circuit.

The DCE shall transfer signal element timing information on this circuit across the interface at all times that the timing source is capable of generating this information.

3.7 *Circuit B – Byte timing* (see Note 2)

Direction: From DCE

Signals on this circuit provide the DTE with 8-bit byte timing information. The condition of this circuit shall be OFF for nominally the period of the ON condition of circuit S-*Signal element timing* which indicates the last bit of an 8-bit byte and shall be ON at all other times within the period of the 8-bit byte.

During the call control phases, the call control characters and steady state conditions used for all information transfers between the DCE and the DTE, in either direction, shall be correctly aligned to the signals of circuit B.

The DTE shall present the beginning of the first bit of each call control character on circuit T-*Transmit* nominally at the time of the OFF to ON transition of circuit S which follows the OFF to ON transition of circuit B.

A change of condition of circuit C-*Control* may occur at any OFF to ON transition of circuit S, but it will be sampled in the DCE at the time of the OFF to ON transition of circuit B, i.e., for evaluation of the following call control character on circuit T.

The centre of the last bit of each call control character will be presented by the DCE on circuit R-*Receive* nominally at the time of the OFF to ON transition of circuit B.

A change of condition of circuit I-*Indication* will occur nominally at the OFF to ON transition of circuit S which follows the OFF to ON transition of circuit B.

The DCE shall transfer byte timing information on this circuit across the interface at all times that the timing source is capable of generating this information.

Note 1 – During the data transfer phase, DTEs communicating by means of an 8-bit code may utilize the byte timing information for mutual character alignment.

It is a prerequisite for the provision of this feature that character alignment is preserved after the call has entered the data transfer phase and that the alignment obtained at one interface is synchronized to the alignment at the other interface. (This is only possible on some connections.)

Furthermore, where this feature is available, a change of condition on circuit C as defined above may result in an equivalent change in the relative alignment on circuit I at the distant interface.

Note 2 – In some Recommendations for the procedural characteristics of the interface (e.g., X.21), the use and termination of this circuit by the DTE is not mandatory even when implemented in the DCE.

3.8 *Circuit F – Frame start identification*

Direction: From DCE

Signals on this circuit continuously provide the DTE with a multiplex frame start indication when connected to a multiplexed DTE/DCE interface.

The condition on this circuit shall be OFF for the nominal period of one bit, indicating the last bit of the multiplex frame. At other times the circuit shall remain ON.

The first data bit on subscriber channel 1 shall be transmitted or received beginning nominally at the OFF to ON transition of circuit F.

References

[1] CCITT Recommendation *International user services and facilities in public data networks,* Vol. VIII, Fascicle VIII.2, Rec. X.2.

[2] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment,* Vol. VIII, Fascicle VIII.1, Rec. V.24.

[3] CCITT Recommendation *International user classes of service in public data networks,* Vol. VIII, Fascicle VIII.2, Rec. X.1.

[4] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits,* Vol. VIII, Fascicle VIII.1, Rec. V.28.

[5] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications,* Vol. VIII, Fascicle VIII.1, Rec. V.10 (X.26).

[6] CCITT Recommendation *Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications,* Vol. VIII, Fascicle VIII.1, Rec. V.11 (X.27).

Recommendation X.25

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

(Geneva, 1976; amended at Geneva, 1980)

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 [1] includes specific user classes of service for data terminal equipments operating in the packet mode, Recommendation X.2 [2] defines user facilities, Recommendations X.21 and X.21 *bis* define DTE/DCE physical level interface characteristics, Recommendation X.92 [3] defines the logical control links for packet-switched data transmission services and Recommendation X.96 [4] defines *call progress* signals;

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

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

(d) the desirability of being able to use a single data circuit to a Data Switching Exchange (DSE) for all user facilities;

(e) that Recommendation X.2 [2] designates virtual call and permanent virtual circuit services as essential (E) services to be provided by all networks and designates datagram service as an additional (A) service which may be provided by some networks;

(f) 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;

(g) that the necessary elements for an interface Recommendation should be defined independently as:

Physical Level – the mechanical, electrical, functional and procedural characteristics to activate, maintain and deactivate the physical link between the DTE and the DCE;

Link Level – the link access procedure for data interchange across the link between the DTE and the DCE;

Packet Level – the packet format and control procedures for the exchange of packets containing control information and user data between the DTE and the DCE;

unanimously declares the view

that for data terminal equipments operating in the packet mode:

(1) the mechanical, electrical, functional and procedural characteristics to activate, maintain, and deactivate the physical link between the DTE and the DCE should be as specified in § 1 below, *DTE/DCE interface characteristics*;

(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*;

(3) the packet level procedures for the exchange of 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*;

(4) the procedures for virtual call and permanent virtual circuit services should be as specified in § 4 below, *Procedures for virtual circuit services*;

(5) the procedures for datagram service should be as specified in § 5 below, *Procedures for datagram service*;

(6) the format for packets exchanged between the DTE and the DCE should be as specified in § 6 below, *Packet formats*;

(7) procedures and formats for optional user facilities should be as specified in § 7 below, *Procedures and formats for optional user facilities.*

CONTENTS

1 DTE/DCE interface characteristics (physical level)

The DTE/DCE physical interface characteristics defined as the Physical Level element shall be in accordance with Recommendation X.21. For an interim period, some Administrations may offer a DTE/DCE interface at this level in accordance with Recommendation X.21 *bis*. The exact use of the relevant points in these Recommendations is detailed below.

1.1 *The interface characteristics for a DTE connected to a packet-switched data transmission service by a dedicated circuit*

1.1.1 *X.21 Interface*

1.1.1.1 The DTE/DCE physical interface elements shall be according to § 2 of Recommendation X.21.

1.1.1.2 The operation of test loops shall be according to § 7 of Recommendation X.21.

1.1.1.3 The procedures for entering operational phases shall be as follows:

a) when the DTE signals c = ON, signals on circuit T shall be according to the higher level procedures described in the following points of this Recommendation;

b) when the DCE signals i = ON, signals on circuit R shall be according to the higher level procedures described in the following points of this Recommendation;

c) the DTE/DCE interface should normally remain in the operational condition with both c = ON and i = ON to enable proper operation of the higher level procedures described in the following points of this Recommendation;

d) if a situation necessitates the DTE to signal *DTE ready* or *DTE uncontrolled not ready*, or the DCE to signal *DCE ready* or *DCE not ready*, the interface should return to the operational condition with both c = ON and i = ON when the situation is appropriate to enable normal operation of higher level procedures described in the following points of this Recommendation.

1.1.2 *X.21 bis interface*

1.1.2.1 The DTE/DCE physical interface elements shall be according to point 1 of Recommendation X.21 *bis*.

1.1.2.2 Failure detection and fault isolation shall be according to § 3 of Recommendation X.21 *bis*.

1.1.2.3 When circuits 105, 106, 107, 108 and 109 are in the ON condition, signals on circuits 103 and 104 shall be according to the higher level procedures described in the following points of this Recommendation.

1.2 *The interface characteristics and procedures for a DTE connected to a packet-switched data transmission service through a circuit switched data transmission service*

Note – The full interworking regarding the user facilities and architectural aspects of the following interface characteristics and procedures is a subject of further study.

1.2.1 *X.21 interface*

1.2.1.1 The DTE/DCE physical interface elements shall be according to § 2 of Recommendation X.21. The procedures for circuit switched access shall be according to §§ 3, 4, 5.1 and 6 of Recommendation X.21.

1.2.1.2 The operation of test loops shall be according to § 7 of Recommendation X.21.

1.2.1.3 When c = ON and i = ON (Recommendation X.21; state 12 or 13), signals on circuits T and R shall be according to the higher level procedures described in the following points of this Recommendation.

1.2.2 *X.21 bis interface*

1.2.2.1 The DTE/DCE physical interface elements and call establishment procedures shall be according to § 2 of Recommendation X.21 *bis.*

1.2.2.2 Failure detection and fault isolation shall be according to § 3 of Recommendation X.21 *bis.*

1.2.2.3 When circuits 105, 106, 107, 108 and 109 are in the ON condition, signals on circuits 103 and 104 shall be according to the higher level procedures described in the following points of this Recommendation.

2 Link access procedure across the DTE/DCE interface

2.1 *Scope and field of application*

2.1.1 The Link Access Procedures (LAP and LAPB) are described as the Link Level Element and are 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 [1].

2.1.2 The procedures use the principles and terminology of the High Level Data Link Control (HDLC) procedures specified by the International Organization for Standardization (ISO).

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) is achieved using the provisions found under the headings annotated as "applicable to LAPB" in this Recommendation.

DTE manufacturers and implementors must be aware that the procedure hereunder described as LAPB will be the only one available in all networks.

Likewise, a DTE may continue to use the provisions found under the headings annotated as "applicable to LAP" in this Recommendation (in those networks supporting such a procedure), 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.

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.

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.

TABLE 1/X.25

Frame formats

Bit order of transmission

	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	16 to 1	1 2 3 4 5 6 7 8
	Flag	Address	Control	FCS	Flag
	F 0 1 1 1 1 1 1 0	A 8-bits	C 8-bits	FCS 16-bits	F 0 1 1 1 1 1 1 0

FCS Frame Checking Sequence

Bit order of transmission

	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8		16 to 1	1 2 3 4 5 6 7 8
	Flag	Address	Control	Information	FCS	Flag
	F 0 1 1 1 1 1 1 0	A 8-bits	C 8-bits	I N-bits	FCS 16-bits	F 0 1 1 1 1 1 1 0

FCS Frame Checking Sequence

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 § 6 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 ones complement of the sum (modulo 2) of:

1) The remainder of $x^k (x^{15} + x^{14} + x^{13} + \dots + x^2 + x + 1)$ 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 polynominal $x^{16} + x^{12} + x^5 + 1$, 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 polynominal (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 polynominal, 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. 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	S	P/F		N(R)	
U frame	1	1	M	M	P/F	M	M	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 bit
M Modifier function bit
P/F Poll bit when issued as a command, final bit when issued as a response (1 = Poll/Final)

2.3.2.1.1 *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 I frames received by the DTE or DCE, and a P/F bit.

2.3.2.1.2 *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.

2.3.2.1.3 *Unnumbered format – U*

The U format is used to provide additional link control functions. This format contains no sequence numbers.

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 1 (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 1. The value of the send state variable is incremented by 1 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 set equal to 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. The receive state variable can take on the value 0 through modulus minus 1. The value of the receive state variable is incremented by one with 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 set equal to the current value of the receive state variable. N(R) indicates that the DTE or DCE transmitting the N(R) has received correctly all I frames numbered up to and including 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 reponse 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.

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) command and response*

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 and including 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 or DCE to ask for the status of the DCE or DTE, respectively.

2.3.4.3 *Reject (REJ) command and response*

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).

TABLE 3/X.25

Commands and responses

Format	Commands	Responses	Encoding							
			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 – DTEs do not have to implement both SARM and SABM; furthermore DM and SABM need not be used if SARM only is used.

Note 3 – RR, RNR and REJ supervisory command frames are not used by the DCE when SARM is used (LAP).

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.

The REJ command with the P bit set to 1 may be used by the DTE or DCE to ask for the status of the DCE or DTE, respectively.

2.3.4.4 *Receive not ready (RNR) command and response*

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 and including 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 or DCE to ask for the status of the DCE or DTE, respectively.

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 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 DCE or DTE 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 DCE or DTE 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 acknowledgement (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 unnumbered 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 the 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 with the F bit set to 1 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) (in the case of LAP, see § 2.4.8.1);

4) the receipt of a frame with an information field which is not permitted or the receipt of an S or U frame with incorrect length.

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) information 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 value 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 or not implemented.
- 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 or is an S or U frame with incorrect length. 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.
- Z set to 1 indicates that the control field received and returned in bits 1 through 8 contained an invalid N(R).

Note – Bits 9, 13 and 21 to 24 shall be set to 0 for CMDR. For FRMR, bits 9 and 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 DTE or DCE. 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 frames 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, the ones 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 DCE or DTE 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 and invalid frame*

Any frame received with an FCS error or which is invalid (see § 2.2.9 above) will be 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) (however see § 2.4.8.1 below for LAP application) or an information field which exceeds the maximum information field length which can be accommodated.

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

2.4 *Description of the procedures*

2.4.1 *Procedure to set the mode variable B (applicable if both LAP and LAPB are implemented)*

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 be initially set to 1 upon restoration of operation, but prior to link set-up by the DTE.

Whenever B is 1, the DCE will use the LAPB link set-up and disconnection procedures 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 procedures 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 DCE will discard all frames received with an address other than A or B; the DTE should do the same.

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

The DTE or DCE receiving a SARM, SABM, DISC, supervisory command or an I frame with the P bit set to 1, will set the F 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 P bit set to 1 will be a UA (or DM) response with the F bit set to 1. The response frame returned by the DCE to an I frame with the P bit set to 1 will be an RR, REJ, RNR, or CMDR (FRMR) response format with the F bit set to 1.

The response frame returned by the DCE to a supervisory command frame with the P bit set to 1 will be an RR, RNR, or CMDR (FRMR) response with the F 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 *Procedures for link set-up and disconnection (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 after transmission of a UA response to a first SARM command from the DTE 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 retransmit 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 and disconnection (applicable to LAPB)*

2.4.5.1 *Link set-up*

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

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

Should the DCE wish to set up the link, it will send the SABM command and start Timer T1 (see § 2.4.11.1 below). Upon reception of the UA response from the DTE the DCE resets both its send and receive state variables V(S) and V(R) to 0 and stops its Timer T1.

Should Timer T1 expire before reception of the UA response from the DTE, the DCE will retransmit the SABM command and restart Timer T1. After transmission of the SABM command N2 times by the DCE, appropriate recovery action will be initiated. The value of N2 is defined in § 2.4.11.2 below.

2.4.5.2 *Information transfer phase*

After having transmitted the UA response to an SABM command or having received the UA response to a transmitted 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.

Should the DCE wish to disconnect the link, it will send the DISC command and start Timer T1 (see § 2.4.11.1 below). Upon reception of the UA response from the DTE, the DCE will stop its Timer T1.

Should Timer T1 expire before reception of the UA response from the DTE, the DCE will retransmit the DISC command and restart Timer T1. After transmission of the DISC command N2 times by the DCE, appropriate recovery action will be initiated. The value of N2 is defined in § 2.4.11.2 below.

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, or having received the UA response to a transmitted DISC command, the DCE will enter the disconnected phase.

In the disconnected phase, the DCE may initiate link set-up. 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 P bit set to 1, the DCE will transmit a DM response with the F bit set to 1.

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

2.4.5.4.2 When the DCE enters the disconnected phase after detecting error conditions as listed in § 2.4.10 below, or exceptionally after recovery from an internal temporary malfunction; it may also indicate this by sending a DM response rather than a DISC command. 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, the DCE will remain in the disconnected phase and appropriate recovery actions will be initiated. The value of N2 is defined in § 2.4.11.2 below.

2.4.5.5 *Collision of unnumbered commands*

Collision situations shall be resolved in the following way:

2.4.5.5.1 If the sent and received U commands are the same, the DTE and DCE shall send the UA response at the earliest possible opportunity. The DCE shall enter the indicated phase after receiving the UA response.

2.4.5.5.2 If the sent and received U commands are different, the DTE and DCE shall enter the disconnected phase and issue a DM response at the earliest possible opportunity.

2.4.5.6 *Collision of DM response with the SABM or DISC commands*

When a DM response is issued by the DCE as an unsolicited response to request the DTE to issue a mode-setting command as described in § 2.4.5.4.2, a collision between a SABM or DISC command issued by the DTE and the unsolicited DM response issued by the DCE may occur. In order to avoid misinterpretation of the DM received, it is suggested that the DTE always send its SABM or DISC command with the P bit set to 1.

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 1 higher" is in reference to a continuously repeated sequence series, i.e., 7 is 1 higher than 6 and 0 is 1 higher than 7 for modulo 8 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 or 2.4.6.8 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 1.

If 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 new 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 new 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 condition it may still transmit I frames, provided that the DTE is not busy itself. When the DCE is in the command rejection condition (LAP), it may still transmit I frames. When the DCE is in the frame rejection condition (LAPB), it 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 1 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). Alternatively, the DCE may 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 field contained in any received I frame.

Note – Zero length information fields shall not be passed to the packet level and this situation should be indicated to the packet level.

2.4.6.3 *Reception of incorrect frames*

When the DCE receives a frame with an incorrect FCS or receives an invalid frame (see § 2.2.9), 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 field 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 field 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 receiving correctly an I or S frame (RR, RNR or REJ), even in the busy or command 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 and including the received N(R) minus one. The DCE will reset the Timer T1 when it receives correctly an I or S frame with the N(R) higher than the last received N(R) (actually acknowledging some I frames).

If Timer T1 has been reset, and if there are outstanding I frames still unacknowledged, the DCE will restart Timer T1. If Timer T1 then runs out, the DCE will follow the retransmission procedure (in § 2.4.6.5 and § 2.4.6.8 below) with respect to 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 value of 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. (Re)transmission 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 have 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 or retransmit the I frame with the send sequence number equal to the N(R) indicated in the RNR. If 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.

Note – The DTE when encountering a DCE busy condition, may send supervisory command frames with the P bit set to 1. In the event that the DTE has not implemented supervisory commands, it may follow the procedures of the DCE (see § 2.4.6.6) (applicable to LAPB).

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 receives correctly an I or S frame with the N(R) higher than the last received N(R) (actually acknowledging some outstanding I frames).

If Timer T1 runs out, the DCE will (re-)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 value of N(R) received from the DTE and retransmit the corresponding I frame with the P bit set to 1 (LAP or LAPB) or transmit an appropriate supervisory command with the P bit set to 1 (LAPB only).

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

If, while in the timer recovery condition, the DCE receives correctly a supervisory frame with the F bit set to 1 and with the N(R) within the range from its current send state variable to x included, it will clear the timer recovery condition and set its send state variable to the value of the received N(R).

If, while in the timer recovery condition, the DCE receives correctly a supervisory frame with the F bit set to 0 and with an N(R) within the range from its current send state variable to x included, it will not clear the timer recovery condition. The value of the received N(R) may be used to update the send state variable. However, the DCE may decide to keep the last transmitted I frame in store (even if it is acknowledged) in order to be able to retransmit it with the P bit set to 1 when Timer T1 runs out at a later time.

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, § 2.4.9.2 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 respone 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 11000000) 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.

The DCE will also initiate a resetting procedure as described in § 2.4.7.3 above when receiving an I frame with correct FCS, with the address B (coded 10000000) and with an invalid N(R) contained in the control field.

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 10000000) 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 or DCE shall indicate a resetting by transmitting an SABM command. After receiving an SABM command, the DCE or DTE, respectively, will return, at the earliest opportunity, a UA response to the DTE or DCE, respectively, 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. Prior to initiating this link resetting procedure, the DTE or DCE may initiate a disconnect procedure as described in § 2.4.5.3 above.

2.4.9.3 Under certain rejection conditions listed in § 2.4.6.8 above and § 2.4.10.2 below, 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 an FRMR response.

After transmitting an 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.

The DCE may start Timer T1 on transmission of the FRMR response. If Timer T1 runs out before the reception of an SABM or DISC command from the DTE, the DCE may retransmit the FRMR response and restart Timer T1. After transmission of the FRMR response N2 times the DCE may reset the link as described in § 2.4.9.2 above. The value of N2 is defined in § 2.4.11.2 below.

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 § 2.4.9.2 or § 2.4.9.3 above when receiving during the information transfer phase a DM response or an FRMR response.

The DCE may initiate a resetting procedure as described in § 2.4.9.2 or § 2.4.9.3 above when receiving during the information transfer phase a UA response or an unsolicited response with the F bit set to 1.

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 Timer T1 will take into account whether the timer is started at the beginning or the end of the frame in the DCE.

The period of 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, FRMR, I or supervisory commands) and the reception of the corresponding frame returned as an answer to this frame (UA, DM or acknowledging frame). Therefore, the DTE 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 system parameter agreed for a period of time with the Administration.

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 DTE or 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

This and subsequent points of the Recommendation relate 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 1 – Possible insertion of more than one packet in the link level information field is for further study.

Note 2 – At present, some networks require the data fields of packets to contain an integral number of octets. The transmission by the DTE of data fields not containing an integral number of octets to the network may cause a loss of data integrity.

Under urgent study are further considerations regarding the trends of future requirements and implementations toward either bit-orientation (any number of bits) or octet-orientation (an integral number of octets) for data fields in X.25 packets.

DTEs wishing universal operation on all networks should transmit all packets with data fields containing only an integral number of octets. Full data integrity can only be assured by exchange of octet-oriented data fields in both directions of transmission.

This point covers a description of the packet level interface for virtual call, permanent virtual circuit and datagram services. As designated in Recommendation X.2 [2], virtual call and permanent virtual circuit services are essential (E) services to be provided by all networks. Datagram service is designated as an additional (A) service which may be provided by some networks.

Note 3 – Under study are considerations regarding the amount of possible duplication between datagram, fast select and possible additional virtual call enhancements with the objective to minimize the variety of interfaces.

Procedures for the virtual circuit service (i.e., virtual call and permanent virtual circuit services) are specified in § 4. Procedures for the datagram service are specified in § 5. Packet formats for all services are specified in § 6. Procedures and formats for optional user facilities are specified in § 7.

3.1 *Logical channels*

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

3.2 *Basic structure of packets*

Every packet transferred across the DTE/DCE interface consists of at least three octets. These three octets contain a general format identifier, a logical channel identifier and a packet type identifier. Other packet fields are appended as required (see § 6).

Packet types and their use in association with various services are given in Table 5/X.25.

TABLE 5/X.25

Packet types and their use in various services

Packet type		Service		
From DCE to DTE	From DTE to DCE	VC	PVC	DG [a)]
	Call set-up and clearing (see Note 1)			
Incoming call	Call request	X		
Call connected	Call accepted	X		
Clear indication	Clear request	X		
DCE clear confirmation	DTE clear confirmation	X		
	Data and interrupt (see Note 2)			
DCE data	DTE data	X	X	
DCE interrupt	DTE interrupt	X	X	
DCE interrupt confirmation	DTE interrupt confirmation	X	X	
	Datagram (see Note 3)			
DCE datagram	DTE datagram			X
Datagram service signal				X
	Flow control and reset (see Note 4)			
DCE RR	DTE RR	X	X	X
DCE RNR	DTE RNR	X	X	X
	DTE REJ [a)]	X	X	X
Reset indication	Reset request	X	X	X
DCE reset confirmation	DTE reset confirmation	X	X	X
	Restart (see Note 5)			
Restart indication	Restart request	X	X	X
DCE restart confirmation	DTE restart confirmation	X	X	X
	Diagnostic (see Note 6)			
Diagnostic [a)]		X	X	X

[a)] Not necessarily available on all networks.

VC Virtual call
PVC Permanent virtual circuit
DG Datagram

Note 1 – See §§ 4.1 and 7.2.4 for procedures and §§ 6.2 and 6.8.2 for formats.

Note 2 – See § 4.3 for procedures and § 6.3 for formats.

Note 3 – See § 5.1 for procedures and § 6.4 for formats.

Note 4 – See §§ 4.4, 5.2 and 7.1.4 for procedures and §§ 6.5 and 6.8.1 for formats.

Note 5 – See § 3.3 for procedures and § 6.6 for formats.

Note 6 – See § 3.4 for procedures and § 6.7 for formats.

3.3 *Procedure for restart*

The restart procedure is used to initialize or re-initialize the packet level DTE/DCE interface. The restart procedure simultaneously clears all the virtual calls and resets all the permanent virtual circuits and datagram channels at the DTE/DCE interface (see §§ 4.5 and 5.3).

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

Table C-2/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE for the restart procedure. Details of the action which should be taken by the DTE are for further study.

3.3.1 *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 (r2).

The DCE will confirm the restart by transferring a *DCE restart confirmation packet* placing the logical channels used for virtual calls in the *ready* state (p1), and the logical channels used for permanent virtual circuits and datagrams in the *flow control ready* state (d1).

Note – States p1 and d1 are specified in §§ 4 and 5.

The *DCE restart confirmation* packet can only be interpreted universally as having local significance. The time spent in the *DTE restart request* state (r2) will not exceed time-limit T20 (see Annex D).

3.3.2 *Restart by the DCE*

The DCE may indicate a restart by transferring across the DTE/DCE interface a *restart indication* packet. The interface for each logical channel is then in the *DCE restart indication* state (r3). In this state of the DTE/DCE interface, the DCE will ignore all packets except for *restart request* and *DTE restart confirmation.*

The DTE will confirm the restart by transferring a *DTE restart confirmation* packet placing the logical channels used for virtual calls in the *ready* state (p1), and the logical channels used for permanent virtual circuits and datagrams in the *flow control ready* state (d1).

The action taken by the DCE when the DTE does not confirm the restart within time-out T10 is given in Annex D.

3.3.3 *Restart collision*

Restart collision occurs when a DTE and a DCE simultaneously transfer a *restart request* and a *restart indication* packet. Under these circumstances, the DCE will consider that the restart is completed. The DCE will not expect a *DTE restart confirmation* packet and will not transfer a *DCE restart confirmation* packet. This places the logical channels used for virtual calls in the *ready* state (p1), and the logical channels used for permanent virtual circuits and datagrams in the *flow control ready* state (d1).

3.4 *Error handling*

Table C-1/X.25 specifies the reaction of the DCE when special error conditions are encountered. Other error conditions are discussed in §§ 4 and 5.

3.4.1 *Diagnostic packet*

The *diagnostic* packet is used by some networks to indicate error conditions under circumstances where the usual methods of indication (i.e., *reset, clear* and *restart* with cause and diagnostic) are inappropriate (see Tables C-1/X.25 and D-1/X.25). The *diagnostic* packet from the DCE supplies information on error situations which are considered unrecoverable at the packet level of Recommendation X.25; the information provided permits an analysis of the error and recovery by higher levels at the DTE if desired or possible.

A *diagnostic* packet is issued only once per particular instance of an error condition. No confirmation is required to be issued by the DTE on receipt of a *diagnostic* packet. After issuance of a *diagnostic* packet, the DCE maintains the logical channel(s) to which the *diagnostic* packet is related in the same state as that when the *diagnostic* packet was generated.

3.5 *Effects of the physical level and the link level on the packet level*

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

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

When a failure on the physical and/or link level is detected, virtual calls will be cleared, permanent virtual circuits will be declared out of order and queued datagrams will be discarded. Further actions are specified in § 4.6 for virtual circuit services and in § 5.4 for the datagram service.

When the failure is recovered on physical and link levels, the DCE will send a *restart indication* packet with the cause "Network operational" to the local DTE. Further actions are specified in § 4.6 for virtual circuit services and in § 5.4 for the datagram service.

In other out-of-order conditions on the physical and/or link level, including transmission of a DISC command by the DTE, the behaviour of the DCE is for further study.

4 Procedures for virtual circuit services

4.1 *Procedures for virtual call service*

Figure B-1/X.25, B-2/X.25 and B-3/X.25 show 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 C gives details of the action taken by the DCE on receipt of packets in each state shown in Annex B. Details of the actions which should be taken by the DTE are for further study.

The call set-up and clearing procedures described in the following points apply independently to each logical channel assigned to the virtual call service at the DTE/DCE interface.

4.1.1 *Ready state*

If there is no call in existence, a logical channel is in the *ready* state (p1).

4.1.2 *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. The calling DTE address field may also be used.

Note 1 – 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.

Note 2 – The *call request* packet should use the logical channel in the *ready* state with the highest number in the range which has been agreed with the Administration (see Annex A). Thus the risk of call collision is minimized.

4.1.3 *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).

The *incoming call* packet will use the logical channel in the *ready* state with the lowest number (see Annex A). The *incoming call* packet includes the calling DTE address. The called DTE address field may also be used.

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

4.1.4 *Call accepted packet*

The called DTE shall indicate its acceptance of the call by 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).

If the called DTE does not accept the call by a *call accepted* packet or does not reject it by a *clear request* packet as described in § 4.1.7 within time-out T11 (see Annex D), the DCE will consider it as a procedure error from the called DTE and will clear the virtual call according to the procedure described in § 4.1.8.

4.1.5 *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 accepted by the called DTE by means of a *call accepted* packet. This places the specified logical channel in the *data transfer* state (p4).

The time spent in the *DTE waiting* state (p2) will not exceed time-limit T21 (see Annex D).

