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DATA NETWORKS AND OPEN SYSTEMS COMMUNICATIONS

OPEN SYSTEMS INTERCONNECTION-CONNECTION-MODE PROTOCOL SPECIFICATIONS

USE OF X.25 LAPB COMPATIBLE DATA LINK PROCEDURES TO PROVIDE THE OSI CONNECTION-MODE DATA LINK SERVICE

ITU-T Recommendation X.222

(Previously "CCITT Recommendation")

FOREWORD

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NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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DATA NETWORKS AND OPEN SYSTEM COMMUNICATIONS

(February 1994)

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SUMMARY

This Recommendation defines a method for providing the OSI connection-mode data link service through the use of the X.25 LAPB-compatible data link procedures as described in Recommendations X.25 and X.75. This Recommendation provides the mapping between the abstract primitives and parameters of the connection-mode data link service and the real elements of the protocol.

USE OF X.25 LAPB-COMPATIBLE DATA LINK PROCEDURES TO PROVIDE THE OSI CONNECTION-MODE DATA LINK SERVICE[1)]

(Geneva, 1995)

1 Introduction

This Recommendation defines a method for providing the OSI Connection-mode Data Link Service (CO-DLS) through the use of the X.25 LAPB-compatible DTE data link procedures as described in Recommendations X.25 and X.75 (abbreviated to X.25/LAPB, for the remainder of this Recommendation).

This Recommendation specifies the detailed mappings between the CO-DLS and X.25/LAPB-compatible DTE single link procedures as described in Recommendation X.25.

2 References

The following Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision: all users of this Recomendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

2.1 Identical Recommendations | International Standards

– ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*.

– ITU-T Recommendation X.210 (1993) | ISO/IEC 10731:1994, *Information technology – Open Systems Interconnection – Conventions for the definition of OSI services*.

2.2 Paired Recommendations | International Standards equivalent in technical content

– CCITT Recommendation X.212 (1988), *Data Link Service definition for Open Systems Interconnection for CCITT applications*.

– ISO/IEC 8886:1992, *Information technology – Telecommunications and information exchange between systems – Data link service definition for Open Systems Interconnection*.

2.3 Additional references

– ITU-T Recommendation X.25 (1993), *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in packet mode and connected to public data networks by dedicated circuit*.

– ITU-T Recommendation X.75 (1993), *Packet switched signalling system between public networks providing data transmission services*.

[1)] This text is a technically aligned subset of ISO/IEC 11575, Information Technology – Telecommunications and Information Exchange between Systems – Protocol Mappings for the OSI Data Link Service.

3 Definitions

This Recommendation uses the following terms defined in ITU-T Rec. X.200 | ISO/IEC 7498-1:

- DL-address;
- DL-connection;
- DL-entity;
- DL-layer;
- DL-protocol-data-unit;
- DL-service access point;
- DL-service access point address;
- DL-service-data-unit;
- DL-subsystem.

This Recommendation uses the following terms defined in ITU-T Rec. X.210 | ISO/IEC TR 10731:

- DLS provider;
- DLS user;
- primitive;
- request (primitive);
- indication (primitive);
- response (primitive);
- confirm (primitive);

For the purposes of this Recommendation, the following definitions apply:

- frame;
- instance of DL-communication;
- a DL-PDU;
- a DL connection.

4 Abbreviations

For the purposes of this Recommendation, the following abbreviations apply:

CO	Connection-mode
DISC	Disconnect
DCE	Data Circuit-terminating Equipment
DL	Data Link
DLC	Data Link Connection
DLS	Data Link Service
DLSAP	Data Link Service Access Point
DLSDU	Data Link Service Data Unit
DM	Disconnected Mode
DTE	Data Terminal Equipment
FRMR	Frame Reject
HDLC	High-Level Data Link Control
I	Information

LAPB	Link Access Protocol Balanced
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
RR	Receiver Ready
SABM	Set Asynchronous Balanced Mode
SABME	Set Asynchronous Balanced Mode Extended
SLP	Single Link Procedure
UA	Unnumbered Acknowledgment

5 General principles of the protocol mappings

5.1 Data Link architecture

The OSI Data Link service defines the properties of individual instances of DL-communication between pairs of DLS users. The definition is abstractly expressed in terms of primitives and parameters exchanged, at Data Link Service Access Points (DLSAPs), between each DLS user and a single DLS provider. This is illustrated in Figure 1.

