INTERNATIONAL TELECOMMUNICATION UNION

CCITT G.773

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

GENERAL ASPECTS OF DIGITAL TRANSMISSION SYSTEMS; TERMINAL EQUIPMENTS

PROTOCOL SUITES FOR Q-INTERFACES FOR MANAGEMENT OF TRANSMISSION SYSTEMS

Recommendation G.773

Geneva, 1990

FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is the permanent organ of the International Telecommunication Union (ITU). CCITT is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

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Recommendation G.773 was prepared by Study Group XV and was approved under the Resolution No. 2 procedure on the 14 of December 1990.

CCITT NOTE

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

Recommendation G.773

PROTOCOL SUITES FOR Q-INTERFACES FOR MANAGEMENT OF TRANSMISSION SYSTEMS

1 Introduction

1.1 *Scope*

This Recommendation defines the characteristics of protocol suites for Q-interfaces of transmission systems/equipments, as defined in Recommendations M.30 [1] and G.771 [58]. Protocol suites for Q-interfaces of other systems/equipments will be specified in other Recommendations. The interfaces will support bidirectional data transfer for the management of telecommunications systems.

This Recommendation defines:

– the layer services;

– the layer protocols;

– the application service elements and protocols;

– the conformance requirements to be met by an implementation of these interfaces.

This Recommendation does not define:

– the structure or meaning of the management information that is transmitted by means of the protocol suites;

– the manner in which management is accomplished as a result of the application protocol exchanges;

– the interactions which result in the use of the application layer protocols.

1.2 *Abbreviations and symbols*

1.2.1 *Abbreviations*

AARE A-associate response

AARQ A-associate request

ACSE Association control service element

AFI Authority and format identifier

APDU Application protocol data unit

ASE Application Service element

ASN.1 Abstract syntax notation one

CD Collision detection

CDO Connect data overflow

CLNS Connectionless-mode network service

CMIP Common management information protocol

CMIS Common management information service

CMISE	Common management information service element
Conf	Confirm
CONS	Connection oriented-mode network service
CSMA	Carrier sense multiple access
DCE	Data circuit terminating equipment
DCN	Data communication network
DIS	Draft international standard
DLC	Data link connection
DLS	Data link service
DSP	Domain specific part
DTE	Data terminal equipment
EOC	Embedded operations channel
FU	Functional unit
HDLC	High-level data link control
IDI	Initial domain identifier
IDP	Initial domain part
Ind	Indication
ISO	International organization for standardization
LCN	Local communication network
LLC	Logical link control
LME	Layer management entity
MAC	Media access control
MD	Mediation device
NDM	Normal disconnected mode
NE	Network element
NLR	Network layer relay
NM-ASE	Network management-application service element
NRM	Normal response mode
NRZ	Non return to zero
NRZI	Non return to zero inverted
NS	Network service

NSAP	Network service access point
OA	Overflow accept
OS	Operations system
OSI	Open systems interconnection
PDU	Protocol data unit
PhC	Physical connection
Ph	Physical
PhS	Physical service
PICS	Protocol implementation conformance statement
PLS	Physical layer service
PPDU	Presentation protocol data unit
PV	Parameter value
PVC	Permanent virtual circuit
PU	Protocol unit
QOS	Quality of service
Req	Request
Res	Response
ROSE	Remote operations service element
SDH	Synchronous digital hierarchy
SP	Session protocol
SPDU	Session protocol data unit
SPF	Segmentation permitted flag
SVC	Switched virtual circuit [1]
TMN	Telecommunications management network
TPDU	Transport protocol data unit
TSAP	Transport service access point
UNC	Unbalanced operation normal response mode class

1.2.2 *Symbols and abbreviations used in tables* [2]

M Mandatory

– The parameter is not present in the interaction described by the service or primitive concerned.

(=) The value of the parameter is equal to the value of the parameter in the column to the left.

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[1] Switched virtual circuit correspond to "virtual call" used in Recommendation X.25.

[2] The requirements are as defined in the referred standards or Recommendations.

2 Protocol suites overview

2.1 *Introduction*

Recommendation G.771 [58] provides guidance for the selection of protocol suites from Recommendation G.773 and the domain of application of these standard protocol suites.

The structures of the protocol suites with the present layers are shown in Figure 1/G.773. The defined communication services and protocols are in accordance with the Open System Interconnection (OSI) reference model [2].

The protocols for the different layers are based on Recommendations and/or ISO standards.

Two types of protocol suites are defined in this Recommendation:

– short stack: protocol suites A1 and A2,

– full 7 layer stack: protocol suites B1, B2 and B3.

The short stack protocol suites (A1 and A2) will be used mainly for LCN application as specified in Recommendation M.30 [1]. The full 7 layer stack protocol suites (B1, B2 and B3) can be applied to both LCN and DCN applications, as defined by Recommendation M.30 [1].

Because of the nulling of the transport layer, session layer and presentation layer for short stack protocol suites, mapping functions have been defined.

The full 7 layer protocol suites satisfy the requirements of complex NEs (e.g. equipments for the SDH). To support already existing networks and to provide maximum flexibility, several possibilities are defined for layers 1, 2 and 3. Each Administration should select depending on its own specific requirements and needs. Layers 5, 6 and 7 are identical for the three protocol suites B1, B2 and B3, whilst almost identical requirements apply to layer 4.

3 Protocol suites A1 and A2

3.1 *Physical layer*

3.1.1 *Physical layer for A1*

3.1.1.1 *Service*

3.1.1.1.1 *Definition*

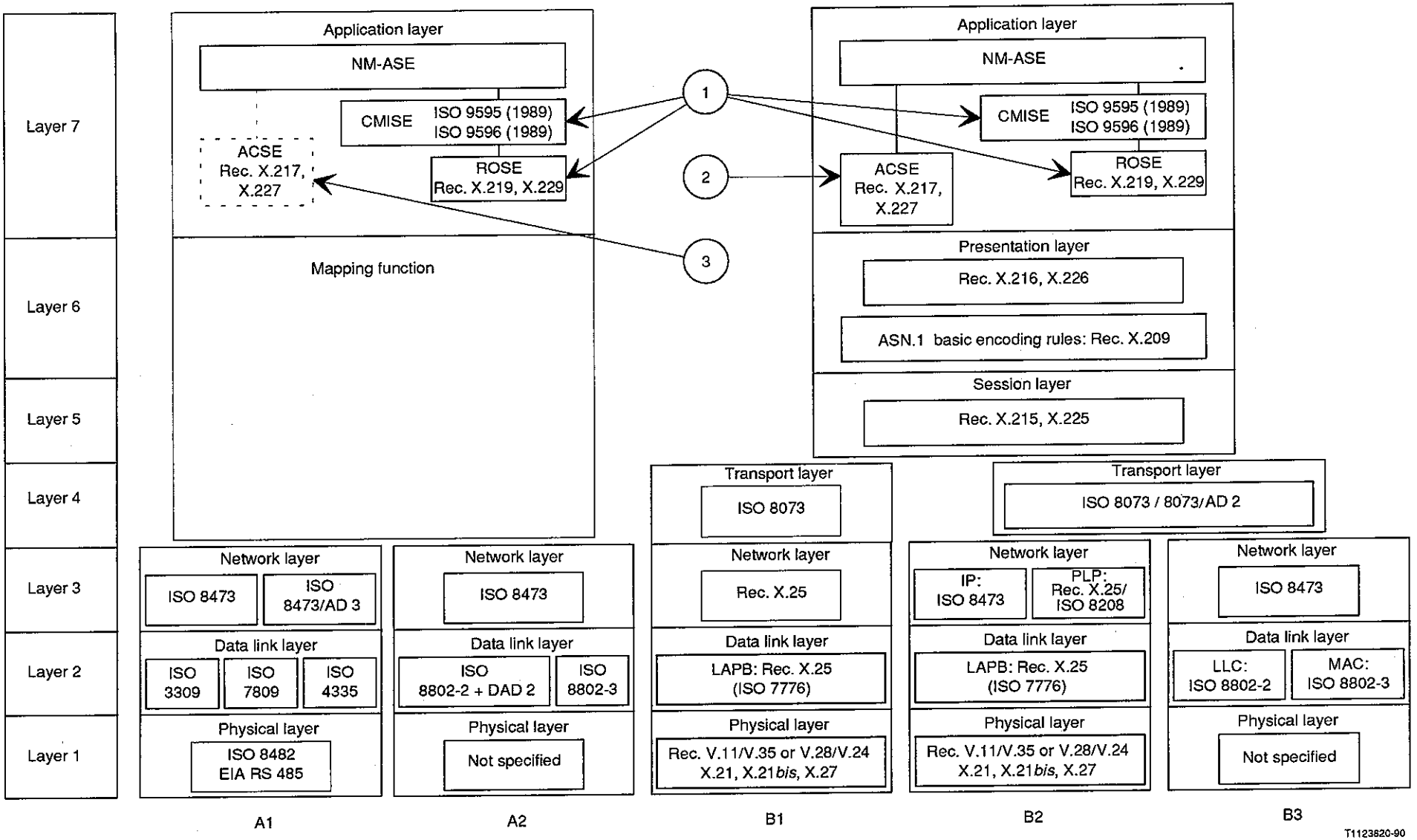
The service definition for the physical layer is in accordance with Recommendation X.211 [3].