4.1.6 *Call collision*

Call collision occurs when a DTE and 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.*

4.1.7 *Clearing by the DTE*

At any time the DTE may indicate clearing by transferring across the DTE/DCE interface a *clear request* packet (see § 4.5). 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).

The *DCE clear confirmation* packet can only be interpreted universally as having local significance; however, within some Administrations' networks, clear confirmation may have end-to-end significance. In all cases the time spent in the *DTE clear request* state (p6) will not exceed time-limit T23 (see Annex D).

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

Note – The calling DTE may abort a call by clearing it before it has received a *call connected* or *clear indication* packet.

The called DTE may refuse an incoming call by clearing it as described in this point rather than transmitting a *call accepted* packet as described in § 4.1.4.

4.1.8 *Clearing by the DCE*

The DCE will indicate clearing by transferring across the DTE/DCE interface a *clear indication* packet (see § 4.5). 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).

The action taken by the DCE when the DTE does not confirm clearing within time-out T13 is given in Annex D.

4.1.9 *Clear collision*

Clear collision occurs when a DTE and DCE simultaneously transfer a *clear request* packet and a *clear indication* packet specifying the same logical channel. Under these circumstances the DCE will consider that the clearing is completed. The DCE will not expect a *DTE clear confirmation* packet and will not transfer a *DCE clear confirmation* packet. This places the logical channel in the *ready* state (p1).

4.1.10 *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.

4.1.11 *Call progress signals*

The DCE will be capable of transferring to the *DTE clearing call progress* signals as specified in Recommendation X.96 [4].

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 § 6.2.3.

4.1.12 *Data transfer state*

The procedures for the control of packets between DTE and DCE while in the *data transfer* state are contained in § 4.3.

4.2 *Procedures for permanent virtual circuit service*

Figures B-1/X.25 and B-3/X.25 show 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 C gives details of the action taken by the DCE on receipt of packets in each state shown in Annex B. 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 or clearing. The procedures for the control of packets between DTE and DCE while in the *data transfer* state are contained in § 4.3.

4.3 *Procedures for data and interrupt transfer*

The data transfer and interrupt procedures described in the following points of § 4.3 apply independently to each logical channel assigned for virtual calls or a permanent virtual circuit existing at the DTE/DCE interface.

Normal network operation dictates that user data in *data* and *interrupt* packets are all passed transparently, unaltered through the network in the case of packet DTE to packet DTE communications. The order of bits in *data* packets is preserved. Packet sequences are delivered as complete packet sequences. DTE diagnostic codes are treated as described in §§ 6.2.3, 6.5.3 and 6.6.1.

4.3.1 *States for data transfer*

A virtual call logical channel is in the *data transfer* state (p4) after completion of call establishment and prior to a clearing or a restart procedure. A permanent virtual circuit logical channel is continually in the *data transfer* state (p4) except during the restart procedure. *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 § 4.4 apply to data transmission on that logical channel to and from the DTE.

When a virtual call is cleared, *data* and *interrupt* packets may be discarded by the network (see § 4.5). In addition, *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 (p7). Hence it is left to the DTE to define DTE to DTE protocols able to cope with the various possible situations that may occur.

4.3.2 *User data field length of data packets*

The standard maximum user data field length is 128 octets.

In addition, other maximum user data field lengths may be offered by Administrations from the following list: 16, 32, 64, 256, 512 and 1024 octets. An optional maximum user data field length may be selected for a period of time as the default maximum user data field length common to all virtual calls at the DTE/DCE interface (see § 7.2.1). A value other than the default may be selected for a period of time for each permanent virtual circuit (see § 7.2.1). Negotiation of maximum user data field lengths on a per call basis may be made with the *flow control parameter negotiation* facility (see § 7.2.2).

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

Note – At present, some networks require the user data field to contain an integral number of octets (see § 3, Note 2).

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

4.3.3 *Delivery confirmation bit*

The setting of the Delivery Confirmation bit (D bit) is used to indicate whether or not the DTE wishes to receive an end-to-end acknowledgement of delivery, for data it is transmitting, by means of the packet receive sequence number P(R) (see § 4.4).

Note 1 – The use of the D bit procedure does not obviate the need for a higher level protocol agreed between the communicating DTEs which may be used with or without the D bit procedure to recover from user or network generated resets and clearings.

Note 2 – After January 1982, the D bit procedure should be considered an integral part of this Recommendation. In the interim period, the D bit procedure will be available on some public data networks and between some pairs of public data networks on a bilateral basis.

During the interim period, Administrations of networks which do not provide the D bit procedure should be consulted to determine whether the significance of P(R) is a local updating of the window across the packet level DTE/DCE interface or conveys an end-to-end acknowledgement of delivery of data.

In order to facilitate the orderly introduction of the D bit procedures in DTEs and DCEs, the following mechanisms are provided.

The calling DTE can ascertain during call establishment that the D bit procedure can be used for the call by setting bit 7 in the General Format Identifier of the *call request* packet to 1 (see § 6.1.1). Every network or part of international network where the D bit procedure is available will pass this bit transparently. If the remote DTE is able to handle the D bit procedure, it should not regard this bit being set to 1 in the *incoming call* packet as invalid.

Likewise, the called DTE can set bit 7 in the General Format Identifier of the *call accepted* packet to 1. Every network or part of international network where the D bit procedure is available will pass this bit transparently. If the calling DTE is able to handle the D bit procedure, it should not regard this bit being set to 1 in the *call connected* packet as invalid.

If any network along the path does not support the D bit procedure, this would be indicated by call clearing by the DCE with a cause indicating "Incompatible destination" and the diagnostic "Invalid general format identifier", or by any other means to indicate an invalid General Format Identifier at a DTE/DCE interface (see Table C-1/X.25).

The use by DTEs of the above mechanism in the *call request* and *call accepted* packets is recommended but is not mandatory for using the D bit procedure during the virtual call.

If a D bit is set to 1 in a *data* packet on a virtual call or permanent virtual circuit where the D bit is not available, this will be indicated to both DTEs by a *reset indication* packet with the cause "Incompatible destination" and the diagnostic "Invalid general format identifier", or by any other means to indicate an invalid General Format Identifier at a DTE/DCE interface (see Table C-1/X.25).

4.3.4 *More data mark*

If a DTE or DCE wishes to indicate a sequence of more than one packet, it uses a *more data* mark (M bit) as defined below.

The M bit can be set to 1 in any *data* packet. When it is set to 1 in a full *data* packet or in a partially full *data* packet also carrying the D bit set to 1, it indicates that more data is to follow. Recombination with the following *data* packet may only be performed within the network when the M bit is set to 1 in a full *data* packet which also has the D bit to 0.

A sequence of *data* packets with every M bit set to 1 except for the last one will be delivered as a sequence of *data* packets with the M bit set to 1 except for the last one when the original packets having the M bit set to 1 are either full (irrespective of the setting of the D bit) or partially full but have the D bit set to 1.

Two categories of *data* packets, A and B, have been defined as shown in Table 6/X.25. Table 6/X.25 also illustrates the network's treatment of the M and D bits at both ends of a virtual call or permanent virtual circuit.

TABLE 6/X.25

Definition of two categories of data packets and network treatment of the M and D bits

Data packet sent by source DTE				Combining with subsequent packet(s) is performed by the network when possible	*Data* packet [a)] received by destination DTE	
Category	M	D	Full		M	D
B	0 or 1	0	No	No	0	0
B	0	1	No	No	0	1
B	1	1	No	No	1	1
B	0	0	Yes	No	0	0
B	0	1	Yes	No	0	1
A	1	0	Yes	Yes (see Note)	1	0
B	1	1	Yes	No	1	1

a) Refers to the delivered *data* packet whose last bit of user data corresponds to the last bit of user data, if any, that was present in the *data* packet sent by the source DTE.

Note – If the *data* packet sent by the source DTE is combined with other packets, up to and including a category B packet, the M- and D-bit settings in the *data* packet received by the destination DTE will be according to that given in the two right-hand columns for the last *data* packet sent by the source DTE that was part of the combination.

4.3.5 *Complete packet sequence*

A complete packet sequence is defined as being composed of a single *category B* packet and all contiguous preceeding *category A* packets (if any). *Category A* packets have the exact maximum user data field length with the M bit set to 1 and the D bit set to 0. All other *data* packets are *category B* packets.

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

Thus, if the receiving end has a larger maximum user data field length than the transmitting end, then packets within a complete packet sequence will be combined within the network. They will be delivered in a complete packet sequence where each packet, except the last one, has the exact maximum user data field length, the M bit set to 1, and the D bit set to 0. The user data field of the last packet of the sequence may have less than the maximum length and the M and D bits are set as described in Table 6/X.25.

If the maximum user data field length is the same at both ends, then user data fields of *data* packets are delivered to the receiving DTE exactly as they have been received by the network, except as follows. If a full packet with the M bit set to 1 and the D bit set to 0 is followed by an empty packet, then the two packets may be merged so as to become a single category B full packet. If the last packet of a complete packet sequence transmitted by the source DTE has a user data field less than the maximum length with the M bit set to 1 and the D bit set to 0, then the last packet of the complete packet sequence delivered to the receiving DTE will have the M bit set to 0.

If the receiving end has a smaller maximum user data field length than the transmitting end, then packets will be segmented within the network, and the M and D bits will be set by the network as described to maintain complete packet sequences.

4.3.6 *Qualifier bit*

A complete 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 the Qualifier bit (Q bit).

When only one level of data is being transmitted on a logical channel, the Q bit is always set to 0. If two levels of data are being transmitted, the transmitting DTE should set the Q bit in all *data* packets of a complete packet sequence to the same value, either 0 or 1. A complete packet sequence, which is transmitted with the Q bit set to the same value in all packets, is delivered by the network as a complete packet sequence with the Q bit set in all packets to the value assigned by the transmitting DTE.

The action of the network when the Q bit is not set to the same value by the transmitting DTE within a complete packet sequence is left for further study.

Recommendation X.29 gives an example of the procedures to be used when the Q bit is set to 1.

Packets are numbered consecutively (see § 4.4.1.1) regardless of their data level.

4.3.7 *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 § 4.4). 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 DTE should not transmit a second *DTE interrupt* packet until the first one is confirmed with a *DCE interrupt confirmation* packet (see Note 2 to Table C-4/X.25). The DCE, after the interrupt procedure is completed at the remote end, will confirm the receipt of the interrrupt by transferring a *DCE interrupt confirmation* packet. The receipt of a *DCE interrupt confirmation* packet indicates that the interrupt has been confirmed by the remote DTE by means of a *DTE 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. A *DCE interrupt* packet is delivered at or before the point in the stream of *data* packets at which the *DTE interrupt* packet was generated. The DTE will confirm the receipt of the *DCE interrupt* packet by transferring a *DTE interrupted confirmation* packet.

4.4 *Procedures for flow control*

Paragraph 4.4 only applies to the *data transfer* state (p4) 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.

4.4.1 *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.

On a virtual call or permanent virtual circuit, flow control also allows a DTE to limit the rate at which the remote DTE can transmit *data* packets. This is achieved by the receiving DTE controlling the rate at which it accepts packets across the DTE/DCE interface, noting that there is a network-dependent limit on the number of *data* packets which may be in the network on the virtual call or permanent virtual circuit.

4.4.1.1 *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. Some Administrations will provide the *extended packet sequence numbering* facility (see § 7.1.1) which, if selected, provides a sequence numbering scheme for packets being performed modulo 128. In this case, packet sequence numbers cycle through the entire range 0 to 127. The packet sequence numbering scheme, modulo 8 or 128, is the same for both directions of transmission and is common for all logical channels at the DTE/DCE interface.

Only *data* 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, when the logical channel has just entered the *flow control ready* state (d1), has a packet send sequence number equal to 0.

4.4.1.2 *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 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 entered the *flow control ready* state (d1), 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).

The standard window size W is 2 for each direction of data transmission at the DTE/DCE interface. In addition, other window sizes may be offered by Administrations. An optional window size may be selected for a period of time as the default window size common to all virtual calls at the DTE/DCE interface (see § 7.1.2). A value other than the default may be selected for a period of time for each permanent virtual circuit (see § 7.1.2). Negotiation of window sizes on a per call basis may be made with the *flow control parameter negotiation* facility (see § 7.2.2).

4.4.1.3 *Flow control principles*

When the sequence number P(S) of the next packet to be transmitted by the DCE is within the window, the DCE is authorized to transmit this *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 DTE should follow the same procedure.

When the sequence number P(S) of the *data* packet received by the DCE is the next in sequence and is within the window, the DCE will accept this *data* packet. A received *data* packet containing a P(S) that is out of sequence (i.e., there is a duplicate or a gap in the P(S) numbering), outside the window, or not equal to 0 for the first *data* packet after entering the *flow control ready* state (d1) is considered by the DCE as a local procedure error. The DCE will reset the virtual call or permanent virtual circuit (see § 4.4.3). The DTE should follow the same procedure.

Some networks do not invoke the error procedure on receipt of a *data* packet containing a P(S) that is out of sequence but is within the window. These networks may pass on such packets to the remote DTE in order to make it possible for the local DTE to retransmit packets on virtual calls or permanent virtual circuits (within the national network).

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 transmitted 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.

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

4.4.1.4 *Delivery confirmation*

When the D bit is set to 0 in a *data* packet having P(S) = p, the significance of the returned P(R) corresponding to that data packet [i.e., P(R) ⩾ p + 1] is a local updating of the window across the packet level interface so that the achievable throughput is not constrained by the DTE-to-DTE round trip delay across the network(s).

When the D bit is set to 1 in a *data* packet having P(S) = p, the significance of the returned P(R) corresponding to that *data* packet [i.e., P(R) ⩾ p + 1] is an indication that a P(R) has been received from the remote DTE for all data bits in the data packet in which the D bit had originally been set to 1.

Note 1 — A DTE, on receiving a *data* packet with the D bit set to 1, should transmit the corresponding P(R) as soon as possible in order to avoid the possibility of deadlocks (e.g., without waiting for further *data* packets). A *data*, *RR* or *RNR* packet may be used to convey the P(R) (see Note to § 4.4.1.6). Likewise, the DCE is required to send P(R) to the DTE as soon as possible from when the P(R) is received from the remote DTE.

Note 2 — In the case where a P(R) for a *data* packet with the D bit set to 1 is outstanding, local updating of the window will be deferred for subsequent *data* packets with the D bit set to 0. Some networks may also defer updating the window for previous *data* packets (within the window) with the D bit set to 0 until the corresponding P(R) for the packet with the outstanding D bit set to 1 is transmitted to the DTE.

Note 3 — P(R) values corresponding to the data contained in *data* packets with the D bit set to 1 need not be the same at the DTE/DCE interfaces at each end of a virtual call or a permanent virtual circuit.

4.4.1.5 *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.

4.4.1.6 *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, but the window is updated by the P(R) value of the

RNR packet. The receive not ready situation indicated by the transmission of an *RNR* packet is cleared by the transmission in the same direction of an *RR* packet or by a reset procedure being initiated.

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

Note – The *RNR* packet may be used to convey across the DTE/DCE interface the P(R) value corresponding to a *data* packet which had the D bit set to 1 in the case that additional *data* packets cannot be accepted.

4.4.2 *Throughput characteristics and throughput classes*

The attainable throughput on virtual calls and permanent virtual circuits carried at the DTE/DCE interface may vary due to the statistical sharing of transmission and switch resources and is constrained by:

1) the access line characteristics, local window size and traffic characteristics of other logical channels at the local DTE/DCE interface;

2) the access line characteristics, local window size and traffic characteristics of other logical channels at the remote DTE/DCE interface; and

3) the throughput achievable on the virtual call or permanent virtual circuit through the network(s) independent of interface characteristics including number of active logical channels. This throughput may be dependent on network service characteristics such as window rotation mechanisms and/or optional user facilities requested on national/international calls.

The attainable throughput will also be affected by:

i) the receiving DTE flow controlling the DCE;

ii) the transmitting DTE not sending *data* packets which have the maximum data field length;

iii) the local DTE/DCE window and/or packet sizes; and

iv) the use of the D bit.

A throughput class for one direction of transmission is an inherent characteristic of the virtual call or permanent virtual circuit related to the amount of resources allocated to this virtual call or permanent virtual circuit. This characteristic is meaningful when the D bit is set to 0 in *data* packets. It is a measure of the throughput that is not normally exceeded on the virtual call or permanent virtual circuit. However, due to the statistical sharing of transmission and switching resources, it is not guaranteed that the throughput class can be reached 100% of the time.

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

Note – The definition of throughput class as a grade of service parameter is for further study. The grade of service might be specified when the D bit is set to 0 or over a time period between the completion and initiation of successive D bit procedures.

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

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

b) the receiving DTE is not flow controlling the DCE such that the throughput class is not attainable;

c) the transmitting DTE is sending *data* packets which have the maximum data field length; and

d) all *data* packets transmitted on the virtual call or permanent virtual circuit have the D bit set to 0.

The throughput class is expressed in bits per second. At a DTE/DCE interface, the maximum data field length is specified for a virtual call or permanent virtual circuit, and thus the throughput class can be interpreted by the DTE as the number of full *data* packets/second that the DTE does not have a need to exceed.

In the absence of the *default throughput class assignment* facility (see § 7.1.3), the default throughput classes for both directions of transmission correspond to the user class of service of the DTE (see § 7.4.2.6) but do not exceed the maximum throughput class supported by the network. Negotiation of throughput classes on a per call basis may be made with the *throughput class negotiation* facility (see § 7.2.3).

Note – The summation of throughput classes of all virtual calls, permanent virtual circuits and datagram logical channels supported at a DTE/DCE interface may be greater than the data transmission rate of the access line.

4.4.3 *Procedure for reset*

The reset procedure is used to re-initialize 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 (see § 4.5). 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 each direction of data transmission shall start from 0.

The reset procedure can only apply in the *data transfer* state (p4) of the DTE/DCE interface. In any other state of the DTE/DCE interface, the reset procedure is abandoned. For example, when a clearing or restarting procedure is initiated, *reset request* and *reset indication* packets can be left unconfirmed.

For flow control, there are three states d1, d2 and d3 within the *data transfer* state (p4). They are *flow control ready* (d1), *DTE reset request* (d2), and DCE *reset indication* (d3) as shown in the state diagram in Figure B-3/X.25. When entering state p4, the logical channel is placed in state d1. Table B-4/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE.

4.4.3.1 *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).

4.4.3.2 *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.

4.4.3.3 *Reset collision*

Reset collision occurs when a DTE and a DCE simultaneously transmit a *reset request* packet and a *reset indication* packet specifying the same logical channel. Under these circumstances the DCE will consider that the reset is completed. The DCE will not expect a DTE *reset confirmation* packet and will not transfer a DCE *reset confirmation* packet. This places the logical channel in the *flow control ready* state (d1).

4.4.3.4 *Reset confirmation packets*

When the logical channel is in the *DTE reset request* state (d2), 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).

The DCE *reset confirmation* packet can only be interpreted universally as having local significance; however, within some Administrations' networks, *reset confirmation* may have end-to-end significance. In all cases the time spent in the *DTE reset request* state (d2) will not exceed time-limit T22 (see Annex D).

When the logical channel is in the *DCE reset indication* state (d3), the DTE will confirm reset by transmitting to the DCE a *DTE reset confirmation* packet. This places the logical channel in the *flow control ready* state (d1). The action taken by the DCE when the DTE does not confirm the reset within time-out T12 is given in Annex D.

4.5 *Effects of clear, reset and restart procedures on the transfer of packets*

All *data* and *interrupt* packets generated by a DTE (or the network) before initiation by the DTE or the DCE of a clear, reset or restart procedure at the local interface will either be delivered to the remote DTE before the DCE transmits the corresponding indication on the remote interface, or be discarded by the network.

No *data* or *interrupt* packets generated by a DTE (or the network) after the completion of a reset (or for permanent virtual circuits also a restart) procedure at the local interface will be delivered to the remote DTE before the completion of the corresponding reset procedure at the remote interface.

When a DTE initiates a clear, reset or restart procedure on its local interface, all *data* and *interrupt* packets which were generated by the remote DTE (or the network) before the corresponding indication is transmitted to the remote DTE will be either delivered to the initiating DTE before DCE confirmation of the initial *clear, reset* or *restart request*, or be discarded by the network.

Note – The maximum number of packets which may be discarded is a function of network end-to-end delay and throughput characteristics and, in general, has no relation to the local window size. Provision of more precise information is for further study. For virtual calls and permanent virtual circuits on which all *data* packets are transferred with the D bit set to 1, the maximum number of packets which may be discarded in one direction of transmission is not larger than the window size of the direction of transmission.

4.6 *Effects of physical and link level failures*

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

1) a *reset* with the cause "Out of order" for each permanent virtual circuit; and

2) a *clear* with the cause "Out of order" for each existing virtual call.

During the failure, the DCE will clear any incoming virtual calls.

When the failure is recovered on the physical and link levels, the restart procedure will be actioned (see § 3.5) and a *reset* with the cause "Remote DTE operational" will be transmitted to the remote end of each permanent virtual circuit.

5 **Procedures for datagram service**

Annex B shows the state diagrams which give a definition of events at the packet level DTE/DCE interface for each logical channel. Figures B-1/X.25 and B-3/X.25 apply to datagram logical channels.

Annex C gives details of the action taken by the DCE on receipt of packets in each state shown in Annex B. Details of actions which should be taken by the DTE are for further study.

There is no call set-up or clearing for datagrams.

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

A *DCE datagram* packet includes the source DTE address; the destination DTE address may also be used.

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

5.1 *Procedures for datagram transfer*

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

Normal network operation dictates that user data in *datagram packets* are all passed transparently, unaltered through the network in the case of packet DTE to packet DTE communications.

Order of bits of user data is preserved within a datagram.

5.1.1 *States for data transfer*

Datagram logical channels are continually in the *data transfer* state (p4) except during the restart procedure. *Datagram*, *datagram service* signal, *flow control*, and *reset* packets may be transmitted and received by a DTE in the *data transfer* state of a datagram logical channel at the DTE/DCE interface. In this state, the flow control and reset procedures described in § 5.2 apply to data transmission on that datagram logical channel to and from the DTE.

5.1.2 *User data field length*

The maximum user data field length for datagrams is 128 octets.

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

Note – At present, some networks require the user data field to contain an integral number of octets (see § 3, Note 2).

5.1.3 *Datagram identification*

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

5.1.4 *Datagram service signals*

The DCE will be capable of transferring to the DTE service signals as specified in Recommendation X.96 [4]. The datagram service signals will be carried in *datagram service signal* packets. Datagram service signals are of two types – specific and general.

5.1.4.1 *Datagram service signal – specific*

This is a service signal generated by the network relative to a specific datagram issued by the DTE. There are three classes for this type of service signal:

a) *Datagram rejected* – datagram discarded by network; a correction, based on the received cause, is required before trying again.

b) *Datagram nondelivery indication* – datagram discarded by network; try again later based on the received cause, next time may be successful.

   Note – This class of service signal is only issued by the network when the *nondelivery indication* facility (see § 7.3.4) has been requested.

c) *Datagram delivery confirmation* – datagram has been accepted by the destination DTE.

   Note – This class of service signal is only issued by the network when the *Delivery confirmation* facility (see § 7.3.5) has been requested.

Datagram service signal – specific packets will include the address information, if valid, and the datagram identification associated with the original datagram for which the service signal applies. The original destination address is provided in the *datagram service signal* packet as the source address while the original source address is shown as the destination address, when present.

5.1.4.2 *Datagram service signal – general*

This is a service signal generated by the network relative to datagram operation but not to any specific datagram issued by the DTE.

5.2 *Procedures for flow control*

Paragraph 5.2 only applies to the *data transfer* state (p4) and specifies the procedures covering flow control of *datagram* and *datagram service signal* packets and *reset* on each datagram logical channel.

5.2.1 *Flow control*

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

5.2.1.1 *Numbering of packets*

Each *datagram* and *datagram service signal* packet transmitted at the DTE/DCE interface for each direction of transmission on a given datagram logical channel is sequentially numbered.

The sequence numbering scheme of the packets is performed modulo 8. The packet sequence numbers cycle through the entire range 0 to 7. Some Administrations will provide the *extended packet sequence numbering* facility (see § 7.1.1) which, if selected, provides a sequence numbering scheme for packets being performed modulo 128. In this case, packet sequence numbers cycle through the entire range 0 to 127. The packet sequence numbering scheme, modulo 8 or 128, is the same for both directions of transmission and is common to all logical channels at the DTE/DCE interface.

For datagram service, only *datagram* and *datagram service signal* packets contain this sequence number called the packet send sequence number P(S).

The first *datagram* or *datagram service signal* packet to be transmitted across the DTE/DCE interface for a given direction of data transmission, when the datagram logical channel has just entered the *flow control ready* state (d1), has a packet send sequence number equal to 0.

5.2.1.2 *Window description*

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

The lowest sequence number in the window is referred to as the lower window edge. When the datagram logical channel has just entered the *flow control ready* state (d1), 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 *flow controlled* packet not authorized to cross the interface is the value of the lower window edge plus W (modulo 8, or 128 when extended).

The standard window size W is 2 for each direction of data transmission at a DTE/DCE interface. In addition, other window sizes may be offered by Administrations and may be selected for a period of time for each datagram logical channel (see § 7.1.2).

5.2.1.3 *Flow control principles*

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

When the sequence number P(S) of the *flow controlled* packet received by the DCE is the next in sequence and is within the window, the DCE will accept this *flow controlled* packet. A received *flow controlled* packet containing a P(S) that is out of sequence [i.e., there is a duplicate or a gap in the P(S) numbering], outside the window, or not equal to zero for the first *flow controlled* packet after entering the *flow control ready* state (d1) is considered by the DCE as a local procedure error. The DCE will reset the datagram logical channel (see § 5.2.3). The DTE should follow the same procedure.

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

The packet receive sequence number, P(R), is conveyed in *datagram*, *datagram service* signal, *receive ready (RR)* and *receive not ready (RNR)* packets.

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

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

The only significance of a P(R) value is a local updating of the window across the packet level interface.

5.2.1.4 *Datagram queue*

The network maintains a datagram queue for each datagram logical channel at the destination DCE. The maximum length of the queue for each datagram logical channel is agreed for a period of time between the DTE and the Administration (see § 7.3.2).

Datagram service signal packets have priority over other *datagram* packets and are inserted at the beginning of the queue. This may lead to the DCE discarding the last *datagram* packet of the queue if the maximum queue length is exceeded. When the queue is full, additional arriving datagrams are discarded.

By agreement for a period of time between the DTE and the Administration (see § 7.3.3), a special datagram logical channel may be assigned for the transmission of datagram service signals. In this case, the maximum length of the queues for datagrams and datagram service signals are independently agreed between the DTE and the Administration.

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

5.2.1.5 *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 *flow controlled* packets within the window starting with P(R), where P(R) is indicated in the *RR* packet.

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

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

5.2.2 *Throughput characteristics*

Throughput is the effective data transfer rate measured in bits per second.

For each datagram logical channel, a throughput class for each direction of data transmission at the DTE/DCE interface is agreed for a period of time between the DTE and the Administration (see § 7.1.3).

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

a) the attainment of throughput on a given datagram logical channel;

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

5.2.3 *Procedure for reset*

The reset procedure is used to re-initialize the datagram logical channel. When a datagram logical channel 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 *flow controlled* packets to cross the DTE/DCE interface for each direction of data transmission shall start from 0.

For datagram logical channels, the reset procedure causes datagrams and datagram service signals to be purged from the DCE queue associated with that datagram logical channel. A datagram service signal with the cause "Remote procedure error" will be issued to the remote end for each datagram requesting the *nondelivery indication* facility.

The reset procedure can only apply in the *data transfer* state (p4) of the DTE/DCE interface. In any other state of the DTE/DCE interface, the reset procedure is abandoned. For example, when a restarting procedure is initiated, *reset request* and *reset indication* packets can be left unconfirmed.

For flow control, there are three states d1, d2, and d3 within the *data transfer* state (p4). They are *flow control ready* (d1), *DTE reset request* (d2), and *DCE reset indication* (d3) as shown in the state diagram in Figure B-3/X.25. When entering state p4, the datagram logical channel is placed in state d1. Table C-4/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE.

