5i’

7.7 Operations, administration and maintenance features of transmission equipment

Recommendation G.771

Q-INTERFACES AND ASSOCIATED PROTOCOLS FOR TRANSMISSION EQUIPMENT IN THE TELECOMMUNICATIONS MANAGEMENT NETWORK (TMN)

(Melbourne, 1988)

1 Introduction

1.1 *Scope*

This Recommendation defines the Q_1 and Q_2 interfaces and associated protocols required to connect transmission equipment to a TMN as defined in Recommendation M.30. Although primarily intended for use on transmission equipment, these interfaces may be used in other applications when appropriate.

A limited set of protocol suites is defined, from which an Administration may select those appropriate to their needs. Guidance is given on a suitable selection process. The set of protocol suites does not yet include a protocol suite capable of interworking with ISDN.

1.2 *Telecommunication management network*

A telecommunications management network (TMN) provides the means to transport and process information related to network operations, administration and maintenance. General principles of the TMN are described in Recommendation M.30. Figure 1/G.771 shows an example of the physical architecture for a TMN.

2 References

Recommendation M.30 — General principles of a TMN

Recommendation X.200 — Reference model of OSI for CCITT applications

Recommendation Q.513 — Interfaces for operations, administration and maintenance

3 Definitions

3.1 *Definitions associated with the TMN architecture*

Definitions of terms relative to the TMN architecture are defined in Recommendation M.30.

3.2 *Additional definitions*

3.2.1 **application messages**

Application messages are the messages flowing on the local communication network (LCN) and the data communication network (DCN) to meet the needs of TMN application functions.

3.2.2 **application message characteristics**

Application message characteristics are the application message attributes and information contents of the application messages.

3.2.3 **application message attributes**

Application message attributes are the attributes that characterize the requirements of communication functions for application messages in the LCN and DCN.

Figure 1/G.771, p. 1

3.2.4 **application message information contents**

Application message information contents provide the structure and the meaning of application messages in the LCN and in the DCN.

3.2.5 **physical configuration attributes**

Physical configuration attributes are those characteristics related to the physical configuration of the LCN and the DCN.

3.2.6 **protocol selection attributes**

Protocol selection attributes are those characteristics of protocol suites related to their ability to meet the communication needs of application messages in the LCN and the DCN.

4 Q-interfaces

4.1 *Purpose*

The Q-interfaces provide for the interconnection of network elements (NEs), operations systems (OSs) and mediation devices (MDs) through the DCN and/or LCN. The purpose of an interface specification is to assure compatibility of devices interconnected, to accomplish a given TMN application function independent of the type of device or of the supplier.

The main purpose of the messages flowing over the Q-interfaces is to facilitate information exchange between network element functions and operation system functions. It is the task of the mediation function to extract or map the information from the one to the other. A list of mediation functions is given in Recommendation M.30. The definition of mediation devices requires further study.

The message transfer via the Q-interface requires the use of protocols. This Recommendation specifies a limited set of protocols, based on the 7 layer OSI model, which take into consideration the division of functions, interface attributes and economics.

4.2 *General physical characteristics of Q-interfaces*

The Q-interfaces are used for all communications within the TMN. (Annex A provides some examples.) A physical Q-interface appears at, or as close as possible to, a device. A device is a physical implementation of a function.

The DCN is used for communications between central operations systems and distributed telecommunications centres. It interfaces at the Q_3 standard interface (see Recommendation Q.513).

The highest level of MDs and OSs are implemented using the Q_3 interface. For practical reasons, an NE incorporating mediation functions may be provided with a Q_3 interface to communicate directly with OSs using the DCN.

The LCN connects at Q_1 and Q_2 standard interfaces as defined in this Recommendation. When operational or economic factors dictate, the LCN may also connect remote NEs to local MDs or to local NEs which incorporate mediation functions.

NEs containing no mediation functions are connected to MDs using the Q_1 interface. NEs containing some mediation functions are connected to MDs using the Q_2 interface. The Q_2 interface is also used for the connection between different MDs.

The Q-interfaces may also be used with Q-interface adapters for connecting the equipment with non-standardized M-interfaces, as specified in Recommendation M.30. Examples of using Q-interface adapters are provided in Annex A.

4.3 *General protocol characteristics*

The characteristics of the protocols associated with the Q-interfaces depend upon the functions to be performed. The need for two families of protocols, based on the 7 layer OSI model have been identified. The PQ(dcn) family, associated with Q_3 interface, is more complex than the PQ(lcn) family, associated with Q_1 and Q_2 interfaces which are capable of a more limited set of functions. Within the PQ(lcn) family, the protocol suites associated with the Q_1 interface will generally be simpler than those associated with Q_2.

Physical configuration attributes characterize the physical configuration of a set of MDs and NEs in a given implementation, and are important factors in the selection of protocol suites of the PQ(lcn) family of protocols.

Some LCN physical configuration attributes are provided in Annex B.

5 PQ(lcn) family of protocol suites

5.1 *Purpose*

The purpose of the PQ(lcn) family of protocol suites is to enable efficient communications to take place between mediation devices and network elements, and/or between mediation devices across the Q_1 and Q_2 interfaces within the telecommunication management network.

5.2 *Description of the family*

The family of PQ(lcn) protocol suites consists of a limited number of members. Each family member is a particular protocol suite and is distinguishable from other family members by protocol attributes defined in § 5.3.4.

A protocol suite consists of OSI layers 1-7. Not all layers of the OSI model have to be provided for the PQ(lcn) family of protocol suites.

5.3 *Guide to protocol suite selection*

5.3.1 *Purpose*

The purpose of this section is to define the process and to provide the information that is necessary to allow the selection of protocol suites from the sets of the PQ(lcn) family of protocols provided in § 5.4.