The following classes of physical services shall be supported:

– type of transmission is synchronous;

– mode of operation is half-duplex;

– topology is point-to-multipoint by a bus.



1 Support ASE for network management transaction-oriented applications
2 Common supporting ASE
3 Optional supporting ASE

FIGURE 1/G.773

Overview of protocol suites

3.1.1.1.2 *Service provided by the physical layer*

The physical layer provides the physical service primitives and parameters as listed in Table 1/G.773.

TABLE 1/G.773

Provided physical service

Service	Primitive	Parameters
PhC-Activation	PH-ACTIVATE-request	
	PH-ACTIVATE-indication	
Data Transfer	PH-DATA-request	PhS-User data
	PH-DATA-indication	
PhC-Deactivation	PH-DEACTIVATE-request	
	PH-DEACTIVATE-indication	

The services PhC-Activation and PhC-Deactivation will be provided to the Layer Management Entity (LME) of the physical layer.

3.1.1.2 *Physical interface*

3.1.1.2.1 *Physical characteristics*

3.1.1.2.1.1 *Configuration*

Serial bus operation in accordance with ISO 8482 [3)] [4], in half-duplex mode.

3.1.1.2.1.2 *Transmission pairs*

Two screened balanced pairs, one for each direction of transmission.

3.1.1.2.1.3 *Connector*

The Administration shall specify the connector type.

3.1.1.2.2 *Electrical characteristics*

3.1.1.2.2.1 *Static and dynamic characteristics*

The static and dynamic characteristics of each bus connection shall be in accordance with ISO 8482 [4]. When all generators connected to the bus are in the high impedance state, the bus shall be set to logical level "1".

3.1.1.2.2.2 *Bus termination*

Each bus end shall be terminated in accordance with ISO 8482 [4].

3.1.1.2.2.3 *Load connection*

Each receiver shall present a maximum of one unit load, as defined in ISO 8482 [4], to the bus. The number of load connections is limited to 32.

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3) Compliance assumes that full compatibility with EIA RS 485 [57] is guaranteed.

3.1.1.2.2.4 *Bit rate*

The bit rate shall be 19200 bit/s or 64000 bit/s. A bit rate of 128000 bit/s may be necessary in some applications. The bit rate tolerance shall be ± 0.05%.

3.1.1.2.2.5 *Turn-off time*

For bit rates of 19200 bit/s and 64000 bit/s a transmitting station shall put its generator in the high impedance state within 0.750 ms from the end of the last bit of the closing flag. For a bit rate of 128 000 bit/s the turn- off time shall be not more than 0.375 ms. This point is not applicable to a primary station (see § 3.2.1.2.1.3).

3.1.1.2.2.6 *Switch-on transient*

Following the enabling of the generator an implementation dependent preamble of no more than 4 bit times is allowed. No assumption as to the state of the bus during this preamble is allowed.

3.1.1.2.3 *Line code*

The line code shall be NRZI.

3.1.1.2.3.1 *Principle*

Each ISO 8482 [4] transition shall represent a ZERO, and no transition shall represent a ONE bit.

3.1.1.2.3.2 *Lock in sequence*

Where required for clock extraction, it shall be possible to send a lock in sequence containing at least four transitions immediately prior to the beginning of the starting flag of the frame to be transmitted.

3.1.1.2.4 *Extended mode*

An example of extended mode is given in Annex A.

3.1.2 *Physical layer for A2*

3.1.2.1 *Overview*

Protocol suite A2 employs local area network technology for the physical and data link layers. Administrations will select the appropriate physical medium, e.g. coaxial cable, screened pairs, optical fibre according to technological and operational requirements.

3.1.2.2 *Service*

3.1.2.2.1 *Definition*

The service definition for the physical layer shall comply with that specified in clause 6 of ISO 8802-3 [20].

3.1.2.2.2 *Service provided by the physical layer*

All of the primitives defined and listed in Table 2/G.773 are mandatory.

TABLE 2/G.773

Primitives of the physical layer

Primitive
PLS-DATA-request
PLS-DATA-indication
PLS-CARRIER-indication
PLS-SIGNAL-indication

3.1.2.3 *Bit rate*

The bit rate will be 1 Mbit/s or higher.

3.2 *Data link layer*

3.2.1 *Data link layer for A1*

3.2.1.1 *Service*

3.2.1.1.1 *Definition*

The service definition of the data link layer is in accordance with Recommendation X.212 [5]. The class of data link service that shall be provided by the data link layer is:

– a connection-mode service.

3.2.1.1.2 *Service required from the physical layer*

The data link layer requires the Data Transfer service from the physical layer.

3.2.1.1.3 *Service provided by the data link layer*

The data link layer shall provide the Data Link service, primitives and parameters as listed in Tables 3/G.773 to 5/G.773.

3.2.1.1.3.1 *DLC-Establishment*

TABLE 3/G.773

DLC-establishment service

Parameter name	Req/Ind	Res/Conf
Called address	M	–
Calling address	M	–
Responding address	–	M
QOS	M	M

3.2.1.1.3.2 *DLC-Release*

TABLE 4/G.773

DLC-release service

Parameter name	Request	Indication
Originator	–	M
Reason	M	M

3.2.1.1.3.3 *Normal Data Transfer*

TABLE 5/G.773

Normal data transfer service

Parameter name	Request	Indication
DLS-User data	M	M

3.2.1.2 *Data link protocol*

The data link protocol is synchronous HDLC type.

3.2.1.2.1 *HDLC frame structure*

The HDLC frame structure shall conform to ISO 3309 (frame structure) [6].

3.2.1.2.1.1 *Addressing field*

The addressing field shall be one octet.

3.2.1.2.1.2 *Information field*

The information field in any HDLC frame shall be an integral number of octets.

Information field octets shall be sent least significant bit first. The maximum length of the information field shall be 256 octets.

3.2.1.2.1.3 *Interframe time fill*

A primary station shall transmit contiguous flags as interframe time fill.

3.2.1.2.2 *Addressing*

The secondary station shall be capable of being assigned any address in the range 1 to 254.

3.2.1.2.2.1 *All station address*

The address field pattern "11111111" is defined as the all-station address.

3.2.1.2.2.2 *No-station address*

The address field pattern "00000000" is defined as the no-station address. The no-station address shall never be assigned to a secondary station.

3.2.1.2.2.3 *Group addresses*

Not used.

3.2.1.2.3 *HDLC procedure*

The HDLC procedure is defined in ISO 4335 [7].

3.2.1.2.3.1 *Commands and response*

The following HDLC commands and responses must be supported:

– *commands*

SNRM: Set normal response mode

DISC: Disconnect

– *commands or responses*

I: Information

RR: Receive ready

RNR: Receive not ready

– *responses*

FRMR: Frame reject

UA: Unnumbered acknowledgement

DM: Disconnect mode

3.2.1.2.3.2 *Modes*

Two modes are selected:

– one operational mode: normal response mode (NRM);

– one non-operational mode: normal disconnected mode (NDM).

3.2.1.2.4 *Class of procedure*

The unbalanced operation normal response mode class (UNC) as defined in ISO 7809 [8] shall be implemented.