5.2.3.1 *Reset request packet*

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

5.2.3.2 *Reset indication packet*

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

5.2.3.3 *Reset collision*

Reset collision occurs when a DTE and a DCE simultaneously transmit a *reset request* packet and a *reset indication* packet specifying the same datagram logical channel. Under this circumstance, the DCE will consider the reset completed. The DCE will not expect a *DTE reset confirmation* packet and will not transfer a *DCE reset confirmation* packet. This places the datagram logical channel in the *flow control ready* state (d1).

5.2.3.4 *Reset confirmation packets*

When the datagram logical channel is in the *DTE reset request* state (d2), the DCE will confirm reset by transmitting to the DTE a *DCE reset confirmation* packet. This places the datagram logical channel in the *flow control ready* state (d1).

The *DCE reset confirmation* packet has local significance. The time spent in the *DTE reset request* state (d2) will not exceed time-limit T22 (see Annex D).

When the datagram 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 datagram logical channel in the *flow control ready* state (d1). The action taken by the DCE when the DTE does not confirm the reset within time-out T12 is given in Annex D.

5.3 *Effects of reset and restart procedures on the transfer of packets*

For datagram logical channels, the reset and restart procedures cause datagrams and datagram service signals to be purged from the DCE queue. A datagram service signal with the cause "Remote procedure error" will be issued to the remote end for each datagram requesting the *nondelivery indication* facility.

5.4 *Effects of physical and link level failures*

When a failure on physical and/or link level is detected, the DCE will purge datagrams and datagram service signals from the DCE queue associated with each datagram logical channel and, for each datagram requesting the *nondelivery indication* facility, transmit to the remote end a datagram service signal with the cause "Out of order".

During the failure, the DCE will discard any incoming datagrams and datagram service signals. A datagram service signal with the cause "Out of order" will be sent to the remote end for each datagram requesting the *nondelivery indication* facility.

When the failure is recovered on the physical and link levels, the restart procedure will be actioned (see § 3.5). Upon completion of this procedure, incoming datagrams and datagram service signals will be handled in the normal manner.

6 Packet formats

6.1 *General*

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

Note – Any such field:

a) would only be provided as an addition following all previously defined fields, and not as an insertion between any of the previously defined fields;

b) would be transmitted to a DTE only when either the DCE has been informed that the DTE is able to interpret this field and act upon it, or when the DTE can ignore the field without adversely affecting the operation of the DCE;

c) would not contain any information pertaining to a user facility to which the DTE has not subscribed.

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.

6.1.1 *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 7/X.25).

Bit 8 of the general format identifier is used for the Qualifier bit in *data* packets. It is set to 1 in *datagram service signal* packets and is set to 0 in all other packets.

Bit 7 of the general format identifier is used for the delivery confirmation procedure in *data* and *call set-up* packets and is set to 0 in all other packets.

Bits 6 and 5 are encoded for four possible indications. Two of the codes are used to distinguish packets using modulo 8 sequence numbering from packets using modulo 128 sequence numbering. The third code is used to indicate an extension to an expanded format for a family of general format identifier codes which are a subject of further study. The fourth code is unassigned.

TABLE 7/X.25

General format identifier

General format identifier		Octet 1 Bits 8	7	6	5
Call set-up packets	Sequence numbering scheme modulo 8	0	X	0	1
	Sequence numbering scheme modulo 128	0	X	1	0
Clearing, datagram, flow control, interrupt, reset, restart and diagnostic packets	Sequence numbering scheme modulo 8	0	0	0	1
	Sequence numbering scheme modulo 128	0	0	1	0
Data packets	Sequence numbering scheme modulo 8	X	X	0	1
	Sequence numbering scheme modulo 128	X	X	1	0
Datagram service signal packets	Sequence numbering scheme modulo 8	1	0	0	1
	Sequence numbering scheme modulo 128	1	0	1	0
General format identifier extension		*	*	1	1

* Undefined.

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

Note 1 – In the absence of the *Extended packet sequence numbering* facility (see § 7.1.1), the sequence numbering scheme is performed modulo 8.

Note 2 – It is envisaged that other general format identifier codes could identify alternative packet formats.

6.1.2 *Logical channel group number*

The logical channel group number appears in every packet except *restart* packets and *diagnostic* packets in bit positions 4, 3, 2 and 1 of octet 1. For each logical channel, this number has local significance at the DTE/DCE interface.

This field is binary coded and bit 1 is the low order bit of the logical channel group number. In *restart* and *diagnostic* packets, this field is coded all zeros.

6.1.3 *Logical channel number*

The logical channel number appears in every packet except *restart* packets and *diagnostic* packets in all bit positions of octet 2. For each logical channel, this number has local significance at the DTE/DCE interface.

This field is binary coded and bit 1 is the low order bit of the logical channel number. In *restart* and *diagnostic* packets, this field is coded all zeros.

6.1.4 *Packet type identifier*

Each packet shall be identified in octet 3 of the packet according to Table 8/X.25.

TABLE 8/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
Datagram a)									
DCE datagram	DTE datagram	X	X	X	X	X	X	X	0
Datagram service signal		X	X	X	X	X	X	X	0
Flow control and reset									
DCE RR (modulo 8)	DTE RR (modulo 8)	X	X	X	0	0	0	0	1
DCE RR (modulo 128) a)	DTE RR (modulo 128) a)	0	0	0	0	0	0	0	1
DCE RNR (modulo 8)	DTE RNR (modulo 8)	X	X	X	0	0	1	0	1
DCE RNR (modulo 128) a)	DTE RNR (modulo 128) a)	0	0	0	0	0	1	0	1
	DTE REJ (modulo 8) a)	X	X	X	0	1	0	0	1
	DTE REJ (modulo 128) a)	0	0	0	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
Diagnostic									
Diagnostic a)		1	1	1	1	0	0	0	1

a) Not necessarily available on every network.

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

6.2 *Call set-up and clearing packets*

6.2.1 *Call request and incoming call packets*

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

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	0	1	0	1	1
4	Calling DTE address length				Called DTE address length			
	DTE address (see Note 2)							
					0	0	0	0
	0	0	Facility length					
	Facilities							
	Call user data (see Notes 3 and 4)							

Note 1 – Coded 0X01 (modulo 8) or 0X10 (modulo 128).

Note 2 – The figure is drawn assuming a single address is present consisting of an odd number of digits.

Note 3 – Bits 8 and 7 of the first octet of the *call user data* field may have particular significance (see § 6.2.1).

Note 4 – Maximum length of the *call user data* field is 16 octets.

FIGURE 1/X.25

Call request and incoming call packet format

6.2.1.1 *General format identifier*

Bit 7 of octet 1 should be set to 0 unless the mechanism defined in § 4.3.3 is used.

6.2.1.2 *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.

6.2.1.3 *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 are for further study.

6.2.1.4 *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.

6.2.1.5 *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 the facility field is defined in § 7.

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 63 octets.

6.2.1.6 *Call user data field*

Following the facility field, the call user data field may be present and has a maximum length of 16 octets.

Note – At present, some networks require the call user data field to contain an integral number of octets (see § 3, Note 2).

If the call user data field is present, the use and format of this field are determined by bits 8 and 7 of the first octet of this field (see Note below).

If bits 8 and 7 of the first octet of the call user data field are 00, a portion of the call user data field is used for protocol identification in accordance with other Recommendations such as Recommendation X.29.

If bits 8 and 7 of the first octet of the call user data field are 01, a portion of the call user data field may be used for protocol identification in accordance with specifications of Administrations.

If bits 8 and 7 of the first octet of the call user data field are 10, a portion of the call user data field may be used for protocol identification in accordance with specifications of international user bodies.

If bits 8 and 7 of the first octet of the call user data field are 11, no constraints are placed on the use by the DTE of the remainder of the call user data field.

Users are cautioned that if bits 8 and 7 of the first octet of the call user data field have any value other than 11, a protocol may be identified that is implemented within public data networks.

Note – When a virtual call is being established between two packet mode DTEs, the network does not act on any part of the call user data field, unless required to do otherwise by an appropriate request for an optional user facility on a per call basis. Such a facility is for further study.

6.2.2 *Call accepted and call connected packets*

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

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	0	1	1	1	1
4	Calling DTE address length [a]				Called DTE address length [a]			
	DTE address (see Note 2) [a]							
					0	0	0	0
	0	0	Facility length [a]					
	Facilities [a]							

[a] These fields are not mandatory in *call accepted* packets (see § 6.2.2).

Note 1 – Coded 0X01 (modulo 8) or 0X10 (modulo 128).

Note 2 – The figure is drawn assuming a single address is present consisting of an odd number of digits.

FIGURE 2/X.25

Call accepted and call connected packet format

6.2.2.1 *General format identifier*

Bit 7 of octet 1 should be set to 0 unless the mechanism defined in § 4.3.3 is used.

6.2.2.2 *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.

The use of the address lengths field in *call accepted* packets is only mandatory when the address field or the facility length field is present.

6.2.2.3 *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.

6.2.2.4 *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.

The use of the facility length field in *call accepted* packets is only mandatory when the facility field is present.

6.2.2.5 *Facility field*

The facility field is present only when the DTE is using an optional user facility requiring some indication in the *call accepted* and *call connected* packets.

The coding of the facility field is defined in § 7.

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 63 octets.

6.2.3 *Clear request and clear indication packets*

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

Octet \ Bits	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	1	0	0	1	1
4	Clearing cause							
5	Diagnostic code [a)]							

[a)] This field is not mandatory in *clear request* packets.

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 3/X.25

Clear request and clear indication packet format

6.2.3.1 *Clearing cause field*

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

The bits of the clearing cause field in *clear request* packets should be set to 0 by the DTE. It is for further study whether other values of these bits are ignored or processed by the DCE.

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

TABLE 9/X.25

Coding of clearing cause field in clear indication packet

	Bits							
	8	7	6	5	4	3	2	1
DTE originated	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
Reverse charging acceptance not subscribed [a]	0	0	0	1	1	0	0	1
Incompatible destination	0	0	1	0	0	0	0	1
Fast select acceptance not subscribed [a]	0	0	1	0	1	0	0	1
Invalid facility request	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
RPOA out of order [a]	0	0	0	1	0	1	0	1

[a] May be received only if the corresponding optional user facility is used.

6.2.3.2 *Diagnostic code*

Octet 5 is the diagnostic code and contains additional information on the reason for the clearing of the call.

In a *clear request* packet, the diagnostic code is not mandatory.

In a *clear indication* packet, if the clearing cause field indicates "DTE originated", the diagnostic code is passed unchanged from the clearing DTE. If the clearing DTE has not provided a diagnostic code in its *clear request* packet, then the bits of the diagnostic code in the resulting *clear indication* packet will all be zero.

When a *clear indication* packet results from a *restart request* packet, the value of the diagnostic code will be that specified in the *restart request* packet, or all zeros in the case where no diagnostic code has been specified in *restart request.*

When the clearing cause field does not indicate "DTE originated", the diagnostic code in a *clear indication* packet is network generated. Annex E lists the codings for network generated diagnostics. The bits of the diagnostic code are all set to 0 when no specific additional information for the clearing is supplied.

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

6.2.4 *DTE and DCE clear confirmation packets*

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

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

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 4/X.25

DTE and DCE clear confirmation packet format

6.3 *Data and interrupt packets*

6.3.1 *DTE and DCE data packets*

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

Octet	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
1	Q	D	0	1	Logical channel group number			
	General format identifier							
2	Logical channel number							
3	P(R)			M	P(S)			0
	User data							

(Modulo 8)

Octet	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
1	Q	D	1	0	Logical channel group number			
	General format identifier							
2	Logical channel number							
3	P(S)							0
4	P(R)							M
	User data							

(When extended to modulo 128)

D Delivery confirmation bit
M More data bit
Q Qualifier bit

FIGURE 5/X.25

DTE and DCE data packet format

6.3.1.1 *Qualifier (Q) bit*

Bit 8 of octet 1 is the qualifier (Q) bit.

6.3.1.2 *Delivery confirmation (D) bit*

Bit 7 of octet 1 is the delivery confirmation (D) bit.

6.3.1.3 *Packet receive sequence number*

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

6.3.1.4 *More data bit*

Bit 5 in octet 3, or bit 1 in octet 4 when extended, is used for the *more data* mark (M bit): 0 for no more data and 1 for more data.

6.3.1.5 *Packet send sequence number*

Bits 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the packet send sequence number P(S). P(S) is binary coded and bit 2 is the low order bit.

6.3.1.6 *User data field*

Bits following octet 3, or octet 4 when extended, contain user data.

Note – At present, some networks require the user data field to contain an integral number of octets (see § 3, Note 2).

6.3.2 *DTE and DCE interrupt packets*

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

Octet \ Bits	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	1	0	0	0	1	1
4	Interrupt user data							

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 6/X.25

DTE and DCE interrupt packet format

6.3.2.1 *Interrupt user data field*

Octet 4 contains user data.

6.3.3 *DTE and DCE interrupt confirmation packets*

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

Bits

Octet	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	1	0	0	1	1	1

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 7/X.25

DTE and DCE interrupt confirmation packet format

6.4 *Datagram and datagram service signal packets*

6.4.1 *DTE and DCE datagram packets*

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

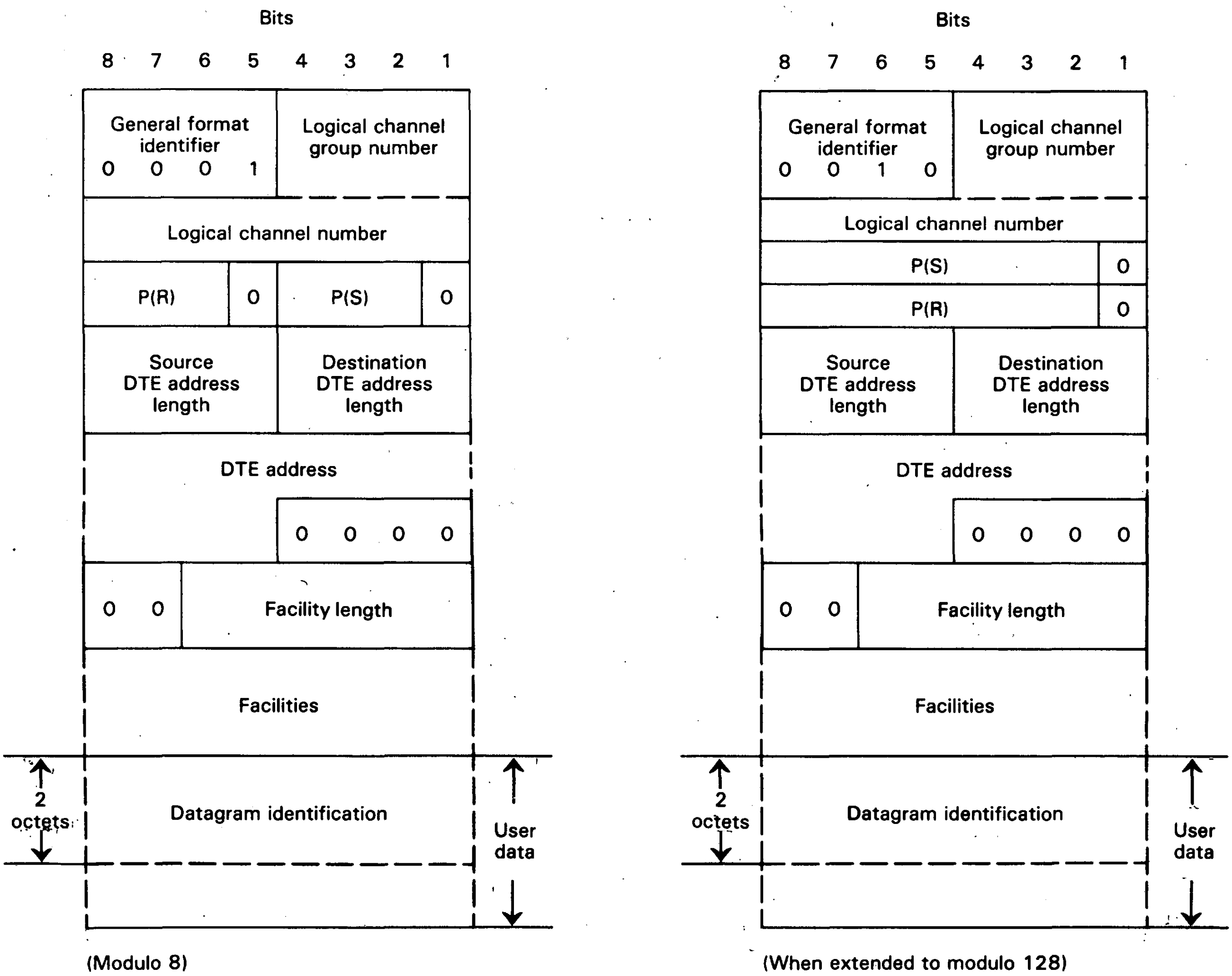


FIGURE 8/X.25

DTE and DCE datagram packet format

6.4.1.1 *Packet receive sequence number*

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

6.4.1.2 *Packet send sequence number*

Bits 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the packet send sequence number P(S). P(S) is binary coded and bit 2 is the low order bit.

6.4.1.3 *Address lengths field*

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

6.4.1.4 *Address field*

The octets following the address length field consist of the destination DTE address when present, then the source DTE address when present.

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

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

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

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

6.4.1.5 *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.

6.4.1.6 *Facility field*

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

The coding of the facility field is defined in § 7.

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 63 octets.

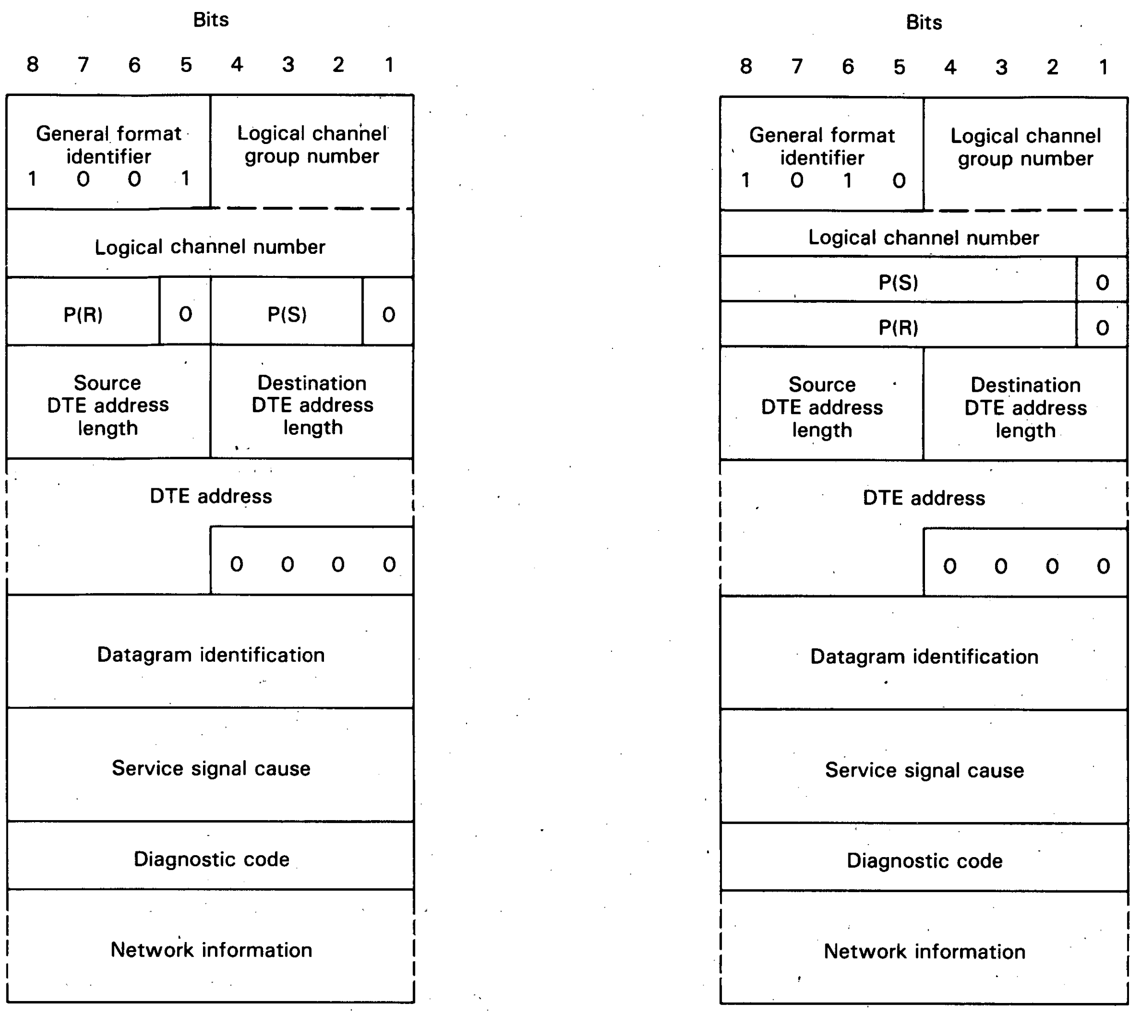
6.4.1.7 *User data field*

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

Note – At present, some networks require the user data field to contain an integral number of octets (see § 3, Note 2).

6.4.2 *Datagram service signal packets*

Figure 9/X.25 illustrates the format of *datagram service signal* packets.



(Modulo 8) (When extended to modulo 128)

FIGURE 9/X.25

Datagram service signal packet format

6.4.2.1 *Packet receive sequence number*

Bits 8, 7 and 6 of octet 3, or bit 8 through 2 of octet 4 when extended, are used for indicating the packet receive sequence number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

6.4.2.2 *Packet send sequence number*

Bits 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the packet send sequence number P(S). P(S) is binary coded and bit 2 is the low order bit.

6.4.2.3 *Address lengths field*

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

The source DTE address length indicator is coded all zeros for *datagram service signal – general* packets.

6.4.2.4 *Address field*

The octets following the address length field consist of the destination DTE address when present, then the source DTE address when present (see § 5.1.4.1).

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

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

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

6.4.2.5 *Datagram identification field*

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

The datagram identification field of *datagram service signal – general* packets is coded with all zeros.

6.4.2.6 *Cause field*

The octet immediately following the datagram identification field is the cause field and contains the reason for the *datagram service* signal.

The coding of the cause field is given in Table 10/X.25.

TABLE 10/X.25

Coding of cause field in datagram service signal packet

	Bits							
	8	7	6	5	4	3	2	1
Datagram service signal – specific								
Datagram rejected								
Local procedure error	0	0	0	1	0	0	1	1
Invalid facility request	0	0	0	0	0	0	1	1
Access barred	0	0	0	0	1	0	1	1
Not obtainable	0	0	0	0	1	1	0	1
Incompatible destination	0	0	1	0	0	0	0	1
Reverse charging acceptance not subscribed	0	0	0	1	1	0	0	1
Datagram non delivery indication (see Note 1)								
Network congestion	0	0	0	0	0	1	0	1
Out of order	0	0	0	0	1	0	0	1
Number busy (destination queue full)	0	0	0	0	0	0	0	1
Remote procedure error	0	0	0	1	0	0	0	1
Datagram delivery confirmation (see Note 2)								
Delivery confirmation	0	0	1	1	0	0	0	1
Datagram service signal – general								
Local DCE queue overflow (see Note 3)	0	1	1	1	1	1	1	1
Network congestion	0	1	0	0	0	1	1	1
Network operational	0	1	0	0	1	1	1	1

Note 1 – Issued only when the *non delivery indication* facility (see § 7.3.4) has been requested.

Note 2 – Issued only when the *delivery confirmation* facility (see § 7.3.5) has been requested.

Note 3 – For further study.

6.4.2.7 *Diagnostic code*

The octet immediately following the cause field contains additional information on the reason for the *datagram service* signal.

The coding of the diagnostic code field is given in Annex E. Assigned diagnostic codes applicable to *datagram service signal* packets include decimal 33, 38, 39, 40, 65, 66, 67 and 68. The bits of the diagnostic code in a *datagram service signal* packet are all set to zero when no specific additional information for the service signal is supplied.

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

6.4.2.8 *Network information field*

Following the diagnostic code field, the network information field may be present and has a maximum length of 16 octets.

If the diagnostic code field designates *facility code not allowed* or *facility parameter not allowed*, then the network information field will contain the octets associated with the facility code and its associated parameter field. If the diagnostic code field designates *invalid address*, then the network information field will contain the octet associated with the two address length fields and the octets associated with the address field.

The information content of this field for other diagnostic codes is for further study.

6.5 *Flow control and reset packets*

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

Figure 10/X.25 illustrates the format of the *DTE* and *DCE RR* packets.

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	P(R)			Packet type identifier 0	0	0	0	1

(Modulo 8)

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

(When extended to modulo 128)

FIGURE 10/X.25

DTE and DCE RR packet format

6.5.1.1 *Packet receive sequence number*

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

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

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

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	P(R)			Packet type identifier 0	0	1	0	1

(Modulo 8)

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

(When extended to modulo 128)

FIGURE 11/X.25

DTE and DCE RNR packet format

6.5.2.1 *Packet receive sequence number*

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

6.5.3 *Reset request and reset indication packets*

Figure 12/X.25 illustrates the format of the *reset request* and *reset indication* packets.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				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 [a]							

[a] This field is not mandatory in *reset request* packets.

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 12/X.25

Reset request and reset indication packet format

6.5.3.1 *Resetting cause field*

Octet 4 is the resetting cause field and contains the reason for the reset.

The bits of the resetting cause field in a *reset request* packet should be set to 0 by the DTE. It is for further study whether other values of these bits are ignored or processed by the DCE.

The coding of the resetting cause field in a *reset indication* packet is given in Table 11/X.25.

TABLE 11/X.25

Coding of resetting cause field in reset indication packet

	Bits 8	7	6	5	4	3	2	1
DTE originated [a]	0	0	0	0	0	0	0	0
Out of order [b]	0	0	0	0	0	0	0	1
Remote procedure error [a]	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
Remote DTE operational [b]	0	0	0	0	1	0	0	1
Network operational [c]	0	0	0	0	1	1	1	1
Incompatible destination [a]	0	0	0	1	0	0	0	1

[a] Applicable to virtual calls and permanent virtual circuits only.

[b] Applicable to permanent virtual circuits only.

[c] Applicable to permanent virtual circuits and datagram logical channels only.

6.5.3.2 *Diagnostic code*

Octet 5 is the diagnostic code and contains additional information on the reason for the reset.

In a *reset request* packet the diagnostic code is not mandatory.

In a *reset indication* packet, if the resetting cause field indicates "DTE originated", the diagnostic code has been passed unchanged from the resetting DTE. If the DTE requesting a reset has not provided a diagnostic code in its *reset request* packet, then the bits of the diagnostic code in the resulting *reset indication* packet will all be zeros.

When a *reset indication* packet results from a *restart request* packet, the value of the diagnostic code will be that specified in the *restart request* packet, or all zeros in the case where no diagnostic code has been specified in the *restart request* packet.

When the resetting cause field does not indicate "DTE originated", the diagnostic code in a *reset indication* packet is network generated. Annex E lists the codings for network generated diagnostics. The bits of the diagnostic code are all set to 0 when no specific additional information for the reset is supplied.

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

6.5.4 *DTE and DCE reset confirmation packets*

Figure 13/X.25 illustrates the format of the *DTE* and *DCE reset confirmation* packets.

Octet \ Bits	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier: 0	0	0	1	1	1	1	1

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 13/X.25

DTE and DCE reset confirmation packet format

6.6 *Restart packets*

6.6.1 *Restart request and restart indication packets*

Figure 14/X.25 illustrates the format of the *restart request* and *restart indication* packets.

6.6.1.1 *Restarting cause field*

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

The bits of the restarting cause field in *restart request* packets should be set to 0 by the DTE. It is for further study whether other values of these bits are ignored or processed by the DCE.

The coding of the restarting cause field in the restart indication packets is given in Table 12/X.25.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				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							
5	Diagnostic code [a]							

[a] This field is not mandatory in *restart request* packets.

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 14/X.25

Restart request and restart indication packet format

TABLE 12/X.25

Coding of the 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
Network operational	0	0	0	0	0	1	1	1

6.6.1.2 *Diagnostic code*

Octet 5 is the diagnostic code and contains additional information on the reason for the restart.

In a *restart request* packet, the diagnostic code is not mandatory. The diagnostic code, if specified, is passed to the corresponding DTEs as the diagnostic code of a *reset indication* packet for permanent virtual circuits or a *clear indication* packet for virtual calls.

