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Foreword

This European Telecommunication Standard (ETS) has been produced by the Terminal Equipment (TE) Technical Committee of the European Telecommunications Standards Institute (ETSI).

This ETS specifies a common set of protocols up to layer 4 of the Open Systems Interconnection (OSI) model to be used by telematic terminals attached to the pan-European Integrated Services Digital Network (ISDN). It bears a close relationship to CCITT Recommendation T.90 [8] and the Functional Standard T/1112 (ENV 41 112) [20]. Full details of these and other normative references are given in Clause 2 of this ETS.

A number of the references given in Clause 2 also involves work currently being carried out within ETSI. All of the ETSI drafts listed should be available from your ETSI agreed National Standards Organisation (NSO).

Reference to this ETS will be made by specifying attachment approval requirements and type approval test suites in the terminal NETs.

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1 Scope

This ETS specifies the usage of all protocols and supplementary services up to and including layer 4 for telematic terminals in the ISDN. The scope of this ETS is limited to demand circuit-switched calls using the 64 kbit/s unrestricted digital information bearer capability and the DTE/DTE case of the Network Layer peer entities in B-channel connection. This ETS is based on other ETSs, International Standards or CCITT Recommendations and, where necessary, it adds new or other requirements as application rules.

The telematic services considered are:

a) teletex;

b) facsimile group 4; and

c) ISDN syntax-based Videotex.

The ETS is applicable to terminals using either basic access or primary rate access to the ISDN. Basic access and primary rate access refer to different ETSs for layer 1.

NOTE: In the context of this ETS, and in the case of Videotex, a terminal is either a real terminal equipment, a Videotex service centre, a Videotex access point or a Videotex host.

Conformance testing to verify to which extent a terminal conforms with this ETS is to be specified in a separate ETS which will cover both the Protocol Implementation Conformance Statement (PICS) proformas and the Abstract Test Suites (ATS).

Interworking capabilities and limitations with implementations following similar Standards such as Functional Standards are described in informative annexes.

2 Normative references

This ETS incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] CCITT Recommendation F.184 (1988): "Operational provision for the international public facsimile service between subscriber stations with group 4 facsimile machines (telefax 4)".

[2] CCITT Recommendation F.200 (1988): "Teletex service".

[3] CCITT Recommendation F.220 (1988): "Service requirements unique to the processable mode number 1 (PM1) used within the teletex service".

[4] CCITT Recommendation F.230 (1988): "Service requirements unique to the mixed mode (MM) used within the teletex service".

[5] CCITT Recommendation I.333 (1988): "Terminal selection in ISDN".

[6] CCITT Recommendation Q.931 (1988): "ISDN user-network interface layer 3 specification for basic call control".

[7] CCITT Recommendation T.70 (1988): "Network-independent basic transport service for the telematic services".

[8] CCITT Recommendation T.90 (1988): "Characteristics and protocols for terminals for telematic services in ISDN".

[9] CCITT Recommendation T.101 (1988): "International interworking for videotex services".

[10] CCITT Recommendation X.25 (1988): "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 circuits".

[11] CCITT Recommendation X.75 (1984): "Packet-switched signalling system between public networks providing data transmission services".

[12] CCITT Recommendation X.224 (1988): "Transport protocol specification for Open Systems Interconnection for CCITT Applications".

[13] ETS 300 102-1 (1990): "Integrated Services Digital Network (ISDN); User-network interface layer 3, Specification for basic call control".

[14] ETS 300 102-2 (1991): "Integrated Services Digital Network (ISDN); User-network interface layer 3 Specification for basic call control Specification Description Language (SDL) diagrams".

[15] ETS 300 011 (1992): "Integrated Services Digital Network (ISDN); Primary rate user-network interface, Layer 1 specification and test principles".

[16] ETS 300 012 (1992): "Integrated Services Digital Network (ISDN); Basic user-network interface, Layer 1 specification and test principles".

[17] ETS 300 125 (1991): "Integrated Services Digital Network (ISDN); User-network interface data link layer specifications Application of CCITT Recommendations Q.920/I.440 and Q.921/I.441".

[18] prETS 300 196: "Integrated Services Digital Network (ISDN); Generic Functional protocol for the support of supplementary services Digital Subscriber Signalling No one (DSS1) protocol".

[19] prETS 300 195: "Integrated Services Digital Network (ISDN); Digital Subscriber Signalling No. one (DSS1); Supplementary services interactions protocol".

[20] FS T/1112: " Provision of the OSI Connection-mode Transport Service and the OSI Connection-mode Network Service by using an ISDN circuit-mode 64 kbit/s unrestricted Bearer Service: Demand Case (ENV 41 112)".

[21] ISO 7776 (1986): "Information processing systems - Data communications - Description of the X.25 LAPB-compatible DTE data link procedures".

[22] ISO/IEC 7776: "Addendum 1 Information processing systems - Data communication - High level data link control procedures - Description of the X.25 LAPB-compatible DTE data link procedure - Addendum 1: PICS proforma".

[23] ISO/IEC 8073 (1988): "Information processing systems - Open Systems Interconnection - Connection oriented transport protocol specification".

[24] ISO/IEC 8073 Addendum x: "Information processing systems; Open Systems Interconnection; Connection oriented transport protocol specification Addendum x: PICS".

[25] ISO/IEC 8208 (1990): "Information technology - Data communications - X.25 Packet Level Protocol for Data Terminal Equipment".

[26] ISO/IEC 8208 Addendum 3: "Information processing systems; Data communication; X.25 Packet Level Protocol for Data Terminal Equipment Addendum 3: Conformance requirements".

[27] ISO/IEC 8878 (1987): "Information processing systems - Data communications - Use of X.25 to provide OSI connection-mode network service".