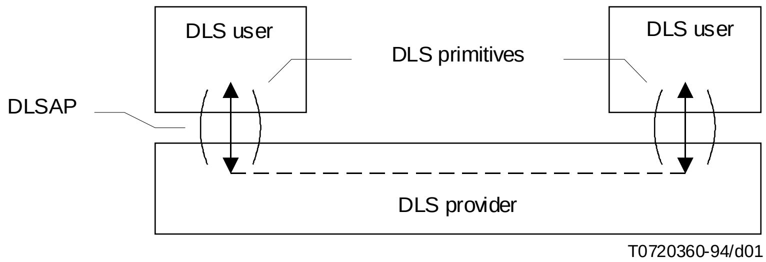

FIGURE 1/X.222

Model of Data Link service provision

Operation of the DLS provider is modelled in terms of the exchange of DL-PDUs, in accordance with DL-protocols, between DL-entities (see Figure 2). Each DLSAP is attached to a unique DL-entity; a given DL-entity can have one or more DLSAPs attached to it, depending upon system configuration and the nature of the underlying DL-protocols.

When real equipment is considered, a data link consists of two Data Link Entities communicating according to X.25 LAPB-compatible protocol together with the interconnecting media supporting information exchange among the Data Link Entities.

Figure 3 depicts the configuration applicable in this Recommendation.

The Data Link service model deals primarily with the properties of individual instances of DL-communication, each occurring between a pair of DL-entities. DL-protocols have to deal with multiple instances of communication between a given pair of DL-entities; representing the protocol facilities that support this forms a part of the specification of the mapping between the protocol and the DLS. Aspects to be considered include the number of DLSAPs supported by a given DL-entity and the number of DL-connections that can be active simultaneously at a DLSAP.

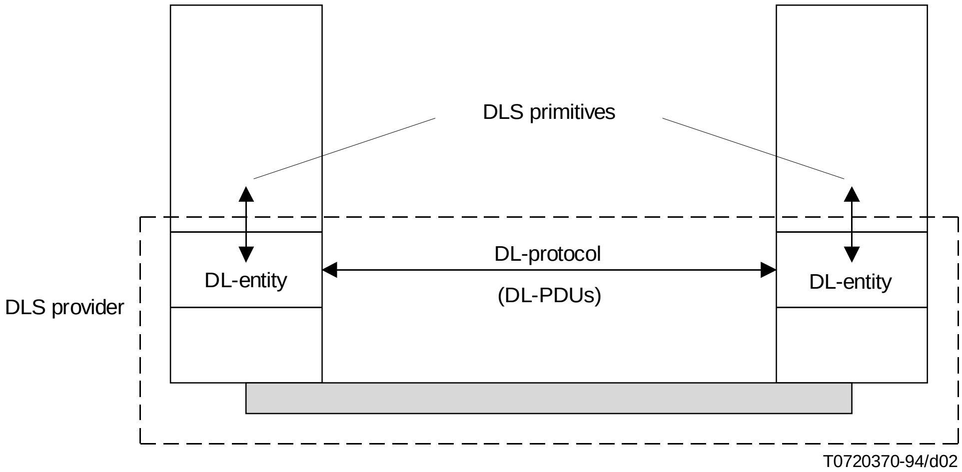

FIGURE 2/X.222

Structure of DLS provider

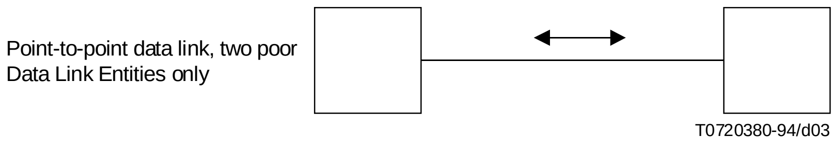

FIGURE 3/X.222

Type data link configuration

5.2 Modelling of service primitives

Primitives are abstractions of the behaviour of real systems engaging in data communication: in specifying the mapping between these abstract primitives and the activity of real implementations of DL-protocol entities, this allows freedom in modelling the timing of when primitives occur, so as to simplify the mapping specification.

NOTE 1 – Recommendation X.212 explicitly allows this freedom; it defines the constraints on the sequence in which primitives can occur, but states that other constraints affect the ability of a DLS user or DLS provider to issue a primitive at any particular time.

For primitives issued by the DLS user – those of types request and response – this Recommendation uses a rendezvous model: that is, a primitive can only occur if both the DLS user and the local DLS provider are prepared for it to occur. This provides two valuable simplifications:

a) occurrence of DLS-user issued primitives can always be related to the externally observable transmission of corresponding frames – the ability to transmit the frames is considered to be an essential part of the DLS provider being prepared for the primitive to occur; and

b) there is no need to complicate the mapping by, for example, introducing any queueing of primitives that have been issued by the DLS user but have not yet resulted in any protocol activity.

