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EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

INTERFACE CHARACTERISTICS FOR A DTE TO OPERATE WITH EUROPEAN REC. X.25 NETWORKS

TR/16

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BRIEF HISTORY

The majority of European countries have either implemented or have advanced plans for the introduction of public packet switching services based on CCITT Rec. X.25. Since Rec. X.25 contains a large number of options and certain areas still remain to be fully defined, it is inevitable that the implementations of the European PTT authorities are not fully harmonized.

The object of this ECMA Technical Report is to identify a common sub-set of facilities, chosen from those commonly implemented, that will permit standardization of a DTE design that will satisfy the majority of users requirements to cover the period at least to 1985.

The information in this Technical Report has been compiled after analysis of the facilities that are provided by the following national networks:

Belgium	: DCS
France	: TRANSPAC
Germany (FR)	: DATEX-P
Italy	: ITAPAC
Spain	: IBERPAC
Switzerland	: Telepac
The Netherlands	: DATANET-1
United Kingdom	: PSS

The analysis is published in ECMA TR/15.

This Technical Report has been prepared assuming that most Rec. X.25 type DTEs will be relatively complex devices requiring the use of multiple virtual circuits. Further, study is required to determine the requirements of simple devices utilizing perhaps one or a small number of virtual circuits.

It is intended that this Technical Report will be converted into an ECMA Standard when further operating experience has been gained with X.25 networks and the relationship of Rec. X.25 to OSI network service becomes clearer.

This Technical Report ECMA TR/16 has been adopted by the General Assembly of ECMA on June 16, 1983.

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1. SCOPE

This Technical Report ECMA TR/16 specifies the interface characteristics of the DTE to operate with the common facilities of various national implementations of Rec. X.25 Packet-Switching Networks in Europe.

This Technical Report is presented in three sections covering the corresponding levels of CCITT Rec. X.25.

This Technical Report is not a full specification for a Rec. X.25 DTE. In general terms the DTE should be designed to operate with a DCE as defined in CCITT Rec. X.25.

The objective is to specify DTE operation in those areas where there are options. The facilities specified in this Technical Report represent a sub-set to provide a basic service that will enable the users to select options to better match the work requirements, e.g. interactive, batch or file transfer. Bilateral agreement of the service options and operating parameters at the packet level may be necessary for effective end-to-end interworking.

Effective operation will be achieved only where the facilities offered do not deviate from Rec. X.25, however, temporary design features to accommodate the differences which at present exist between the national implementations are contained in Appendix II.

2. REFERENCES

CCITT Rec. X.2	as defined in the CCITT Yellow Book, Vol. VIII.2
CCITT Rec. X.25	as defined in the CCITT Yellow Book, Vol. VIII.2
CCITT Rec. X.21 bis	as defined in the CCITT Yellow Book, Vol. VIII.2
CCITT Rec. V.28	as defined in the CCITT Yellow Book, Vol. VIII.1

3. DEFINITIONS

In this Technical Report the DTE-to-DCE interface covers the physical level, procedural aspects of the link level and procedural aspects of the packet level.

4. CONFORMANCE

A DTE conforms to this Technical Report if it implements all the mandatory provisions and facilitates parameter settings across the full stated ranges.

Conformance with this Technical Report will not guarantee operation with any particular network since the facilities may be changed from time to time. However, it is expected that the changes would be in the direction of enhancements rather than change or withdrawal of basic facilities.

Conformance with this Technical Report will not guarantee the granting of "permission to connect" by the network administration authority.

5. PHYSICAL LEVEL DESCRIPTION

5.1 DTE-to-DCE Connection

The DTE shall provide an X.21bis interface (V.28 electrical characteristics) for use with a duplex data circuit at one or more of the following speeds: 2400, 4800 or 9600 bps.

6. LINK LEVEL DESCRIPTION

6.1 Mode of Operation

The DTE shall operate according to Rec. X.25, Level 2, LAP B.

6.2 Parameterization

There are four parameters applicable to the link level.

k : the maximum number of I frames which may be waiting for acknowledgement.

N1 : the maximum number of bits in an I frame.

N2 : the maximum number of transmissions and retransmissions allowed for a frame.

T1 : the time-out period for acknowlegement of a frame.

The parameters shall be given the following values. The justification for the choice of values is given in Appendix I.

k : Variable in the range 1 to 7. The value of k used shall be the same for the DTE and DCE. Where the DCE permits selection, a value in the range 1 to 7 shall be chosen as recommended in Appendix I.

N1 : The link level frame size is determined by the options chosen for the packet level (see Appendix I). Any value in excess of 132 octets should be checked with the administrations concerned.

N2 : There is no need for correlation between the DTE and DCE retry parameter values (see Appendix I).