3.2.1.2.4.1 *HDLC optional functions*

The following HDLC optional functions shall be implemented:

– unnumbered information (option No. 4);

– data link test (option No. 12).

3.2.1.2.5 *Other parameters of data link layer*

3.2.1.2.5.1 *Window size*

The window size for unacknowledged frames is to be optional between 1 and 7. The default value is 1.

3.2.1.2.5.2 *Waiting-time before a repetition*

In the case of no-reply or lost-reply, the primary station shall provide a waiting time function. The waiting-time before a repetition shall be greater than the duration of the longest frame to be sent by the primary station, added to the response-time of the secondary station and the duration of the longest frame to be sent by the secondary station.

3.2.1.2.5.3 *Number of repetitions*

Under the conditions described in § 3.2.1.2.5.2, the maximum number of repetition before detecting a no-reply or a lost-reply condition is fixed to 5 (6 requests).

3.2.1.2.5.4 *Response time*

The secondary station shall commence the opening flag of its response not later than 5 ms after the end of the closing flag of the frame sent from the primary station.

3.2.2 *Data link layer for A2*

3.2.2.1 *Overview*

The data link layer provides the acknowledged connectionless-mode service. The access method employed is Carrier Sense Multiple Access with Collision Detection (CSMA/CD).

3.2.2.2 *Media access control (MAC)*

3.2.2.2.1 The services and protocol of the CSMA/CD access method shall comply with those specified in ISO 8802-3 [20].

3.2.2.2.2 The address length used at the MAC sublayer shall be 48 bits.

3.2.2.3 *Logical link control (LLC)*

3.2.2.3.1 The definition of the acknowledged connectionless mode LLC service shall comply with that specified in ISO 8802-2/DAD 2 [23]. All of the primitives defined for type 3 operation (Table 6/G.773) are mandatory.

TABLE 6/G.773

Primitives for type 3 operation

DL-DATA-ACK-request/indication
DL-DATA-ACK-STATUS-indication
DL-REPLY-request/indication
DL-REPLY-STATUS-indication
DL-REPLY-UPDATE-request
DL-REPLY-UPDATE-STATUS-indication

3.2.2.3.2 The protocol used to provide the acknowledged connectionless-mode LLC service shall be as specified in ISO 8802-2 [22] and ISO 8802/DAD 2 [23]. All of the commands and responses defined for type 3 operation (Table 7/G.773) are mandatory.

TABLE 7/G.773

Commands and responses for type 3 operation

Commands	Responses
AC0	AC0
AC1	AC1

3.3 *Network layer for A1 and A2*

3.3.1 *Service*

3.3.1.1 *Service definition*

The definition of the connectionless-mode network service shall comply with that specified in ISO 8348/AD 1 [9]. Address formats supported shall conform to ISO 8348/AD 2 [10].

3.3.1.2 *Service required from the data link layer*

The network layer requires the Normal Data Transfer service from the data link layer.

3.3.1.3 *Service provided by the network layer*

The network layer shall provide the N-UNITDATA service as listed in Table 8/G.773.

TABLE 8/G.773

N-UNITDATA service

Parameter name	Request	Indication
Source address	M	M(=)
Destination address	M	M(=)
QOS	M	M
NS-User data	M	M(=)

3.3.2 *Network protocol*

3.3.2.1 *General*

The Network protocol is as specified in ISO 8473 [11]. The sub-network dependent convergence function required for protocol suite A1 is specified in ISO 8473/AD 3 [19]. ISO 8473 [11] defines in addition to the full protocol (see § 3.3.2.4), two subsets namely:

– inactive network layer protocol (see § 3.3.2.2),

– non-segmenting network layer protocol (see § 3.3.2.3).

The address part shall have the structure as defined in ISO 8348/AD 2 [10].

For protocol suite A1 the Authority and Format Identifier (AFI) shall be set to 49, coded by 2 decimal digits as defined in ISO 8348/AD 2 [10], which specifies "local" and binary coding of the Domain Specific Part (DSP).

For protocol suite A2 the authority and format identifier (AFI) shall be set to 38, 39, 48 or 49, coded by two decimal digits as defined in ISO 8348/AD 2 [10], which means ISO Data Country Code (ISO DCC) and decimal coding of domain specific part (DSP), ISO DCC and binary coding of DSP, "local" and decimal coding of DSP, or "local" and binary coding of DSP, respectively.

The full protocol and the two subsets permit the use of known sub-network characteristics and are therefore not sub-network independent.

Depending on the required usage and the sub-network architecture the full protocol, or one or both subsets, shall be supported by protocol suite A. The selection shall be put in the Protocol Implementation Conformance Statement (PICS).

3.3.2.2 *Inactive network layer protocol*

The protocol shall be in accordance with the inactive subset of the protocol as defined in ISO 8473 [11].

3.3.2.3 *Non-segmenting network layer protocol*

The protocol shall be in accordance with category type 1 functions of the non-segmenting subset of the protocol as defined in ISO 8473 [11].

From the optional functions (type 3) defined in the non-segmenting subset only the "priority function" shall be supported as defined in ISO 8473 [11].

3.3.2.4 *Full network layer protocol*

The full protocol subset of category type 1 functions, as specified in ISO 8473 [11], shall be supported.

An implementation shall not transmit PDUs encoded using the inactive subset. Received PDUs encoded using the inactive subset will be discarded.

An implementation shall not generate data PDUs without a segmentation part, i.e. the Segmentation Permitted Flag (SPF) shall be set to 1 and the segmentation part shall be included. However, an implementation shall be capable of receiving and correctly processing PDUs which do not contain the segmentation part.

3.4 *Mapping functions for A1 and A2*

3.4.1 *Introduction*

No transport layer, session layer and presentation layer will be specified for protocol suites A1 and A2.

To provide the required service to the application layer and using the provided service of the network layer a mapping function is defined.

No protocol for the mapping function is defined.

3.4.2 *Service*

3.4.2.1 *Service definition*

The service definition of the mapping function, which provides the required presentation service to the application layer, shall be in accordance with Recommendation X.216 [12].

3.4.2.2 *Service required from network layer*

The mapping function requires the N-UNITDATA as the connectionless-mode network service.

3.4.2.3 *Service provided by the mapping function*

The mapping function shall provide the presentation service as listed in Table 9/G.773.

TABLE 9/G.773

Service provided by the mapping function

Service	Primitive	Parameters
P-DATA	P-DATA-request	User data
	P-DATA-indication	

When ACSE is supported in the application layer the mapping function shall also provide the presentation services P-CONNECT, P-RELEASE, P-U-ABORT and P-P-ABORT. Only the parameters defined as mandatory in Recommendation X.216 [12] shall be supported. The value of the Mode parameter of P-CONNECT shall be “normal”.

3.4.3 *Procedure*

The mapping function will provide the values for the source address, destination address, QOS and NS-User data as required by the network service parameters. The mapping function will translate the presentation addresses to the Network-Service-Access-Point (NSAP) addresses and vice versa. It will provide the value of the quality of service parameter of N-UNITDATA Request. The NS-User data will be provided by the User data of P-DATA and vice versa.

Note – This is not a mapping protocol. While the service description of this function is standard, the implementation itself needs not to be standardized.

3.5 *Application layer for A1 and A2*

3.5.1 *Overview*

The network management application layer shall provide the CMISE service to the NM-ASE.

The required application service elements for this service are Common Management Information Service Element (CMISE) and Remote Operations Service Element (ROSE). Some applications may require the addition of the Association Control Service Element (ACSE).

3.5.2 *Syntax and encoding*

The application layer protocol data unit presentation is described by using Abstract Syntax Notation One (ASN.1), as defined in Recommendation X.208 [15] and is encoded in accordance with the basic encoding rules for ASN.1, as defined in Recommendation X.209 [16].

3.5.3 *Association control*

3.5.3.1 The ACSE service description is detailed in Recommendation X.217 [25]. When the ACSE is used all of the defined ACSE services (Table 10/G.773) are mandatory. The value of mode parameter of A-ASSOCIATE shall be "normal".

3.5.3.2 The protocol specification for ACSE shall follow Recommendation X.227 [26]. When the ACSE is used all five APDUs (see Table 10/G.773) specified in the standard are mandatory. The value of protocol version field of AARQ and AARE shall be version 1 only.