5.3.2 *PQ(lcn) protocol suite selection process*

The following steps are involved in an iterative manner to select the protocol suites that will satisfy user needs:

i) identify TMN application functions that will be carried by the LCN, as per Recommendation M.30;

ii) identify the distribution of mediation functions;

iii) identify the physical configuration attributes of the LCN;

iv) define the TMN application messages to be carried on the LCN;

v) prepare individual TMN application message characteristics which meet the needs of the TMN application functions. These are the characteristics of application messages that are to be carried on the LCN, on the basis of a set of application message characteristics provided in § 5.3.3;

vi) analyze both the physical configuration attributes and the individual application message characteristics in order to associate these with protocol selection attributes provided in § 5.3.4;

vii) select appropriate protocol suites which meet the needs of TMN application functions by associating the protocol selection attributes with members of the PQ(lcn) family of protocol suites.

Note — Figure 2/G.771 pictures the steps vi) and vii) of the selection process above. It should be noted that the application message characteristics pose requirements on the services provided at the application layer, which is the collective view of the services provided at all layers, whereas the protocol selection attributes are given for each OSI layer individually.

Figure 2/G.771, p.

5.3.3 *TMN application message characteristics*

There are two types of characteristics that must be considered in the evaluation of application messages:

— application message attributes;

— application message information contents.

Annex C provides a list of possible LCN application message characteristics that can be applied to application messages.

Annex D provides an example of application messages profile characterization.

The values and names associated with application message characteristics in the LCN must be consistent with the values and names associated with overall TMN application message characteristics.

5.3.4 *LCN protocol selection attributes*

Annex E provides some LCN protocol selection attributes.

5.4 *Protocol suites*

This section defines the protocol suites to be used to support Q_1 and Q_2 interfaces and lists the protocol selection attribute values for each protocol suite.

5.4.1 *Protocol selection attribute values*

A table identifying the protocol selection attributes for each of the protocol suites defined in this Recommendation will be provided when protocol suites are included in the PQ(lcn) family.

Table F-5/G.771 provides an example of such a table for candidate protocol suites.

5.4.2 *Protocol suite definitions*

Several proposed candidate protocol suites can be found in Annex F. The choice of candidates for this section is under study.

ANNEX A
(to Recommendation G.771)

Examples of
physical implementations using TMN architecture

The following are some of the equipments covered by Recommendation G.771:

— transmission terminals (multiplexers, digital cross-connects, channel translation equipments, etc.);

— digital and analogue transmission systems (via metallic and fibre cables, via radio and satellite, etc.);

— associated support systems (test modules, power supply systems, building alarm systems, fault location systems, etc.).

Examples of physical implementations using TMN architecture are shown in the following figures, A-1/G.771 and A-2/G.771.

Figure A-1/G.771, p. 3

Figure A-2/G.771, p. 4

ANNEX B

(to Recommendation G.771)

LCN physical configuration attributes

The LCN physical configuration attributes represent the requirements an Administration imposes on the configuration of the whole of the particular LCN to be designed. In the PQ(lcn) protocol suite selection process (§ 5.3.2), the LCN physical configuration attributes will not only influence the choice of PQ(lcn) protocol suite, but also determine the type and quantity of mediation devices needed.

During the design of the LCN the Administration may also consider the number of ports per configuration and the number of such configurations that can be served by a particular mediation device that implements the selected protocol suite. Together with the distribution of network elements over space and the extent of cascading the mediation devices, this leads to the layout of the LCN. However, such mediation device design characteristics are beyond the scope of this Recommendation.

Some LCN physical configuration attributes are:

B.1 *Number of NE ports*

Specifies how many network element local communication ports are to be served by an LCN (including mediation devices).

Descriptor: (ports) small 32

medium > 32, 256

large > 256, 2048

very large > 2048

B.2 *Configuration*

Specifies the configuration to be used for the LCN.

Descriptor: star;

bus;

ring.

B.3 *Number of ports per configuration*

Specifies how many ports are to be interconnected within a single configuration (star, bus or ring) of the LCN.

For a star configuration, count the number of branches since one port per branch is implicitly assumed. For master-slave protocol suites for the bus or ring configuration, the master is excluded from the count of ports per configuration.

Descriptor: (ports) small 8

medium > 8, 32

large > 32, 128

very large > 128

B.4 *Communication distance*

Specifies the distance to be bridged within the LCN.

Descriptor: (metres) very short 10

short > 10, 100

medium > 100, 1000

long > 1000

B.5 *Communication environment*

Descriptor: within-rack;

on the same floor;

in-building;

out of building.

B.6 The need to provide further attributes is for further study.

ANNEX C

(to Recommendation G.771)

LCN application message characteristics

C.1 *Application message attributes*

C.1.1 *Communication pattern*

Response — subordinate node only answers questions and executes explicit commands.

Autonomous — subordinate node can also provide the master with other information (e.g. when polled).

Peer — subordinate node can also communicate with other subordinate nodes.

C.1.2 *Data quantity*

Amount of data transferred. General criteria of 4096 octets and 256 octets can be used as descriptor.

Descriptor: (octets) low 256

medium > 256, 4096

large > 4096

C.1.3 *Frequency*

Describes how often the message instance is expected to use the LCN.

Descriptor: (transactions per day) seldom 1

periodic > 1, 1440

often > 1440

C.1.4 *Delay*

Defines the amount of delay that can be accepted in LCN communication. Delay here does not include mediation processing time.

Descriptor: (seconds) short 1

medium > 1, 10

long > 10

C.1.5 *Multiple responses*

Denotes that there can be more than one response to a request from the same source.

Descriptor: single, multiple.

C.1.6 *Priority*

States the order of importance, or priority associated with a message.