The coding of the diagnostic code field in a *restart indication* packet is given in Annex E. The bits of the diagnostic code are all set to zero when no specific additional information for the restart is supplied.

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

6.6.2 *DTE and DCE restart confirmation packets*

Figure 15/X.25 illustrates the format of the *DTE* and *DCE restart confirmation* packets.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				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

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 15/X.25

DTE and DCE restart confirmation packet format

6.7 *Diagnostic packet*

Figure 16/X.25 illustrates the format of the *diagnostic* packet.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet type identifier: 1	1	1	1	0	0	0	1
4	Diagnostic code							
5	Diagnostic explanation (see note 2)							

Note 1 – Coded 0001 (modulo 8) or 0010 (modulo 128).

Note 2 – The figure is drawn assuming the diagnostic explanation field is an integral number of octets in length.

FIGURE 16/X.25

Diagnostic packet format

6.7.1 *Diagnostic code field*

Octet 4 is the diagnostic code and contains information on the error condition which resulted in the transmission of the *diagnostic* packet. The coding of the diagnostic code field is given in Annex E.

6.7.2 *Diagnostic explanation field*

When the *diagnostic* packet is issued as a result of the reception of an erroneous packet from the DTE (see Table C-1/X.25), this field contains the first three octets of header information from the erroneous DTE packet. If the packet contains less than 3 octets, this field contains whatever bits were received.

When the *diagnostic* packet is issued as a result of a DCE time-out (see Table D-1/X.25), the diagnostic explanation field contains 2 octets coded as follows:

- bits 8, 7, 6 and 5 of the first octet contain the general format identifier for the interface;
- bits 4 to 1 of the first octet and bits 8 to 1 of the second octet are all 0 for expiration of time-out T10 and give the number of the logical channel on which the time-out occurred for expiration of time-out T12 or T13.

6.8 *Packets required for optional user facilities*

6.8.1 *DTE reject (REJ) packet for the packet retransmission facility*

Figure 17/X.25 illustrates the format of the *DTE REJ* packets, used in conjunction with the *packet retransmission* facility described in § 7.1.4.

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	P(R)			Packet type identifier 0	1	0	0	1

(Modulo 8)

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

(When extended to modulo 128)

FIGURE 17/X.25

DTE RJE packet format

6.8.1.1 *Packet receive sequence number*

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

6.8.2 *Call set-up and clearing packets for the fast select facility and fast select acceptance facility*

6.8.2.1 *Call request and incoming call packets*

Figure 18/X.25 illustrates the format of *call request* and *incoming call* packets used in conjunction with the *fast select* facility and *fast select acceptance* facility described in § 7.2.4 and § 7.2.5.

The description in § 6.2.1 applies here, except that the length of the call user data field has a maximum length of 128 octets.

Note – At present, some networks require the call user data field to contain an integral number of octets (see § 3, Note 2).

Octet \ Bits	8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier: 0	0	0	0	1	0	1	1
4	Calling DTE address length				Called DTE address length			
	DTE address (see Note 2)							
					0	0	0	0
	0	0	Facility length					
	Facilities							
	Call user data (see Notes 3 and 4)							

Note 1 – Coded 0X01 (modulo 8) or 0X10 (modulo 128).

Note 2 – The figure is drawn assuming a single address is present consisting of an odd number of digits.

Note 3 – Bits 8 and 7 of the first octet of the call user data field may have particular significance (see § 6.2.1).

Note 4 – Maximum length of the call user data field is 128 octets.

FIGURE 18/X.25

Call request and incoming call packet format for the fast select facility

6.8.2.2 *Call accepted and call connected packets*

Figure 19/X.25 illustrates the format of *call accepted* and *call connected* packets used in conjunction with the *fast select* facility and *fast select acceptance* facility described in § 7.2.4 and § 7.2.5.

Octet	Bit 8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	0	0	1	1	1	1
4	Calling DTE address length				Called DTE address length			
	DTE address (see Note 2)							
					0	0	0	0
	0	0	Facility length					
	Facilities							
	Called user data (see Notes 3 and 4)							

Note 1 – Coded 0X01 (modulo 8) or 0X10 (modulo 128).

Note 2 – The figure is drawn assuming a single address is present consisting of an odd number of digits.

Note 3 – Bits 8 and 7 of the first octet of the called user data field may have particular significance (see § 6.8.2.2).

Note 4 – Maximum length of the call user data field is 128 octets.

FIGURE 19/X.25

Call accepted and call connected packet format for the fast select facility

The description in § 6.2.2 applies here and, in addition, the called user data field may be present and has a maximum length of 128 octets. The address length fields and facility length field are mandatory.

Note – At present, some networks require the called user data field to contain an integral number of octets (see § 3, Note 2).

If the called user data field is present, the use and format of this field is determined by bits 8 and 7 of the first octet of this field (see Note below).

If bits 8 and 7 of the first octet of the called user data field are 00, a portion of the called user data field is used for protocol identification in accordance with other Recommendations.

If bits 8 and 7 of the first octet of the called user data field are 01, a portion of the called user data field may be used for protocol identification in accordance with specifications of Administrations.

If bits 8 and 7 of the first octet of the called user data field are 10, a portion of the called user data field may be used for protocol identification in accordance with specifications of international user bodies.

If bits 8 and 7 of the first octet of the called user data field are 11, no constraints are placed on the use by the DTE of the remainder of the called user data field.

Users are cautioned that if bits 8 and 7 of the first octet of the called user data field have any value other than 11, a protocol may be identified that is implemented within public data networks.

Note – When a virtual call is being established between two packet mode DTEs, the network does not act on any part of the called user data field, unless required to do otherwise by an appropriate request for an optional user facility on a per call basis. Such a facility is for further study.

6.8.2.3 *Clear request and clear indication packets*

Figure 20/X.25 illustrates the format of *clear request* and *clear indication* packets used in conjunction with the *fast select* facility and *fast select acceptance* facility described in § 7.2.4 and § 7.2.5.

Octet \ Bits	8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	1	0	0	1	1
4	Clearing cause							
5	Diagnostic code							
6	Calling DTE address length				Called DTE address length			
	DTE address (see Note 2)							
					0	0	0	0
	0	0	Facility length					
	Facilities							
	Clear user data (see Note 3)							

Note 1 – Coded 0001 (modulo 8) or 0010 (modulo 128).

Note 2 – The figure is drawn assuming a single address is present consisting of an odd number of digits.

Note 3 – Maximum length of the clear user data field is 128 octets.

FIGURE 20/X.25

Clear request and clear indication packet format for the fast select facility

The descriptions of the clearing cause field and the diagnostic code field in § 6.2.3 apply here. In addition the following fields may follow the diagnostic code field and in such cases the use of the diagnostic code field is mandatory.

6.8.2.3.1 *Address length field*

Octet 6 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 addresses 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.

Note – This field is coded with all 0s. Other codings are for further study.

6.8.2.3.2 *Address field*

Note – Pending the further study indicated above, this field is not present.

6.8.2.3.3 *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.

Note – This field is coded with all 0s. Other codings are for further study.

6.8.2.3.4 *Facility field*

Note – Pending the further study indicated above, this field is not present.

6.8.2.3.5 *Clear user data field*

Following the facility field, the clear user data field may be present and has a maximum length of 128 octets.

Note – At present, some networks require the clear user data field to contain an integral number of octets (see § 3, Note 2).

7 Procedures and formats for optional user facilities

7.1 *Procedures for optional user facilities associated with virtual circuit and datagram services*

7.1.1 *Extended packet sequence numbering*

Extended packet sequence numbering is an optional user facility agreed for a period of time. It is common to all logical channels at the DTE/DCE interface.

This user facility, if subscribed to, provides sequence numbering of packets performed modulo 128. In the absence of this facility, the sequence numbering of packets is performed modulo 8.

7.1.2 *Nonstandard default window sizes*

Nonstandard default window sizes is an optional user facility agreed for a period of time. This facility, if subscribed to, provides for the selection of default window sizes from the list of window sizes supported by the Administration. Some networks may constrain the default window sizes to be the same for each direction of data transmission across the DTE/DCE interface. In the absence of this facility, the default window sizes are 2.

Values other than the default window sizes may be negotiated for a virtual call by means of the *flow control parameter negotiation* facility (see § 7.2.2). Values other than the default window sizes may be agreed for a period of time for each permanent virtual circuit and each datagram logical channel.

7.1.3 *Default throughput classes assignment*

Default throughput classes assignment is an optional user facility agreed for a period of time. This facility, if subscribed to, provides for the selection of default throughput classes from the list of throughput classes supported by the Administration. Some networks may constrain the default throughput classes to be the same for each direction of data transmission. In the absence of this facility, the default throughput classes correspond to the user class of service of the DTE (see § 7.4.2.6) but do not exceed the maximum throughput class supported by the network.

The default throughput classes are the maximum throughput classes which may be associated with any virtual call at the DTE/DCE interface. Values other than the default throughput classes may be negociated for a virtual call by means of the *throughput class negotiation* facility (see § 7.2.3). Values other than the default throughput classes may be agreed for a period of time for each permanent virtual circuit and each datagram logical channel.

7.1.4 *Packet retransmission*

Packet retransmission is an optional user facility agreed for a period of time. It is common to all logical channels at the DTE/DCE interface.

Note – In this section, the term "Flow controlled packet" refers to the *DCE data* packet for virtual call and permanent virtual circuit logical channels and refers to the *DCE datagram* and *datagram service signal* packets for datagram logical channels.

This user facility, if subscribed to, allows a DTE to request retransmission of one or several consecutive *flow controlled* packets from the DCE by transferring across the DTE/DCE interface a *DTE reject* packet specifying a logical channel number and a sequence number P(R). The value of this P(R) should be within the range from the last P(R) received by the DCE up to, but not including, the P(S) of the next *flow controlled* packet to be transmitted by the DCE. If the P(R) is outside this range, the DCE will initiate the reset procedure with the cause "local procedure error" and diagnostic # 2.

When receiving a *DTE reject* packet, the DCE initiates on the specified logical channel retransmission of the *flow controlled* packets; the packet send sequence numbers of which are starting from P(R), where P(R) is indicated in the *DTE reject* packet. Until the DCE transfers across the DTE/DCE interface a *flow controlled* packet with a packet send sequence number equal to the P(R) indicated in the *DTE reject* packet, the DCE will consider the receipt of another *DTE reject* packet as a procedure error and reset the logical channel.

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

A *DTE receive not ready* situation indicated by the transmission of an *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 (see Annex C).

7.1.5 *Incoming calls barred*

Incoming calls barred is an optional user facility agreed for a period of time. This facility applies to all logical channels used at the DTE/DCE interface for virtual calls and datagrams.

This user facility, if subscribed to, prevents incoming virtual calls and datagrams from being presented to the DTE. The DTE may originate outgoing virtual calls and datagrams.

Note – Logical channels used for virtual calls retain their full duplex capability. Logical channels used for datagrams and datagram service signals retain their capability to convey datagram service signals.

7.1.6 *Outgoing calls barred*

Outgoing calls barred is an optional user facility agreed for a period of time. This facility applies to all logical channels used at the DTE/DCE interface for virtual calls and datagrams.

This user facility, if subscribed to, prevents the DCE from accepting outgoing virtual calls and datagrams from the DTE. The DTE may receive incoming virtual calls and datagrams.

Note – Logical channels used for virtual calls retain their full duplex capability.

7.1.7 *One-way logical channel outgoing*

One-way logical channel outgoing is an optional user facility agreed for a period of time. This user facility, if subscribed to, restricts the logical channel use to originating outgoing virtual calls or datagrams only.

Note – A logical channel used for virtual calls retains its full duplex capability. A logical channel used for datagrams and datagram service signals retains its capability to convey datagram service signals.

The rules according to which logical channel group numbers and logical channel numbers can be assigned to one-way outgoing logical channels for virtual calls are given in Annex A.

Note – If all the logical channels for virtual calls and datagrams are one-way outgoing at a DTE/DCE interface, the effect is equivalent to the *incoming calls barred* facility (see § 7.1.5).

7.1.8 *One-way logical channel incoming*

One-way logical channel incoming is an optional user facility agreed for a period of time. This user facility, if subscribed to, restricts the logical channel use to receiving incoming virtual calls or datagrams only.

Note – A logical channel used for virtual calls retains its full duplex capability.

The rules according to which logical channel group numbers and logical channel numbers can be assigned to one-way incoming logical channels for virtual calls are given in Annex A.

Note – If all the logical channels for virtual calls and datagrams are one-way incoming at a DTE/DCE interface, the effect is equivalent to the *outgoing calls barred* facility (see § 7.1.6).

7.1.9 *Closed user group*

Closed user group is an optional user facility agreed for a period of time for virtual calls or datagrams. This facility, if subscribed to, enables the DTE to belong to one or more closed user groups. A closed user group permits the DTEs belonging to the group to communicate with each other, but precludes communication with all other DTEs.

The calling/source DTE should specify the closed user group selected for a virtual call or datagram using the optional user facility parameters (see § 7.4.2.1) in the *call request* or *DTE datagram* packet.

The closed user group selected for a virtual call or datagram will be indicated to a called/destination DTE using the optional user facility parameters (see § 7.4.2.1) in the *incoming call* or *DCE datagram* packet.

When a DTE only belongs to one closed user group or when the virtual call or datagram is associated with the DTE's preferential closed user group, this indication may not be present in the *call request, incoming call, DTE datagram* or *DCE datagram* packet.

7.1.10 *Closed user group with outgoing access*

Closed user group with outgoing access is an optional user facility agreed for a period of time for virtual calls or datagrams. This user facility, if subscribed to, enables the DTE to belong to one or more closed user groups (as in § 7.1.9) and to originate virtual calls or datagrams to DTEs in the open part of the network and to DTEs having the incoming access capability.

The procedures for using this facility are the same as those given in § 7.1.9. However, the optional user facility parameters may not be present when originating virtual calls or datagrams to DTEs in the open part of the network or to DTEs having the incoming access capability.

7.1.11 *Closed user group with incoming access*

Closed user group with incoming access is an optional user facility agreed for a period of time for virtual calls or datagrams. This user facility, if subscribed to, enables the DTE to belong to one or more closed user groups (as in § 7.1.9) and to receive incoming calls or datagrams from DTEs in the open part of the network and from DTEs having the outgoing access capability.

The procedures for using this facility are the same as those given in § 7.1.9. However, the optional user facility parameters may not be present when receiving incoming calls or datagrams from DTEs in the open part of the network or from DTEs having the outgoing access capability.

7.1.12 *Incoming calls barred within a closed user group*

Incoming calls barred within a closed user group is an optional user facility agreed for a period of time. This user facility, if subscribed to for a given closed user group, permits the DTE to originate virtual calls or datagrams to DTEs in this closed user group, but precludes the reception of incoming calls or datagrams from other DTEs in this closed user group.

The procedures for using this facility are the same as those given in §§ 7.1.9, 7.1.10 and 7.1.11.

7.1.13 *Outgoing calls barred within a closed user group*

Outgoing calls barred within a closed user group is an optional user facility agreed for a period of time. This user facility, if subscribed to for a given closed user group, permits the DTE to receive virtual calls or datagrams from other DTEs in this closed user group, but prevents the DTE from originating virtual calls or datagrams to other DTEs in this closed user group.

The procedures for using this facility are the same as those given in §§ 7.1.9, 7.1.10 and 7.1.11.

7.1.14 *Bilateral closed user group*

Bilateral closed user group is an optional user facility agreed for a period of time for virtual calls or datagrams. This facility, if subscribed to, enables the DTE to belong to one or more bilateral closed user groups. A bilateral closed user group permits a pair of DTEs who bilaterally agree to communicate with each other to do so, but precludes communication with all other DTEs.

The calling/source DTE should specify the bilateral closed user group selected for a virtual call or datagram using the optional user facility parameters (see § 7.4.2.2) in the *call request* or *DTE datagram* packet. The called/destination DTE address length shall be coded all zeros.

The bilateral closed user group for a virtual call or datagram will be indicated to a called/destination DTE using the optional user facility parameters (see § 7.4.2.2) in the *incoming call* or *DCE datagram* packet. The calling/source DTE address length will be coded all zeros.

7.1.15 *Bilateral closed user group with outgoing access*

Bilateral closed user group with outgoing access is an optional user facility agreed for a period of time for virtual calls or datagrams. This facility, if subscribed to, enables the DTE to belong to one or more bilateral closed user groups (as in § 7.1.14) and to originate virtual calls or datagrams to DTEs in the open part of the network.

The procedures for using this facility with bilateral closed user group calls or datagrams are the same as those given in § 7.1.14.

7.1.16 *Reverse charging*

Reverse charging is an optional user facility which may be requested by a DTE for a given virtual call or for a datagram (see § 7.4.2.3).

7.1.17 *Reverse charging acceptance*

Reverse charging acceptance is an optional user facility agreed for a period of time.

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

7.1.18 *RPOA selection*

RPOA selection is an optional user facility which may be requested by a DTE for a given virtual call or for a datagram.

This user facility, when requested, provides for the user specification by the calling/source DTE of a particular RPOA transit network through which the call or datagram is to be routed internationally, when more than one RPOA transit network exists at an international gateway (see § 7.4.2.4).

7.2 *Procedures for optional user facilities only available with virtual circuit services*

7.2.1 *Nonstandard default packet sizes*

Nonstandard default packet sizes is an optional user facility agreed for a period of time. This facility, if subscribed to, provides for the selection of default packet sizes from the list of packet sizes supported by the Administration. Some networks may constrain the packet sizes to be the same for each direction of data transmission across the DTE/DCE interface. In the absence of this facility, the default packet sizes are 128 octets.

Note – In § 7.2.1, the term "Packet sizes" refers to the maximum *user data* field lengths of *DCE data* and *DTE data* packets.

Values other than the default packet sizes may be negotiated for a virtual call by means of the *flow control parameter negotiation* facility (see § 7.2.2). Values other than the default packet sizes may be agreed for a period of time for each permanent virtual circuit.

7.2.2 *Flow control parameter negotiation*

Flow control parameter negotiation is an optional user facility agreed for a period of time which can be used by a DTE for virtual calls. This facility, if subscribed to, permits negotiation on a per call basis of the flow control parameters. The flow control parameters considered are the packet and window sizes at the DTE/DCE interface for each direction of data transmission.

Note – In § 7.2.2, the term "Packet sizes" refers to the maximum *user data* field lengths of *DCE data* and *DTE data* packets.

In the absence of the *flow control parameter negotiation* facility, the flow control parameters to be used at a particular DTE/DCE interface are the default packet sizes (see § 7.2.1) and the default window sizes (see § 7.1.2).

When the calling DTE has subscribed to the *flow control parameter negotiation* facility, it may separately request packet sizes and window sizes for each direction of data transmission (see § 7.4.2.5). If a particular window size is not explicitly requested in a *call request* packet, the DCE will assume that the default window size was requested. If a particular packet size is not explicitly requested, the DCE will assume that the default packet size was requested.

When a called DTE has subscribed to the *flow control parameter negotiation* facility, each *incoming call* packet will indicate the packet and window sizes from which DTE negotiation can start. No relationship needs to exist between the packet sizes (P) and window sizes (W) requested in the *call request* packet and those indicated in the *incoming call* packet. The called DTE may request window and packet sizes with facilities in the *call accepted* packet. The only valid facility requests in the *call accepted* packet, as a function of the facility indications in the *incoming call* packet, are given in Table 13/X.25. If the facility request is not made in the *call accepted* packet, the DTE is assumed to have accepted the indicated values (regardless of the default values).

TABLE 13/X.25

Valid facility requests in call accepted packets in response to facility indications in incoming call packets

Facility indication	Valid facility request
W(indicated) ⩾ 2	W(indicated) ⩾ W(requested) ⩾ 2
W(indicated) = 1	W(requested) = 1 or 2
P(indicated) ⩾ 128	P(indicated) ⩾ P(requested) ⩾ 128
P(indicated) < 128	128 ⩾ P(requested) ⩾ P(indicated)

When the calling DTE has subscribed to the *flow control parameter negotiation* facility, every *call connected* packet will indicate the packet and window sizes to be used at the DTE/DCE interface for the call. The only valid facility indications in the *call connected* packet, as a function of the facility requests in the *call request* packet, are given in Table 14/X.25.

TABLE 14/X.25

Valid facility indications in call connected packets in response to facility requests in call request packets

Facility request	Valid facility indication
W(requested) ⩾ 2	W(requested) ⩾ W(indicated) ⩾ 2
W(requested) = 1	W(indicated) = 1 or 2
P(requested) ⩾ 128	P(requested) ⩾ P(indicated) ⩾ 128
P(requested) < 128	128 ⩾ P(indicated) ⩾ P(requested)

The network may have constraints requiring the flow control parameters used for a call to be modified before indicating them to the DTE in the *incoming call* packet or *call connected* packet; e.g., the ranges of parameter values available on various networks may differ.

Window and packet sizes need not be the same at each end of a virtual call.

The role of the DCE in negotiating the flow control parameters may be network dependent.

7.2.3 *Throughput class negotiation*

Throughput class negotiation is an optional user facility agreed for a period of time which can be used by a DTE for virtual calls. This facility, if subscribed to, permits negotiation on a per call basis of the throughput classes. The throughput classes are considered independently for each direction of data transmission.

Default values are agreed between the DTE and the Administration (see § 7.1.3). The default values correspond to the maximum throughput classes which may be associated with any virtual call at the DTE/DCE interface.

When the calling DTE has subscribed to the *throughput class negotiation* facility, it may separately request the throughput classes of the virtual call in the *call request* packet (see § 7.4.2.6). If particular throughput classes are not requested, the DCE will assume the default values.

When a called DTE has subscribed to the *throughput class negotiation* facility, each *incoming call* packet will indicate the throughput classes from which DTE negotiation may start. These throughput classes are lower or equal to the ones selected at the calling DTE/DCE interface, either explicitly, or by default if the calling DTE has not subscribed to the *throughput class negotiation* facility or has not explicitly requested throughput class values in the *call request* packet. These throughput classes indicated to the called DTE will also not be higher than the default throughput classes, respectively for each direction of data transmission, at the calling and the called DTE/DCE interfaces. They may be further constrained by internal limitations of the network.

The called DTE may request with a facility in the *call accepted* packet the throughput classes that should finally apply to the virtual call. The only valid throughput classes in the *call accepted* packet are lower than or equal to the ones (respectively) indicated in the *incoming call* packet. If the called DTE does not make any *throughput class* facility request in the *call accepted* packet, the throughput classes finally applying to the virtual call will be the ones indicated in the *incoming call* packet.

If the called DTE has not subscribed to the *throughput class negotiation* facility, the throughput classes finally applying to the virtual call are less than or equal to the ones selected at the calling DTE/DCE interface, and less than or equal to the default values defined at the called DTE/DCE interface.

When the calling DTE has subscribed to the *throughput class negotiation* facility, every *call connected* packet will indicate the throughput classes finally applying to the virtual call.

When neither the calling DTE nor the called DTE has subscribed to the *throughput class negotiation* facility, the throughput classes applying to the virtual call will not be higher than the ones agreed as defaults at the calling and called DTE/DCE interfaces. They may be further constrained to lower values by the network, e.g., for international service.

Note 1 – Since both *throughput class negotiation* and *flow control parameter negotiation* (see § 7.2.2) facilities can be applied to a single call, the achievable throughput will depend on how users manipulate the D bit.

Note 2 – Users are cautioned that the choice of too small a window and packet size of a DTE/DCE interface (made by use of the *flow control parameter negotiation* facility) may adversely affect the attainable throughput class of a virtual call. This is likewise true of flow control mechanisms adopted by the DTE to control data transmission from the DCE.

7.2.4 *Fast select*

Fast select is an optional user facility which may be requested by a DTE for a given virtual call.

DTEs can request the *fast select* facility on a per call basis by means of an appropriate facility request (see § 7.4.2.7) in a *call request* packet using any logical channel which has been assigned to virtual calls.

The *fast select* facility, if requested in the *call request* packet and if it indicates no restriction on response, allows this packet to contain a call user data field of up to 128 octets and authorizes the DCE to transmit to the DTE, during the *DTE waiting* state, a *call connected* packet with a called user data field of up to 128 octets or a *clear indication* packet with a clear user data field of up to 128 octets.

The *fast select* facility, if requested in the *call request* packet and if it indicates restriction on response, allows this packet to contain a call user data field of up to 128 octets and authorizes the DCE to transmit to the DTE, during the *DTE waiting* state, a *clear indication* packet with a clear user data field of up to 128 octets; the DCE would not be authorized to transmit a *call connected* packet.

Where a DTE requests the *fast select* facility in a *call request* packet, the *incoming call* packet should only be delivered to the called DTE if that DTE has subscribed to the *fast select acceptance* facility (see § 7.2.5).

If the called DTE has subscribed to the *fast select acceptance* facility, it will be advised that the *fast select* facility, and an indication of whether or not there is a restriction on the response, has been requested through the inclusion of the appropriate facility (see § 7.4.2.7) in the *incoming call* packet.

If the called DTE has not subscribed to the *fast select acceptance* facility, an *incoming call* packet with the *fast select* facility requested will not be transmitted and a *clear indication* packet with the cause "Fast select acceptance not subscribed" will be returned to the calling DTE.

The presence of the *fast select* facility indicating no restriction on response in an *incoming call* packet permits the DTE to issue as a direct response to this packet a *call accepted* packet with a called user data field of up to 128 octets or a *clear request* packet with a clear user data field of up to 128 octets.

The presence of the *fast select* facility indicating restriction on response in an *incoming call* packet permits the DTE to issue as a direct response to this packet a *clear request* packet with a clear user data field of up to 128 octets; the DTE would not be authorized to send a *call accepted* packet.

The possibility to send a *clear request* packet with a clear user data field of up to 128 octets at any time instead of just in the *DCE waiting* state (p3) is for further study.

Note – The call user data field, the called user data field and the clear user data field will not be fragmented for delivery across the DTE/DCE interface.

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

All other procedures of a call in which the *fast select* facility has been requested are the same as those of a virtual call.

7.2.5 *Fast select acceptance*

Fast select 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 *fast select* facility. In the absence of this facility, the DCE will not transmit to the DTE incoming calls which request the *fast select* facility.

7.2.6 *D bit modification*

D bit modification is an optional user facility agreed for a period of time. This facility applies to all virtual calls and permanent virtual circuits at the DTE/DCE interface. This facility is only intended for use by those

DTEs implemented prior to the introduction of the D bit procedure which were designed for operation on public data networks that support end-to-end p(R) significance. It allows these DTEs to continue to operate with end-to-end p(R) significance within a national network after the network supports the delivery confirmation (D bit) procedure.

For communications within the national network, this facility, when subscribed to:

a) will change the value of the D bit from 0 to 1 in all *call request*, *call accepted* and *DTE data* packets received from the DTE, and

b) will set the D bit to 0 in all *incoming call*, *call connected* and *DCE data* packets transmitted to the DTE.

For international operation, conversion b) above applies and conversion a) above does not apply. Other conversion rules for international operation are for bilateral agreement between Administrations.

7.3 *Procedures for optional user facilities only available with datagram service*

7.3.1 *Abbreviated address*

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

7.3.2 *Datagram queue length selection*

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

7.3.3 *Datagram service signal logical channel*

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

7.3.4 *Datagram nondelivery indication*

Datagram nondelivery indication is an optional user facility which may be agreed for a period of time or selected on a per-datagram basis (see § 7.4.2.8).

This user facility, when requested, provides for a *nondelivery indication service* signal generated by the network when a datagram cannot be delivered to the destination DTE.

7.3.5 *Datagram delivery confirmation*

Datagram delivery confirmation is an optional user facility which may be agreed for a period of time or selected on a per-datagram basis (see § 7.4.2.9).

This user facility, when requested, provides for a *delivery confirmation service* signal generated by the network after the datagram has been accepted by the destination DTE.

7.4 *Formats for optional user facilities*

7.4.1 *General*

The *facility* field is present only when a DTE is using an optional user facility requiring some indication in the *call request, incoming call, call accepted, call connected, clear request, clear indication, DTE datagram* or *DCE datagram* packet.

The facility field contains one or more facility elements. The first octet of each facility element contains a facility code to indicate the facility or facilities requested.

Note – The action taken by the DCE when a facility code appears more than once is for further study.