TABLE 10/G.773

ACSE services and associated APDUs

ACSE service	Associated APDUs	Related P-Service
A-ASSOCIATE	AARQ, AARE	P-CONNECT
A-RELEASE	RLRQ, RLRE	P-RELEASE
A-ABORT	ABRT	P-U-ABORT
A-P-ABORT	(None)	P-P-ABORT

3.5.4 *Remote operations*

3.5.4.1 The remote operations service element (ROSE) shall be a mandatory service element for the protocol suites A1 and A2. The ROSE service description is detailed in Recommendation X.219 [14]. All of the defined ROSE services (Table 11/G.773) are mandatory.

3.5.4.2 The protocol specification for ROSE shall follow Recommendation X.229 [18]. All four APDUs specified in the standard (see Table 11/G.773) are mandatory. In addition, the ability to support correct origination and reception of the linked-ID protocol element is required for protocol suites A1 and A2.

The requirement specified in Table 11/G.773 implies association class 3 in ROSE.

TABLE 11/G.773

ROSE services and associated APDUs

ROSE service	Associated APDUs	Related underlying service
RO-INVOKE	ROIV	P-DATA
RO-RESULT	RORS	P-DATA
RO-ERROR	ROER	P-DATA
RO-REJECT-U	RORJ	P-DATA
RO-REJECT-P	RORJ	P-DATA

3.5.5 *Common management information*

3.5.5.1 The common management information service element (CMISE) shall be a mandatory service element for the protocol suites A1 and A2. The CMISE service description is detailed in ISO 9595 [13], ISO 9595/DAD 1 [27] and ISO 9595/DAD 2 [28]. The CMISE services are listed in Table 12/G.773.

TABLE 12/G.773

CMISE services

Service	Type
M-EVENT-REPORT	confirmed/non-confirmed
M-GET	confirmed
M-SET	confirmed/non-confirmed
M-ACTION	confirmed/non-confirmed
M-CREATE	confirmed
M-DELETE	confirmed
M-CANCEL-GET	confirmed

3.5.5.2 The protocol specification for CMISE shall follow ISO 9596 [17], ISO 9596/DAD 1 [29] and ISO 9596/DAD 2 [30].

3.6 *Conformance*

For further study.

4 Protocol suites B1, B2 and B3

4.1 *Physical layer*

4.1.1 *Physical layer for B1 and B2*

4.1.1.1 *Protocol*

The protocol of the physical layer of protocol suites B1 and B2 shall comply with the following specifications:

- X.21 interface in accordance with § 1.1 of Recommendation X.25 [39];
- X.21 *bis* interface in accordance with § 1.2 of Recommendation X.25 [39];
- V-Series interface in accordance with § 1.3 of Recommendation X.25 [39].

4.1.1.2 *Bit rate*

The supported bit rates are: 1200, 2400, 4800, 9600, 19200 and 64000 bit/s. The bit rates 48000 bit/s and 56000 bit/s may be used for an interim period (see note a) to Table 19b/G.773).

4.1.1.3 *Connector*

Table 13/G.773 lists the connectors to be used in accessing the X.21 [61] and X.21 *bis* [62] interfaces. Tables 14/G.773, 15/G.773 and 16/G.773 list respectively the pin descriptions of ISO 2110 [37], ISO 2593 [38], ISO 4902 [24] and ISO 4903 [63].

TABLE 13/G.773

X.21/X.21*bis* connectors

Data signalling rate	X.21 *bis*	X.21
2 400 bit/s	ISO 2110	ISO 4903
4 800 bit/s	ISO 2110	ISO 4903
9 600 bit/s	ISO 2110	ISO 4903
19 200 bit/s	ISO 2110	ISO 4903
48 000 bit/s	ISO 2593 ISO 4902	ISO 4903
56 000 bit/s	ISO 2593	ISO 2593
64 000 bit/s	ISO 4902	ISO 4903

TABLE 14/G.773

ISO 2110 [37] pin description (Note 6)

Pin	V.24 [32] circuit	Description	Notes
1	101	Protective ground (shield)	1
7	102	Signal ground	2
2	103	Transmitted data	2
3	104	Received data	2
4	105	Request to send	2
5	106	Clear to send	2
6	107	Data set ready (DCE Ready)	2
20	108.2	Data terminal ready (DTE Ready)	3
22	125	Ring indicator	3
8	109	Received line signal detector	2
24	113	Transmitter signal element timing (DTE to DCE)	4
15	114	Transmitter signal element timing (DCE to DTE)	5

Note 1 – Equipment: removable strap to frame ground or other equivalent grounding arrangement. Cable: connected to shield.

Note 2 – Basic interchange circuits, all systems.

Note 3 – Additional interchange circuits required for switched service.

Note 4 – Circuit 113 is not used in OS/MD-NE interfaces.

Note 5 – Additional interchange circuits required for synchronous channel.

Note 6 – Duplex, Interface Type D.

Circuits are grouped by function: ground, data, control and timing.

For further information, see Recommendations V.24 [32] and V.28 [34], and ISO 2110 [37].

TABLE 15/G.773

V.35 [35], ISO 2593 [38] pin description (Note 3)

Pin	Circuit	Description	Notes
A	101	Protective ground	1
B	102	Signal ground	
P	103	Transmitted data A-wire	2
S	103	Transmitted data B-wire	2
R	104	Received data A-wire	2
T	104	Received data B-wire	2
C	105	Request to send	
D	106	Ready for sending	
E	107	Data set ready	
F	109	Data channel receive line signal detector	
Y	114	Transmitter signal element timing A (DCE to DTE)	2
AA	114	Transmitter signal element timing B (DCE to DTE)	2
V	115	Receiver signal element timing A (DCE to DTE)	2
X	115	Receiver signal element timing B (DCE to DTE)	2

Note 1 – Equipment: removable strap to frame ground or other equivalent grounding arrangement. Cable: connected to shield.

Note 2 – The electrical characteristics of the interchange circuits 103, 104, 114 and 115 shall be balanced double-current, conforming to Appendix II of Recommendation V.35 [35].

All other circuits shall conform to Recommendation V.28 [34].

Note 3 – The mode is synchronous at 64000 bit/s.

Some countries may use 56000 bit/s for an interim period of time.

Circuits are grouped by function: ground, data, control and timing.

For further information, see Recommendations V.35 [35], V.24 [32] and V.28 [34] and ISO 2593 [38].

TABLE 16/G.773

ISO 4903 [63] pin description (Note 2)

Pin	X.21 circuit	Description	Notes
1 8	– G	Protective ground Signal ground or common return	1
2 9 4 11	T T R R	Transmit A-wire Transmit B-wire Receive A-wire Receive B-wire	
3 10 5 12	C C I I	Control A-wire Control B-wire Indication A-wire Indication B-wire	
6 13	S S	Signal element timing A-wire Signal element timing B-wire	

Note 1 – Equipment: removable strap to frame ground or other equivalent grounding arrange-ment.
Cable: connected to shield.

Note 2 – Circuits are grouped by functions: ground, data, control and timing.

For further information: see Recommendations V.10 [64],V.11 [36] and X.21 [61] and ISO 4903 [63].

4.1.2 *Physical layer for B3*

4.1.2.1 *Overview*

Protocol suite B3 employs local area network technology for the physical and data link layers. Administrations will select the appropriate physical medium, e.g. coaxial cable, screened pairs, optical fibre according to technological and operational requirements.

4.1.2.2 *Service*

The service definition for the physical layer shall comply with that specified in clause 6 of ISO 8802-3 [20].

All of the primitives defined and listed in Table 17/G.773 are mandatory.

TABLE 17/G.773

Primitives of the physical layer

Primitive
PLS-DATA-request
PLS-DATA-indication
PLS-CARRIER-indication
PLS-SIGNAL-indication

4.1.2.3 *Bit rate*

The possible bit rate will be 1 Mbit/s, 10 Mbit/s or higher.

4.2 *Data link layer*

4.2.1 *Data link layer for B1 and B2*

It is mandatory that the data link layer conforms to LAPB as defined in Recommendation X.25 [39]. In addition, provision shall be made for connection between data terminal equipments without an intervening packet switched network. The interface shall conform to ISO 7776 [40]. Further detail is provided in § 4.2.1.1.