Descriptor: yes, no.

C.1.7 *Receipt confirmation*

Critical messages communicated from one system may require confirmation that the peer system is in receipt of that specific data.

Descriptor: yes, no.

C.1.8 *Reliability*

Describes whether information can be lost or affected by transmission in the LCN.

Descriptor: (error) low: no requirement;

medium: infrequent;

high: none.

C.1.9 *Phase commit*

Required if a series of actions must be carried out in a coordinated manner by one or more NEs under supervision of MD.

Descriptor: yes, no.

C.1.10 *Availability*

The amount of isolation that can be tolerated from impairments in the LCN.

Descriptor: (%) low > 85

medium > 95

high > 99.5

C.1.11 *Data organization*

Describes whether the information is organized in files and the type of data organization associated.

Descriptor: (data organization) yes, no.

C.2 *Applications message information content*

The list below provides types of data elements that are common across operations functions. As such they will allow a structure to be provided for the information contained in specific messages and thus be eventually mapped into a notation associated with the LCN protocol.

The common data elements described below may not all be needed for every individual LCN nor will they necessarily be organized in the order given below.

C.2.1 *Type of message*

Refers to the mode of interaction and not the specific operation functions invoked by the message.

Example: message type (report, command, etc.).

C.2.2 *Type of resource*

Refers to the general network entity which is being managed.

Examples: fibre optic system; model X.

C.2.3 *Instance of resource*

Refers to the specific instance of the NE which is being managed, such as model X, number Y.

C.2.4 *Date/time*

May or may not be applicable.

C.2.5 *Name of the message*

Refers to the specific operation being performed.

Examples: equipment alarm report; equipment control command; facility performance report.

C.2.6 *Resource sub-entity*

Refers to the detailed resource sub-entity targeted by the operation.

Examples: fibre optic transmitter; primary rate circuit.

C.2.7 *Resource sub-entity instance*

Identification of the particular instance of the resource sub-entity.

Example: fibre optic transmitter No. 5.

C.2.8 *Message parameters*

Refers to data elements that are specific to the message name.

Examples: major or minor; error-free seconds.

C.2.9 *Result parameters*

These are the data elements that represent the values that, where applicable, will be associated with message parameters or other data elements.

Example: 100 error-free seconds.

C.2.10 *Error message type*

Category of reply to unsuccessful information exchange attempt.

Example: invalid alarm type.

C.2.11 *Error message parameters*

Parameters that may accompany error message types.

C.2.12 *Multiple response names*

This data element is a combination of other data elements in the situation where a specific message is part of a suitable response chain, for example, where individual messages must be referred to an initiating message.

C.2.13 *Multiple response parameters*

Output data elements associated with multiple response names.

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ANNEX D

(to Recommendation G.771)

Examples of
application message profile characterization

Example of fibre optic transmission system

Major Alarm Report

APPLICATION MESSAGE ATTRIBUTES:

1. INITIATOR NE 2. DATA QUANTITY Low 3. FREQUENCY Seldom 4. DELAY High

5. MULTIPLE RESPONSES Not applicable 6. PRIORITY Yes 7. RECEIPT CONFIRMATION ? 8. RELIABILITY High

9. PHASE COMMIT Not applicable 10. AVAILABILITY High 11. DATA ORGANIZATION Not applicable

APPLICATION MESSAGE INFORMATION CONTENT: 1. TYPE OF MESSAGE Report 2. TYPE OF RESOURCE Fibre optic transmission system XYZ

3. INSTANCE OF RESOURCE Unit number N 4. DATE/TIME YYYY/MM/DD HR/MIN/SEC 5. NAME OF MESSAGE Equipment alarm report 6. RESOURCE SUB-ENTITY Transmit unit

7. RESOURCE SUB-ENTITY INSTANCE Channel number M 8. MESSAGE PARAMETER Laser failure 9. RESULT PARAMETERS Not applicable 10. ERROR MESSAGE TYPE Not applicable

11. ERROR MESSAGE PARAMETERS Not applicable 12. MULTIPLE RESPONSE NAMES Not applicable 13. MULTIPLE RESPONSE PARAMETERS Not applicable .bp

ANNEX E

(to Recommendation G.771)

LCN protocol selection attributes

These LCN protocol selection attributes summarize the capabilities of the individual PQ(lcn) protocol suites for use in the LCN protocol suite selection process described in § 5.3.2.

Note — Abbreviations are given for each allowed attribute value as a key to Table F-5/G.771, which groups all the candidate selection attribute values.

The protocol selection attributes are:

a) At layer 1:

Configuration S: star; B: bus; R: ring Number of ports per configuration (ports) S: small 8

M: medium > 8, 32 L: large > 32, 128 VL: very large > 128 Physical medium SP: screened pair; TP: twisted pair;

CP: coaxial pair; OF: optical fibre; O: other Transmission mode S: synchronous; AS: asynchronous; HD: half duplex; FD: full duplex

Operating speed (bits per second) 1200; 2400; 4800; 9600; 19 200; 64 | 00; 128 000; 1 | 00 | 00 Communication distance (metres) VS: very short 10 S: short > 10, 100

M: medium > 100, 1000 L: long > 1000 Communication environment WR: within-rack; OF: on the same floor; IB: in-building; OB: out of building

Availability (%) L: low ?04 M: medium ?05 under study

H: high

b) At layer 2:

Data link connection CO: connection oriented CL: connection-less Data link initiator M: master; AP: all participants

Data link address size (addresses) S: small 8 M: medium > 8, 32 L: large > 32, 128 VL: very large > 128 Receipt confirmation Y: yes; N: no

Maximum frame size (octets) S: small 256 M: medium > 256, 4096 L: large > 4096 Max. frame frequency per port (frames per second) L: low 1/60

M: medium > 1/60, 1 H: high > 1 .bp

Max. frame transmit delay (seconds) S: short 0.1 M: medium > 0.1, 1 L: long > 1 Error detection N: none; P: parity, CS: checksum (n);

CRC: cyclic redundancy check (n) Hamming distance 1; 2; 3; 4; n Error recovery N: none; R: repetition; C: correction

c) At layer 3:

LCN network size (ports) S: small 32 M: medium > 32, 256 L: large > 256, 2048 VL: very large > 2048

Routing Y: yes; N: no (Un) packing Y: yes; N: no Connections N: none; P: permanent; SW: switched

Priority Y: yes; N: no d) The other layers are for further study.

