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## GENERAL ASPECTS OF DIGITAL TRANSMISSION SYSTEMS

# PROTOCOL SUITES FOR Q-INTERFACES FOR MANAGEMENT OF TRANSMISSION SYSTEMS

## ITU-T Recommendation G.773

(Previously “CCITT Recommendation”)

## FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation G.773 was revised by the ITU-T Study Group XV (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

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NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 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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**Recommendation G.773**

# PROTOCOL SUITES FOR Q-INTERFACES FOR MANAGEMENT OF TRANSMISSION SYSTEMS

*(Geneva, 1990; revised at Helsinki, 1993)*

## 1 Introduction

### 1.1 Scope

This Recommendation defines the characteristics of protocol suites for Q-interfaces to connect transmission systems/equipments, as defined in Recommendation M.3010 [1]. 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

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

| | |
|---|---|
| AARE | A-associate response |
| AARQ | A-associate request |
| ACSE | Association control service element |
| AFI | Authority and format identifier |
| ASE | Application service element |
| ASN.1 | Abstract Syntax Notation One |
| CD | Collision detection |
| 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 |
| DIS | Draft international standard |

DLC Data link connection

DLS Data link service

DSP Domain specific part

DTE Data terminal equipment

EOC Embedded operations channel

HDLC High-level data link control

Ind Indication

ISO International Organization for Standardization

LLC Logical link control

LME Layer management entity

MAC Media access control

NDM Normal disconnected mode

NE Network element

NRM Normal response mode

NRZ Non return to zero

NRZI Non return to zero inverted

NS Network service

NSAP Network service access point

OSI Open Systems Interconnection

PhC Physical connection

Ph Physical

PhS Physical service

PICS Protocol implementation conformance statement

PLS Physical layer service

QOS Quality of Service

Req Request

Res Response

ROSE Remote operations service element

SDH Synchronous digital hierarchy

SM-ASE System management-application service element

SP Session protocol

TMN Telecommunications management network