The facility codes are divided into four classes, by making use of bits 8 and 7 of the facility code field, in order to specify facility parameters consisting of 1, 2, 3, or a variable number of octets. The general class coding of the facility code field is shown in Table 15/X.25.

TABLE 15/X.25

Bits	8	7	6	5	4	3	2	1	
Class A	0	0	X	X	X	X	X	X	for single octet parameter field
Class B	0	1	X	X	X	X	X	X	for double octet parameter field
Class C	1	0	X	X	X	X	X	X	for triple octet parameter field
Class D	1	1	X	X	X	X	X	X	for variable length parameter field

For class D the octet following the facility code indicates the length, in octets, of the facility parameter field. The facility parameter field length is binary coded and bit 1 is the low order bit of this indicator.

The formats for the four classes are shown in Table 16/X.25.

The facility code field is binary coded and, without extension, provides for a maximum of 64 facility codes for classes A, B and C and 63 facility codes for class D giving a total of 255 facility codes.

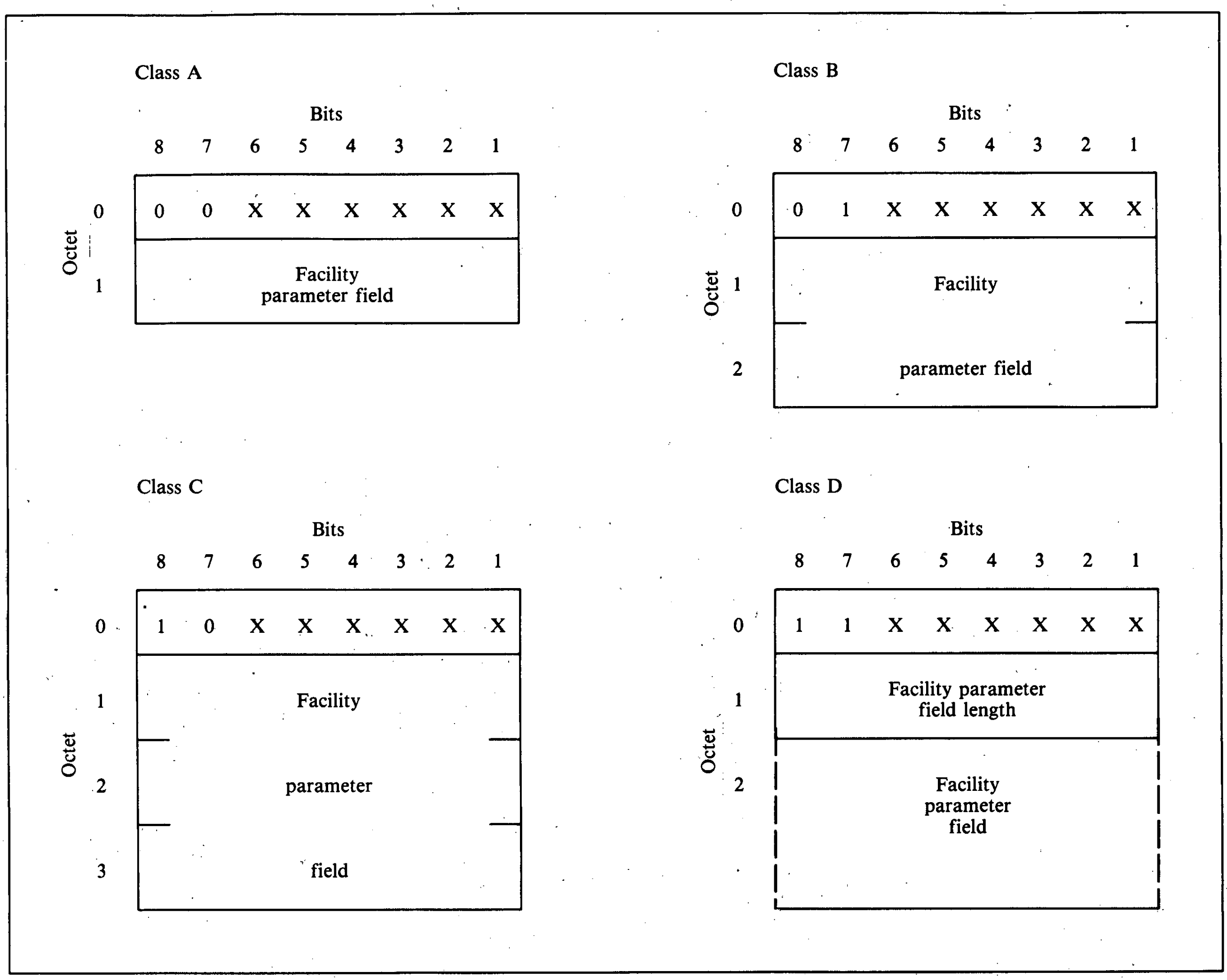
Facility code 11111111 is reserved for extension of the facility code. The octet following this octet indicates an extended facility code having the format A, B, C or D as defined above. Repetition of facility code 11111111 is permitted and thus additional extensions result.

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

A facility code may be assigned to identify a number of specific facilities, each having a bit in the parameter field indicating facility requested/facility not requested. In this situation, the parameter field is binary encoded with each bit position relating to a specific facility. A 0 indicates that the facility related to the particular bit is not requested and a 1 indicates that the facility related to the particular bit is requested. Parameter bit positions not assigned to a specific facility are set to zero. If none of the facilities represented by the facility code are requested for a virtual call or datagram, the facility code and its associated parameter field need not be present.

A *facility marker*, consisting of a single octet pair, is used to separate requests for X.25 facilities, as defined in this section, from requests for non-X.25 facilities that may also be offered by an Administration. The first octet is a facility code and is set to zero and the second octet is the facility parameter field.

TABLE 16/X.25



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

Requests for non-X.25 facilities offered by the calling/source and called/destination networks may be simultaneously present within the facility field and in such cases two *facility markers* will be required with parameter fields coded as described above.

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

7.4.2 *Coding of facility field for particular facilities*

7.4.2.1 *Coding of closed user group facility*

The coding of the facility code field and the format of the facility parameter field for *closed user groups* are the same in *call request, incoming call, DTE datagram* and *DCE datagram* packets.

7.4.2.1.1 *Facility code field*

The coding of the facility code field for *closed user groups* is:

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

7.4.2.1.2 *Facility parameter field*

The index to the *closed user group* selected for the virtual call or datagram is in the form of two decimal digits. Each digit is coded in a semi-octet in binary coded decimal with bit 5 being the low order bit of the first digit and bit 1 being the low order bit of the second digit.

Indexes to the same *closed user group* at different DTE/DCE interfaces may be different.

7.4.2.2 *Coding of bilateral closed user group facility*

The coding of the facility code field and the format of the facility parameter field for the *bilateral closed user group* are the same in *call request, incoming call, DTE datagram* and *DCE datagram* packets.

7.4.2.2.1 *Facility code field*

The coding of the facility code field for *bilateral closed user group* is:

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

7.4.2.2.2 *Facility parameter field*

The index to the *bilateral closed user group* selected for the virtual call or datagram is in the form of 4 decimal digits.

Each digit is coded in a semi-octet in binary coded decimal with bit 5 of the first octet being the low order bit of the first digit, bit 1 of the first octet being the low order bit of the second digit, bit 5 of the second octet being the low order bit of the third digit, and bit 1 of the second octet being the low order bit of the fourth digit.

Indexes to the same *bilateral closed user group* at different DTE/DCE interfaces may be different.

7.4.2.3 *Coding of reverse charging facility*

The coding of the facility code and parameter fields for *reverse charging* is the same in *call request, incoming call, DTE datagram,* and *DCE datagram* packets.

7.4.2.3.1 *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

7.4.2.3.2 *Facility parameter field*

The coding of the facility parameter field is:

bit 1 = 0 for *reverse charging* not requested

bit 1 = 1 for *reverse charging* requested

Note – Bits 6, 5, 4, 3 and 2 may be used for other facilities; if not, they are set to 0. Use of bits 8 and 7 are described in § 7.4.2.7.

7.4.2.4 *Coding of RPOA selection facility*

The coding of the facility code and parameter fields for *RPOA selection* is the same in *call request, incoming call, DTE datagram* and *DCE datagram* packets.

7.4.2.4.1 *Facility code field*

The coding of the facility code field for *RPOA selection* is:

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

7.4.2.4.2 *Facility parameter field*

The parameter field contains the data network identification code for the requested RPOA transit network, and is in the form of 4 decimal digits.

Each digit is coded in a semi-octet in binary coded decimal with bit 5 of the first octet being the low order bit of the first digit, bit 1 of the first octet being the low order bit of the second digit, bit 5 of the second octet being the low order bit of the third digit, and bit 1 of the second octet being the low order bit of the fourth digit.

7.4.2.5 *Coding of the flow control parameter negotiation facility*

7.4.2.5.1 *Coding for packet sizes*

The coding of the facility code field and the format of the facility parameter field for packet sizes are the same in *call request, incoming call, call accepted,* and *call connected* packets.

7.4.2.5.1.1 *Facility code field*

The coding of the facility code field for packet sizes is:

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

7.4.2.5.1.2 *Facility parameter field*

The packet size for the direction of transmission from the called DTE is indicated in bits 4, 3, 2 and 1 of the first octet. The packet size for the direction of transmission from the calling DTE is indicated in bits 4, 3, 2 and 1 of the second octet. Bits 5, 6, 7 and 8 of each octet must be zero.

The four bits indicating each packet size are binary coded and express the logarithm base 2 of the number of octets of the maximum packet size.

Networks may offer values from 4 to 10, corresponding to packet sizes of 16, 32, 64, 128, 256, 512, or 1024, or a subset of these values. All Administrations will provide a packet size of 128.

7.4.2.5.2 *Coding for window sizes*

The coding of the facility code field and the format of the facility parameter field for window sizes are the same in *call request, incoming call, call accepted,* and *call connected* packets.

7.4.2.5.2.1 *Facility code field*

The coding of the facility code field for window sizes is:

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

7.4.2.5.2.2 *Facility parameter field*

The window size for the direction of transmission from the called DTE is indicated in bits 7 to 1 of the first octet. The window size for the direction of transmission from the calling DTE is indicated in bits 7 to 1 of the second octet. Bit 8 of each octet must be zero.

The bits indicating each window size are binary coded and express the size of the window. A value of zero is not allowed.

Window sizes of 8 to 127 are only valid if extended numbering is used (see § 7.1.1). The ranges of values allowed by a network for calls with normal numbering and extended numbering are network dependent. All Administrations will provide a window size of 2.

7.4.2.6 *Coding of throughput class negotiation facility*

The coding of the facility code field and the format of the facility parameter field for *throughput class negotiation* are the same in *call request, incoming call, call accepted* and *call connected* packets.

7.4.2.6.1 *Facility code field*

The coding of the facility code field for *throughput class negotiation* is:

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

7.4.2.6.2 *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 correspond to throughput classes as indicated in Table 17/X.25.

TABLE 17/X.25

Bits: / or Bits:	4 / 8	3 / 7	2 / 6	1 / 5	Throughput class (bit/s)
	0	0	0	0	Reserved
	0	0	0	1	Reserved
	0	0	1	0	Reserved
	0	0	1	1	75
	0	1	0	0	150
	0	1	0	1	300
	0	1	1	0	600
	0	1	1	1	1 200
	1	0	0	0	2 400
	1	0	0	1	4 800
	1	0	1	0	9 600
	1	0	1	1	19 200
	1	1	0	0	48 000
	1	1	0	1	Reserved
	1	1	1	0	Reserved
	1	1	1	1	Reserved

7.4.2.7 *Coding of fast select facility*

The coding of the facility code and parameter fields for *fast select* is the same in *call request* and *incoming call* packets.

7.4.2.7.1 *Facility code field*

The coding of the facility code field for *fast select* is:

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

7.4.2.7.2 *Facility parameter field*

The coding of the facility parameter field is:

bit 8 = 0 and bit 7 = 0 or 1 for *fast select* not requested

bit 8 = 1 and bit 7 = 0 for *fast select* requested with no restriction on response

bit 8 = 1 and bit 7 = 1 for *fast select* requested with restriction on response

Note – Bits 6, 5, 4, 3 and 2 may be used for other facilities; if not, they are set to 0. Use of bit 1 is described in § 7.4.2.3.

7.4.2.8 *Coding of datagram nondelivery indication facility*

The coding of the facility code and parameter fields is the same in the *DTE datagram* and *DCE datagram* packets.

7.4.2.8.1 *Facility code field*

The coding of the facility code field for *datagram nondelivery indication* is:

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

7.4.2.8.2 *Facility parameter field*

The coding of the facility parameter field is:

bit 2 = 0 for *datagram nondelivery indication* not requested

bit 2 = 1 for *datagram nondelivery indication* requested

Note – Bits 8, 7, 6, 5, 4 and 3 may be used for other facilities; if not, they are set to 0. Use of bit 1 is described in § 7.4.2.9.

7.4.2.9 *Coding of datagram delivery confirmation facility*

The coding of the facility code and parameter fields is the same in the *DTE datagram* and *DCE datagram* packets.

7.4.2.9.1 *Facility code field*

The coding of the facility code field for *datagram delivery confirmation* is:

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

7.4.2.9.2 *Facility parameter field*

The coding of the facility parameter field is:

bit 1 = 0 for *datagram delivery confirmation* not requested

bit 1 = 1 for *datagram delivery confirmation* requested

Note – Bits 8, 7, 6, 5, 4 and 3 may be used for other facilities; if not, they are set to 0. Use of bit 2 is described in § 7.4.2.8.

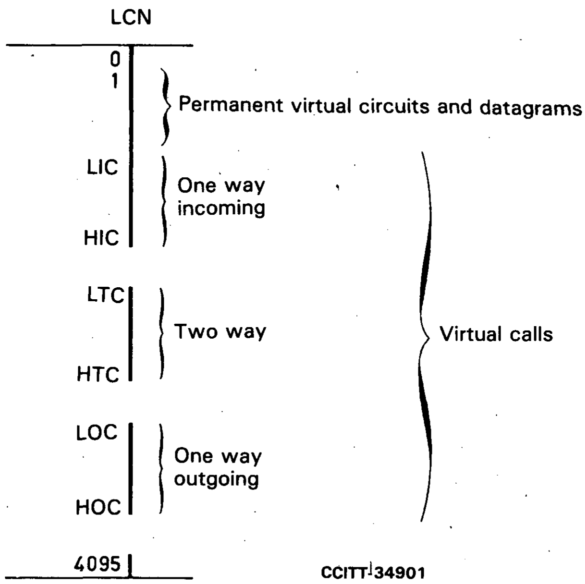
ANNEX A

(to Recommendation X.25)

Range of logical channels used for virtual calls, permanent virtual circuits and datagrams

In the case of a single logical channel DTE, logical channel 1 will be used.

For each multiple logical channel DTE/DCE interface, a range of logical channels will be agreed upon with the Administration according to Figure A-1/X.25.



LCN Logical channel number
LIC Lowest incoming channel
HIC Highest incoming channel
LTC Lowest two-way channel
HTC Highest two-way channel
LOC Lowest outgoing channel
HOC Highest outgoing channel

Logical channels 1 to LIC-1: range of logical channels which may be assigned to permanent virtual circuits and datagrams.
Logical channels LIC to HIC: range of logical channels which are assigned to one-way incoming logical channels for virtual calls (see § 7.1.8).
Logical channels LTC to HTC: range of logical channels which are assigned to two-way logical channels for virtual calls.
Logical channels LOC to HOC: range of logical channels which are assigned to one-way outgoing logical channels for virtual calls (see § 7.1.7).
Logical channels HIC + 1 to LTC − 1, HTC + 1 to LOC − 1, and HOC + 1 to 4095 are non-assigned logical channels.

Note 1 – The reference to the number of logical channels is made according to a set of contiguous numbers from 0 (lowest) to 4095 (highest) using 12 bits made up of the 4 bits of the logical channel group number (see § 6.1.2) and the 8 bits of the logical channel number (see § 6.1.3). The numbering is binary coded using bit positions 4 through 1 of octet 1 followed by bit positions 8 through 1 of octet 2 with bit 1 of octet 2 as the low order bit.

Note 2 – All logical channel boundaries are agreed with the Administration for a period of time.

Note 3 – In order to avoid frequent rearrangement of logical channels, not all logical channels within the range for permanent virtual circuits and datagrams are necessarily assigned.

Note 4 – In the absence of permanent virtual circuits and datagram channels, logical channel 1 is available for LIC. In the absence of permanent virtual circuits, datagram channels and one-way incoming logical channels, logical channel 1 is available for LTC. In the absence of permanent virtual circuits, datagram channels, one-way incoming logical channels and two-way logical channels, logical channel 1 is available for LOC.

Note 5 – DCE search algorithm for a logical channel for a new incoming call will be to use the lowest logical channel in the *ready* state in the range of LIC to HIC and LTC to HTC.

Note 6 – In order to minimize the risk of call collision, the DTE search algorithm is suggested to start with the highest numbered logical channel in the *ready* state. The DTE could start with the two-way logical channel or one-way outgoing logical channel ranges.

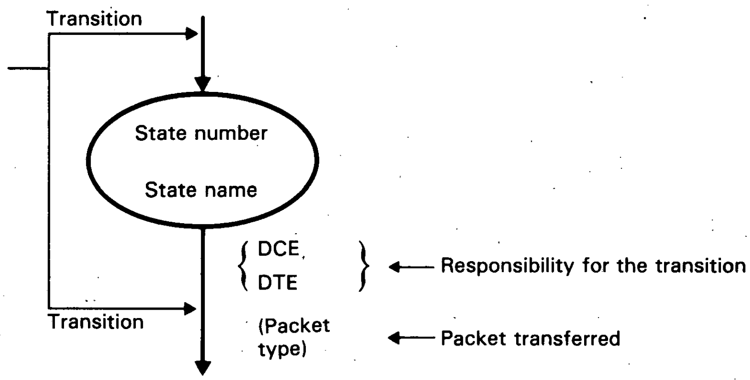
FIGURE A-1/X.25

ANNEX B

(to Recommendation X.25)

Packet level DTE/DCE interface state diagrams

B.1 *Symbol definition of the state diagrams*



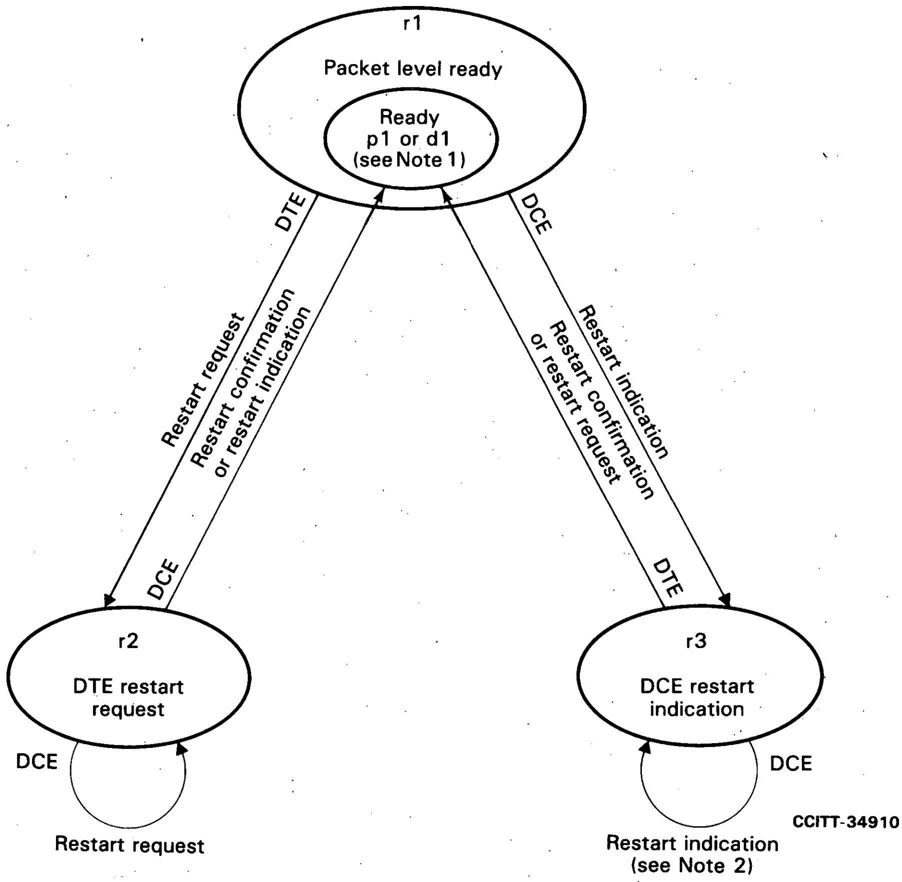
Note 1 – Each state is represented by an ellipse wherein the state name and number are indicated.

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

B.2 *Order definition of the state diagrams*

For the sake of clarity, the normal procedure at the interface is described in a number of small state diagrams. In order to describe the normal procedure fully, it is necessary to allocate a priority to the different figures and to relate a higher order diagram with a lower one. This has been done by the following means:

- The figures are arranged in order of priority with Figure B-1/X.25 *(restart)* having the highest priority and subsequent figures having lower priority. Priority means that when a packet belonging to a higher order diagram is transferred, that diagram is applicable and the lower order one is not.
- The relation with a state in a lower order diagram is given by including that state inside an ellipse in the higher order diagram.

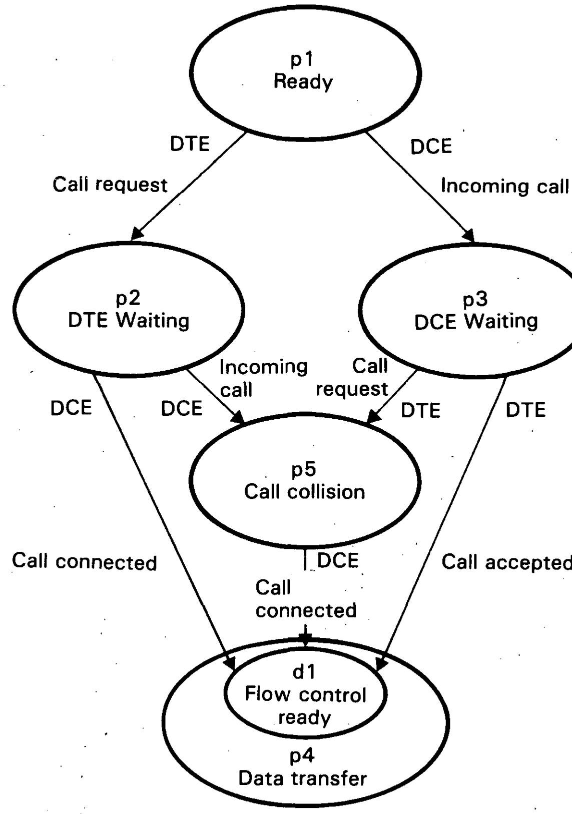


Note 1 – State p1 for virtual calls or state d1 for permanent virtual circuits and datagrams.

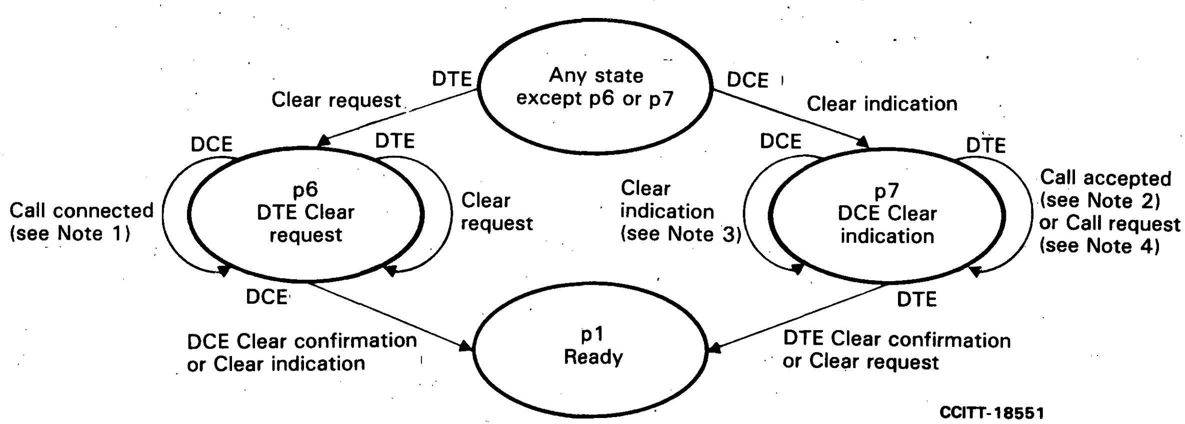
Note 2 – This transition may take place after time-out T10.

FIGURE B-1/X.25

Diagram of states for the transfer of restart packets



a) *Call set-up phase*



b) *Call clearing phase*

Note 1 – This transition is possible only if the previous state was DTE Waiting (p2).

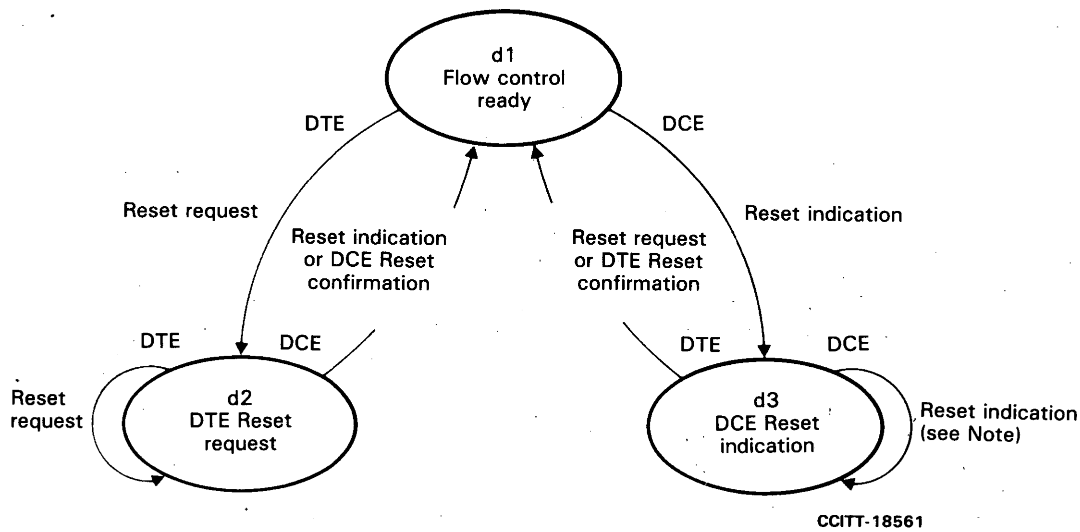
Note 2 – This transition is possible only if the previous state was DCE Waiting (p3).

Note 3 – This transition may take place after time-out T13.

Note 4 – This transition is possible only if the previous state was Ready (p1) or DCE Waiting (p3).

FIGURE B-2/X.25

Diagram of states for the transfer of call set-up and call clearing packets within the packet level ready (r1) state



Note – This transition may take place after time-out T12.

FIGURE B-3/X.25

Diagram of states for the transfer of reset packets within the data transfer (p4) state

ANNEX C

(to Recommendation X.25)

Actions taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface as perceived by the DCE

TABLE C-1/X.25

Special cases

Packet from the DTE	Any state
Any packet with packet length <2 octets	DIAG # 38
Any packet with incorrect general format identifier	DIAG # 40
Any packet with unassigned logical channel	DIAG # 36
Any packet with correct GFI and assigned logical channel	(See Table C-2/X.25)

The number following the symbol # is the diagnostic code (see Annex E).

DIAG: The DCE discards the received packet and, for networks which implement the diagnostic packet, transmits a *diagnostic* packet to the DTE containing the indicated diagnostic code.

There may be more than one error associated with a packet. The network will stop normal processing of a packet when an error is encountered. Thus only one diagnostic code is indicated in the *diagnostic* packet. The order of packet decoding and checking on networks is not standardized.