Timer T1

The minimum value selected for the DTE and DCE should be $T1 = 3,5\ t_1$, where:

t_1 = the transmission time for the total link level frame.

This formula for T1 assumes that the timer is started at the beginning of frame transmission and allows 0,5 t_1 for propagation delays and data processing.

6.3 Address Conventions

The address conventions shall be as stated in Rec. X.25.

7. PACKET LEVEL DESCRIPTION

7.1 Basic Services

The DTE shall support the Virtual Call Service.

7.2 Packet Handling Procedure

The DTE shall be able to handle the following packet types in accordance with Rec. X.25 unless stated otherwise in this section. All packets shall contain an integral number of octets (see also Appendix II).

7.2.1 Call set-up and clearing

DCE to DTE	DTE to DCE
Incoming call	Call request
Call connected	Call accepted
Clear indication	Clear request
Clear confirmation	Clear confirmation

DTE Time Limits

X.25 Ref.	Started when	DTE action
T11	DCE issues an Incoming Call	Accept or reject within 180 s - See Appendix II.
T13	DCE issues a Clear Indication	Respond within 60 s - See Appendix II.
T21	DTE issues a Call Request	Wait for a minimum of 200 s for DCE Call connected or DCE Clear Indication. When timer expires transmit Clear Request.
T23	DTE issues a Clear Request	Wait for a minimum of 180 s for DCE Clear Confirmation or Clear Indication. When timer expires repeat the Clear Request. If the second Clear Request is unsuccessful, report logical channel out-of-order to a higher level.

7.2.2 Data transfer and flow control

DCE to DTE	DTE to DCE
DCE Data	DTE Data
RR (modulo 8)	RR (modulo 8)
RNR (modulo 8)	RNR (modulo 8)

Data packets sent by the DTE shall be numbered consecutively modulo 8, without any gap. Each P(S) must be within the current window, as defined in Rec. X.25 (4.4.1.2).

Data packets received in correct sequence shall be acknowledged by the DTE using the P(R) field of data, RR or RNR packets.

How and when the acknowledgement has to be sent is related to throughput and subject to local and higher-level-dependent considerations (see also Note 2).

Detection of an out-of-sequence packet or incorrect P(R) shall be interpreted as a protocol error and shall cause the DTE to initiate a Reset.

NOTE 1:

There is no mechanism in Rec. X.25 to ensure that data packets are acknowledged by the DCE within a reasonable time (i.e. by rotation of the window).

If a DTE wishes to guard agains a protracted delivery delay of a data packet this must be done at a higher level. If a data packet is not acknowledged within the time limit set, the virtual circuit should be reset before retransmission is attempted.

NOTE 2:

Packet retransmission is not a generally available facility and therefore the DTE shall not send REJ packets.

7.2.3 Reset and restart

DCE-to-DTE	DTE-to-DCE
Reset Indication	Reset Request
Reset Confirmation	Reset Confirmation
Restart Indication	Restart Request
Restart Confirmation	Restart Confirmation

DTE Time Limits

X.25 Ref.	Started when	DTE action
T10	DCE issues a Restart Indication	Respond within 60 s - see Appendix II.
T12	DCE issues a Reset Indication	Respond within 60 s - see Appendix II.

X.25 Ref.	Started when	DTE action
T20	DTE issues a Restart Request	Wait for a minimum of 180 s - for DCE Restart Confirmation or Restart Indication. When timer expires, repeat Restart Request. If the second Restart Request is unsuccessful, report failure to a higher level.
T22	DTE issues a Reset Request	Wait for a minimum of 180 s for DCE Reset Confirmation or Reset Indication. If timer expires: - For SVC, transmit a Clear Request. - For PVC, repeat the Reset Request. If still unsuccessful, report failure to a higher level.

7.3 Delivery Confirmation

7.3.1 Delivery Confirmation (D bit)

The DTE shall set the Delivery Confirmation Bit (D bit) to zero selecting local P(R) significance.

If end-to-end delivery confirmation is required, the DTE shall achieve this with a higher level protocol.

7.3.2 More Data Mark (M bit)

The M bit may be used to ensure that higher level data is sent and received as a complete packet sequence. If the M bit is used by the sending DTE each packet sequence shall consist of:

i) zero or more full data packets with the M bit set to ONE, followed by,

ii) one data packet (empty, nonfull or full) with the M bit set to ZERO (see Note 3).

The receiving DTE shall be prepared to receive such a sequence (see Note 4).

NOTE 3:

Some networks may reject or discard empty data packets.

NOTE 4:

M bits may be added by the network if the receiving DTE data packet length is shorter than the sending DTE.

7.3.3 Qualifier bit (Q bit)

The Q bit shall normally be set to ZERO. Use of the Q bit as defined in X.25 Sect. 4.3.6 to distinguish between data on two levels requires bilateral agreement.