ANNEX F
(to Recommendation G.771)

Proposed candidate protocol suites

This annex contains the candidate protocol suites currently under consideration for selection as members of the PQ(lcn) family of protocol suites. The description of the individual protocol suites is of varying completeness, but each description is limited to the specification of the lower two or three OSI layers. For a complete protocol suite specification, higher layers must be defined; however, the available information is provided here to guide hardware decisions. The completion of the descriptions and the selection is for further study.

Candidate protocol suite No. 3 has the widest support, but no candidate protocol suite has yet been subjected to a formal selection process by CCITT.

Each candidate protocol suite is described in the following sections. Following the descriptions is a summary section which contains in Table F-5/G.771 the candidate protocol selection attribute values (see Annex E). Differences of the values in Table F-5/G.771 indicate differences in capabilities which may affect the suitability of individual candidates for particular application areas.

Some initial applications are indicated for each candidate protocol suite. However, the range of applications appropriate to these suites has not been thoroughly examined.

F.1 *Candidate protocol suite No. 1 (CPS 1)*

Initial application:

Alarm surveillance, performance monitoring and configuration control of NEs found in reasonably large numbers in the telecommunications network (e.g. muldex, line transmission terminal).

F.1.1 *OSI layer 1*

F.1.1.1 *Configuration*

One serial bus connects up to 30 nodes.

Configurations with more than 30 nodes can be realized by a hierarchical structure of several serial buses.

Such a hierarchical structure is characterized by a high throughput with a low transmission rate per bus.

F.1.1.2 *Communication environment*

The serial bus configuration shall be used only for in-building application.

F.1.1.3 *Physical connection*

One balanced, screened pair with a maximum length of 500 metres.

F.1.1.4 *Electrical requirements*

Each bus interface shall be in accordance with Recommendation V.11 multipoint interconnections [1, 3, 14, and 23].

Each bus shall be terminated by resistors in accordance with [23].

Each receiver shall present a maximum of one unit load to the bus, as defined in [23].

F.1.1.5 *Line code*

The line code shall be NRZ (non-return to zero).

F.1.1.6 *Speed*

The bit rate shall be 19.2 kbitB/Fs.

The bit rate tolerance shall be ± 1%.

F.1.1.7 *Transmission mode*

The transmission mode shall be half duplex, asynchronous.

F.1.2 *OSI layer 2*

Asynchronous, byte oriented protocol according to [15].

F.1.2.1 *Transmission frame format*

The transmission frame format shall be in accordance with [15 (i)].

F.1.2.2 *Link transmission procedure*

The link transmission procedure shall be in accordance with [15 (ii)].

All standard transmission frames specified in [15] shall be used (frame with variable length, frame with fixed length and single character).

The operation mode shall be: master/slave, cyclical polling.

F.1.2.3 *Addressing*

The addresses 1 to 30 of the 256 possible addresses shall be used for cyclical polling.

The address 255 shall be used for broadcasting (one message to all nodes).

F.1.2.4 *Window size*

The window size is fixed to one.

F.1.3 *Higher layers*

Under study.

F.2 *Candidate protocol suite No. 2 (CPS 2)*

Initial application:

Alarm surveillance, performance monitoring, testing commands and response, and configuration control of NEs including cross-connect equipment, can be applied to both NEs found in reasonably large numbers in the telephone network (e.g., muldex, line transmission terminal) and to high capability NEs found in limited numbers in the telecommunications network (e.g. cross-connect).

F.2.1 *OSI layer 1*

F.2.1.1 *Configuration* : | us.

F.2.1.2 *Line speed* : | Mbit/s.

F.2.1.3 *Medium* : | creened pair.

F.2.1.4 *Electrical requirement* : | ecommendation V.11 interface with pulse transformer.

F.2.1.5 *Line code* : | MI.

F.2.2 *OSI layer 2*

F.2.2.1 *Frame format*

Frame components:

— flag,

— destination address: 2 octets,

— source address: 2 octets,

— control: 1 octet,

— logical link control (LLC) data: variable length (maximum 512 octets),

— frame check sequence: CRC 16,

— flag.

F.2.2.2 *Media access control*

The media access control discipline known as carrier sense multiple access (CSMA) is used [12, 18].

F.2.2.3 *Logical link control layer*

Acknowledged connectionless mode protocol specification to be specified in [11, 17] is used.

F.2.3 *Upper layers*

Under study.

F.3 *Candidate protocol suite No. 3 (CPS 3)*

Initial application:

Alarm surveillance, performance monitoring, and configuration control of NEs found in reasonably large numbers in the telecommunications network (e.g. muldex, line transmission terminals).

F.3.1 *OSI layer 1*

F.3.1.1 *Physical characteristics*

F.3.1.1.1 *Configuration*

Serial bus operation in accordance with [14] (ring configuration under study).

Use of full or half-duplex operation shall be determined by the Administration.

F.3.1.1.2 *Transmission pairs*

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

Note — Two Administrations have proposed using each of the pairs in half-duplex mode to provide additional bus security without additional wiring. Certain additional requirements relating to bus occupancy may then be necessary for correct operation in this mode.