The following link layer specification applies to all cases.

4.2.1.1 *Equipment type during link set-up and reset*

When a packet switched network is used to connect systems, they are each designated Data Terminal Equipment (DTE) and the network acts as a Data Circuit-Terminating Equipment (DCE). When a dedicated or dial-up link is provided, other means must be used to supply the DCE role.

At the physical layer, the modems will provide the DCE interface, supplying bit synchronization.

At the link level, the procedures specified in ISO 7776 [40] shall be followed. A system must be able to start the set-up or reset of the link (a DCE function in Recommendation X.25 [39]). In addition, provision must be made for assignments of the A/B addresses. This mandatory option is to be field-settable and stored in non-volatile memory. Equipment which meets this requirement is compatible with connection to either a DCE or remote DTE.

4.2.1.2 *Window*

Modulo 8 operation shall be used. Support of modulo 128 is optional. The window for unacknowledged frames is to be optional between 1 and 7 frames and 1 to 127 with modulo 128. The standard default is 7.

4.2.1.3 *User information*

The user information is to be arranged in an integral number of octets.

The maximum length of the user information shall be user settable, consistent with the range of values for the N1 parameter as shown in Table 18/G.773. Maximum information field lengths that shall be supported are 131 and 259 octets with optionally 515, 1027, 2051 or 4099 octets. These values provide for three packet header octets and maximum length of packet data units of 128, 256, 512, 1024, 2048 and 4096 octets, respectively.

4.2.1.4 *Other frame parameters*

Certain other frame parameters shall be set by the user to be consistent with the bit rate, frame size and characteristics of the connecting network. A system design should be sufficiently flexible to accommodate parameter sets for diverse networks, both as order options and later reconfigurations. The range of parameters is shown in Table 18/G.773. These options, like those of the physical layer, are to be set at installation, changeable by the user, and non-volatile.

TABLE 18/G.773

LAPB data link layer attributes

LAPB protocol octet aligned Single link procedure (SLP)			
Parameter	Function	Range	Default
K	I-Frames window	1 to 7 (with modulo 8) 1 to 127 (with optional modulo 128)	7 7
T1	Waiting acknowledgement (retry) timer [a] for up to 9600 bit/s for 56 000 bit/s	 2 to 20 seconds 0.2 to 20 seconds	 3 3
T2	Response delay parameter [a]	Not greater than 0.3 seconds	
T3	Disconnect timer	[b]	
T4	No activity timer	4 to 120 seconds	20
N1	Bits per I-frame, excluding flags and zero bit insertion for transparency [c]	1080, 2104 (with modulo 8) Optional [d] (with modulo 8): 4152, 8248, 16440, 32824 1096, 2120 (with modulo 128) Optional [d] (with modulo 128): 4168, 8264, 16456, 32840	2104 2120
N2	Retransmission count	2 to 16	7
A/B	Address assignment	Selectable by the user	

a) Further guidelines on the use of T1 and T2 can be found in Recommendation X.25 [39] and ISO 7776 [40]. The transport layer T1 timer should always be greater than the link layer T1 timer.

b) The value of timer T3, the disconnect timer, is not critical for successful interworking of OSs and NEs. Therefore no value is specified.

c) In some cases, users may need to choose a maximum information field length of 259 octets (N1 = 2104 for modulo 8 or N1 = 2120 for modulo 128) with a 128 octet packet data unit in order to accommodate call request packets containing 128 octet user data fields in addition to the packet header and facility fields. These values are based on modulo 8 or modulo 128 operation at both link and packet layer.

d) Optional

The default values shall be part of a vendor's offering. That is, unless otherwise specified by the user, the default parameters shall be the initial values supplied. They can be subsequently changed by the user within the specified range.

4.2.2 *Data link layer for B3*

4.2.2.1 *Overview*

The data link layer provides the unacknowledged connectionless-mode service. The access method employed is carrier sense multiple access with collision detection (CSMA/CD).

4.2.2.2 *Media access control (MAC)*

The services and protocol of the CSMA/CD access method shall comply with those specified in ISO 8802-3 [20].

The address length used at the MAC sublayer shall be 48 bits.

4.2.2.3 *Logical link control (LLC)*

The definition of the unacknowledged connectionless-mode LLC service shall comply with that specified in ISO 8802-2 [22]. All of the primitives defined for type 1 operation shall be supported.

The protocol used to provide the unacknowledged connectionless-mode LLC service shall be as specified in ISO 8802-2 [22]. All of the commands and responses defined for type 1 operation shall be supported.

4.3 *Network layer*

4.3.1 *Network layer for B1*

It is mandatory that the packet layer conforms to Recommendation X.25 [39]. In addition, the packet layer must provide for connection of data terminal equipment without an intervening packet network; the required interface for this purpose conforms to ISO 8208 [41]. In addition, the provisions of Recommendation X.223 [42] shall apply.

The attributes which must be supported are summarized in Tables 19a/G.773 and 19b/G.773. Note in particular that these tables show the different attributes needed to support PVCs (the X.25/PVC [39] procedures) and SVCs (the X.25/SVC [39] procedures).

4.3.1.1 *Equipment type during restart*

When the packet level X.25 [39] interface is used, automatic selection of the DCE/DTE role during restart is required, as specified in ISO 8208 [41].

4.3.1.2 *Other features and parameters*

The packet layer attributes are summarized in Tables 19a/G.773 and 19b/G.773.

TABLE 19a/G.773

X.25 [39] packet layer attributes for permanent virtual circuits

	Range	Default
Extended packet sequence numbering	Modulo 128 optional	
Packet size (octets)	128, 256 512, 1024, 2048, 4096 optional	128
Window size Extended sequence number option	1-7 (with modulo 8) 1-127 (with optional modulo 128)	2 2
Interrupt packets	Optional	

Note 1 – The default values shall be part of a vendor's offering. That is, unless otherwise specified by the user, the default parameters shall be the initial values supplied. They can be subsequently changed by the user within the specified range.

Note 2 – The attributes which are not marked optional are mandatory.

Note 3 – The ranges specified for negotiated parameters in no way affect the normal negotiation rules specified in the international standards.

TABLE 19b/G.773

X.25 [39] packet layer attributes for switched virtual circuits

	Range	Default
Flow control parameters		
Packet size (octets)	128, 256 (512 optional)	128
Window size	1-7 (with modulo 8)	2
Extended sequence number option	1-127 (with optional modulo 128)	2
Throughput class [a] bit rate (bit/s)	1200, 2400, 4800, 9600, 19200 and 64000	2400
Expedited data negotiation closed user group		
Closed user group selection basic format	2 decimal digits	
Fast select		
Fast select acceptance	128 octets	
Hunt group	Optional	
Transit delay selection and indication		
Calling address extension		
Called address extension		
Minimum throughput class negotiation		
End-to-end transit delay negotiation		

a) Some countries may use 56000 bit/s for an interim period of time. In addition to the codes specified in the table in § 7.2.2.2 of Recommendation X.25 [39], 56 000 bit/s shall be encoded as binary "1100". 48 000 bit/s is encoded as binary "1100" in that table, but when 56000 bit/s is supported, the code shall stand for 56000 bit/s.

Note 1 – The default values shall be part of a vendor's offering. That is, unless otherwise specified by the user, the default parameters shall be the initial values supplied. They can be subsequently changed by the user within the specified range.

Note 2 – The attributes which are not marked optional are mandatory.

Note 3 – The ranges specified for negotiated parameters in no way affect the normal A negotiation rules specified in the international standards.

4.3.1.3 *Expedited data negotiation*

The initiator shall be capable of proposing the non-use of the Expedited Data service. Responders shall be capable of receiving requests for the Expedited Data service, but shall be capable of responding with non-use of the service. The Expedited Data service is neither required nor precluded by this Recommendation.

4.3.1.4 *Receipt confirmation negotiation*

The initiator shall be capable of setting bit 7 of the general format identifier to 0. Responders shall be capable of receiving bit 7 set to 1, but shall be capable of responding with bit 7 set to 0. The Receipt Confirmation service is neither required nor precluded by this Recommendation.

4.3.1.5 *Throughput class*

When the end system requires only one network layer connection on a physical access port, support of throughput classes up to the access line transmission rate is required. When multiple network layer connections are required, support of the throughput class equal to the access line transmission rate is optional. Further study of throughput class range and default values at various access line rates is needed.