Conversely, for primitives issued by the DLS provider – those of types indication and confirm – it is convenient to simplify the model by considering primitives to occur as soon as the DLS provider is ready.

NOTE 2 –An implementation of a DL-protocol is free to use an interface that queues requests, e.g., for data transmission; however, the issuing of corresponding DLS primitives is modelled as occurring after the requests are removed from such a queue, not when they are entered into the queue.

NOTE 3 – Any queueing mechanisms in real systems are matters of implementation detail; as in the case described in Note 2, the boundary between DLS provider and DLS user is modelled as being at the DLS provider's end of the queue.

NOTE 4 – This model does not impose a requirement to support queues of unbounded size; interface flow control by the DLS user will in general affect the behaviour of the DL-protocol entity and prevent excessive demands.

5.3 Relationships between service features and protocol functions

All of the mappings covered by this Recommendation use natural relationships between functions of the various protocols and corresponding abstractions as Data Link service features.

The primary function in each mapping is that of transferring units of user data. For each mapping, the correspondence is between the DLSDU of a DL-DATA primitive and the basic delimited unit of data transfer in the protocol: that is, the contents of the Information field of a single frame conveying user data.

NOTE 1 – It is possible that future Data Link layer protocols could provide intrinsic support for segmentation and reassembly of user data across sequences of frames; the absence of this feature from the X.25 LAPB does not preclude the possibility of single DLSDUs mapping to multiple frames of such future DL-protocols.

The other functions of DL-protocols are defined to complement the primary data-transfer function, and the correspondences in the DLS mappings are similarly direct.

For connection-mode operation, protocol functions for setting up, disconnecting, and resetting the connections used for data transfer are mapped to DL-connection establishment, DL-connection release and DL connection reset.

NOTE 2 – Recommendation X.212 defines a somewhat idealized connection-mode service, which does not fully represent all the peer-to-peer interactions that can occur when real DL-protocols such as X.25/LAPB are used. The differences affect only link set-up, disconnection and reset, and not any successfully established period of data transfer. They occur typically when DL-PDUs responding to link set-up, disconnection or reset are lost, and are more likely to occur if, at the same time, one of the DL-entities undergoes two or more changes in its readiness to participate in data transfer. In such circumstances, one DL-entity may observe, for example, a single successful DLC-establishment, whereas the other observes a rejected incoming DLC establishment attempt followed by a successful incoming DLC establishment; or one DL-entity may observe a single DLC reset where the other observes two DLC resets, with no data received between the two. These do not represent malfunctions of the protocols, since they never affect the integrity of any successful transfers of user data between the DL-entities.

6 Protocol mapping for X.25 LAPB single link procedure

6.1 General protocol functions

X.25 LAPB applies to a point-to-point data link (as in Figure 3), connecting the Data Link Entity for which the SLP is specified (the DTE) with a single remote Data Link Entity (the DCE). The protocol for the SLP provides no facilities for addressing or multiplexing; consequently, the data link supports a single DLSAP in the DTE and a single DLSAP in the DCE, and there can be at most one DL-connection in existence between the two DLSAPs at any given time.

Table 1 specifies the mapping between the principal protocol functions of X.25 LAPB SLP and the corresponding features of the OSI CO-DLS.

TABLE 1/X.222

Mapping between principal X.25 LAPB protocol functions and CO-DLS features

Protocol Function	Data Link service feature
Asynchonous disconnected mode	Absence of a DL-connection (idle state) (Note)
Link set-up	DL-connection establishment phase
Link disconnection	DL-connection release phase and absence of a DLC (Note)
Information transfer	Data transfer phase, normal data transfer
Link reset, including frame rejection exception condition	Data transfer phase, reset
NOTE – The DL-connection release phase at each DLSAP is instantaneous, since it contains only a single DL-DISCONNECT primitive. However, the corresponding protocol exchanges are extended in time, with a resulting transient period at each DLSAP during which the protocol's link disconnection corresponds to absence of a DLC, with DLC-establishment phase unable to be entered.	

6.2 DL connection establishment

Table 2 specifies the mapping between DL-CONNECT primitives and the frames used for link set-up according to X.25 LAPB.

The called address, calling address and responding address parameters of the DL-CONNECT primitives are associated *a priori* with the DTE and the DCE or remote DTE at the two ends of the point-to-point data link, and hence are not mapped in the protocol.

Similarly, the Quality of Service parameter set parameters are not mapped in the protocol, since only one level of QOS is available and is assumed known *a priori*.