TABLE C-2/X.25

Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface as perceived by the DCE: restart procedure for assigned logical channels

Packet from the DTE with assigned logical channel / State of the interface as perceived by the DCE	Packet level ready r1	DTE restart request r2	DCE restart indication r3
Restart request	NORMAL (r2)	DISCARD (r2)	NORMAL (p1 or d1) (see Note 2)
DTE restart confirmation	ERROR (r3) # 17	ERROR (r3) # 18	NORMAL (p1 or d1) (see Note 2)
Data, datagram, interrupt, call set-up and clearing, flow control or reset	(see Table C-3/X.25)	ERROR (r3) # 18	DISCARD (r3)
Restart request or DTE restart confirmation with bits 1 to 4 of octet 1 or bits 1 to 8 of octet 2 unequal to zero	(see Table C-3/X.25)	ERROR (r3) # 41	DISCARD (r3)
Packets having a packet type identifier which is shorter than 1 octet or is not supported by the DCE	(see Table C-3/X.25)	ERROR (r3) # 38 # 33	DISCARD (r3)

The figures in brackets are the new states to be entered.
The number following the symbol # is the diagnostic code (see Note 1).

NORMAL: The action taken by the DCE follows the procedures as defined in § 3. If a *restart request* packet or DTE *restart confirmation* packet received in state r3 exceeds the maximum permitted length, the DCE will invoke the *error* procedure with diagnostic # 39 and enter state r3. If a *restart request* packet received in state r1 exceeds the maximum permitted length, the action taken by the DCE is for further study.

DISCARD: The DCE discards the received packet and takes no subsequent action as a direct result of receiving that packet.

ERROR: The DCE discards the received packet and indicates a restarting by transmitting to the DTE a *restart indication* packet, with the cause "Local procedure error" (diagnostic per Table C-2/X.25). If connected through the virtual call, the distant DTE is also informed of the restarting by a *clear indication* packet, with the cause "Remote procedure error" (same diagnostic). In the case of a permanent virtual circuit, the distant DTE will be informed by a *reset indication* packet, with the cause "Remote procedure error" (same diagnostic).

If a *restart indication* is issued as a result of an error condition in state r2, the DCE should eventually consider the DTE/DCE interface to be in the *packet level ready* state (r1).

Note 1 – There may be more than one error associated with a packet. The network will stop normal processing of a packet when an error is encountered. Thus only one diagnostic code is associated with an ERROR indication by the DCE. The order of packet decoding and checking on networks is not standardized.

Note 2 – p1 for logical channels assigned to virtual calls; d1 for logical channels assigned to permanent virtual circuits and datagrams.

TABLE C-3/X.25

Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface as perceived by the DCE: call set-up and clearing on assigned logical channel

State of the interface as perceived by the DCE / Packet from the DTE with assigned logical channel	Packet level ready r1						
	Ready p1	DTE Waiting p2 (see Note 3)	DCE Waiting p3 (see Note 2)	Data transfer p4	Call collision p5 (see Notes 2, 3)	DTE Clear request p6	DCE Clear indication p7
Call request	NORMAL (p2) (see Note 4)	ERROR (p7) # 21	NORMAL (p5) (see Note 4)	ERROR (p7) (see Note 5) # 23	ERROR (p7) # 24	ERROR (p7) # 25	DISCARD (p7)
Call accepted	ERROR (p7) # 20	ERROR (p7) # 21	NORMAL (p4) (see Note 6) ERROR (p7) (see Note 7) # 42	ERROR (p7) (see Note 5) # 23	ERROR (p7) # 24	ERROR (p7) # 25	DISCARD (p7)
Clear request	NORMAL (p6)	NORMAL (p6)	NORMAL (p6)	NORMAL (p6) (see Note 5)	NORMAL (p6)	DISCARD (p6)	NORMAL (p1)
DTE Clear confirmation	ERROR (p7) # 20	ERROR (p7) # 21	ERROR (p7) # 22	ERROR (p7) (see Note 5) # 23	ERROR (p7) # 24	ERROR (p7) # 25	NORMAL (p1)
Data, datagram, interrupt, reset or flow control	ERROR (p7) # 20	ERROR (p7) # 21	ERROR (p7) # 22	See Table C-4/X.25	ERROR (p7) # 24	ERROR (p7) # 25	DISCARD (p7)
Restart request or DTE Restart confirmation with bits 1 to 4 of octet 1 or bits 1 to 8 of octet 2 unequal to zero	ERROR (p7) # 41	ERROR (p7) # 41	ERROR (p7) # 41	See Table C-4/X.25	ERROR (p7) # 41	ERROR (p7) # 41	DISCARD (p7)
Packets having a packet type identifier which is shorter than one octet or is not supported by the DCE	ERROR (p7) # 38 # 33	ERROR (p7) # 38 # 33	ERROR (p7) # 38 # 33	See Table C-4/X.25	ERROR (p7) # 38 # 33	ERROR (p7) # 38 # 33	DISCARD (p7)

The figures in brackets are the new states to be entered.
The number following the symbol # is the diagnostic code (see Note 1).

NORMAL: The action taken by the DCE follows the procedures as defined in § 4. If the packet exceeds the maximum permitted length the DCE will invoke the ERROR procedure with diagnostic # 39 and enter state p7.

DISCARD: The DCE discards the received packet and takes no subsequent action as a direct result of receiving that packet.

ERROR: The DCE discards the received packet and indicates a clearing by transmitting to the DTE a *clear indication* packet, with the cause "local procedure error" (diagnostic per Table C-3/X.25). If connected through the virtual call, the distant DTE is also informed of the clearing by a *clear indication* packet, with the cause "Remote procedure error" (same diagnostic).

It is required that in the absence of an appropriate DTE response to a *clear indication* packet issued as a result of an error condition in state p6, the DCE should eventually consider the DTE/DCE interface to be in the *ready* state (p1).

Note 1 – There may be more than one error associated with a packet (e.g., packet too long and transmitted in a wrong state). The network will stop processing of the packet when an error is encountered, Thus only one diagnostic code is associated with an ERROR indication by the DCE. The order of packet decoding and checking on networks is not standardized.

Note 2 – This state does not exist in the case of an outgoing one-way logical channel (as perceived by the DTE).

Note 3 – This state does not exist in the case of an incoming one-way logical channel (as perceived by the DTE).

Note 4 –

a) In the case of an incoming one-way logical channel (as perceived by the DTE) the DCE will transmit a *clear indication* with the cause "Local procedure error" and diagnostic # 34.

b) The DCE will transmit a *clear indication* if the *call request* contains an improper address format or facility field; *call progress* signals and diagnostic codes are listed below:

Error condition	*Cause*	*Possible diagnostics*
1. Address contains a non BCD digit	Local procedure error	# 67, 68
2. Prefix digit not supported	Local procedure error	# 67, 68
3. National address smaller than national address format permits	Local procedure error	# 67, 68
4. National address larger than national address format permits	Local procedure error	# 67, 68
5. DNIC less than four digits	Local procedure error	# 67, 68
6. Facility length larger than 63	Local procedure error	# 64
7. No combination of facilities could equal facility length	Local procedure error	# 64
8. Facility length larger than remainder of packet	Local procedure error	# 38
9. Facility values conflict (e.g., a particular combination not supported)	Local procedure error	# 66
10. Facility code not allowed	Invalid facility request	# 65
11. Facility value not allowed	Invalid facility request	# 66

c) The DCE will transmit a *clear indication* if the remote DTE makes a procedure error, either for one of the above reasons associated with its call acceptance, or because of an expired time-out (diagnostic # 49).

Note 5 – In the case of a permanent virtual circuit, the DCE discards the received packet and indicates a reset by transmitting to the DTE a *reset indication* packet, with the cause "Local procedure error" (diagnostic # 35). The distant DTE is also informed of the reset by a *reset indication* packet, with the cause "Remote procedure error" (same diagnostic).

In the case of a datagram logical channel, the DCE discards the received packet and indicates a reset by transmitting to the DTE a *reset indication* packet, with the cause "Local procedure error".

Note 6 – The ERROR procedure will be invoked by the DCE if the *call accepted* packet contains an improper address format or facility field. Examples are similar to those in Note 4 point (b) above.

Note 7 – The presence of the *fast select* facility indicating restriction on response in an *incoming call* packet prohibits the DTE from sending a *call accepted* packet.

TABLE C-4/X.25

Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface as perceived by the DCE: data transfer (flow control and reset) on assigned logical channels

Packet from the DTE with assigned logical channel \ State of the interface as perceived by the DCE	Data transfer p4: Flow control ready d1	Data transfer p4: DTE Reset request d2	Data transfer p4: DCE Reset indication d3
Reset request	NORMAL (d2)	DISCARD (d2)	NORMAL (d1)
DTE Reset confirmation	ERROR (d3) # 27	ERROR (d3) # 28	NORMAL (d1)
Data, datagram, interrupt or flow control	NORMAL (d1) (see Note 2)	ERROR (d3) # 28	DISCARD (d3)
Restart request or DTE Restart confirmation with bits 1 to 4 of octet 1 or bits 1 to 8 of octet 2 unequal to zero	ERROR (d3) # 41	ERROR (d3) # 41	DISCARD (d3)
Packets having a packet type identifier which is shorter than one octet or is not supported by the DCE	ERROR (d3) # 27	ERROR (d3) # 28	DISCARD (d3)
Invalid packet type on a permanent virtual circuit	ERROR (d3) # 35	ERROR (d3) # 35	DISCARD (d3)
Reject packet not subscribed	ERROR (d3) # 37	ERROR (d3) # 37	DISCARD (d3)

The figures in brackets are the new states to be entered.
The number following the symbol # is the diagnostic code (see Note 1).

NORMAL: The action taken by the DCE follows the procedures as defined in §§ 4 and 5. If the packet exceeds the maximum permitted length, the DCE will invoke the ERROR procedure using diagnostic code # 39 and enter state d3.

DISCARD: The DCE discards the received packet and takes no subsequent action as a direct result of receiving that packet.

ERROR: The DCE discard the received packet and indicates a reset by transmitting to the DTE a *reset indication* packet, with the cause "Local procedure error" (diagnostic per Table C-4/X.25). For virtual calls and permanent virtual circuits, the distant DTE is also informed of the reset by a *reset indication* packet, with the cause "Remote procedure error" (same diagnostic).

If a *reset indication* is issued as a result of an error condition in state d2 for permanent virtual circuits and datagram logical channels, the DCE should eventually consider the DTE/DCE interface to be in the *flow control ready* state (d1). In this case, the action to be taken on a virtual call is for further study.

Note 1 – There may be more than one error associated with a packet (e.g., invalid P(S) and invalid P(R)). The network will stop processing of the packet when an error is encountered. Thus only one diagnostic code is associated with an ERROR indication by the DCE. The order of packet decoding and checking on networks is not standardized.

Note 2 – If the P(S) or P(R) received is not valid, the DCE will invoke the ERROR procedure with diagnostics # 1 and # 2 respectively, and enter state d3.

The DCE will consider the receipt of a ***DTE interrupt confirmation*** packet which does not correspond to a yet unconfirmed ***DCE interrupt*** packet as an error and will reset the virtual call or permanent circuit (diagnostic # 43). The DCE will either discard or consider as an error a ***DTE interrupt*** packet received before a previous ***DTE interrupt*** packet has been confirmed (diagnostic # 44).

ANNEX D

(to Recommendation X.25)

Packet level DCE time-outs and DTE time-limits

D.1 *DCE time-outs*

Under certain circumstances this Recommendation requires the DTE to respond to a packet issued from the DCE within a stated maximum time.

Table D-1/X.25 covers these circumstances and the actions that the DCE will initiate upon the expiration of that maximum time.

D.2 *DTE time-limits*

Under certain circumstances, this Recommendation requires the DCE to respond to a packet from the DTE within a stated maximum time. Table D-2/X.25 gives these maximum times. The actual DCE response times should be well within the specified time-limits. The rare situation where a time-limit is exceeded should only occur when there is a fault condition.

To facilitate recovery from such fault conditions, the DTE may incorporate timers. The time-limits given in Table D-2/X.25 are the lower limits of the times a DTE should allow for proper operation. A time-limit longer than the values shown may be used. Suggestions on possible DTE actions upon expiration of the time-limits are given in Table D-2/X.25.

Note – A DTE may use a timer shorter than the value given for T21 in Table D-2/X.25. This may be appropriate when the DTE knows the normal response time of the called DTE to an incoming call. In this case, the timer should account for the normal maximum response time of the called DTE and the estimated maximum call set-up time.

TABLE D-1/X.25

DCE Time-outs

Time-out number	Time-out value	State of the logical channel	Started when	Normally terminated when	Actions to be taken when the time-out expires (see Note 1)	
					Local side	Remote side
T10	60 s	r3	DCE issues a *restart indication*	DCE leaves the r3 state (i.e., the *restart confirmation* or *restart request* is received)	DCE remains in r3 and may issue a *diagnostic* packet (see Note 2)	For permanent virtual circuits, DCE enters the d3 state signalling a *reset indication* (remote procedure error)
T11	180 s	p3	DCE issues an *incoming call*	DCE leaves the p3 state (e.g., the *call accepted, clear request* or *call request* is received)	DCE enters the p7 state signalling a *clear indication* (local procedure error)	DCE enters the p7 state signalling a *clear indication* (remote procedure error)
T12	60 s	d3	DCE issues a *reset indication*	DCE leaves the d3 state (e.g., the *reset confirmation* or *reset request* is received)	For virtual calls, DCE enters the p7 state signalling a *clear indication* (local procedure error). For permanent virtual circuits and datagram logical channels, DCE remains in d3 and may issue a *diagnostic* packet (see Note 3)	For virtual calls, DCE enters the p7 state signalling a *clear indication* (remote procedure error). For permanent virtual circuits, DCE enters the d3 state signalling a *reset indication* (remote procedure error)
T13	60 s	p7	DCE issues a *clear indication*	DCE leaves the p7 state (e.g., the *clear confirmation* or *clear request* is received)	DCE remains in p7 and may issue a *diagnostic* packet (see Note 4)	

Note 1 – The following Notes 2, 3 and 4 describe alternative DCE actions on timer expiration. It is envisaged that all networks will eventually conform to Table D-1/X.25; however for an interim period the following procedures may be used.

No values have yet been assigned to the time-out *t* and the maximum number of retries *n* applying to the following notes; however it should be noted that some Administrations may use the combination *t*—infinite, *n*—zero (i.e., no retries and no recovery action) or *t*—finite, *n*—zero (i.e., no retries with recovery action on timer expiration). The values of *n* and *t* will not necessarily be the same for the clear, reset and restart procedures.

Note 2 – Alternatively, the DCE will retransmit the *restart indication* at regular intervals of *t* until a *DTE restart confirmation* is received or a restart collision occurs or a period $(n + 1)\ t$ elapses since the first transmission of the *restart indication.* If the restart procedure is not completed within the time-out period, appropriate recovery action will be taken.

Note 3 – Alternatively, the DCE will transmit the *reset indication* at regular intervals of *t* until a *DTE reset confirmation* is received or a reset collision occurs or a period $(n + 1)\ t$ elapses since the first transmission of the *reset indication.* If the reset procedure is not completed within the time-out period the DCE will either:

i) clear the virtual call with an indication of procedure error, or

ii) in the case of permanent virtual circuit forward a *reset indication* (remote procedure error) to the local DTE at regular intervals *t* until a *DTE reset confirmation* is received or a reset collision occurs.

Note 4 – Alternatively, the DCE will retransmit a *clear indication* at regular intervals of *t* until a *DTE clear confirmation* is received or a clear collision occurs or a period $(n + 1)\ t$ elapses since the first retransmission of the *clear indication.* If the clear procedure is not completed within the time-out period, appropriate recovery action will be initiated. The nature of the recovery action is for further study.

TABLE D-2/X.25

DTE Time-limits

Time-out number	Time-limit value	State of the logical channel	Started when	Normally terminated when	Preferred action to be taken when time-limit expires
T20	180 s	r2	DTE issues a *restart request*	DTE leaves the r2 state (i.e., the *restart confirmation* or *restart indication* is receved)	To retransmit the *restart request* (see Note 1)
T21	200 s	p2	DTE issues a *call request*	DTE leaves the p2 state (e.g., the *call connected, clear indication* or *incoming call* is received)	To transmit a *clear request*
T22	180 s	d2	DTE issues a *reset request*	DTE leaves the d2 state (e.g., the *reset confirmation* or *reset indication* is received)	For virtual calls, to retransmit the *reset request* or to transmit a *clear request* For permanent virtual circuits and datagram logical channels, to retransmit the *reset request* (see Note 2)
T23	180 s	p6	DTE issues a *clear request*	DTE leaves the p6 state (e.g., the *clear confirmation* or *clear indication* is received)	To retransmit the *clear request* (see Note 2)

Note 1 – After unsuccessful retries, recovery decisions should be taken at higher levels.

Note 2 – After unsuccessful retries, the logical channel should be considered out-of-order. The restart procedure should only be invoked for recovery if reinitialization of all logical channels is acceptable.

ANNEX E

(to Recommendation X.25)

Coding of X.25 network generated diagnostic fields in clear, reset and restart indication and diagnostic packets
(see Notes 1, 2 and 3)

Diagnostics	Bits 8	7	6	5	4	3	2	1	Decimal
No additional information	0	0	0	0	0	0	0	0	0
Invalid P(S)	0	0	0	0	0	0	0	1	1
Invalid P(R)	0	0	0	0	0	0	1	0	2
	. . .								
	0	0	0	0	1	1	1	1	15
Packet type invalid	0	0	0	1	0	0	0	0	16
For state r1	0	0	0	1	0	0	0	1	17
For state r2	0	0	0	1	0	0	1	0	18
For state r3	0	0	0	1	0	0	1	1	19
For state p1	0	0	0	1	0	1	0	0	20
For state p2	0	0	0	1	0	1	0	1	21
For state p3	0	0	0	1	0	1	1	0	22
For state p4	0	0	0	1	0	1	1	1	23
For state p5	0	0	0	1	1	0	0	0	24
For state p6	0	0	0	1	1	0	0	1	25
For state p7	0	0	0	1	1	0	1	0	26
For state d1	0	0	0	1	1	0	1	1	27
For state d2	0	0	0	1	1	1	0	0	28
For state d3	0	0	0	1	1	1	0	1	29
	. . .								
	0	0	0	1	1	1	1	1	31
Packet not allowed	0	0	1	0	0	0	0	0	32
Unidentifiable packet	0	0	1	0	0	0	0	1	33
Call on one way logical channel	0	0	1	0	0	0	1	0	34
Invalid packet type on a permanent virtual circuit	0	0	1	0	0	0	1	1	35
Packet on unassigned logical channel	0	0	1	0	0	1	0	0	36
Reject not subscribed to	0	0	1	0	0	1	0	1	37
Packet too short	0	0	1	0	0	1	1	0	38
Packet too long	0	0	1	0	0	1	1	1	39
Invalid general format identifier	0	0	1	0	1	0	0	0	40
Restart with nonzero in bits 1-4, 9-16	0	0	1	0	1	0	0	1	41
Packet type not compatible with facility	0	0	1	0	1	0	1	0	42
Unauthorized interrupt confirmation	0	0	1	0	1	0	1	1	43
Unauthorized interrupt	0	0	1	0	1	1	0	0	44
	. . .								
	0	0	1	0	1	1	1	1	47
Timer expired	0	0	1	1	0	0	0	0	48
For incoming call	0	0	1	1	0	0	0	1	49
For clear indication	0	0	1	1	0	0	1	0	50
For reset indication	0	0	1	1	0	0	1	1	51
For restart indication	0	0	1	1	0	1	0	0	52
	. . .								
	0	0	1	1	1	1	1	1	63
Call set-up problem	0	1	0	0	0	0	0	0	64
Facility code not allowed	0	1	0	0	0	0	0	1	65
Facility parameter not allowed	0	1	0	0	0	0	1	0	66
Invalid called address	0	1	0	0	0	0	1	1	67
Invalid calling address	0	1	0	0	0	1	0	0	68
	. . .								
	0	1	0	0	1	1	1	1	79
Not assigned	0	1	0	1	0	0	0	0	80
	. . .								
	0	1	0	1	1	1	1	1	95
Not assigned	0	1	1	0	0	0	0	0	96
	. . .								
	0	1	1	0	1	1	1	1	111

Diagnostics	Bits								Decimal
	8	7	6	5	4	3	2	1	
Not assigned	0	1	1	1	0	0	0	0	112
	...								
	0	1	1	1	1	1	1	1	127
Reserved for network specific diagnostic information	1	0	0	0	0	0	0	0	128
	...								
	1	1	1	1	1	1	1	1	255

Note 1 – Not all diagnostic codes need apply to a specific network, but those used are as coded in the table.

Note 2 – A given diagnostic need not apply to all packet types (i.e., *reset indication, clear indication, restart indication* and *diagnostic* packets).

Note 3 – The first diagnostic in each grouping is a generic diagnostic and can be used in place of the more specific diagnostics within the grouping. The decimal 0 diagnostic code can be used in situations where no additional information is available.

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.1.

[2] CCITT Recommendation *International user services and facilities in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.2.

[3] CCITT Recommendation *Hypothetical reference connections for public synchronous data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.92.

[4] CCITT Recommendation *Call progress signals in public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.96.

Recommendation X.26

ELECTRICAL CHARACTERISTICS FOR UNBALANCED DOUBLE-CURRENT INTERCHANGE CIRCUITS FOR GENERAL USE WITH INTEGRATED CIRCUIT EQUIPMENT IN THE FIELD OF DATA COMMUNICATIONS

(For the text of this Recommendation, see Recommendation V.10 for which Study Group XVII is responsible.)

Recommendation X.27

ELECTRICAL CHARACTERISTICS FOR BALANCED DOUBLE-CURRENT INTERCHANGE CIRCUITS FOR GENERAL USE WITH INTEGRATED CIRCUIT EQUIPMENT IN THE FIELD OF DATA COMMUNICATIONS

(For the text of this Recommendation, see Recommendation V.11 for which Study Group XVII is responsible.)

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

(provisional, Geneva, 1977; amended, Geneva, 1980)

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 [1] and X.2 [2] define user classes of service and user facilities provided by a public data network, and Recommendation X.96 [3] defines call progress signals,

(b) that Recommendation X.29 defines procedures for a packet mode DTE to control the PAD and for interworking between PADs,

(c) that the logical control links for packet-switched data transmission services are defined in Recommendation X.92 [4],

(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 [5],

(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 in accordance with Recommendation V.21 [6].

The particular interchange circuits provided, and their operation, shall be in accordance with the Recommendation cited in [7] and clamping of circuit 104 shall be implemented in accordance with the Recommendation cited in [8]. The modem shall be set up for channel operation in accordance with the Recommendation cited in [9].

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 [10].

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 the Recommendation cited in [11] 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 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 and the procedure for determining the speed and code of the start-stop mode DTE is for urgent 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 circuits 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 if 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 circuit-switched data network are described in § 3 and § 4 of Recommendation X.20. The procedures for setting up a virtual call in a packet-switched network are those given in §§ 2, 3 and 4 of this Recommendation. The use of Recommendation X.20 procedures to establish a virtual call via a PAD is for further study.

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

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*.

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 urgent 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 generate a signal length 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 used in the exchange of control information between start-stop mode DTE and a PAD*

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 [5]. The general structure of characters shall be in accordance with Recommendation X.4 [12]. The character format specified below applies to the procedures described in §§ 2 and 3.

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 remote DTE, it will only inspect the first seven bits and will not take account of the eighth bit (the last bit preceding the stop element). Whenever the PAD generates characters (e.g. *PAD 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, 2/X.28 and 3/X.28.

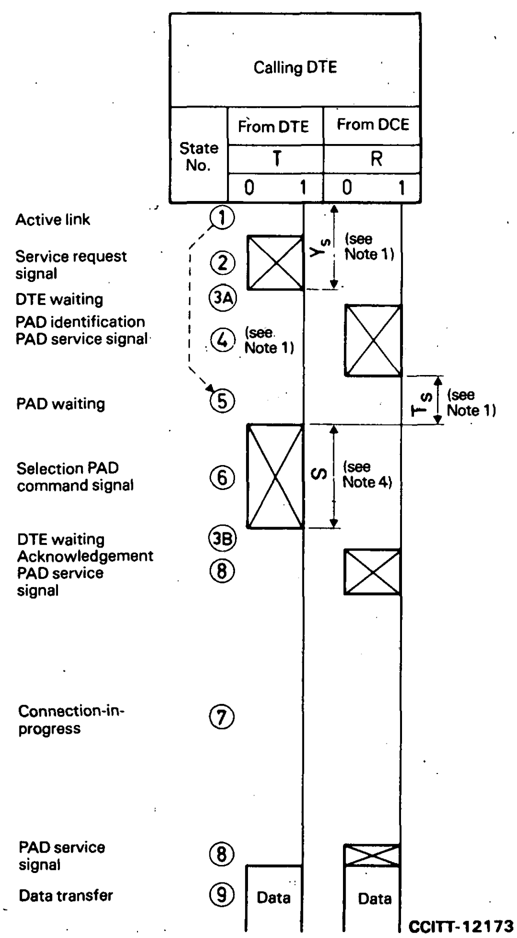
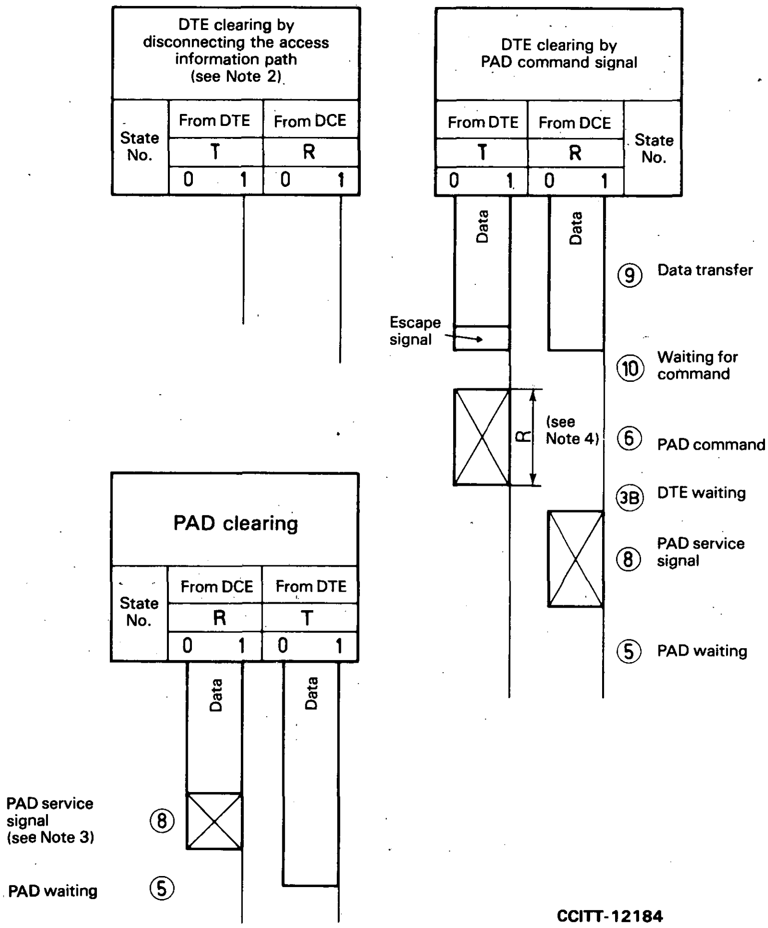


FIGURE 1a/X.28

Sequence of events at the interface: call establishment



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

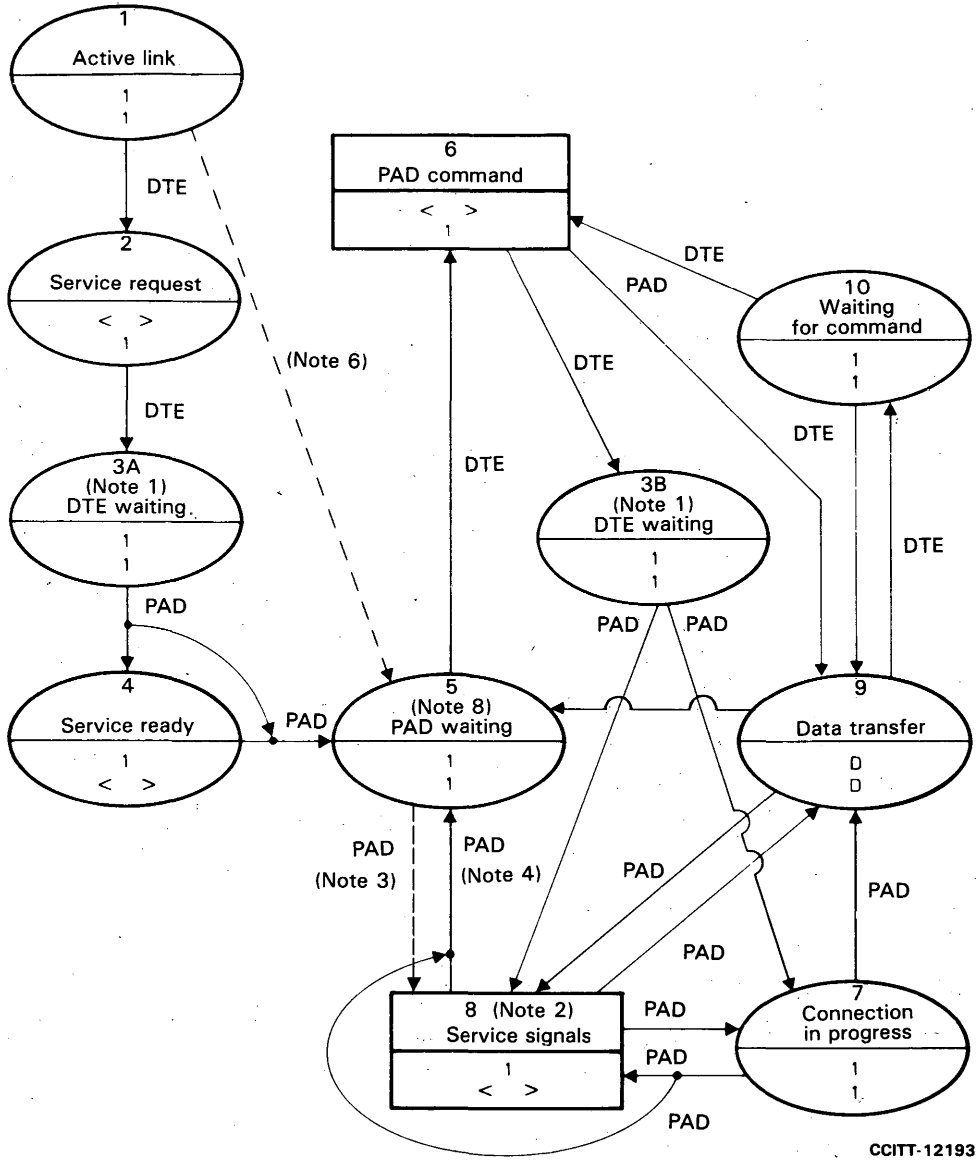
Note 2 – The *DTE clear* may be performed by disconnecting the access information path (see § 1 of this Recommendation). The response from the DCE is *PAD clearing* which also disconnects the access information path.