4.3.1.6 *Packet size negotiation*

Interoperability is achieved by having the initiator propose a packet size from the set specified in Tables 19a/G.773 and 19b/G.773, and by the responder selecting the most appropriate packet size between 128 and the proposed packet size. The rules for negotiation of the size of the packet to be used in a given instance of communication are specified in ISO 8208 [41].

The choice of packet size is a local issue which can depend on, for example, the quality of service requested or needed by the user or application and the sub-network characteristics.

4.3.1.7 *User data field*

When layers above X.25 [39] are used, the initial octets of a DATA primitive and the corresponding data transfer packet are used for peer-to-peer protocol data for those layers.

In following the procedures of Recommendation X.244 [43], ISO DTR 9577 [44], Annex B of Recommendation X.224 [49] and ISO 8073/AD 1 [45], the initial octets of the user data field of the call request packet may only be used for protocol identification. For those cases in which the fast select feature is used, the call request packet may contain a call user data field of up to 128 octets.

4.3.1.8 *Numbering plans*

To support communications over public networks, public numbering plans may be used on the packet-switched network between OSs/MDs and NEs. The Recommendations E.164 [21] and X.121 [46] specify public numbering plans. Equipment may be assigned numbers in accordance with either of these international Recommendations. The escape code values of "0" and "9" shall be supported as specified in Table 2/X.121 of Recommendation X.121 [46]. Where a public numbering plan is not necessary, a private numbering plan may be used.

4.3.1.9 *Addressing*

Network layer addressing as specified in Recommendation X.213, Annex A [47] and ISO 8348/AD 2 [10] shall be supported.

4.3.2 *Network layer for B2*

4.3.2.1 *Protocol*

The protocols for the network layer shall be identical to the network layer protocol of protocol suite B1 (see § 4.3.1) with the inclusion of ISO 8473 [11] as specified in ISO 8880/3 [59] § 3, to provide the connectionless-mode network service over the connection-mode network service.

For those instances of communication requiring interworking between a Connection Oriented Service (CONS) and a Connectionless-mode Network Service (CLNS), ISO DTR 10172 [60] provides an ISO compatible interworking capability. This capability is known as a Network Layer Relay (NLR) and utilizes the ISO 8473 [11] protocol to provide this service.

4.3.2.2 *Network layer attributes*

Characteristics of the connectionless-mode network layer service, and the connectionless-mode network layer protocol shall be as shown in Table 20/G.773.

4.3.3 *Network layer for B3*

4.3.3.1 *Service*

The definition of the connectionless-mode network service shall comply with that specified in ISO 8348/AD 1 [9]. Address formats supported shall conform to ISO 8348/AD 2 [10].

The network layer shall provide the N-UNITDATA service as specified in ISO 8348/AD 1 [9].

4.3.3.2 *Protocol*

The protocol shall be in accordance with the full protocol subset of category type 1 functions, as specified in ISO 8473 [11].

4.3.3.3 *Network layer attributes*

Characteristics of the connectionless-mode network layer service and the connectionless-mode network layer protocol shall be as shown in Table 20/G.773.

TABLE 20/G.773

Network layer service/protocol parameters

a) Destination and source addresses used by this protocol shall be network service access points (NSAP) addresses, as specified in ISO 8348/AD 2 [10] or Rec. X.213 [47] (Annex A). The destination and source addresses are of variable length. The destination and source address fields shall be as network protocol address information using the preferred binary encoding specified in ISO 8348/AD 2 [10].
b) The setting of the error reporting flag (E/R) shall be a local matter. *Note* – The use of error reporting and setting the E/R flag to 1 may lead to excessive network traffic.
c) Partial source routing shall NOT be supported. A defect exists with this option which can cause PDUs to loop in the network until their lifetime expires.
d) Inactive subset – Implementations shall not transmit PDUs encoded using the ISO 8473 [11] inactive subset. Received PDUs encoded with the inactive subset shall be discarded.
e) Segmentation – The non-segmentation subset shall NOT be used. However, implementations shall be capable of receiving and correctly processing PDUs which do not contain the segmentation part.
f) Segmentation permitted flag – Implementations shall NOT generate data PDUs without a segmentation part, i.e. the segmentation permitted flag (SPF) shall be set to 1 and segmentation part shall be included.
g) Lifetime control – The lifetime parameter shall be used as specified in clause 6.4 of ISO 8473 [11]. This parameter shall have an initial value of at least three times the network span (number of network entities) or three times the maximum transmission delay (in units of 500 milliseconds), whichever is greater.

4.4 *Transport layer*

4.4.1 *Transport layer for B1*

It is mandatory that for the connection-oriented network service, the transport layer shall conform to Recommendations X.214 [48] and X.224 [49] and to those provisions of ISO 8072 [50] and 8073 [51] that apply to the use of the Connection-Oriented Network Service (CONS).

4.4.1.1 *Class of service*

Classes 4, 2 and 0 shall be supported as shown in Table 21/G.773 in countries requiring the features of transport layer class 4. The conformance rules of Recommendation X.224 [49] require that classes 0 and 2 be supported as well when class 4 is specified.

TABLE 21/G.773

Transport layer attributes for connection-oriented network service

	Range	Default
Maximum TPDU (octets)	128, 256, 512, 1024 (2048, 4096, 8192 optional)	128
TSAP-ID [a]	Up to 32 octets	
Class of service	4, 2, 0	
Preferred class	4, 2, 0	4
Alternative class	0, none	None
Expedited data	non-use	
Options for class 4		
Data TPDU numbering [b]	Normal, extended	Normal
Checksum [c]	Use, non-use	Non use
Options for class 2		
Data TPDU numbering [b]	Normal, extended	Normal
Flow control	Explicit	
Parameters for class 4		
T1 Retransmission time	0.25-64 seconds [d]	8
N Retransmissions	2 (other values for further study)	
L Bound on reference	1-256 seconds	32
I Inactivity time	2-512 seconds	64

a) Some systems may require TSAP-IDs. However, all systems shall be capable of generating called TSAP-IDs in CR TPDUs and capable of receiving calling and called TSAP-IDs in received CR and CC TPDUs, respectively.

b) Extended format option shall be implemented. Non-use of this option shall be negotiable. The responder shall honour the initiator's request whenever possible. Negotiation to other than what has been requested shall only occur under abnormal conditions: for example, severe congestion, as determined by the implementor. Initiators shall be prepared to operate in the mode confirmed by the responder.

c) Use of checksum is required for the CR TPDU. An additional requirement is that all implementations shall support the negotiated "non-use" of the checksum. Initiators shall request and responders shall agree to "non- use" of the checksum.

d) The transport layer T1 timer should always be greater than the link layer T1 timer.

Note – The default values shall be part of a vendor's offering. That is, unless otherwise specified by the user, the default parameters shall be the initial values supplied. They can be subsequently changed by the user within the specified range.

In addition to the requirements specified in Recommendation X.224 [49], equipment shall meet the following requirement: if a responder receives an alternate class of "none", it shall respond with the preferred class. Rules for responders are specified in Table 22a/G.773. Acceptance rules for initiators are specified in Table 22b/G.773.

User options shall be provided to designate the preferred and alternate classes (see Table 3 of Recommendation X.224 [49]). When all of the classes are supported, the preferred class for connection is class 4.

TABLE 22a/G.773

Transport class selection rules: Response rules for responder

Preferred class	Alternative class		
	0	2	None
0	Not valid	Not valid	Class 0
2	Classes 0, 2	Class 2	Class 2
4	Classes 0, 2, 4	Class 2 or 4	Class 4

Note 1 – When all of the classes are supported, the preferred class, when initiating a CR-TPDU, shall be class 4.

Note 2 – If a responder receives an alternative class of "none", it shall respond with the preferred class.

TABLE 22b/G.773

Transport class selection rules: Acceptance rules for initiator

Preferred class	Alternative class		
	0	2	None
0	Not valid	Not valid	Class 0
2	Classes 0, 2	Class 2	Class 2
4	Classes 0, 2, 4	Class 2 or 4	Class 2 or 4

Note 1 – When all of the classes are supported, the preferred class, when initiating a CR-TPDU, shall be class 4.