The Q bit of every data packet belonging to the same complete packet sequence shall have the same value.

7.4 Flow Control Parameters

The DTE shall support the Rec. X.25-defined default values for the window size and packet size, viz.:

window size = 2
packet size = 128 octets max.

This relates to the user data field in data packets.

NOTE 5:

For some applications non-standard values for the Flow Control parameters may improve the performances of the concerned DTEs. Rec. X.25 describes optional facilities permitting some flexibility in the choice of these parameters for PVCs and VCs. But bilateral DTE-to-DTE agreement and knowledge of the network characteristics are required to make effective use of alternative Flow Control parameter values.

In most cases, however, the standard default window size and packet size permit satisfactory operations without further complications either for the DTEs or for the networks.

7.5 User Facilities

It has yet to be determined that any of the optional user facilities of Rec. X.25 are of sufficient value to be included in a general DTE standard. Therefore, until further operational experience is available, the use of these facilities is optional.

7.6 Logical Channel Assignments

Logical channel assignments will be agreed between the User and the Administration for a contractual period.

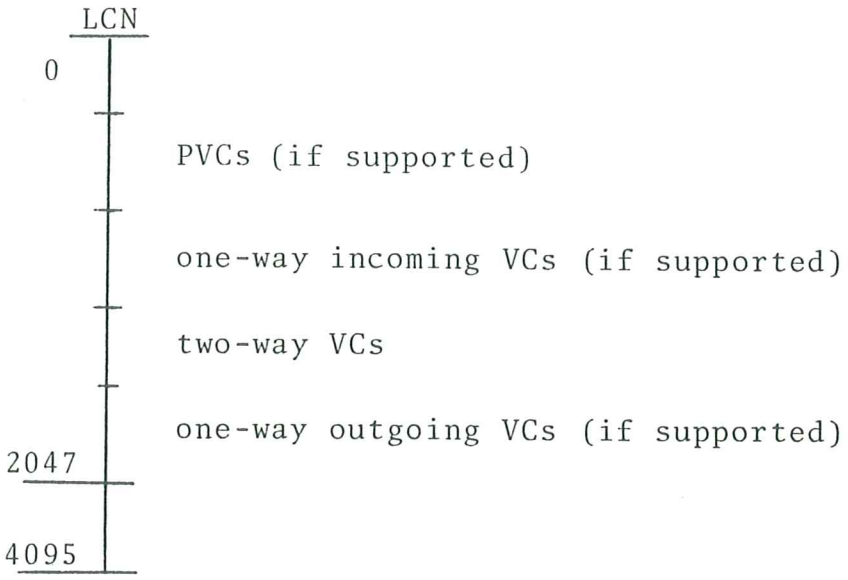
The DTE shall support the classes of logical channel shown below.

Although CCITT Rec. X.25 permits channel numbering up to 4095, many applications will use a much smaller number of channels.

To be compatible with European networks the DTE shall support channel numbering up to 2047, with Channel 0 reserved for restarts.

The DTE shall be able to cope with gaps in the numbering between the different classes of logical channel.

In order to minimize the risk of call collision when using the "two-way" logical channels, the DTE shall use the highest numbered logical channel in the "Ready" state when making a call.



7.7 Diagnostic Codes

The DTE shall accept and act upon Clear, Reset or Restart packets with any codings in the diagnostic field irrespective of whether these codes are recognized.

NOTE 6:

The need for agreed diagnostic codes and the values is for further study.

APPENDIX I

LINK LEVEL PARAMETERS

Link Parameter k

LAP B operates by transmitting I frames up to a limit of k while waiting for acknowledgement. k is related to the line speed and the nature of the traffic.

While awaiting an acknowledgement to a specific frame the idle time on the line can be used to transmit other frames. The optimum throughput on the line occurs when the idle time waiting for an acknowledgement is used as much as possible in sending other frames. The value of k, therefore, has to be calculated from a comparison between the average time to send a frame and process its acknowledgement and the average time to process and send a supplementary frame. A large k will not necessarily be beneficial and will tie up more buffers in the equipment at either end of the link, while a small k will give less throughput.

For links with a small acknowledgement delay it can be shown that k lies between 2 and 3 for the case where the amount of information flowing in each direction is similar both in volume and number of I frames; k approximates to 1 when the remote end is only acknowledging frames and not transmitting data. The convergence of k to 1 in the second case is particularly marked for larger frame sizes.

For links where large delays are expected (e.g. satellite circuits) k can get very high and large sequence counts (modulo 128) would appear desirable.

For X.25 k may take any value between 1 and 7. Seven is the maximum sequence count size in the LAP B frame. The value of k = 3 would appear to be a reasonable compromise for all X.25 networks when the frame lengths are similar in each direction or do not vary very much. Alternative values of k should be chosen to suit the traffic patterns.