UNC Unbalanced operation normal response mode class

### 1.2.2 Symbols and abbreviations used in tables

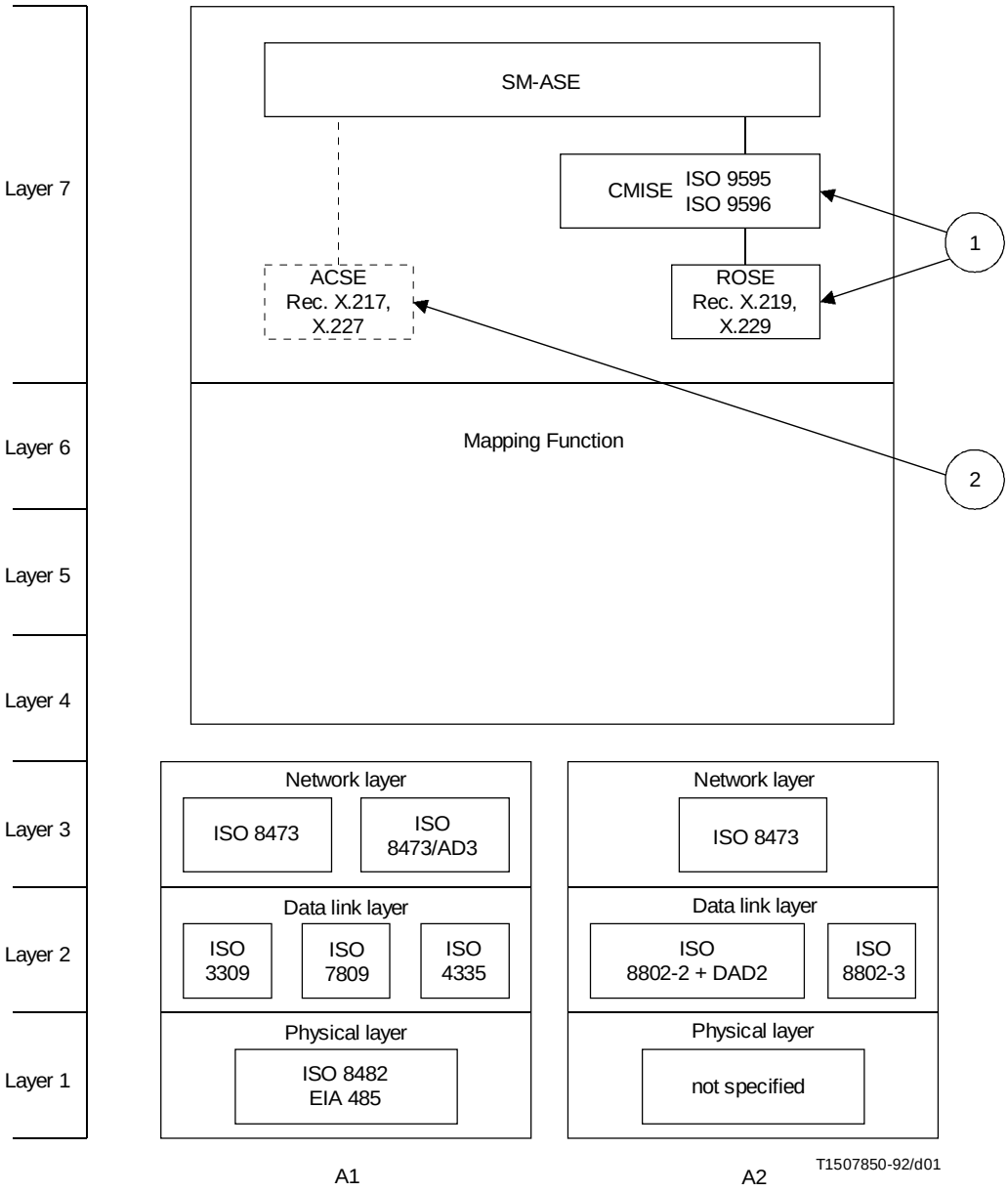
M Mandatory

– 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

## 2 Protocol suites overview

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




1 Support ASE for network management transaction-oriented applications
2 Optionally support ASE

FIGURE 1/G.773

**Overview of protocol suites short stacks**

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

Two types of protocol suites are recommended to connect transmission systems/equipment to a TMN:

- The short stack protocol suites (A1 and A2) which will be used mainly as Qx protocol suites as specified in Recommendation M.3010 [1].

- The full 7 layer stack protocol suites (CONS1, CLNS1 and CLNS2) which can be used as Qx/Q3 protocol suites, as defined by Recommendation M.3010 [1] and are mainly used to satisfy the requirements of complex NEs (e.g. equipment for the synchronous digital hierarchy).

Protocol profiles for CONS1, CLNS1 and CLNS2 layers 1, 2 and 3 are defined in Recommendation Q.811 [30]. Protocol profiles for CONS1, CLNS1 and CLNS2 layers 4, 5, 6 and 7 are defined in Recommendation Q.812 [31].

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 needed. Layers 5, 6 and 7 are identical for the three protocol suites CONS1, CLNS1 and CLNS2 whilst almost identical requirements apply to layer 4.

This Recommendation defines the two protocol suites A1 and A2.

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

NOTE – The protocol suites CONS1, CLNS1 and CLNS2 replace the B protocol suites from the 1990 issue of this Recommendation.

In particular:

CONS1 replaces B1,

CLNS1 replaces B3,

CLNS2 replaces B2.

# 3 Physical layer

## 3.1 Physical layer for A1

### 3.1.1 Service

#### 3.1.1.1 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.

#### 3.1.1.2 Service provided by the physical layer

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

The services PhC-Activation and PhC-Deactivation will be provided to the layer management entity (LME) of the physical layer.

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 | |

### 3.1.2 Physical interface

#### 3.1.2.1 Physical characteristics

##### 3.1.2.1.1 Configuration

Serial bus operation in accordance with ISO 8482[1)] [4], in half-duplex mode.