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

Note 4 – The time-outs S and R are not less than 60 s.

FIGURE 1b/X.28

Sequence of events at the interface: call clearing



Note 1 – States 3A and 3B are represented in Figure 2a/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 – The transition from state 5 to state 8 occurs only when the PAD receives a call destined for the start-stop mode DTE.

Note 4 – The PAD will permit entry to the *PAD waiting* state N times before performing PAD clearing.

Note 5 – Under certain circumstances *DTE clearing* is performed by disconnecting the access information path (see § 1 of the text).

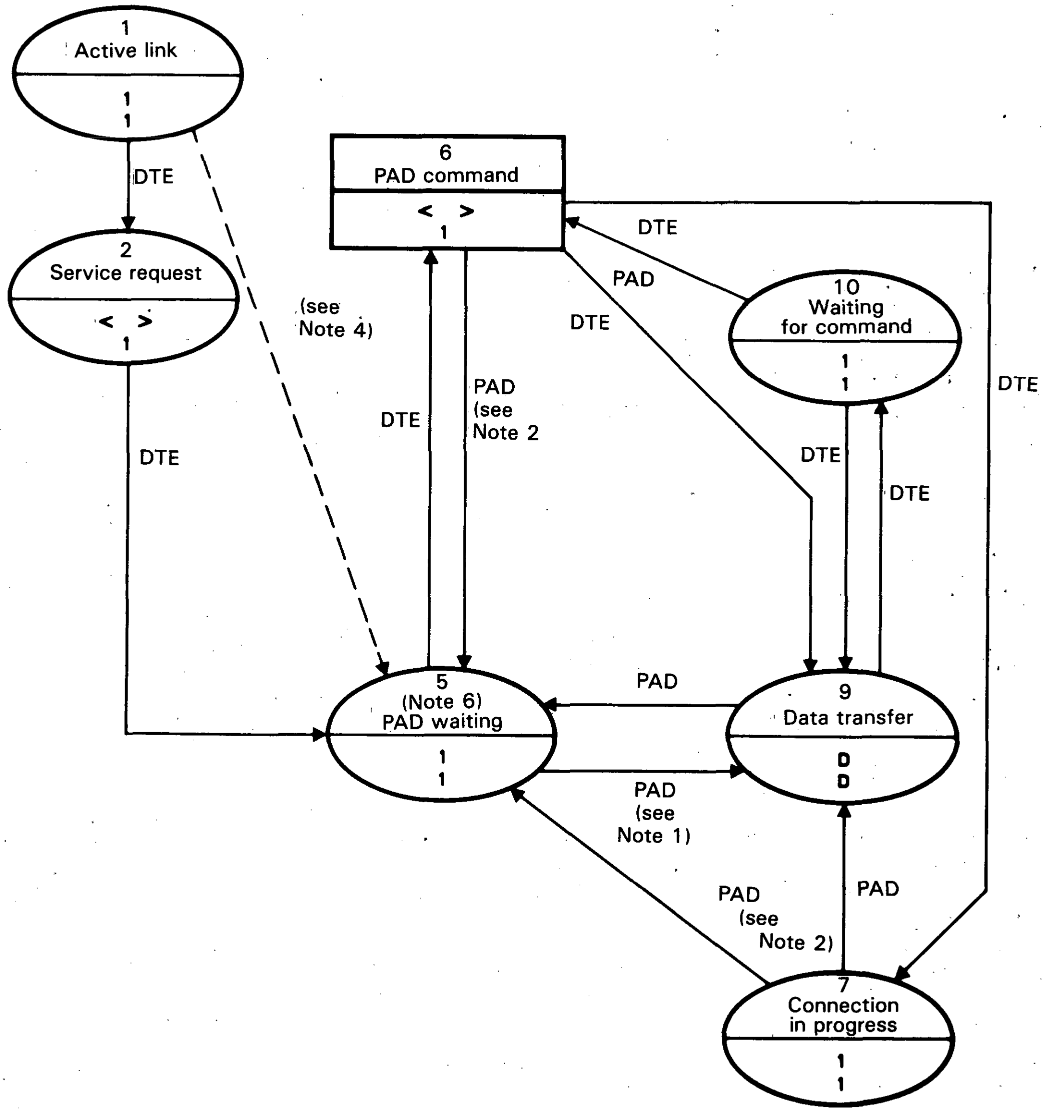
Note 6 – Some networks may allow states 2 to 4 to be bypassed.

Note 7 – See Figure 3/X.28 for the symbol definitions of the state diagram.

Note 8 – The condition of the interchange circuit 103 (Recommendations X.20 *bis* and V.21 [6]) or the T interchange circuit (Recommendation X.20) shown in state 5 is the preferred condition. It is recognized that the DTE may not have sufficient information to maintain this condition under all circumstances and consequently may transmit characters.

FIGURE 2a/X.28

State diagram of call establishment and call clearing by PAD command and service signals when parameter 6 is set to 1



Note 1 – The transition from state 5 to state 9 occurs only when the PAD receives a call destined for the start-stop mode DTE.

Note 2 – The PAD will permit entry to the *PAD waiting* state N times before performing PAD clearing.

Note 3 – Under certain circumstances *DTE clearing* is performed by disconnecting the access information path (see § 1 of the text).

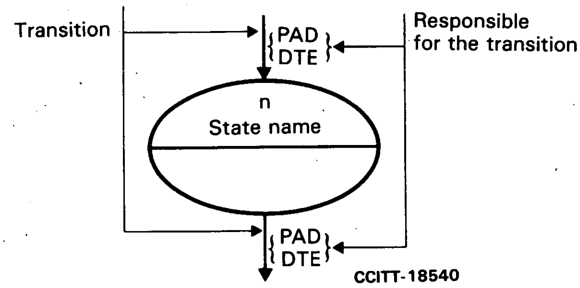
Note 4 – Some networks may allow state 2 to be bypassed.

Note 5 – See Figure 3/X.28 for the symbol definitions of the state diagram.

Note 6 – The condition of the interchange circuit 103 (Recommendations X.20 *bis* and V.21 [6]) or the T interchange circuit (Recommendation X.20) shown in state 5 is the preferred condition. It is recognized that the DTE may not have sufficient information to maintain this condition under all circumstances and consequently may transmit characters.

FIGURE 2b/X.28

State diagram of call establishment and call clearing by PAD command and service signals when parameter 6 is set to 0.



n	State number
t	Value on interchange circuit 103 when access is via X.20 *bis* or V.21 [6]; 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 [6]; or on R interchange circuit when access is via X.20
D	DTE to DTE data signal
0 and 1	Steady binary conditions
< >	An International Alphabet No. 5 character sequence

FIGURE 3/X.28

Symbol definitions of the state diagrams

2.2.1 *Active link (state 1)*

After the access information path has been established, the start-stop mode DTE and the PAD exchange binary 1 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 § 3.5.16 below.

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

Some network may allow state 2 to be bypassed. This is generally the case if the DTE is connected to the PAD by a leased line.

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.

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.

2.2.4 *Service ready (state 4)*

When parameter 6 is set to 1 or 5 the interface will enter the *service ready* state when the PAD transmits a *PAD identification PAD service* signal after receiving a *service request* signal. If the *PAD identification PAD service* signal is not received within V seconds, the DTE should retransmit the *service request* signal. Following transmission of the *service request* signal W times the user should report a fault to the appropriate point. The values of V and W are for further study.

The format of the *PAD identification PAD service* signal is given in § 3.5.18 below.

TABLE 1/X.28

PAD parameter settings

The parameter references and values relate to Recommendation X.3 [13] (see Note 1)

Parameter reference number (see Note 3)	Parameter description	Parameter setting for standard profiles (see Note 2)	
		Transparent standard profile (see Note 4)	Simple standard profile (see Note 4)
1	PAD recall using a character	Set to *not possible* (value 0)	Set to *possible* (value 1)
2	Echo	Set to *no echo* (value 0)	Set to *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)
4	Selection of *idle timer delay*	Set to *one second* (value 20)	Set to *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)
6	Control 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)
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)
8	Discard output	Set to *normal data delivery* (value 0)	Set to *normal data delivery* (value 0)
9	Padding after carriage return (CR)	Set to *no padding after CR* (value 0) (see Note 5)	Set to *no padding after CR* (value 0) (see Note 5)
10	Line folding	Set to *no line folding* (value 0)	Set to *no line folding* (value 0)
11	Binary speed of start-stop mode DTE	Set to speed of DTE as *110 bit/s*, (value 0) *200 bit/s* (value 8), or *300 bit/s* (value 2)	Set to speed of DTE as *110 bit/s* (value 0), *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)
13 (see Note 6)	Linefeed insertion after carriage return	Set to *no linefeed insertion* (value 0)	Set to *no linefeed insertion* (value 0)
14 (see Note 6)	Linefeed padding	Set to *no padding after LF* (value 0)	Set to *no padding after LF* (value 0)
15 (see Notes 6 and 7)	Editing	Set to no editing in *data transfer* state (value 0)	Set to no editing in *data transfer* state (value 0)
16 (see Note 6)	Character delete	(see Note 8)	(see Note 8)
17 (see note 6)	Line delete	Set to character 1/8 (CAN) (value 24)	Set to character 1/8 (CAN) (value 24)
18 (see Note 6)	Line display	(see Note 8)	(see Note 8)

Note 1 – All parameters standardized by CCITT are listed in Table 1/X.3 [14] including those which provide additional user facilities listed in Recommendation X.2 [2].

Note 2 – The definition of other *standard* profiles is for further study.

Note 3 – Parameter reference 0 is not used to define a PAD parameter. Specific use of the decimal value 0 in PAD messages to permit the existence of parameters not defined by CCITT is provided in Recommendation X.29. A similar use of this value in Recommendation X.28 is for further study.

Note 4 – The procedures for selecting *transparent standard* profile or *simple standard* profile by the start-stop mode DTE are currently defined by using the *service request* signal or *standard profile selection PAD command* signal. Urgent study is needed to define the method of indicating which of the two profiles is required using these procedures.

Note 5 – There will be no padding except that *PAD service* signals will contain a number of padding characters according to the data transmission rate of the start-stop mode DTE.

Note 6 – Parameters which provide additional user facilities are available in some countries for international and national services (see Recommendation X.2 [2]). The implementation of these parameters in a PAD is a matter for national determination, but when implemented the values appropriate when a *standard* profile is selected are given in this table.

Note 7 – Editing functions apply during the *PAD command* state irrespective of the value of parameter 15. The default values or selectable values of parameters 16, 17 and 18 apply for these functions.

Note 8 – The default values are for further study.

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 described at the time of sending a *service request* signal or by previous arrangement with the Administration. The parameter values for the *transparent* and *simple standard* profile are given 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);

e) sending of an interrupt;

f) requesting the status of the circuit;

g) resetting the virtual call.

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 Annex A.

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 135 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 more than 100 ms.

3.1.3 *Prompt PAD service signal*

If parameter 6 is set to 5 on entering the *PAD waiting* state or *waiting for command* state, the PAD will indicate its readiness to receive a *PAD command* signal by transmitting the *prompt PAD service* signal.

If the value of parameter 6 is 0 or 1, the PAD will not transmit the *prompt PAD service* signal to the start-stop mode DTE.

If the value of parameter 6 is 5, a *PAD command* signal transmitted before the *prompt PAD service* signal has been received from the PAD will be ignored.

The format of the *prompt PAD service* signal is given in § 3.5.23.

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.

If parameter 2 is set to 1, all characters are echoed.

Note – In certain networks the *active link* state will lead directly to the *PAD waiting* state.

3.2.1.2 *Network user identification (NUI)*

When required, 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. When implemented, the *network user identification* signal will be defined in the *facility request* block of a *selection PAD command* signal.

The format of the *facility request* block is defined in § 3.5.15.1 and Annex B.

The information content of the *network user identification* signal is 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 the interface 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 2 is set to 1, characters in *PAD command* signals are echoed, except the characters following the character P in a *selection PAD command* signal, which are not echoed.

If parameter 6 is set to 1 or 5, the PAD will ignore all characters received from the DTE following the receipt of a *PAD command* signal until the associated *PAD service* signal or sequence of *PAD service* signals has been transmitted to the DTE by the PAD.

If parameter 6 is set to 0, the PAD will not transmit a *PAD service* signal. Therefore it is for the user to define the way in which information regarding the completion of the connection is signalled to the start-stop mode DTE.

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.

The DTE may edit *PAD command* signals before they are actioned by the PAD by using the procedures in § 3.6 below.

The formats of *PAD command* signals are given in 3.5 below. A summary of *PAD command* signals is given in Table 2/X.28.

TABLE 2/X.28

Summary of PAD command signals

PAD command signals	Valid before virtual call set-up	Valid after escaping from data transfer state
Selection (§ 3.2.1.3)	X	
Profile selection (§§ 3.3.1 and 4.9.2.5)	X	X
Set (§§ 3.3.2 and 4.9.2.5)	X	X
Set and read (§§ 3.3.2 and 4.9.2.5)	X	X
Read (§§ 3.4 and 4.9.2.5)	X	X
Clear request [§§ 3.2.2.1 a) i) and 4.9.2.1]		X
Status (§ 4.9.2.2)	X	X
Reset (§ 4.9.2.3)		X
Interrupt (§ 4.9.2.4)		X

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 or 5, on receipt of a valid *selection PAD command* signal the PAD will transmit an *acknowledgement PAD service* signal followed by binary 1 and the interface will enter the *connection-in-progress* state. The interface will enter the *PAD service signals* 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. Characters are not echoed.

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 and the *PAD service* signals state will be bypassed.

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

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

3.2.1.7 *Incoming calls*

The PAD will indicate *incoming call* to the start-stop mode DTE only if the DTE/DCE interface is in the *PAD waiting* state (state 5).

The PAD will transmit to the start-stop mode DTE an *incoming call PAD service* signal.

The PAD will not expect a response to the *incoming call PAD service* signal from the start-stop mode DTE and will consider the interface to enter at once the *data transfer* state (state 9).

The format of the *incoming call PAD service* signal is given in § 3.5.22 below.

3.2.2 *Clearing*

3.2.2.1 *Clearing by the start-stop mode DTE*

a) When parameter 6 is set to 1 or 5, 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 within B seconds. The value of B is for further study. 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 or 5, 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 § 3.5.17 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, PAD clearing may be performed by:

   i) not disconnecting the access information path and the interface will enter the *PAD waiting* state (state 5); or

   ii) disconnecting the access information path.

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*

3.2.3.1.1 *Failure to receive a PAD command signal*

If the first character of a *PAD command* signal is not received within T seconds 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 T is for further study.

This restriction does not apply to a DTE which accessess the PAD by a leased line.

If following the first character of a *PAD command* signal a complete *PAD command* signal is not received within S seconds, the PAD will transmit an *error PAD service* signal, if parameter 6 is set to 1 or 5, indicating that an error has occurred (see § 3.5.19 below) and the interface will return to the *PAD waiting* state. The value of S is for further study but will not be less than 60s.

If the PAD receives an unrecognized *PAD command* signal it will transmit an *error PAD service* signal, if parameter 6 is set to 1 or 5, indicating that an error has occurred and the interface will return to the *PAD waiting* state.

The operation of the PAD when parameter 6 is set to 0 is for further study.

3.2.3.1.2 *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 disconnect the access information path. This restriction does not apply to DTEs which access the PAD by leased lines.

The value of N is for further study.

3.2.3.1.3 *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 indication PAD service* signal with local procedure error cause if parameter 6 is set to 1 or 5 and the interface will return to the *PAD waiting* state. The format of the relevant *clear indication PAD service* signal is given in § 3.5.17.5 below.

3.2.3.1.4 *Invalid facility request*

If the PAD receives an invalid facility request code the PAD will perform PAD clearing in accordance with § 3.2.2.2 a)i) or b)i) above.

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 3.1.1 b) above] by sending the *standard 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 start-stop mode DTE which accesses the PAD by a leased line may select a set of parameter values as an initial profile at subscription time by agreement with the Administration.

The format of the standard *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*, all corresponding parameter values and their identifiers are subjects for further study.

When parameter 6 is set to 1 or 5, the PAD will acknowledge the standard *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.

When parameter 6 is set to 1 or 5, the PAD will respond to a valid *set and read PAD command* signal by transmitting a *parameter value PAD service* signal as described in 3.5.14 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 Table 1/X.3 [14].

The format of the *parameter value PAD service* signal is defined in § 3.5.14 below.

When parameter 6 is set to 0, the PAD will accept and invoke valid parameters without advising the start-stop mode DTE of any invalid parameters or parameter values.

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 or 5, before the *selection PAD command* signal is sent and also after escaping from the *data transfer* state. The PAD will ignore a *read PAD command* signal if parameter 6 is set to 0.

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 § 3.5.14 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), 2/11 (+) and the characters assigned to perform editing functions, will be recognized by the PAD as forming part of a *PAD command* signal. The PAD will recognize both the character 0/13 (CR) and 2/11 (+) as the *PAD command signal delimiter.* The *PAD command signal delimiter* is not part of the command. Characters 2/0 (SP) and 7/15 (DEL) are not considered as part of a *PAD command* signal and are ignored by the PAD. Characters from columns 0 to 7 may be assigned to perform editing functions and in this case the PAD will operate in accordance with § 3.6 below. Characters 0/13 (CR) and 2/11 (+) are always used by the PAD as *PAD command signal delimiter.* Unassigned characters in columns 0 and 1 will be ignored by the PAD.

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

PAD service signals, other than the *acknowledgement, prompt and line deleted PAD service* signals (see §§ 3.5.2, 3.5.23 and 3.5.24) 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 § 3.5.20 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.

Characters of International Alphabet No. 5 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

The format required to read national parameters is for further study.

3.5.5 *Format of standard profile selection PAD command signal*

The characters 5/0 (P) 5/2 (R) 4/15 (0) 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 *set PAD command* signal will consist of the characters 5/3 (S) 4/5 (E) 5/4 (T) followed by the decimal reference of the parameter to be set, followed by character 3/10 (:) and the parameter value required. 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 parameter value as 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

The format required to set national parameters is for further study.

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:

a) the characters 4/4 (D) 5/4 (T) 4/5 (E)

b) the characters 4/5 (E) 5/2 (R) 5/2 (R)

c) the characters 4/14 (N) 4/3 (C).

Following one of the above, 1, 2 or 3 characters may be sent which represent the decimal value of the diagnostic code as specified in Recommendation X.25.

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 (O) 4/14 (N) 4/6 (F).

3.5.10 *Format of the status PAD command signal*

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

3.5.11 *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.

3.5.12 *Format of the reset PAD command signal*

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

3.5.13 *Format of the interrupt PAD command signal*

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

3.5.14 *Format of 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

3.5.15 *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 call user field.

3.5.15.1 *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 2/12 (,) is sent to separate the *facility request* codes. The character 2/13 (−) shall be sent at the end of the *facility request* block.

The format of the *NUI facility request* signal is defined in Annex B.

The format of other *facility request* codes is for further study.

3.5.15.2 *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. When an abbreviated address is used, the call user data field shall be separated from the *abbreviated address* signal by the character 2/10 (*).

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

3.5.15.3 *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.

Note – The characters 0/13 (CR) and 2/11 (+) should not be included in the user data field because they will be treated as a *PAD command delimiter* and not transmitted to the remote packet mode DTE. The editing characters should not be included in the user data field as they will be treated as providing the editing function.

3.5.16 *Format of service request signal*

The format is for further study.

3.5.17 *Format of clear indication PAD service signals*

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

a) the characters 4/15 (O) 4/3 (C) 4/3 (C)

b) the characters 4/14 (N) 4/3 (C)

c) the characters 4/9 (I) 4/14 (N) 5/6 (V)

d) the characters 4/14 (N) 4/1 (A)

e) the characters 4/5 (E) 5/2 (R) 5/2 (R)

f) the characters 5/2 (R) 5/0 (P) 4/5 (E)

g) the characters 4/14 (N) 5/0 (P)

h) the characters 4/4 (D) 4/5 (E) 5/2 (R)

i) the characters 5/0 (P) 4/1 (A) 4/4 (D)

j) the characters 4/4 (D) 5/4 (T) 4/5 (E).

Following one of the above, 1, 2 or 3 characters may be sent which represent the decimal value of the diagnostic code as specified in Recommendation X.25.

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

3.5.18 *Format of 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.

3.5.19 *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.

3.5.20 *Format of padding characters*

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

3.5.21 *Format of the connected PAD service signal*

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

3.5.22 *Format of the incoming call PAD service signal*

The format of the *incoming call PAD service* signal will consist of the following elements:

– a sequence of alphabetic characters indicating an incoming call;
– calling DTE address block;
– optional facility block;
– call data block.

It is for further study whether these fields will be separated by a 2/0 (SP) character or the format effector. The call data block will be last.

The order of transmission of the elements of this *PAD service* signal is as follows:

– <calling DTE address block> <formatting character>

– <optional facility block> <formatting character>

– <COM> <formatting character(s)>

– <call data block>

In some networks an alternative *incoming call PAD service* signal may be transmitted.

3.5.22.1 *Format of calling DTE address block*

The format of the calling DTE address block is for further study.

3.5.22.2 *Format of optional facility block*

The format of the optional facility block is for further study.

3.5.22.3 *Format of the call data block*

The 12 or less characters from the call data field received from the remote DTE shall be sent.

3.5.23 *Format of the prompt PAD service signal*

The format of the *prompt PAD service* signal is for further study, but it should contain a graphic character following a *format effector.*

3.5.24 *Format of the line deleted PAD service signal*

The characters 5/8 (X) 5/8 (X) 5/8 (X) will be sent followed by a format effector.

3.6 *Editing functions in the PAD*

The PAD provides functions for the start-stop mode DTE to edit characters input to the PAD in *PAD command* signals before being processed by the PAD. The functions provided are:

a) character delete,

b) line delete,

c) line display.

Optionally available in some PADs are identical functions for use by the start-stop mode DTE during the *data transfer* state. When the value of parameter 15 is set to 0 no editing is available during the *data transfer* state.

When the value of parameter 15 is set to 1 editing is provided during the *data transfer* state (see § 4.17).

The user may also have the ability in some PAD implementations to select the character used to effect each of the above functions by setting the value of parameters 16, 17 and 18 appropriately.

The procedures for editing described in this section apply to both *PAD command* and *data transfer* state (when provided).

3.6.1 *Editing buffer*

3.6.1.1 To perform the functions of editing the PAD provides temporary storage of characters in an editing buffer. The size of the editing buffer is network dependent and is 128 or 256 characters. Entry of characters into the editing buffer will be terminated when any of the forwarding conditions described in § 4.4 and Recommendation X.29, § 2.1 occurs except that the PAD will not take account of the value of the idle timer delay defined by the value of parameter 4.

Once the editing buffer has been terminated, previously input characters can no longer be edited by the start-stop mode DTE by the use of the PAD editing functions.

3.6.1.2 If the editing buffer is full, the PAD will act as follows:

a) If the next character is an editing character, the PAD will edit the contents of the editing buffer in accordance with the procedure given in § 3.6.2 below.

b) If the next character is not an editing character, the PAD will ignore the character and if parameter 2 is set to 1 not echo the character. The contents of the editing buffer will be forwarded in accordance with the operational conditions provided by the PAD for the start-stop mode DTE as a complete user sequence.

Subsequent characters received by the PAD will be ignored including any editing characters until a character 0/13 (CR) is received after which characters will be stored in the editing buffer and may be edited.

3.6.2 *Procedures for editing*

The procedures for editing *PAD command* signals and user data (when this facility is provided) use PAD parameters are defined in Recommendation X.3 [13].

3.6.2.1 *Procedure for character delete editing function*

The character delete editing function is performed when the PAD receives a *character delete* character or a series of *character delete* characters from the start-stop mode DTE. The receipt of each *character delete* character causes the last character currently in the editing buffer to be deleted. If parameter 2 is set to 1 the *character delete* character will be echoed to the start-stop mode DTE. Alternate or subsequent action with respect to the transmission of other characters by the PAD is for further study.

The *character delete* character when user selectable is determined by the value of parameter 16. The default value of parameter 16 or the *character delete* character when not user selectable is for further study.

3.6.2.2 *Procedure for line delete editing function*

The line delete editing function is performed when the PAD receives a *line delete* character from the start-stop mode DTE. The receipt of the *line delete* character causes the deletion of the current contents of the editing buffer. The PAD will transmit, if parameter 6 is set to 1, a *line delete PAD service* signal.

If parameter 2 is set to 1, the *line delete PAD service* signal will be preceded by the echo of the *line delete* character.

The *line delete* character when user selectable is determined by the value of parameter 17. The default value of parameter 17 or the *line delete* character when not user selectable is the character 1/8 (CAN).

3.6.2.3 *Procedure for line display editing function*

The line display editing function is performed when the PAD receives a *line display* character from the start-stop mode DTE. The receipt of the *line display* character causes the PAD to transmit to the start-stop mode DTE a format effector followed by the characters currently stored in the editing buffer. If parameter 2 is set to 1 the format effector would be preceded by the echo of the *line display* character.

The *line display* character when user selectable is determined by the value of parameter 18. The default value of parameter 18 or the *line display* character when not user selectable is for further study.

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 of the interface to a start-stop mode DTE.

4.1 *Data transfer state*

After receipt of the *connected PAD service* signal, the interface 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 parameters 1, 12 and 15 are set to 0, during the *data transfer* state any character sequence may be transmitted by the start-stop mode DTE for delivery to the remote DTE. If parameter 1 is set to 1, the character 1/0 (DLE) can only be transferred by following the procedure described in § 4.9.1.1 below.

If parameter 12 is set to 1, characters 1/1 (DC1) and 1/3 (DC3) are unable to be transferred to the remote DTE and if parameter 15 is set to 1 the characters assigned for editing functions are unable to be transferred to the remote DTE.

The values of other parameters may affect the characters which may be transferred during the *data transfer* state.