F.3.1.1.3 *Bus security*

Where additional bus security is required, bus duplication or output driver protection resistors may be considered.

Note — Where duplicated buses are employed, no deliberate transmission should take place on both buses at the same time, and the functioning of one bus shall not be prejudiced by continuous noise or unintentional transmissions on the other.

F.3.1.1.4 *Connector*

The Administration shall specify the connector type.

F.3.1.2 *Electrical characteristics*

F.3.1.2.1 *Static and dynamic characteristics*

Static and dynamic characteristics of each bus connection shall be in accordance with [14].

F.3.1.2.2 *Bus termination*

Each bus end shall be terminated by resistors (120 ohms +10%, —0%) in accordance with [14].

F.3.1.2.3 *Load connection*

Each receiver shall present a maximum of one unit load, as defined in [14], to the bus. The number of load connections is limited to 32.

F.3.1.2.4 *Bit rate*

The bit rate shall be 19.2 or 64 kbit/s. A bit rate of 128 kbit/s may be necessary in some applications. The bit rate tolerance shall be ± 1%.

F.3.1.2.5 *Turn-off time*

A transmitting station shall put its generator in the high impedance state within 1 ms from the end of the last bit of the final closing flag.

Note — The need to reduce this time for bit rates above 19.2 kbitB/Fs is under study.

F.3.1.2.6 *Preamble*

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

F.3.1.3 *Line code*

The line code shall be NRZ1.

Clock extraction by the remaining station is assumed.

F.3.1.3.1 *Principle*

Each transition [14] shall represent a ZERO, and no transition shall represent a ONE bit.

F.3.1.3.2 *Lock-in process*

For clock extraction, a lock-in sequence of either one octet of ZEROES or one or two flags in accordance with [6], shall be sent immediately prior to the beginning of the opening flag of the frame to be transmitted and immediately following the preamble of § F.3.1.2.6 (if implemented).

F.3.1.4 *Extended mode*

Where an extended mode capability is required (e.g., using a modem) the requirements of §§ F.3.1.1 to F.3.1.3 shall apply with the following exceptions:

F.3.1.4.1 *Configuration — full duplex*

F.3.1.4.2 *Connector*

The connector shall conform to [16]. Appropriate signal leads are to be provided for modem control in accordance with Recommendation V.24 [2], [22]. See Table F-1/G.771.

F.3.1.4.3 *Electrical requirements*

Data set control leads shall conform to Recommendation V.24 [2], [22].

F.3.1.4.4 *Line code*

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

F.3.1.4.5 *Speed*

The bit rate shall be 9.6 or 64 kbit/s. Lower speed, e.g. 1.2, 2.4 and 4.8 kbit/s, may be necessary in some applications.

F.3.2 *OSI layer 2*

The data link protocol is synchronous HDLC type.

F.3.2.1 *HDLC frame structure*

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

F.3.2.1.1 *Addressing field*

The addressing field shall be one octet.

F.3.2.1.2 *Information field*

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

Information field octets shall be sent with the least significant bit first.

Maximum information field lengths of 128 and 256 octets shall be supported.

A maximum information field length of 512 octets may be necessary in some applications.

F.3.2.2 *Addressing*

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

F.3.2.2.1 *All-station address*

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

F.3.2.2.2 *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.

F.3.2.2.3 *Group address*

Not used.

F.3.2.3 *HDLC procedure*

The HDLC procedure is defined by [7].

F.3.2.3.1 *Commands and responses*

The following HDLC commands and responses must be supported:

a) commands:

— SNRM: set normal response mode;

— DISC: disconnect;

b) commands or responses:

— I: information;

— RR: receive ready;

— RNR: receive not ready;

c) responses:

— FRMR: frame reject;

— UA: unnumbered acknowledgement;

— DM: disconnected mode.

F.3.2.3.2 *Modes*

Two modes are selected:

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

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

F.3.2.4 *Class of procedure*

The Unbalanced operation Normal response mode Class (UNC) as defined by [9] shall be implemented.

F.3.2.4.1 *HDLC optional functions*

The following HDLC optional functions shall be implemented:

a) unnumbered information (option No. 4):

— command UI;

— response UI;

b) data link test (option No. 12):

— command TEST;

— response TEST.

F.3.2.5 *Other parameters of OSI layer 2*

F.3.2.5.1 *Window size*

The window size is fixed to 1.

3.2.5.2 *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 has to be greater than the duration of the longest frame to be sent by the primary station, added with the response-time of the secondary station and the duration of the longest frame to be sent by the secondary station.

F.3.2.5.3 *Number of repetitions*

In the situation of § F.3.2.5.2, the maximum number of repetitions before detecting a no-reply or a lost-reply condition is fixed at 5 (6 requests).

F.3.2.5.4 *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.

Note — The need to reduce this time for bit rates above 19.2 kbitB/Fs is under study.

F.3.3 *Higher layers*

Under study.

H.T. [T1.771]
TABLE F-1/G.771
Pin description of 24-pin connector [16]

Pin	V.24 circuit	Description	Notes
1 13	101 102	Protective ground Signal ground	1
2 14 11 23	103 103 104 104	Send data A-wire Send data B-wire Receive Data A-wire Receive Data B-wire	
3 15 7 19 8 20 9 21	105 105 106 106 107 107 109 109	Request to Send A-wire Request to Send B-wire Clear to Send A-wire Clear to Send B-wire Data Mode A-wire Data Mode B-wire Receiver Ready A-wire Receiver Ready B-wire	2 2 2 2 2 2 2 2
6 Send Timing A-wire (DCE to DTE) } 18 Send Timing B-wire (DCE to DTE) } 10 Receive Timing A-wire (DCE to DTE) } 22 Receive Timing B-wire (DCE to DTE) }	114 114 115 115	{ { { {	

Note 1 — Equipment: removable strap to frame ground. Cable: connected to shield.