##### 3.1.2.1.2 Transmission pairs

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

##### 3.1.2.1.3 Connector

The Administration shall specify the connector type.

#### 3.1.2.2 Electrical characteristics

##### 3.1.2.2.1 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".

##### 3.1.2.2.2 Bus termination

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

##### 3.1.2.2.3 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.

##### 3.1.2.2.4 Bit rate

The bit rate shall be 19 200 bit/s or 64 000 bit/s. A bit rate of 128 000 bit/s may be necessary in some applications. The bit rate tolerance shall be $\pm 0.05$ %.

##### 3.1.2.2.5 Turn-off time

For bit rates of 19 200 bit/s and 64 000 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 4.1.2.1.3).

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1) Compliance assumes that full compatibility with EIA 485 [32] is guaranteed.

#### 3.1.2.2.6 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.

### 3.1.2.3 Line code

The line code shall be NRZI.

#### 3.1.2.3.1 Principle

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

#### 3.1.2.3.2 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.

### 3.1.2.4 Extended mode

An example of extended mode is given in Annex A.

## 3.2 Physical layer for A2

### 3.2.1 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.

### 3.2.2 Service

#### 3.2.2.1 Definition

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

#### 3.2.2.2 Service provided by the physical layer

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

TABLE 2/G.773

**Primitives of the physical layer**

| Primitives |
|---|
| PLS-DATA request |
| PLS-DATA indication |
| PLS-CARRIER indication |
| PLS-SIGNAL indication |

### 3.2.3 Bit rate

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

# 4 Data link layer

## 4.1 Data link layer for A1

### 4.1.1 Service

#### 4.1.1.1 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

– connection-mode service.

#### 4.1.1.2 Service required from the physical layer

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

#### 4.1.1.3 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 to 5.

##### 4.1.1.3.1 DLC-Establishment

See Table 3.

TABLE 3/G.773

**DLC-Establishment service**

| Parameter name | Request/Indication | Response/Confirmation |
|---|---|---|
| Called address | M | – |
| Calling address | M | – |
| Responding address | – | M |
| QOS | M | M |

##### 4.1.1.3.2 DLC-Release

See Table 4.

TABLE 4/G.773

**DLC-Release service**

| Parameter name | Request | Indication |
|---|---|---|
| Originator | – | M |
| Reason | M | M |

#### 4.1.1.3.3 Normal Data Transfer

See Table 5.

TABLE 5/G.773

**Normal Data Transfer service**

| Parameter name | Request | Indication |
|---|---|---|
| DLS-User data | M | M |

### 4.1.2 Data link protocol

The data link protocol is synchronous HDLC type.

#### 4.1.2.1 HDLC frame structure

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

#### 4.1.2.1.1 Addressing field

The addressing field shall be one octet.

#### 4.1.2.1.2 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.

#### 4.1.2.1.3 Inter-frame time fill

A primary station shall transmit contiguous flags as inter-frame time fill.

#### 4.1.2.2 Addressing

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

#### 4.1.2.2.1 All-station address

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

#### 4.1.2.2.2 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.

#### 4.1.2.2.3 Group addresses

Not used.

#### 4.1.2.3 HDLC procedure

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

#### 4.1.2.3.1 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

#### 4.1.2.3.2 Modes

Two modes are selected:

– *one operational mode:* Normal response mode (NRM);

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

### 4.1.2.4 Class of procedure

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

#### 4.1.2.4.1 HDLC optional functions

The following HDLC optional functions shall be implemented:

– unnumbered information (option No. 4);

– data link test (option No. 12).

### 4.1.2.5 Other parameters of data link layer

#### 4.1.2.5.1 Window size

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

#### 4.1.2.5.2 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.

#### 4.1.2.5.3 Number of repetitions

Under the conditions described in 4.1.2.5.2, the maximum number of repetitions before detecting a no-reply or a lost-reply condition is fixed to 5 (6 requests).