NOTE

Some networks fix the value of k.

Link Parameter N1

N1 is the maximum number of bits permitted in a link level 2 I frame. The I field size must permit the largest packet size used at packet level.

It must be noted that Data packets with their headers are not necessarily the largest packets. Call Request packets may contain a large number of facilities and possibly also Fast Select data.

N1 may be calculated from the following formula:

$$N1 = (A + C + P + FCS) \cdot 8$$

where:

P = the total packet size including headers, facilities, etc, in octets.

A = address field length in octets

C = control field length in octets

FCS = frame check sequence length in octets.

Link Parameter N2

N2 defines the maximum number of transmissions and retransmissions that should be tried before giving up. The DCE retry limit is normally a fixed value for each X.25 network. The DTE may set any value for N2 but it is suggested that N2 should be at least 10.

Link Parameter T1

HDLC specifies that a timer should be run on the first frame waiting for an acknowledgement. The minimum value for T1 must exceed the time to transmit the frame, process the acknowledgement and transmit the response, and process the response.

The time value for T1 is often selectable from a range of network values. The choice of T1 is tempered by the throughput rate and error rate of the link. If a relatively large value of T1 is selected on a link which is error prone, the throughput will be decreased as the retry rate is slowed down. As a guide T1 is normally required to exceed 3 times the maximum frame transmission time. This allows time for the transmission of the initial frame plus two response frames, since the acknowledgement may miss the first response frame.

APPENDIX II

PROCEDURES TO ACCOMMODATE X.25 DEVIATIONS AND NETWORK-SPECIFIC CHARACTERISTICS

A2.1 Introduction

At present deviations exist from Rec. X.25, and there are also network-specific characteristics, in certain European national network implementations. It is hoped that these deviations will eventually disappear, but in the meantime this Appendix suggests temporary design features and procedures to accomModate these deviations.

The known deviations from Rec. X.25 are defined in the appendices of "X.25 Network Analysis", ECMA TR/..

A2.2 Tactics to Accommodate Deviations

A2.2.1 Physical Level

The majority of networks do not monitor the link idle state and many do not monitor physical level failure. This can lead to virtual calls not being cleared on failure.

It is suggested that the DTE could implement a higher-level timer to monitor the receipt of data or flow control packets. If the timer expires, the virtual call should be cleared. Thus the call will be cleared by the DTE which is on an active link.

The value of the timer and other possible actions are system-dependent.

A2.2.2 Link Level

A2.2.2.1 Link set-up

There are some variations in network behaviour in the link disconnected state. For example, UK PSS sends repeated DISC and the Belgian network sends repeated SABM.

As these variations are likely to remain for a long period, it is recommended that the DTE should implement a link set-up procedure that will accommodate such variations.

A2.2.2.2 FRMR handling

Coding of the FRMR information field is not the same on all networks. In particular, TRANSPAC always sets Bit Y to zero as frames with I fields exceeding the maximum agreed length are ignored. Thus the DTE error recovery or diagnostic procedures must take care of this.

The DCE responses to FRMR from the DTE are not consistent. Some networks reset by sending SABM, others send DISC followed by SABM.

A2.2.3 Packet Level

A2.2.3.1 Called DTE address

In general terms, the called DTE address conforms with the structures in CCITT Rec. X.121. However, the national, international and sub-address requirements make it essential that the DTE implementation imposes no restrictions on the number of digits or structure of this address field.

A2.2.3.2 Call User Data Field

Free use may be made of the 16 octets of the Call User Data Field in Call Request packets, but the data should be octet-structured and bits 8 and 7 of the first octet should be set to "11" otherwise a network-implemented protocol may be invoked.

A2.2.3.3 Diagnostic field

The use of the diagnostic field in Clear, Reset and Restart packets from the networks will vary since values 128-255 (decimal) are assigned by CCITT for network-specific use. In addition, EURONET and TRANSPAC differ from those defined in X.25 Annex E for values in the range 0 to 127.

It is therefore recommended that the DTE should be designed to permit interpretation of the diagnostic codes on a network-specific basis.

A2.2.3.4 DTE time limits

The DTE should implement timers T10, T11, T12 and T13 so that they can be set to network-specific values. The values shown in sections 7.2.1 and 7.2.3 of this Technical Report are the values recommended in X.25, but CCITT recognizes that there will be an interim period before all networks conform.

At present some networks wait indefinitely for a DTE response.

A2.2.3.5 Logical channel disconnection

Following initial switch-on, physical level failure, link level failure, or link level disconnect, the DTE shall assume the disconnection of all virtual circuits and ensure a "Restart" procedure following Level 2 reconnection.