Note 2 — These circuits are optional for connection to an embedded operations channel 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 of a multipoint bus. For further information, see [2], [16], [22], [23].

Table F-1/G.771 [T1.771], p.

F.4 *Candidate protocol suite No. 4 (CPS 4)*

Initial application:

Alarm surveillance, performance monitoring, testing on specific NEs found in limited numbers in the telecommunications network (e.g. muldex, line transmission equipment).

F.4.1 *Layer 1*

— Electrical characteristics in accordance with Recommendations V.24 and V.28 [20];

— Configuration: star;

— Physical connection: ISO 2110 (25 pin) (see Table F-2/G.771);

— Transmission mode: duplex, interface type D;

— Operating speed: 1200, 2400, 4800 and 9600 bit/s (user option);

— Shield: ground strap to frame (user option).

H.T. [T2.771]

TABLE F-2/G.771

ISO 2110 pin description

Pin	V.24 circuit	Description	Notes
1	101 |	Protective ground	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	2
20	108.2	Data Terminal 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		
17	115 |	{	
Receiver Signal Element Timing (DCE to DTE)			
}	5		

Note 1 — Equipment: removable strap to frame ground. Cable: connected to shield.

Note 2 — Basic interchange circuits, all systems.

Note 3 — Additional interchange circuits required for switched service.

Note 4 — Circuit DA (CCITT 113) is not used in OS/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 [2], [3], [5], [19].

Tableau F-2/G.771 [T2.771], p.

F.4.2 *Layer 2*

It is mandatory that the data link layer conform to LAPB as defined in Recommendation X.25 [4]. In addition, provision shall be made for connection between data terminal equipments (OSs and NEs) without an intervening packet switched network. The interface shall conform to [8].

The link layer specification that follows applies to all cases.

F.4.2.1 *Equipment type during link set-up and reset*

When a packet switched network is used to connect the NE and OS, they each are 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 level 1, the modems will provide the DCE interface, supplying bit synchronization.

At the link level, the procedures specified in [8] are followed. The NE or OS must be able to start the set-up or reset of the link (a DCE function in Recommendation X.25) as well as to respond to a start from the connecting equipment (a DTE function in Recommendation X.25). In addition, provision must be made for assignment 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.

F.4.2.2 *Window*

Modulo 8 operation shall be used. The window for unacknowledged frames is to be optional between 1 and 7 frames. Typical values are 7 and 2.

F.4.2.3 *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 F-3/G.771. Maximum information field lengths that shall be supported are 131 and 259 octets with 515 octets optional. These values provide for three packet header octets and maximum length of packet data units of 128, 256 and 512 octets respectively.

F.4.2.4 *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. The NE 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 F-3/G.771. These options, like those of the physical layer, are to be set at installation, changeable by the user, and non-volatile.

F.4.3 *Other layers*

No layer 3 is planned for this suite.

Layers 4-7 are under study.

F.5 *Candidate protocol suite No. 5 (CPS 5)*

Initial application:

All management of high capability NEs found in limited numbers in the telecommunications network (e.g. digital cross-connect).

F.5.1 *Layer 1*

— Electrical characteristics in accordance with Recommendations V.24 and V.28 [20];

— Configuration: star;

— Physical connection: ISO 2110 (25 pin) (see Table F-2/G.771);

— Transmission mode: duplex, interface type D;

— Operating speed: 1200, 2400, 4800 and 9600 bit/s (user option);

— Shield: ground strap to frame (user option).

H.T. [T3.771]
TABLE F-3/G.771
LAPB data link layer attributes

LAPB Protocol Octet aligned

Single link procedure (SLP)	Range	Default values (Note 1)	Units
K — I-Frames window:	1 to 7	7	
{ T1 — Waiting acknowledgement (Retry) timer: }	2 to 20	3	seconds
T2 — Response delay timer	0.3		seconds
T3 — Disconnect time	Note 2		
T4 — No activity timer	4 to 120	20	seconds
{ N1 — Bits per I-Frame, excluding flags }	1080, 2104	1080	bits
N2 — Retransmission count	2 to 16	7	
A/B address assignment	Selectable by the user		

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

Tableau F-3/G.771 [T3.771], p. 7

F.5.2 *Layer 2*

It is mandatory that the data link layer conform to LAPB as defined in Recommendation X.25 [4]. In addition, provision shall be made for connection between data terminal equipments (OSs and NEs) without an intervening packet switched network. The interface shall conform to [8].

The link layer specification that follow applies to all cases.

F.5.2.1 *Equipment type during link set-up and reset*

When a packet switched network is used to connect the NE and OS, they each are 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 level 1, the modems will provide the DCE interface, supplying bit synchronization.

At the link level, the procedures specified in [8] are followed. The NE or OS must be able to start the set-up or reset of the link (a DCE function in Recommendation X.25) as well as to respond to a start from the connecting equipment (a DTE function in Recommendation X.25). In addition, provision must be made for assignment of the AB/FB 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.

F.5.2.2 *Window*

Modulo 8 operation shall be used. The window for unacknowledged frames is to be optional between 1 and 7 frames. Typical values are 7 and 2.

F.5.2.3 *User information*

The user information is to be arranged in an integral number of octets. In other words, the data is to be structured in 8 bit bytes.

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 F-3/G.771. Maximum information field lengths that shall be supported are 131 and 259 octets with 515 octets optional. These values provide for three packet header octets and maximum length of packet data units of 128, 256 and 512 octets, respectively.

F.5.2.4 *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. The NE 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 F-3/G.771. These options, like those of the physical layer, are to be set at installation, changeable by the user, and non-volatile.