#### 4.1.2.5.4 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.

## 4.2 Data link layer for A2

### 4.2.1 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).

### 4.2.2 Media access control (MAC)

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

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

### 4.2.3 Logical link control (LLC)

**4.2.3.1** The definition of the acknowledged connectionless mode LLC service shall comply with that specified in ISO 8802-2/DAD2 [23]. All of the primitives defined for type 3 operation (see Table 6) 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 |

**4.2.3.2** The protocol used to provide the acknowledged connectionless mode LLC service shall be as specified in ISO 8802-2 [22] and ISO 8802-2/DAD2 [23]. All of the commands and responses defined for type 3 operation (see Table 7) are mandatory.

TABLE 7/G.773

**Commands and responses for type 3 operation**

| Commands | Responses |
|---|---|
| AC0 | AC0 |
| AC1 | AC1 |

# 5 Network layer for A1 and A2

## 5.1 Service

### 5.1.1 Service definition

The definition of the connectionless mode network service shall comply with that specified in ISO 8348/AD1 [9]. Address formats supported shall conform to ISO 8348/AD2 [10].

### 5.1.2 Service required from the data link layer

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

### 5.1.3 Service provided by the network layer

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

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(=) |

## 5.2 Network protocol

### 5.2.1 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/AD3 [19]. ISO 8473 [11] defines in addition to the full protocol (see 5.2.4), two subsets namely:

- inactive network layer protocol (see 5.2.2);
- non-segmenting network layer protocol (see 5.2.3).

The address part shall have the structure as defined in ISO 8348/AD2 [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/AD2 [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/AD2 [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).

### 5.2.2 Inactive network layer protocol

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

### 5.2.3 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].

#### 5.2.4 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” 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.

# 6 Mapping functions for A1 and A2

## 6.1 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.

## 6.2 Service

### 6.2.1 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].

### 6.2.2 Service required from network layer

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

### 6.2.3 Service provided by the mapping function

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

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”.

TABLE 9/G.773

**Service provided by the mapping function**

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

## 6.3 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.

# 7 Application layer for A1 and A2

## 7.1 Overview

The network management application layer shall provide the CMISE service to the SM-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).

## 7.2 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].

## 7.3 Association control

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

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 |

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

## 7.4 Remote operations

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

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 |

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

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

### 7.5 Common management information

**7.5.1** The common management information service element (CMISE) shall be a mandatory service element for the protocol suite A1 and A2. The CMISE service description is detailed in ISO 9595 [13]. The CMISE services are listed in Table 12.

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 |

**7.5.2** The protocol specification for CMISE shall follow ISO 9596 [17].

## 8 Conformance

For further study.

## References


[1] CCITT Recommendation M.3010 (1993), *Principles for a telecommunications management network (TMN)*.

[2] CCITT Recommendation X.200 (1984), *Reference model of open system interconnection for CCITT applications*, (ISO 7498, 1984).

[3] CCITT Recommendation X.211 (1988), *Physical layer service definition of open system interconnection (OSI) for CCITT applications* (ISO 10022, 1989).

[4] ISO 8482:1987, *Information processing systems – Data communication – Twisted pair multipoint interconnections*.

[5] CCITT Recommendation X.212 (1988), *Data link service definition for open system interconnection for CCITT applications* (ISO 8886, 1988).

[6] ISO 3309:1988, *Information processing systems – Data communication – High-level data link control procedures – Frame structure*.

[7] ISO 4335:1987, *Information processing systems – Data communication – Consolidation of elements of procedures*.

[8] ISO 7809:1984, *Information processing systems – Data communication – High-level data link control procedures – Consolidation of classes of procedures*.

[9] ISO 8348/AD1:1987, *Information processing systems – Data communications – Network service definition; Addendum 1: Connectionless-mode transmission*.

[10] ISO 8348/AD2:1988, *Information processing systems – Data communications – Network service definition; Addendum 2: Network layer addressing*.

[11] ISO 8473:1988, *Information processing systems – Data communications – Protocol for providing the connectionless-mode network service*.

[12] CCITT Recommendation X.216 (1988), *Presentation service definition for open system interconnection for CCITT applications* (ISO 8822, 1987).

