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	*	
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*							

* Under study.

REFERENCES

- Transmission medium: one balanced screened pair (with the possibility of providing by-passes of faulty sections of the "loop" and slaves)

- Maximum connection length between two connected slaves: 1000 m

6.2Layer 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: ≤ 19200 bits per second

6.3Further layers are under study

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*	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 (bits per second)	19200	1000000	19200 64000 128000	1200	1200	≤ 19200
communication distance	M	M	M(L)	M(L)	M(L)	M
communication environment	IB	IB	IB(OB)	IB(OB)	IB(OB)	IB
availability*	X	X	X	X	X	X

6.Candidate protocol suite No. 8 (CPS 8)

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).

Interface characteristics

6.1General characteristics

- Network topology: "loop" (a variety of a ring chain configuration)

-Serial data transmission

- Master-slave principle

- Maximum number of slaves: 30

TABLE F.4/G.771

X.25 packet layer attributes

_____

- Equipment: removable strap to frame ground
  Cable: connected to shield

s Additional interchange circuits required for switched service

t Additional interchange circuits required for synchronous channel

x Basic interchange circuits, all systems

= Circuit DA (CCITT 113) is not used in OS/NE interfaces

Duplex, interface type D.

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

For further information, see [2, 3, 5, 19].

TABLE F.3/G.771

LAPB data link layer attributes

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 ISO 8208. In addition, the provisions of ISO 8878 shall apply.

The attributes which must be supported are summarized in Table F.4. 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).

5.2.1Equipment 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 ISO 8208.

5.3.2Other features and parameters

The Packet Layer attributes are summarized in Table F.4.

5.Upper layers

Under study.

TABLE F.2/G.771

ISO 2110 pin description

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 synch.

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 CCITT Recommendation X.25) as well as to respond to a start from the connecting equipment (a DTE function in CCITT 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.

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.

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. 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.

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. These options, like those of the physical layer, are to be set at installation, changeable by the user, and non- volatile.

5.3 Layer 3

It is mandatory that the Packet Layer conform to CCITT Recommendation X.25. In addition the

tions. The range of parameters is shown in Table F.3. These options, like those of the physical layer, are to be set at installation, changeable by the user, and non- volatile.

4.3Other layers

No layer 3 is planned for this suite.

Layers 4-7 are under study.

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).

Layer 1

Electrical - Recommendations V.24, V.28

Configuration - star

Physical connection - ISO 2110 (25 pin)
(see Table F.2)

Transmission mode - duplex, interface type D

Operating speed - 1200, 2400, 4800 and 9600 bits per second
(user option)

Shield - Ground strap to frame
(user option)

5.2Layer 2

It is mandatory that the data link layer conform to LAPB as defined in CCITT Recommendation X.25. 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]. Further detail is provided in the subsection entitled "Equipment type during link set-up and reset" below.

The link layer specification that follow applies to all cases.

Recommendation X.25. 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]. Further detail is provided in the subsection entitled "Equipment type during link set-up and reset" below.

The link layer specification that follows applies to all cases.

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 synch.

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 CCITT Recommendation X.25) as well as to respond to a start from the connecting equipment (a DTE function in CCITT 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.

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.

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. 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, and 256 and 512 octets respectively.

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 reconfigura-

- Equipment: removable strap to frame ground
  Cable: connected to shield

* These circuits are optional for connection to an embedded operations channel or modem and are not used for connections to a multipoint bus

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 characteristic impedance (typically, 120 ohms, resistive), should the equipment be at one end of a multipoint bus.

For further information, see [2, 16, 22, 23].

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).

4.1 Layer 1

Electrical	- Recommendations V.24, V.28
Configuration	- star
Physical connection	- ISO 211 (25 pin) (see Table F.2)
Transmission mode	- duplex, interface type D
Operating speed	- 1200, 2400, 4800 and 9600 bits per second (user option)
Shield	- ground strap to frame (user option)

4.2 Layer 2

It is mandatory that the data link layer conform to LAPB as defined in CCITT

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.

3.2.5.3Number of repetitions

In the situation of § 3.2.5.2, the maximum number of repetitions before detecting a no-reply or a lost-reply condition is fixed to five (six requests).

3.2.5.4Response 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 kbit/s is under study).

3.3Higher layers

Under study.