F.5.3 *Layer 3*

It is mandatory that the packet layer conform to Recommendation X.25. In addition the packet layer must provide for connection of data terminal equipment (OSs and NEs) without an intervening packet network; the required interface for this purpose conforms to [10]. In addition, the provisions of [13] shall apply.

The attributes which must be supported are summarized in Table F-4/G.771. Note in particular that this table shows the different attributes needed to support PVCs (the X.25/PVC procedures) and SVCs (the X.25/SVC procedures).

F.5.3.1 *Equipment type during restart*

When the packet level X.25 interface is used, automatic selection of the DCE/DTE role during restart is required, as specified in [10].

F.5.3.2 *Other features and parameters*

The packet layer attributes are summarized in Table F-4/G.771.

F.5.4 *Higher layers*

Under study.

F.6 *Candidate protocol suite No. 6 (CPS 6)*

Initial application:

Alarm surveillance, performance monitoring and configuration control of NEs found in reasonably large numbers in the telecommunications network (e.g. muldex, line transmission terminal).

F.6.1 *Interface characteristics*

F.6.1.1 *General characteristics*

— Network topology: ‘‘loop’’ (a variety of a ring chain configuration);

— Serial data transmission;

— Master-slave principle;

— Maximum number of slaves: 30;

— Transmission medium: one balanced screened pair (with the possibility of providing bypasses of faulty sections of the ‘‘loop’’ and slaves);

— Maximum connection length between two connected slaves: 1000 m.

H.T. [T4.771]
TABLE F-4/G.771
X.25 packet layer attributes

Attributes	Range (Notes 1, 2)	Default values (Note 3)	Units
{			
Permanent virtual circuits			
}			
Packet size	128, 256, 512 optional	128	octets
Window size	1-7	2	
Interrupt packets	optional		
{			
Switched virtual circuits			
}			
{			
Flow control parameter negotiation			
}			
Packet size	128, 256, 512 optional	128	octets
Window size	1-7	2	
{			
Throughput class negotiation			
}			
Bit rate	1200, 2400, 4800, 9600	2400	bit/s
{			
Expedited data negotiation			
Closed user group			
}			
Closed user group selection			
Basic format	2		decimal digits
Fast select	128		octets
Fast select acceptance			
Hunt group			
{			
Transit delay selection and indication			
}			
Calling address extension			
Called address extension			
{			
Minimum throughput class negotiation			
}			
End-to-end transit delay negotiation			

Note 1 — The ranges specified for negotiated parameters in no way affect the normal negotiation rules specified in the international standards.

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

Note 3 — 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.

Tableau F-4/G.771 [T4.771], p. 8

F.6.1.2 *Layer 1 of the ISO-OSI reference model* | physical layer)

— Electrical characteristics in accordance with Recommendations V.11 and V.24 [1], [2], [21];

— Transmission method: asynchronous;

— Mode of operation of the slave: duplex;

— Transmission rate: 19 | 00 bit/s.

F.6.1.3 Further layers are under study.

H.T. [T5.771]

TABLE F-5/G.771

Candidate protocol selection attribute values

Attribute	CPS 1	CPS 2	CPS 3	CPS 4	CPS 5	CPS 6
Layer 1						
Configuration	B	B	B,R | ua)	S	S	R
{						
No. of ports per configuration						
}	M	VL	M	M	M	M
Physical medium	SP	SP	SP	SP	SP	SP
Transmission mode	AS-HD	S-FD	S-HD,FD	S-FD	S-FD	AS-HD
Operating speed (bit/s)	19 | 00	1 | 00 | 00	19 | 00 64 | 00 128 | 00	1200 9600	1200 9600	19 | 00
Communication distance	M	M	M(L)	M(L)	M(L)	M
Communication environment	IB	IB	IB(OB)	IB(OB)	IB(OB)	IB
Availability | ua)						
Layer 2						
Data link connection	CO	CL	CO	CO	CO	CO
Data link initiator	M	AP	M	AP	AP	M
Data link address size	M	VL	VL	S	S	a)
Receipt confirmation	Y	Y	Y	Y	Y	Y
Max. frame size	S	M	S,M	S,M	S,M	S
Max. frame frequency per port	H	H	H	H	H	M
Max. frame transmit delay	M	S	M	S,M	S,M	S
Error detection	P+CS8	CRC16	CRC16	CRC16	CRC16	CRC
Hamming distance	4					
Error recovery	R	R	R	R	R	R
Layer 3						
LCN network size					VL	
Routing					Y	
(Un) packing					Y	
Connections					P,SW	
Priority					Y	
Higher layers | ua)						

a) Under study.

Note — An explanation of the abbreviations used in this Annex is given in Annex E.

Table F.5/G.771 [T5.771], p.

References

[1] CCITT Recommendation *Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communication* , Vol. VIII, Rec. V.11.

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

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

[4] CCITT Recommendation *Interface between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit* , Vol. VIII, Rec. X.25.

[5] ISO 2110 *Data communications — 25-pin DTE/DCE interface connector and pin assignments* .

[6] ISO 3309 *Data communications — High-level data link control procedures — Frame structure* .

[7] ISO 4335 *Data communications — High-level data link control procedures — Consolidation of elements of procedures* .

[8] ISO 7776 *Data communications — High-level data link control procedures — Description of the X.25 LAPB-compatible DTE data link procedures* .

[9] ISO 7809 *Data communications — High-level data link control procedures — Consolidation of classes of procedures* .

[10] ISO 8208 *Information Processing Systems — X.25 packet level protocol for data terminal equipment* .

[11] ISO 8802.2 *Information Processing Systems — Local area networks — Part 2: Logical link control* .