Note 2 – If class 4 is proposed, then class 2 is a valid response.

Note 3 – For existing equipment and in countries not requiring class 4, support of classes 0 and 2 is mandatory.

4.4.1.2 *Protocol identification*

For the purpose of transport layer protocol identification, the procedures specified in Recommendation X.224 [49] Annex B and ISO 8073/AD 1 [45] shall be used. The conventions for protocol identification given in ISO DTR 10172 [60] should be followed. Selection of codes not specified in the referenced standards is for further study. The absence of call user data in a call request or call accept packet of Recommendation X.25 [39] and ISO 8208 [41] indicates the operation of the transport layer procedures of ISO 8073 [51] and Recommendation X.224 [49].

4.4.1.3 *Attributes*

Attributes of the transport layer for use with CONS are summarized in Table 21/G.773. The selection of values within required and optional ranges depends on characteristics of the messages.

Note – The need to support high priority messages that require low transit delay on a given transport connection must be reflected in the quality of service parameters requested when the transport connection is established. A properly implemented transport entity should not multiplex high priority messages that require low transit delay if it cannot provide the requested quality of service.

4.4.1.4 *User data in connection request and connection confirm TPDUs*

User data in the connection request and connection confirm TPDUs are optional in Recommendation X.224 [49]. No transport service user shall send it: all protocol implementations shall be prepared to receive it and all implementations may ignore it, i.e. it shall not cause a disconnect.

4.4.1.5 *Splitting*

Responders may refuse network connections which could impose an unnecessary restriction on the ability to establish outgoing network connections. To prevent repeated ineffective attempts during splitting, initiators shall refrain from immediately requesting additional network connections for a transport connection after a network connection has been refused. The time delay before requesting additional network connections is for further study.

4.4.1.6 *Quality of service negotiation*

Quality of service negotiation is outside the scope of this Recommendation. If quality of service negotiation is not supported, receipt of the parameters "throughput", "residual error rate", "priority" and "transit delay" in the CR and CC TPDUs shall be ignored.

4.4.1.7 *TPDU size negotiation*

Interoperability is achieved by having the initiator propose a TPDU size from the set specified in Table 21/G.773 and by the responder selecting the most appropriate TPDU size between 128 octets and the proposed TPDU size. The rules for negotiation of the size of the TPDU to be used in a given instance of communication are specified in ISO 8073 [51].

The choice of the TPDU size is a local implementation issue.

4.4.1.8 *Class 0 error TPDU*

When transport class 0 has been negotiated, the error transport protocol data unit (ER-TPDU) may be used at any time and upon receipt requires that the recipient disconnect the network connection and, by extension, the transport connection.

4.4.1.9 *Negotiation of protection*

Negotiation of protection is outside the scope of this Recommendation. If negotiation of protection is not supported, receipt of the protection parameters in any CR TPDU and any CC TPDU shall be ignored.

4.4.1.10 *Unknown CR TPDU parameters*

An unknown parameter in any received CR TPDU shall be ignored.

4.4.1.11 *Invalid values of known CR TPDU parameters*

Known parameters with valid lengths but with invalid values in a CR TPDU shall be handled as depicted in Table 23/G.773.

TABLE 23/G.773

TPDU parameters

Parameter	Action
TSAP ID	Send DR TPDU
TPDU size	Ignore parameter, use default
Version	Ignore parameter, use default
Checksum	Discard CR TPDU
Alternate protocol classes	Protocol error

4.4.1.12 *Additional options parameter*

Unrecognized or not applicable bits of the Additional Options shall be ignored.

4.4.1.13 *Code misalignment*

For further study.

A misalignment between Recommendation X.224 [49] and ISO 8073 [51] code values for subsequence number and flow control confirmation has been identified. As a short-term solution, ISO 8073 [51] shall apply.

Subsequence number	1000	1010
Flow control confirmation	1000	1100

It is intended that when an ISO/CCITT solution to this defect is available, this Recommendation will be modified to align with the solution.

4.4.2 *Transport layer for B2 and B3*

4.4.2.1 *Protocol*

Operation of the transport protocol over the connectionless-mode network layer service (CLNS), as described in ISO 8348/AD 1 [9], shall use the elements of ISO 8073/AD 2 [52], class 4 operation over the CLNS.

4.4.2.2 *Class of service*

Support of class 4 operation of ISO 8073/AD 2 [52] is mandatory.

4.4.2.3 *Transport layer attributes*

Transport layer attributes for class 4 operation over the connectionless-mode network layer service shall be as shown in Table 24/G.773.

TABLE 24/G.773

Transport layer attributes for connectionless network service

	Range	Default
Maximum TPDU (octets)	128, 256, 512, 1024 (2048, 4096, 8192 optional)	128
TSAP-ID [a]	Up to 32 octets	
Class of service	4	
Preferred class	4	
Alternative class	None	
Expedited data	Non-use	
Options for class 4		
Security parameters	Optional	
Data TPDU numbering [b]	Normal, extended	Normal
Checksum [c]	Use, non-use	Non use
Parameters		
T1 Retransmission time	0.25-64 seconds [d]	8
N Retransmissions	2-15	2
L Bound on reference	1-256 seconds	32
I Inactivity time	2-512 seconds	64

a) Some systems may require TSAP-IDs. However, all systems shall be capable of generating called TSAP-IDs in CR TPDUs and capable of receiving calling and called TSAP-IDs in received CR and CC TPDUs, respectively.

b) Extended format option shall be implemented. Non-use of this option shall be negotiable. The responder shall honour the initiator's request whenever possible. Negotiation to other than what has been requested shall only occur under abnormal conditions: for example, severe congestion, as determined by the implementor. Initiators shall be prepared to operate in the mode confirmed by the responder.

c) Use of checksum is required for the CR TPDU. An additional requirement is that all implementations shall support the negotiated "non-use" of the checksum. Initiators shall request and responders shall agree to "non-use" of the checksum.

d) The transport layer T1 timer should always be greater than the link layer T1 timer.

Note 1 – The default values shall be part of a vendor's offering. That is, unless otherwise specified by the user, the default parameters shall be the initial values supplied. They can be subsequently changed by the user within the specified range.

Note 2 – A conflict in the code values for subsequence number and flow control confirmation exists between CCITT and ISO. The conflict is expected to be resolved as specified in ISO 8073 [51].

4.5 *Session layer for B1, B2 and B3*

The session layer conforms to the service definition and protocol specification in Recommendations X.215 [53] and X.225 [54] respectively. Support of version 2 of the session protocol is mandatory. Two session layer functional units (FU) are required in this Recommendation:

1) Kernel

2) Duplex

Restrictions applied to parameters and their values are specified in the following sections.

4.5.1 *Session protocol data units*

The following Session Protocol Data Units (SPDUs) associated with the Kernel and Duplex functional units shall be supported as detailed in Table 25/G.733.

TABLE 25/G.773

Session PDUs

Connect	(CN SPDU)
Accept	(AC SPDU)
Refuse	(RF SPDU)
Finish	(FN SPDU)
Disconnect	(DN SPDU)
Abort	(AB SPDU)
Abort Accepted	(AA SPDU)
Data Transfer	(DT SPDU)

4.5.2 *Transport expedited service*

The use of the Transport Expedited service is as stated in Recommendation X.225 [54]: if available, it must be used. When the Transport Expedited service is available, the Prepare (PR) SPDU shall be supported as in Recommendation X.225 [54]. The Prepare Type parameter value in the PR SPDU, to indicate the arrival of an Abort (AB) SPDU, is ABORT.

4.5.3 *Parameters*

All mandatory parameters defined in Recommendation X.225 [54] for the SPDUs required by the Kernel and Duplex FUs are mandatory parameters for this Recommendation.

4.5.4 *User data*

The maximum length of the session user data shall be 10240 octets. This restriction implies that the Overflow Accept (OA) and Connect Data Overflow (CDO) SPDUs are not required to be supported. Session-selector (s-selector) parameter values shall have a maximum length of 16 octets.

4.5.5 *Reuse*

Reuse of the transport connection is not required. The Transport Disconnect parameter value (PV) field may be absent or set to “transport connection is released” in appropriate SPDUs. Furthermore, on receipt of a transport disconnect PV field indicating “transport connection is kept”, the transport connection can be released.