TABLE F.1/G.771

Pin description of 24-pin connector [16]

Two modes are selected:

- one operational mode:

  Normal Response Mode (NRM)

- one non-operational mode:

  Normal Disconnected Mode (NDM)

3.2.4Class of procedure

The Unbalanced operation Normal response mode Class (UNC) as defined by ISO 7809 shall be implemented.

3.2.4.1HDLC optional functions

The following HDLC optional functions shall be implemented:

- unnumbered information (option No. 4)
  - command UI
  - response UI
- data link test (option No. 12)
  - command TEST
  - response TEST

3.2.5Other parameters of OSI layer 2

3.2.5.1Window size

The window size is fixed to one.

3.2.5.2Waiting-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

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

3.2.2.2No 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.

3.2.2.3Group address

Not used.

3.2.3HDLC procedure

The HDLC procedure is defined by [7].

3.2.3.1Commands and responses

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 Acknowledgment
    - DM: Disconnected Mode

3.2.3.2Modes

trol in accordance with CCITT Recommendation V.24 [2, 22]. See Table F.1/6.771.

3.1.4.3Electrical requirements

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

3.1.4.4Line code

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

3.1.4.5Speed

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

3.2OSI layer 2

The data link protocol is synchronous HDLC type.

3.2.1HDLC frame structure

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

3.2.1.1Addressing field

The addressing field shall be one octet.

3.2.1.2Information 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.

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.

3.2.2Addressing

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

3.2.2.1All-station address

3.1.2.4Bit rate

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

3.1.2.5Turn 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 kbit/s per second is under study.

3.1.2.6Preamble

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.

3.1.3Line code

The line code shall be NRZI.

Clock extraction by the remaining station is assumed.

3.1.3.1Principle

Each transition [14] shall represent a zero, and no transition shall represent one bit.

3.1.3.2Lock-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 § 3.1.2.6 (if implemented).

3.1.4Extended mode

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

3.1.4.1Configuration - full duplex

3.1.4.2Connector

The connector shall conform to [16]. Appropriate signal leads are to be provided for modem con-

3.1.1.1Configuration

Serial bus operation in accordance with ISO DIS 8482 (ring configuration under study).

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

3.1.1.2Transmission pairs

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

Note - Two administrations have proposed using each of the pairs of 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.

3.1.1.3Bus 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 to unintentioned transmissions on the other.

3.1.1.4Connector

The administration shall specify the connector type.

3.1.2Electrical characteristics

3.1.2.1Static and dynamic characteristics

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

3.1.2.2Bus termination

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

3.1.2.3Load 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.

2.2.1Frame format

Frame components:

- flag,
- destination address --- 2 octets,
- source address --- 2 octets,
- control --- 1 octet,
- LLC data --- variable length (maximum 512 octets),
- frame check sequence --- CRC 16,
- flag.

2.2.2Media access control

The media access control discipline known as carrier sense multiple access is used.

2.2.3Logical link control layer

Acknowledged connectionless mode protocol specification to be specified in ISO 8802-2/AD 2 is used.

2.3Upper layers

Under study.

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).

3.1OSI layer 1

3.1.1Physical characteristics

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.

1.2.3Addressing

The address one 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).

1.2.4Window size

The window size is fixed to one.

1.3Higher layers

Under study.

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

Initial application:

Alarm surveillance, performance monitoring, testing commands, 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).

2.1OSI layer 1

2.1.1Configuration: Bus.

2.1.2Line speed: 1 Mbit per second.

2.1.3Medium: Screened pair.

2.1.4Electrical requirement: V.11 interface with pulse transformer.

2.1.5Line code: CMI.

2.2OSI layer 2

per bus.

1.1.2Communication environment

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

1.1.3Physical connection

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

1.1.4Electrical requirements

Each bus interface shall be in accordance with 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].

1.1.5Line code

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

1.1.6Speed

The bit rate shall be 19.2 kbit/s per second.

The bit rate tolerance shall be $\pm$ 1%.

1.1.7Transmission mode

The transmission mode shall be half duplex, asynchronous.

1.2OSI layer 2

Asynchronous, byte oriented protocol according to [15].

1.2.1Transmission frame format

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

1.2.2Link transmission procedure

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.tmn the the candidate protocol selection attribute values (see Annex E of this Recommendation). Differences of the values in Table F.5/ G.tmn 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.

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).

1.1OSI layer 1

1.1.1Configuration

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