[12] ISO 8802.3 *Information Processing Systems — Local area networks — Part 3: Carrier sense multiple access with collision detection* .

[13] ISO 8878 *Data communications — Use of X.25 to provide the OSI connection-mode network service* .

[14] ISO DIS 8482 *Data communications — Twisted pair multipoint interconnections* . Compatible with Rec. V.11 and Reference 23.

[15] IEC TC 57 Part 5

(i) IEC TC 57 Part 5-1. Format FT 1.2

(ii) IEC TC 57 Part 5-2.

[16] IEEE STD 488 *Standard digital interface for programmable instrumentation* .

[17] IEEE STD 802.2 *Local area networks — Logical link control* .

[18] IEEE STD 802.3 *Local area networks — Carrier sense multiple access/collision detection* .

[19] EIA-232-C *Interface between Data Terminal Equipment and Data Communications Equipment employing serial binary data interchange* .

[20] EIA-232-D *Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment employing serial binary data interchange*

[21] EIA-422 *Electrical characteristics of balanced voltage digital interface circuits* .

[22] EIA-449 *General purpose 37-position and 9-position interface for Data Terminal Equipment and Data Circuit-Terminating Equipment employing serial binary data interchange* .

[23] EIA-485 *Electrical characteristics of generators and receivers for use in balanced digital multipoint systems* .

Recommendation G.772

DIGITAL PROTECTED MONITORING POINTS

(Melbourne, 1988)

Note — The detailed requirements contained in this Recommendation are applicable to the 2048 kbit/s hierarchy. The application of the principles defined in this Recommendation to the 1544 kbit/s hierarchy is for further study.

1 Definition

A **protected monitoring point (PMP)** provides a digital interface at which it is possible to monitor the transmitted signal and to make measurements with suitable test equipments [1].

2 Location

The possible locations for protected monitoring points can be:

a) at the output ports of an equipment;

b) in the signal path between equipments.

Some examples are shown in Figure 1/G.772.

3 Electrical characteristics of the protected monitoring point

Note — The reference for all parameters associated with protected monitoring points shall be the relevant output interface as defined in Recommendation G.703 [2] (see Figures 1/G.772 and 2/G.772).

3.1 *Impedance*

The load impedance presented by the test equipment at the protected monitoring point is the nominal impedance for the corresponding transmission path interface as defined in Recommendation G.703.

3.2 *Attenuation*

The attenuation between the transmission path interface and the protected monitoring point, when the impedance presented by the test and measuring equipment connected to the protected monitoring point is equal to the nominal impedance for the relevant interface as defined in Recommendation G.703, shall be $A \pm 1$ dB for all frequencies in the range 2.5% to 150% of the nominal bit rate at the interface (see Figure 2/G.772).

Different values may be necessary at different nominal bit rates.

The value of A | s under study.

The digital signal level presented at the transmission path interface of the protected monitoring point shall be as defined in Recommendation G.703 but modified by the characteristics of the interconnecting cable. The attenuation of the cable shall be assumed to follow a $\sqrt{fIf\ \ |}$ law and the loss *X* at a frequency equal to half the nominal bit rate is given below:

0 *X* 3 dB for 64 kbit/s

0 *X* 6 dB for 2 and 8 Mbit/s

0 *X* 12 dB for 34 and 140 Mbit/s.

Note — For a protected monitoring point device at an equipment output port, as described in Figure 1a/G.772, the value of *X* is 0 dB.

3.3 *Protection of the PMP device*

3.3.1 The protection of the protected monitoring point device against electrostatic discharges shall accord with the requirements of Recommendation K.21 [3] and IEC Publication 801-2 [4].

3.3.2 No damage shall result from the application of any load impedance, including short and open circuits, to the protected monitoring point.

3.3.3 The protection against the inadvertent application of voltages to the protected monitoring point is under study.

4 Electrical characteristics of the transmission path interface

Note — The reference for all parameters associated with the transmission path interface shall be the relevant output interface as defined in Recommendation G.703.

4.1 *Impedance*

The transmission path interface shall have the nominal impedance as defined in Recommendation G.703 for the relevant bit rate output interface.

4.2 *Return loss*

With the transmission path interface terminated with its nominal impedance, the return loss shall comply with the requirements defined in Recommendation G.703 for the relevant bit rate output interface. This shall apply with any value of load impedance, including short and open circuits, applied to the protected monitoring point.

4.3 *Attenuation*

The attenuation in the transmission path, when the transmission path interface is terminated in its nominal impedance, shall be less than Y dB (see Figure 2/G.772) for all frequencies in the range 2.5% to 150% of the nominal bit rate, when the protected monitoring point is terminated in any load impedance, including short and open circuit.

The value of Y is for further study; 1 dB has already been proposed.

4.4 *Impact of the protected monitoring point on the maximum cable length*

The introduction of a protected monitoring point as described in Figure 1b with an attenuation of Y dB will effectively reduce the maximum attenuation allowed for in Recommendation G.703 by Y dB.

4.5 *Protection of the transmitted signal*

Under study.

The degree of protection shall be specified in terms of an X% variation in the pulse mask of the signal on the transmission path when the protected monitoring point is terminated in any impedance including short and open circuit.

Blanc

Figure 1/G.772, p. 10

Figure 2/G.772, p. 11

References

[1] CCITT Recommendation *Maintenance terminology and definitions,* Vol. IV, Rec. M.60.

[2] CCITT Recommendation *Physical/electrical characteristics of hierarchical digital interfaces* , Vol. III, Rec. G.703.

[3] CCITT Recommendation *Resistability of subscribers terminals to overvoltages and overcurrents* , Vol. IX, Rec. K.21.

[4] IEC Publication 801-2 *Prescriptions relatives aux d´echarges ´electrostatiques* .