4.5.6 *Segmentation*

The segmentation feature in the session layer is not required. Support for extended concatenation of SPDUs is not required.

4.5.7 *Invalid SPDUs*

Upon receipt of an invalid SPDU, the session protocol machine shall take any action specified in § A.4.3.2 of Recommendation X.225 [54] with the exception of action “d” (take no action).

4.6 *Presentation layer for B1, B2 and B3*

It is mandatory that the presentation layer conform to the services and protocols specified in Recommendations X.216 [12] and X.226 [55] respectively. One presentation layer Functional Unit (FU) is required in this Recommendation: Kernel

The presentation protocol shall be used in the normal mode. Restrictions applied to parameters and their values are specified in the following sections.

4.6.1 *Presentation protocol units*

The following presentation protocol data units (PPDU) associated with the Kernel functional unit shall be supported as detailed in Table 26/G.733.

TABLE 26/G.773

Presentation PDUs

Connect Presentation	(CP PPDU)
Connect Presentation Accept	(CPA PPDU)
Connect Presentation Reject	(CPR PPDU)
Abnormal Release Provider	(ARP PPDU)
Abnormal Release User	(ARU PPDU)
Presentation Data	(TD PPDU)

4.6.2 *Parameters*

All mandatory parameters defined in Recommendation X.226 [55] for the above PPDUs are mandatory for this Recommendation. The "presentation context identifier" value shall be encoded in no more than 2 octets. Also, the value(s) in the parameter presentation context definition list shall be consistent with the value(s) defined in the application-specific standards. Presentation-selector (p-selector) parameter values shall have a maximum length of 4 octets.

4.6.3 *Encoding rules for transfer syntax*

The encoding rules defined in Recommendation X.209 [16] shall be applied to derive the transfer syntax for the Application Protocol Data Units (APDUs). The ASN.1 OBJECT IDENTIFIER {joint-iso-ccitt asn1 (1) basic-encoding (1)} shall be used as the value for the transfer syntax name. The maximum value of an ASN.1 basic encoding tag that needs to be handled for conformance to this Recommendation is 16383. This is the largest unsigned integer that can be represented in 14 bits. Hence the identifier octets shall consist of an initial octet and up to two more octets, thus occupying a maximum of 3 octets. Also, the largest number of octets in the "contents octets" component of an ASN.1 data value encoding that needs to be handled for conformance to this Recommendation is 4294967295. This is the largest unsigned integer that can be represented in 32 bits. Hence in the "long form" encoding, the length octets shall consist of an initial octet and up to four more octets, thus occupying a maximum of 5 octets. (Note that this restriction does not apply to "indefinite length" encodings.)

4.7 *Application layer for B1, B2 and B3*

It is mandatory that the application layer conforms to the architecture for the application layer outlined in ISO 9545 [56]. Abstract Syntax Notation One (ASN.1) shall be used as the abstract syntax for specifying application protocols.

4.7.1 *Supporting ASE*

It is mandatory that the association control service elements (ACSE) conform to the services and protocols specified in Recommendations X.217 [25] and X.227 [26]. The ACSE shall establish, release and abort the associations required. The ACSE service shall operate in the "normal mode".

Network management applications shall use the common management information service element (CMISE). Services defined by CMISE that are applicable include:

1) the reporting of an event to an OS/MD;

2) the transfer of information between OSs/MDs and NEs;

3) the transer of action requests and results between OSs/MDs and NEs.

4.7.2 *Application protocol data units*

The following application protocol data units shall be supported as detailed in Table 27/G.773.

TABLE 27/G.773

Application PDUs

A-Associate-Request	(AARQ APDU)
A-Associate-Response	(AARE APDU)
A-Release-Request	(RLRQ APDU)
A-Release-Response	(RLRE APDU)
A-Abort	(ABRT APDU)

All mandatory parameters defined in Recommendation X.227 [26] for the above APDUs are mandatory for this Recommendation.

4.7.3 *Abstract syntax name*

The ACSE abstract syntax name has the ASN.1 type OBJECT IDENTIFIER. The following value shall be used to identify the ACSE abstract-syntax-definition:

{
joint-iso-ccitt association-control (2)
abstract-syntax (1) apdus (0) version (1)
}

4.7.4 *Common management information service (CMIS)*

The common management information service element (CMISE) shall be a mandatory service element for the Protocol Suite B1, B2 and B3. The CMISE service description is detailed in ISO 9595 [13], ISO 9595/DAD 1 [27] and ISO 9595/DAD 2 [28].

Multiple object selection filter and Multiple reply functional units as defined in ISO 9595 [13] are optional. Their use is application dependent. The negotiation during association establishment to use or not use the Functional Units shall be supported.

Support of the extended service functional unit defined in ISO 9595 [13] is not required for conformance to this Recommendation and negotiation shall be supported, at association establishment, for its non-use.

4.7.5 *Common management information protocol*

Implementations shall support those operations defined in ISO 9596 [17], ISO 9596/DAD 1 [29] and ISO 9596/DAD 2 [30] that are required by specific applications. All mandatory parameters defined in ISO 9596 [17], ISO 9596/DAD 1 [29] and ISO 9596/DAD 2 [30] for the required operations are mandatory parameters for this Recommendation.

4.7.6 *Remote operations service element (ROSE)*

Network Management Transaction-oriented applications shall use the following underlying service defined in Recommendation X.219 [14]:

– Remote operations service element (ROSE). The protocol is specified in Recommendation X.229 [18].

The requirement specified above implies association class 3 in ROSE.

4.8 *Conformance*

For further study.

ANNEX A

(to Recommendation G.773)

Example of extended mode for A1 protocol suite

A.1 *Extended mode*

For those cases where it is required to extend beyond the range of the bus, one or several different capabilities may be used. For the case using modems the requirements of §§ 3.1.1.2.1 to 3.1.1.2.3 apply with the following exceptions:

A.1.1 *Configuration – Full duplex*

The connector shall conform to IEEE 488 [31]. Appropriate signal lines are to be provided for modem control in accordance with Recommendation V.24 [32]. See Table A-1/G.773.

A.1.2 *Electrical requirements*

Data set control leads shall conform to Recommendation V.24 [32].

A.1.3 *Line code*

NRZ line code shall be employed. A separate clock distribution shall be provided.

A.1.4 *Speed*

The bit rate shall be 9600 bit/s or 64000 bit/s. Lower speeds, e.g. 1200, 2400 and 4800 bit/s, may be necessary in some applications.

TABLE A-1/G.773

Pin description of 24-pin IEEE STD 488 [31] connector

Pin	Circuit			Description	Notes
	RS 232-C	RS 449	V.24		
1	AA	Shield	101	Protective ground	1
13	AB	SG	102	Signal ground	
2	BA	SD	103	Send data A-wire	
14		SD	103	Send data B-wire	
11	BB	RD	104	Receive data A-wire	
23		RD	104	Receive data B-wire	
3	CA	RS	105	Request to send A-wire	2
15		RS	105	Request to send B-wire	2
7	CB	CS	106	Clear to send A-wire	2
19		CS	106	Clear to send B-wire	2
8	CC	DM	107	Data mode A-wire [a)]	2
20		DM	107	Data mode B-wire [a)]	2
9	CF	RR	109	Receiver ready A-wire	2
21		RR	109	Receiver ready B-wire	2
6	DB	ST	114	Send timing A-wire (DCE to DTE)	
18		ST	114	Send timing B-wire (DCE to DTE)	
10	DD	RT	115	Receive timing A-wire (DCE to DTE)	
22		RT	115	Receive timing B-wire (DCE to DTE)	

Note 1 – Equipment removable strap to frame ground cable connected to shield.

Note 2 – These circuits are optional for connection to an EOC or modem and are not used for connections to a multipoint bus.

Note 3 – Circuits are grouped by function: ground, data, control and timing.

Provision should be made at each interface point on a multipoint bus for the continuation of the interface to the next network element.

Provision shall be made for the termination of the lines in their characteristics impedance (typically, 120 ohms, resistive), should the equipment be at one end of a multipoint bus.

For further information, see EIA RS 485 [57] and EIA RS 449 [33], Recommendation V.24 [32] and IEEE STD 488 [31].

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Printed in Switzerland

Geneva, 1990