[13] ISO 9595:1992, *Information processing systems – Open systems interconnection – Common management information service definition (CMIS)*.

[14] CCITT Recommendation X.219 (1988), *Remote operations: Model, notation and service definition* (ISO 9072-1, 1988).

[15] CCITT Recommendation X.208 (1988), *Specification of Abstract Syntax Notation One (ASN.1)* (ISO 8824, 1987).

[16] CCITT Recommendation X.209 (1988), *Specification of basic encoding rules for Abstract Syntax Notation One (ASN.1)* (ISO 8825, 1987).

[17] ISO 9596:1992, *Information processing systems – Open systems interconnection – Common management information protocol specification (CMIP)*.

[18] CCITT Recommendation X.229 (1988), *Remote operations: Protocols specification*.

[19] ISO 8473/AD3:1989, *Information processing systems – Data communications – Protocol for providing the connectionless-mode network service; Addendum 3: Provision of the underlying service assumed by ISO 8473 over sub-networks which provide the OSI data link service*.

[20] ISO 8802-3:1988, *Information processing systems – Local area networks – Part 3 – Carrier sense multiple access with collision detection – Access method and physical layer specifications*.

[21] CCITT Recommendation E.164 (1988), *Numbering plan for the ISDN era*.

[22] ISO 8802-2:1988, *Information processing systems – Local area networks – Part 2 – Logical link control*.

[23] ISO 8802-2/DAD2:1988, *Logical link control; Addendum 2: Acknowledged connectionless-mode service and protocol, type 3 operation*.

[24] ISO 4902:1980, *Data communication – 37 pin and 9 pin DTE/DCE interface connectors and pin assignments*.

[25] CCITT Recommendation X.217 (1988), *Association control service definition for open system interconnections for CCITT applications* (ISO 8649, 1988).

[26] CCITT Recommendation X.227 (1988), *Association control protocol specification for open system interconnections for CCITT applications* (ISO 8650, 1988).

[27] IEEE 488 (1978), *Standard digital interface for programmable instrumentation*.

[28] CCITT Recommendation V.24 (1988), *List of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE)*.

[29] EIA 449 (1980), *General purpose 37-position and 9-position interface for data terminal equipment and data circuit-terminating equipment employing serial binary data interchange*.

[30] CCITT Recommendation Q.811 (1993), *Lower layer protocol profiles for the Q3-interface*.

[31] CCITT Recommendation Q.812 (1993), *Upper layer protocol profiles for the Q3-interface*.

[32] EIA 485 (1983), *Standard for electrical characteristics of generators and receivers for use in balanced digital multipoint systems*.

# Annex A

## Example of extended mode for A1 protocol suite

(This annex forms an integral part of this Recommendation)

### A.1 Extended mode

For those cases where it is required to extend beyond the range of the bus, one of several different capabilities may be used. For the case using modems the requirements of 3.1.2.1 to 3.1.2.3 apply with the following exceptions.

### A.2 Configuration – Full duplex

The connector shall conform to IEEE 488 [27]. Appropriate signal lines are to be provided for modem control in accordance with Recommendation V.24 [32, 33]. See Table A.1.

### A.3 Electrical Requirements

Data set control leads shall conform to Recommendation V.24 [28, 29].

### A.4 Line code

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

### A.5 Speed

The bit rate shall be 9600 bit/s or 64 000 bit/s. Lower speeds, e.g. 1200 bit/s, 2400 bit/s and 4800 bit/s, may be necessary in some applications.

TABLE A.1/G.773

**Pin description of 24-pin IEEE 488 [27] connector**

| Pin | Circuit | | | Description | Notes |
|---|---|---|---|---|---|
| | EIA 232-C | EIA 449 | Rec. 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 | 2 |
| 20 | | DM | 107 | Data mode B-wire | 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) | |

NOTES

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

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

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

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

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

6 For further information, see EIA 485 [32] and EIA 449 [29], Recommendation V.24 [28] and IEEE 488 [27].