TABLE 2/X.222

Mapping between primitives and X.25 LAPB frames at DLC establishment

Primitive	Frame
DL-CONNECT request	SABM or SABME conmmmand transmitted when in disconnected mode, together with any retransmissions on timer expiry
DL-CONNECT indication	SABM or SABME command received when in disconnected mode
DL-CONNECT response	UA response transmitted in response to SABM or SABME command received in disconected mode
DL-CONNECT confirm	UA response received for SABM or SABME command (re)transmitted in disconnected mode

6.3 DL-connection release

Table 3 specifies the mapping between DL-DISCONNECT primitives and the frames used for link disconnection according to X.25 LAPB.

The Originator parameter in a DL-DISCONNECT indication primitive is "DLS provider" if the primitive corresponds to a DM frame received in data transfer phase, and otherwise is "unknown".

The Reason parameter in every DL-DISCONNECT request and indication primitive is "reason unspecified".

TABLE 3/X.222

Mapping between primitives and X.25 LAPB frames, etc, at DLC release

Primitive	Frame, etc.
DL-DISCONNECT request	DISC command transmitted when in information transfer phase, together with any retransmissions on timer expiry DM response transmitted in response to SABM or SABME command received in disconnected mode (rejection of DLC establishment)
DL-DISCONNECT indication	DISC command or DM-response received when in information transfer phase DM-response received for SABM or SABME command (re)transmitted in disconnected mode (rejection of DLC establishment) DM-response transmitted during information transfer phase (in response to received FRMR or unsolicited UA response, or to unsolicited response frame with F bit set to 1), together with any retransmissions on timer expiry Entry to disconnected mode on retransmission-count expiry during information transfer phase or link set-up Detection of loss of physical layer communication

6.4 Data transfer

Each DL-DATA request primitive maps to transmission of an I-frame, together with any retransmissions required by the X.25 LAPB procedures for information transfer. Each transmitted I-frame with an Information field having non-zero length corresponds to a DL-DATA request primitive in this way.

Each new in-sequence I-frame received and accepted with non-zero Information field length maps to a DL-DATA indication primitive.

The DLS User-data parameter of a DL-DATA primitive is the sequence of octets that forms the Information field of the corresponding transmitted or received I-frame.

6.5 DL connection reset

Table 4 specifies the mapping between DL-RESET primitives and the frames used for link reset according to X.25 LAPB.

The Originator and Reason parameters in a DL-RESET indication primitive are respectively:

a) "DLS provider" and "Data Link error" if the primitive corresponds to a FRMR response transmitted or received, or to a SABM or SABME command transmitted by the DL-entity in response to an error; or

b) "unknown" and "reason unspecified" when the primitive corresponds to a SABM or SABME command received.

The Reason parameter in a DL-RESET request primitive is "user resynchronization".

TABLE 4/X.222

Mapping between primitives and X.25 LAPB frames for DLC reset

Primitive	Frame
DL-RESET request	SABM or SABME command transmitted see Note 1
DL-RESET indication	SABM or SABME command received (Note 1) SABM or SABME command transmitted on receiving unsolicited response frame with F bit set to 1 (Note 1) FRMR response received (Note 1) FRMR response transmitted on entry to frame rejection exception condition (Note 1)
DL-RESET response (Note 2)	Following a DL-RESET indication UA response transmitted or received, as appropriate, to complete a link reset Time-out waiting for UA response, after sending UA response to a colliding SABM or SABME command received
DL-RESET confirm (Note 2)	Following a DL-RESET request same mapping as for DL-RESET response

NOTES

1 The first occurrence of one of these frames during normal data transfer, together with any retransmissions required by the X.25 LAPB procedures, maps to the DL-RESET request or indication primitive. Subsequent occurrences of other frames from this set before either the link reset is completed or the link is disconnected do not map to any DLS primitive.

2 The correspondence between these primitives, marking completion of DLC resetting, and the protocol frames or time-outs uses the earliest externally observable real-world events with which the abstract primitves can be associated. The significance of the primitives in the CO-DLS is that they separate a period when DL-DATA primitives cannot occur from the following period when DL-DATA primitives are again possible: the mapping specified simply relates this to the equivalent separation between the X.25 LAPB link resetting procedure, during which no information transfer occurs, and the resumption of the capability for normal information transfer on completion of the link reset. Within an implementation, it may be convenient to consider representations of the primitives as occurring either earlier or later. If earlier, there will be a period during which DL-DATA request primitives cannot be issued at the DLSAP, since the X.25 LAPB procedures prevent transmission of I-frames; if later, there will be a period following completion of the X.25 LAPB link reset during which I-frames are not transmitted, because the local implementation is not ready. Such an implementation-related view is not precluded, since it is outside the scope of OSI standardization.