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. In the absence of any mechanism for parity selection, which is for further study, the PAD will not take account of the value of bit 8 of all characters received and will forward the 8 bits as received.

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 treated as contiguous octets. Each octet will be transmitted to the start-stop mode DTE at the data signalling rate appropriate to the start-stop mode DTE. The value of bit 8 (parity) will be unchanged by the PAD. Start and stop bits will be added to the data characters in accordance with Recommendation X.4 [12]. For an interim period some Administrations will provide PADs which conform as follows: 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.

4.4 *Packet forwarding conditions*

A packet will be forwarded, subject to flow control, whenever more than enough data has been received from the start-stop mode DTE to fill a packet after the last packet was forwarded. A packet will also be forwarded when the maximum assembly timer delay period, which starts upon receipt by the PAD of the first character to be assembled into a packet, elapses. The value of the time-out, when implemented, is network dependent and will be greater than or equal to 15 minutes.

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:

a) Allows the idle timer delay period (see parameter 4 in Table 1/X.3 [14]), 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.

b) Transmits one of the data forwarding characters (see parameter 3 in Table 1/X.3 [14]). The character will be included in the data field of the packet it delimits before the packet is forwarded.

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

d) 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 receive 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.

This procedure will not operate if parameter 6 is set to 0.

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 as the X-ON character.

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 as the X-OFF character.

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.

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, by the remote start-stop mode DTE connected via a PAD or by the network, the PAD will send a *reset PAD service* signal, if the value of parameter 6 is set to 1 or 5, 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.

When parameter 6 is set to 0, the PAD is unable to indicate to the start-stop mode DTE that a reset has occurred.

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 by the PAD (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.

If parameter 1 is set to a decimal value from 32 to 126, the PAD will recognize the binary representation of the decimal value as the *escape* signal from the start-stop mode DTE.

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.

If parameter 6 is set to 5 the *prompt PAD service* signal will be transmitted by the PAD.

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

a) 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.

b) 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.

c) 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 R seconds 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. The value of R is for further study but will not be less than 60s.

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 or following the time-out condition specified above.

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 § 3.2.2.1 a)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 or 5, 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 §§ 3.5.10 and 3.5.11 respectively.

4.9.2.3 *Reset*

The start-stop mode DTE may request a resetting of the virtual call by sending a *reset PAD command* signal to the PAD. The format of the *reset PAD command* signal is given in § 3.5.12 above.

The PAD will acknowledge the *reset PAD command* signal, if parameter 6 is set to 1 or 5, by transmitting the *acknowledgement PAD service* signal.

4.9.2.4 *Interrupt*

The start-stop mode DTE may request that an *interrupt* packet (with the interrupt user data field appropriately coded, see Recommendation X.29) is sent by the PAD by sending an *interrupt PAD command* signal to the PAD. The format of the *interrupt 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 or 5, by transmitting the *acknowledgement PAD service* signal.

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.

4.9.2.6 *Procedure when parameter 6 is set to 0*

In all cases of the procedures given, when parameter 6 is set to 0 the *PAD service* signal state (state 8) is bypassed and the interface will enter *PAD waiting* state or the *data transfer* state as appropriate.

4.10 *Echo*

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

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 characters.

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 the state of the interface and which procedure the PAD will perform when the PAD receives the *break* signal from the start-stop mode DTE. The start-stop mode DTE may select any one of the following:

a) If parameter 7 is set to 0, the state of the interface remains the same and no action is taken by the PAD.

b) If parameter 7 is set to 1, the state of the interface remains the same and the PAD causes an *interrupt* packet, (with the interrupt user data field appropriately coded) to be transmitted by the PAD (see Recommendation X.29).

c) If parameter 7 is set to 2, the state of the interface remains the same and the PAD causes the virtual call to be reset (see Recommendation X.29).

d) If parameter 7 is set to 21, the state of the interface remains the same, the PAD discards all data received for delivery to the start-stop mode DTE, and the PAD sends an *interrupt* packet (with the interrupt user data field appropriately coded) followed by an *indication of break PAD message* (see Recommendation X.29).

e) If parameter 7 is set to 8, the interface will escape from the *data transfer* state and will enter the *waiting for command* state.

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

Note 1 – The receipt by the PAD of a *break* signal is a packet forwarding condition except when parameter 7 is set to 0.

Note 2 – The receipt of a *break* signal by the PAD when there is no virtual call established may be ignored and the PAD may take no action.

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 subsequent to the transmission of a graphic character including echoed characters, 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 and the reset character to be transmitted to the start-stop mode DTE is a graphic character, 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 0.

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

The action of the PAD after the transmission of the character 0/8 (BS) is for further study.

Line folding also applies to *PAD service* signals.

4.14 *Procedure for the start-stop mode DTE to indicate to the PAD a temporary inability to accept additional information*

The start-stop mode DTE, by means of parameter 12, will be able to select the use of X-ON and X-OFF characters to flow control the PAD.

If the value of parameter 12 is set to 1 and the interface is in the *data transfer* state the following procedure applies:

The start-stop mode DTE may indicate a temporary inability to receive additional characters from the PAD by transmitting the X-OFF character 1/3 (DC3).

Following transmission of the character 1/3 (DC3), the X-OFF condition will exist until the start-stop mode DTE indicates the ability to receive additional characters from the PAD by transmitting the X-ON character 1/1 (DC1).

While the X-OFF condition exists, the PAD will not transmit characters to the start-stop mode DTE.

The X-OFF condition is cancelled when the interface leaves the *data transfer* state, and does not exist when the interface enters the *data transfer* state.

4.15 *Selection of linefeed insertion after carriage return*

The start-stop mode DTE, by means of parameter 13, will be able to select which procedure the PAD will perform during the *data transfer* state when it receives the character 0/13 (CR) to be transmitted to the start-stop mode DTE.

If parameter 13 is set to 0, the PAD takes no action.

If parameter 13 is set to 1, 5 or 7, the PAD will insert a character 0/10 (LF) after every character 0/13 (CR) in the data stream *to* the start-stop mode DTE.

If parameter 13 is set to 6 or 7, the PAD will insert a character 0/10 (LF) after every character 0/13 (CR) in the data stream *from* the start-stop mode DTE.

If parameter 13 is set to 4, 5, 6 or 7 (and parameter 2 is set to 1) the PAD will insert a character 0/10 (LF) after the echo of a character 0/13 (CR) to the start-stop mode DTE.

4.16 *Selection of padding characters to be inserted after the character 0/10 (LF)*

The start-stop mode DTE, by means of parameter 14, will be able to select the number of padding characters that will be inserted after each character 0/10 (LF) transmitted or echoed to it during the *data transfer* state. The value selected will not apply to the number of padding characters transmitted after the character 0/10 (LF) of the *format effector* as described in §§ 3.5.2 and 4.12 above.

4.17 *Editing of user data*

The editing functions described in § 3.6 above may also apply during the *data transfer* state. The start-stop mode DTE by means of parameter 15 may select whether or not to use the editing functions. The start-stop mode DTE may select, by using parameters 16, 17, 18, the character used for each editing function provided by the PAD (see Recommendation X.3 [13]).

ANNEX A

(to Recommendation X.28)

PAD command signals and PAD service signals

TABLE A-1/X.28

PAD command signals

PAD command signal format	Function	PAD service signal sent in response (See Note)
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 or INV)
SET? List of parameter references and corresponding values	To request changing or setting of the current values of the specified parameters and to request the current values of specified parameters	PAR (list of parameter references with their current values or INV)
PROF (identifier)	To give to PAD parameters a standard set of values	Acknowledgement
RESET	To reset the virtual call	Acknowledgement
INT	To transmit an *interrupt* packet	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

Note – *PAD service* signals are not sent when parameter 6 is set to 0.

TABLE A-2/X.28

PAD service signals

Format of the PAD service signal		Explanation
RESET	DTE 1, 2 or 3 characters which represent the ERR decimal value of the diagnostic code NC (see Note 1)	Indication that the remote DTE has reset the virtual call Indication of a reset of a virtual call due to a local procedure error Indication of a reset of a virtual call due to network congestion
CLR	See Table A-3/X.28	Indication of clearing
COM	—	Indication of call connected
PAD identification PAD service signal	The characters to be sent are network dependent	
ERROR	ERR	Identification that a *PAD command* signal is in error
See Note 2		Indication of incoming call
XXX		Indication of line delete function completed (see Note 3)
ENGAGED		Response to *status PAD command* signal when a call has been established
FREE		Response to *status PAD command* signal when a call is not established
PAR	Decimal value of parameter: parameter value or INV,...	Response to *set and read* or *read PAD command* signal
For further study		*Prompt PAD service* signal
Format effector		*Acknowledgement PAD service* signal

Note 1 – The diagnostic codes are specified in Recommendation X.25. Some networks may not provide these characters.

Note 2 – The format of the *incoming call PAD service* signal is for further study. The order in which the various elements of the *incoming call PAD service* signal are transmitted is given in § 3.5.2.2.

Note 3 – When parameter 2 is set to 1 the *line delete* character is echoed before the *line deleted PAD service* signal is transmitted.

TABLE A-3/X.28

Clear indication PAD service signals

Clear indication PAD service signal	Possible mnemonics (see Note)	Explanation (see Recommendation X.96[3])
Number busy	OCC	The called DTE is detected by the DCE as engaged in other calls and therefore is not able to accept the incoming call
Network congestion	NC	A condition exists within the network such as: 1) temporary network congestion 2) temporary fault condition within the network
Invalid facility request	INV	Invalid facility requested by the calling DTE
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	A procedure error caused by the DTE is detected by the PAD. An example is incorrect format
Remote procedure error	RPE	A procedure error caused by the DTE is detected by the DCE at the remote DTE/DCE interface
Not obtainable	NP	The called DTE address is out of the number plan or is not assigned to any DTE
Out of order	DER	The called number is out of order
PAD clearing	PAD	The call has been cleared by the local PAD as an answer to an invitation to clear from the remote DTE
DTE clearing	DTE	The remote DTE has cleared the call

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

ANNEX B

(to Recommendation X.28)

NUI facility request signal format

The following description uses Backus Normal Form as the formalism for syntactic description, for example as in ISO Recommendation R.1538 [15]. A vertical line " | " separates alternatives.

<NUI facility request> : : = <N> <NUI string>

<NUI string> : : = <NUI character> | <NUI character> <NUI string>

<NUI character> : : = A character in columns 2 to 7 of International Alphabet No. 5, except 2/0 (SP), 7/15 (DEL), 2/13 (–), 2/12 (,), 2/11 (+)

<N> : : = IA5 character 4/14 (N).

Note 1 – The recognition by the PAD of the presence of *NUI facility request* signal should turn off the echo (irrespective of its parameter value) for the duration of the <NUI facility request>.

Note 2 – The length of the <NUI string> is network dependent.

Note 3 – Characters in columns 0 and 1, except 0/13 (CR), and characters 7/15 (DEL) and 2/0 (SP) may be included during the transmission of the *NUI string* but will not form part of the *NUI string* and will be discarded.

ANNEX C

(to Recommendation X.28)

PAD Time-outs

TABLE C-1/X.28

PAD Time-outs

Time-out value (provisional)	Time-out number	Interface State	Started by	Normally terminated by	Action to be taken when time-out expires	Remarks
Y	T10	State 1	Binary 1 is transmitted on both T and R	The PAD has received a valid *service request* signal	The PAD will disconnect the access information path	
T = 60 s	T11	State 6	The PAD enters the *PAD waiting* state	The PAD has received the first character of a *PAD command* signal	The PAD clears in accordance with § 3.2.2.2	4 possible methods may be used
S > 60 s	T12	State 6	The PAD has received the first character of a *PAD command* signal	The PAD has received a complete *PAD command* signal	The PAD will transmit an *error PAD service* signal (when parameter 6 is not set to 0) and will return to the *PAD waiting* state or its action is for further study (when parameter 6 is set to 0)	The PAD will permit entry into the *PAD waiting* state N times before disconnecting the access information paths; these time-outs are not applicable in the case of leased line access
R > 60 s	T13	State 6	The PAD receives a graphic character other than 2/0, 2/11 or 7/15 after the DTE escapes from the *data transfer* state	Reception of a complete *PAD command* signal	The PAD will transmit an *error PAD service* signal and will return to the *data transfer* state (when parameter 6 is not set to 0) or the *PAD waiting* state or *data transfer* state as appropriate (when parameter 6 is set to 0)	
V	T20	State 4	DTE transmits the *service request* signal	DTE has received a *PAD identification service* signal	DTE should retransmit the *service request* signal	When this time-out expires W times a fault should be reported
B	T21	State 6	DTE transmits a *clear request PAD command* signal	The PAD has transmitted *clear confirmation PAD service* signal (when parameter 6 is not set to 0) or has disconnected the access information path (when parameter 6 is set to 0)	The DTE will disconnect the access information path (indeterminate result)	

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.1.

[2] CCITT Recommendation *International user services and facilities in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.2.

[3] CCITT Recommendation *Call progress signals in public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.96.

[4] CCITT Recommendation *Hypothetical reference connections for public synchronous data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.92.

[5] CCITT Recommendation *International Alphabet No. 5*, Vol. VIII, Fascicle VIII.1, Rec. V.3.

[6] CCITT Recommendation *300-bits per second duplex modem standardized for use in the general switched telephone network*, Vol. VIII, Fascicle VIII.1, Rec. V.21.

[7] *Ibid.*, § 8.

[8] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment*, Vol. VIII, Fascicle VIII.1, Rec. V.24, § 4.3.

[9] CCITT Recommendation *300-bits per second duplex modem standardized for use in the general switched telephone network*, Vol. VIII, Fascicle VIII.1, Rec. V.21, § 7 a).

[10] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits*, Vol. VIII, Fascicle VIII.1, Rec. V.28.

[11] CCITT Recommendation *Automatic calling and/or answering equipment on the general switched telephone network, including disabling of echo suppressors on manually established calls*, Vol. VIII, Fascicle VIII.1, Rec. V.25, § 6.

[12] CCITT Recommendation *General structure of signals of International Alphabet No. 5 code for data transmission over public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.4.

[13] CCITT Recommendation *Packet assembly/disassembly facility (PAD) in a public data network*, Vol. VIII, Fascicle VIII.2, Rec. X.3.

[14] *Ibid.*, Table 1/X.3.

[15] *Programming language – ALGOL*, ISO Recommendation R.1538-1972 (cancelled).

Recommendation X.29

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

(provisional, Geneva, 1977; amended, Geneva, 1980)

Preface

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 Recommendations X.1 [1] and X.2 [2] define the user classes of service and facilities in a public data network, and Recommendation X.96 [3] 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 Recommendation X.3 [4] defines the PAD in a public data network;

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

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

(f) 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;

(g) the need to allow interworking between PADs;

(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 Recommendation X.29 procedures may be applied for interworking between PADs;

(3) the procedures be as specified below in § 1 *Procedures for the exchange of PAD control information and user data*;

(4) the manner in which user data is transferred be as specified below in § 2 *User data transfer*;

(5) the procedures for the control of the PAD via PAD messages be as specified below in § 3 *Procedures for the use of PAD messages*;

(6) the formats of the data fields which are transferable on a virtual call be as specified below in § 4 *Formats.*

Note 1 – For ease of understanding, this Recommendation refers to specific packet types and procedures of Recommendation X.25. When PAD to PAD interworking is considered within a national network these packet types or procedures may be represented in a different form from that used in Recommendation X.25 but will have the same operational meaning.

Note 2 – The following items are for further study:

– the use of the permanent virtual circuit facility;

– 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 PAD control information and user data

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

1.2 The Annex briefly describes some of the characteristics of virtual calls as defined in Recommendation X.25, 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* or *call request* packets to or from the packet mode DTE or the PAD is comprised of two fields:

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.

A *call request* packet received by the PAD, containing no call user data field, will be accepted by the PAD.

If a call data field is present, the PAD will send it, unchanged, to the start-stop mode DTE, using the call data block of the *incoming call PAD service* signal (see § 3.5.22, Recommendation X.28).

1.4 *User sequences*

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

1.4.2 User sequences are conveyed in the user data fields of complete packet sequences with Q = 0, and in both directions on a virtual call. (See Recommendation X.25.)

1.4.3 There will be only one user sequence in a complete packet sequence.

1.4.4 The operation of the PAD in respect of the transmission and reception of *data* packets with the D bit set to 1 is for urgent further study.

1.5 *PAD messages*

1.5.1 *PAD* messages are used to exchange control information between the PAD and the packet mode DTE or PAD. 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 packet sequences with Q = 1 and in both directions on a virtual call. (See Recommendation X.25.)

1.5.3 There will be only one *PAD* message in a complete packet sequence.

1.5.4 The PAD will take into consideration a *PAD* message 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 The operation of the PAD in respect of the transmission and reception of *data* packets with the D bit set to 1 is for urgent further study.

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, 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 The current values of PAD parameters may be changed and read 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 received 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.

3.1.3 The PAD will respond to a valid *read* or *set and read PAD* message by transmitting a *parameter indication PAD* message with a parameter field containing a list of the parameter references and current values, after any necessary modification, of the PAD parameters to which the *PAD* message received referred.

3.1.4 The PAD will not return a *parameter indication PAD* message in response to a valid *set PAD* message received.

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

PAD message received by the PAD		Action upon PAD parameters	Corresponding *parameter indication PAD* message transmitted to the packet mode *DTE* (see Note 2)
Type	Parameter field		
Set	None	Reset all implemented Recommendation X.3 [4] parameters to their initial values corresponding to the initial profile (see Note 1)	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 implemented Recommendation X.3 [4] parameters to their initial values corresponding to the initial profile (see Note 1)	List all implemented Recommendation X.3 [4] parameters, and their initial values (see Note 1)
	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 all implemented Recommendation X.3 [4] parameters with their current values (see Note 1)
	List of selected parameters	None	List of these parameters with their current values

Note 1 – The procedure for setting, setting and reading, and reading parameter values for parameters not contained in Recommendation X.3 [4] is for further study.

Note 2 – The corresponding *parameter indication PAD* message transmitted to the packet-mode DTE when the parameter field is coded with all 0's is for further study.

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 by the PAD after delivery of the last 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 with all bits of the interrupt user data field set to 0 followed by an *indication of break PAD* message to indicate that the PAD, at the request of the start-stop mode DTE, is discarding the user sequences received. The *PAD* message will contain an indication in its parameter field that parameter 8 (see Recommendation X.3 [4]) has been set to 1 *(discard output).*

3.3.2 Before resuming data transmission to the PAD, the response to the *indication of break PAD* message shall be a *set* or *set and read PAD* message, indicating that parameter 8 should be set to 0 *(normal data delivery).*

3.3.3 If a PAD receives an *indication of break PAD* message which contains a parameter field as described in § 3.3.1 above, it will respond by transmitting a *set PAD* message as described in § 3.3.2 above and will transmit a *break* signal to the start-stop mode DTE. If a PAD receives an *indication of break PAD* message which does not contain a parameter field, it will not respond to the packet mode DTE or PAD but it will transmit a *break* signal to the start-stop mode DTE.

3.3.4 When the PAD transmits an *interrupt* packet after the receipt from the start-stop mode DTE of an *interrupt PAD command* signal or a *break* signal, when parameter 7 is set to 1, the interrupt user data field is coded in bits 8 to 1 as 00000001.

3.3.5 If the PAD receives an *interrupt* packet it will confirm it in accordance with Recommendation X.25 procedures. The PAD will not transmit the contents of the interrupt user data field to the start-stop mode DTE. The PAD will ignore the values of the interrupt user data field. It is for further study whether the coding of this field given in § 3.3.4 above causes a different response.

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 all other PAD parameters 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 containing an invalid reference to a PAD parameter, the parameter field within the *parameter indication PAD* message transmitted by the PAD 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* and *set and read PAD* messages only);

d) the requested value is invalid: (*set* and *set and read PAD* messages only);

e) the parameter follows an invalid parameter separator (see § 4.4.5.4 below).

3.5.2 The PAD will transmit an *error PAD* message containing the message code of an invalid *PAD* message received 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.

3.5.4 If the PAD receives an *error PAD* message it will not respond with a *PAD* message of any type. Subsequent action is for further study.

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 standardized by CCITT 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 *packet 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 from the PAD 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.

4.3.2 No maximum is specified for the length of a user sequence.

4.4 *Control message format*

4.4.1 Bits 8, 7, 6, 5 of octet 1 of a user data field of complete packet sequences with Q = 1 is the *control identifier field*, used to identify the facility, such as PAD, to be controlled. The control identifier field coding for *PAD* messages to control a PAD for a start-stop mode DTE is 0000. Other codings of the control identifier field are reserved for future standardization.

Note – The possibility 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 which may be followed by a parameter field. The parameter field, if present, consists of a parameter reference octet followed by a parameter value octet.

The *invitation to clear PAD* message consists of octet 1 only.

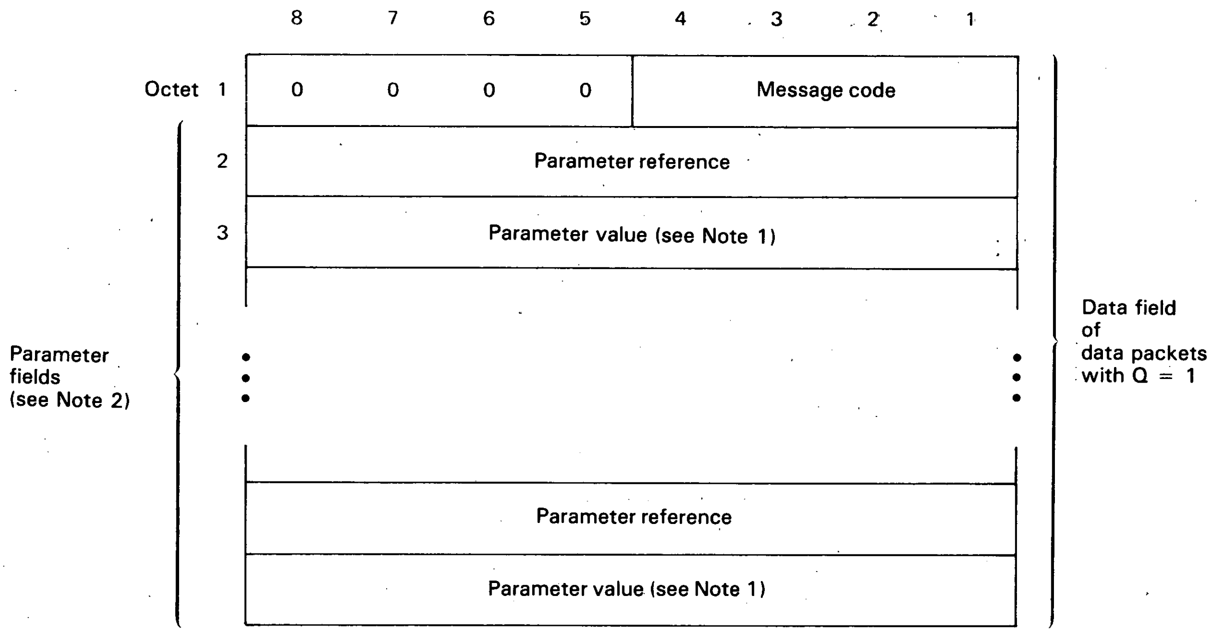
4.4.4 The maximum length of PAD message is for further study.

4.4.5 *Parameter field for set, read, set and read, and parameter indication PAD messages* (see Figure 2/X.29)

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 [4], 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 reference field will be ignored. In *parameter indication PAD* messages, bit 8 of each reference field set to 1 will indicate an invalid access to the referred parameter as described in § 3.5 above.



Message code: 0010 – Set
0100 – Read
0110 – Set and read
0000 – Parameter indication

Note 1 – These octets contain all 0s in read PAD messages.

Note 2 – Parameter field need not be present (see Table 1/X.29).

FIGURE 2/X.29

Set, read, set and read, and parameter indication PAD message format

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 [4], 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.

The code 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 [4] minus 127.

4.4.5.4 To provide for the existence of parameters not standardized by CCITT, provision is made to indicate that these parameters are to be *set, set and read* or *read* in appropriate *PAD* messages.

To indicate the separation between parameters listed in Recommendation X.3 [4] and any others implemented nationally or only locally, the parameter reference field in the appropriate *PAD* messages is set to 00000000 and the parameter value field is also set to 00000000.

It is for further study whether or not this mechanism is also used in *parameter indication PAD* messages to distinguish national or local parameters and their values.

Note – It is recommended that packet mode DTEs use only the parameters defined in Recommendation X.3 [4] when communicating with a PAD in a different country or network.

4.4.6 *Parameter field for error PAD messages* (see Figure 3/X.29)

Octet	Bit 8	7	6	5	4	3	2	1	
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)

Octet	Bit 8	7	6	5	4	3	2	1	
1	0	0	0	0	0	0	1	1	Data field of data packets with Q = 1
2	Parameter reference								
3	Parameter value								

FIGURE 4/X.29

Indication for break PAD message format

4.4.7.1 When transmitted by the packet mode DTE, this *PAD* message may either contain no parameter field, or contain a parameter field as described in § 4.4.7.2 below.

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.

ANNEX A

(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

A.1 *General interface characteristics*

A.1.1 The mechanical, electrical, functional and procedural characteristics to activate, maintain and deactivate the physical link between the DTE and the DCE will be in accordance with the physical level procedures of Recommendation X.25.

A.1.2 The link access procedure for data interchange across the link between the DTE and DCE will be in accordance with the link level procedures of Recommendation X.25.

A.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 packet level procedures of Recommendation X.25.

A.2 *Interface procedures for virtual call control*

A.2.1 Incoming calls are indicated to the packet mode DTE as specified in Recommendation X.25. Call requests are indicated by the packet mode DTE as specified in Recommendation X.25. Any use of optional user facilities are indicated in accordance with § 7 of Recommendation X.25.

A.2.2 The default throughput classes used by the PAD are determined by the data rates of the start-stop mode DTE (where exact correspondence is not obtained, the next higher throughput class is used).

A.2.3 The PAD and the packet mode DTE will use the clearing procedures specified in §§ 4.1.7, 4.1.8 and 4.1.9 of Recommendation X.25.

A.3 *Interface procedures for data transfer*

A.3.1 Data transfer on a virtual call can only take place in the *data transfer* state and when flow control permits (see § 4.4 of Recommendation X.25). The same is true for the transfer of *interrupt* packets (see § 4.3 of Recommendation X.25).

A.3.2 *Interrupt* packets transmitted by the packet mode DTE will be confirmed by the PAD following the procedures in Recommendation X.25.

A.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 § 4.4.3 of Recommendation X.25.

A.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.

A.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.

A.3.6 If bit 7 of octet 1 in the *call connected* packet received by the PAD is 0, the PAD will set the D bit to 0 in all transmitted *data* packets. If bit 7 of octet 1 in the *call connected* packet received by the PAD is 1, the PAD is permitted to use the D bit procedure in *data* packets.

For calls received by the PAD with bit 7 of octet 1 in the *incoming call* packet set to 0, the PAD will set bit 7 of octet 1 in the *call accepted* packet to 0 and will set the D bit in transmitted *data* packets to 0.

Pending further study, and in the absence of bilateral agreement between Administrations (used in conjunction with the D bit modification facility), the following applies:

If the *incoming call* packet received by the PAD has bit 7 of octet 1 set to 1, the PAD may set bit 7 of octet 1 of the *call accepted* packet to 1 and, if so, may use the D bit procedure in *data* packets.

Calls originated by the PAD will set bit 7 of octet 1 in *call request* packets to 0. The called DTE can indicate if it requires the support of the D bit procedure by setting bit 7 of octet 1 of *call accepted* packets to 1.

PAD procedures associated with the Delivery Confirmation (D) bit (see § 4.3.3 of Recommendation X.25) are for further study in particular in conjunction with the further study on non-packet mode DTE other than start-stop.

A.4 *Virtual call characteristics*

A.4.1 *Resetting*

A.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.

A.4.2 *Interrupt transfer*

A.4.2.1 An *interrupt* packet is always delivered at or before the point in the data packet stream at which it was generated.

A.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.

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.1.

[2] CCITT Recommendation *International user services and facilities in public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.2.

[3] CCITT Recommendation *Call progress signals in public data networks*, Vol. VIII, Fascicle VIII.3, Rec. X.96.

[4] CCITT Recommendation *Packet assembly/disassembly facility (PAD) in a public data network*, Vol. VIII, Fascicle VIII.2, Rec. X.3.

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