[28] ISO/IEC DIS 9574 (1989): "Information technology - Telecommunications and information exchange between systems - Provision of the OSI connection-mode network service by packet mode terminal equipment connected to an Integrated Services Digital Network (ISDN)".

[29] ISO/IEC DIS 9574 PDAD 1: "Information technology - Telecommunications and information exchange between systems - Provision of the OSI connection-mode network service by packet mode terminal equipment connected to an Integrated Services Digital Network (ISDN) ADDENDUM 1: Operation over an ISDN circuit-switched channel connecting directly to the remote terminal".

[30] ISO/IEC 10025: "Transport conformance testing (temporary title)".

In the Standards and Recommendations listed above, further normative references are given which are not listed here.

3 Abbreviations

The following abbreviations shall apply:

CC	Call Connect
CLIP	Calling Line Identification Presentation
CR	Connection Request
DCE	Data Circuit-terminology Equipment
DDI	Direct Dialling-In
DISC	Disconnect
DM	Disconnected Mode
DTE	Data Terminology Equipment
FRMR	Frame Reject
HLC	Higher Layer Compatibility
ISDN	Integrated Services Digital Network
LAPB	Link Access Procedure - Balanced
LAPD	Link Access Procedure on the D-channel
LI	Length indicator

LLC	Lower Layer Compatibility
MLP	Multilink Procedure
MSN	Multiple Subscriber Number
NSAP	Network Service Access Point
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
RNR	Receive Not Ready
SABM	Set Asynchronous Balanced Mode
SABME	Set Asynchronous Balanced Mode Extended
SPI	Subsequent Protocol Identifier
TBR	Transport Block Reject

4 Model description

4.1 Protocol pillars

Either CCITT Recommendation X.75 [11] or ISO 7776 [21], plus some additional rules in each case as indicated in subclause 7.1, shall serve as the layer 2 protocol in the B-channel. Either CCITT Recommendation T.70 [7] or ISO/IEC 8073 [23] plus some application rules in either case as indicated in Clause 8, shall serve as the layer 4 protocol in the B-channel. Therefore, each of the protocol pillars shown in figure 1a and figure 1b is allowed to conform with this ETS:

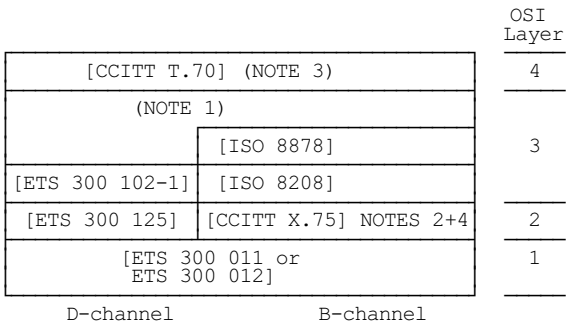

Figure 1a

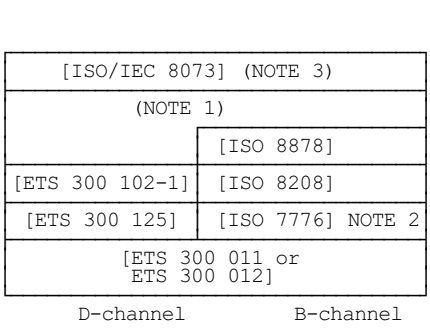

Figure 1b

NOTE 1: This function, called co-ordinating function and detailed below, specifies the relationship between the B-channel and D-channel protocol pillars, and is consistent with ISO/IEC 9574 PDAD 1 [29], the scope of which does not include the functions defined in this document.

NOTE 2: Additional rules are imposed on the protocol (see subclause 7.1). In the case of CCITT Recommendation X.75 [11], the rules are modifying the protocol, while in the case of ISO 7776 [21] the rules are in conformance with the protocol. The two protocols plus their additional rules are still different. However, it is shown in Annex C that they can interwork.

NOTE 3: The layer 4 protocol is not applicable to Videotex.

NOTE 4: CCITT Recommendation T.90 [8] uses a modified version of CCITT Recommendation X.75 [11], the usage of other protocols as alternative options being indicated for further study. ISO 7776 [21] is such a candidate in CCITT Recommendation T.90 [8] and is already allowed to be implemented to conform with this ETS.

At layer 1, ETS 300 012 [16] is used for ISDN basic access and ETS 300 011 [15] is used for ISDN primary rate access. At layer 2, ETS 300 125 [17] provides the Link Access Procedure - Balanced (LAPB) Data Link procedures for the D-channel and CCITT Recommendation X.75 [11] or ISO 7776 [21] (both with additional rules imposed as indicated in subclause 7.1) provides the LAPB Data Link procedures for the B-channel. At layer 3, ETS 300 102-1 [13] signalling procedures are used in the D-channel, and the ISO/IEC 8208 [25] packet level protocol is used in DTE/DTE operation in the B-channel. The provisions of ISO/IEC 8878 [27] apply with regard to the mappings of the OSI CONS primitives and parameters to and from the elements of the ISO/IEC 8208 [25] packet level protocol.

NOTE: The provision of the full OSI CONS for Videotex is for further study.

For the application of teletex and facsimile group 4, transport connections are provided by CCITT Recommendation T.70 [7] or ISO/IEC 8073 [23] (both with application rules imposed as indicated in Clause 8), while in Videotex no transport protocol is employed at all.

Additional conformance requirements to the standards in figure 1a and figure 1b can be found in Clauses 7 and 8.

4.2 Co-ordination between B-channel and D-channel

Independently of the choice made at layer 2 of the B-channel (taking figure 1a or figure 1b as the protocol pillar), the terminal implements two protocol stacks below layer 4. One stack is used over the ISDN D-channel for establishing, maintaining and clearing circuit-switched B-channel connections. The other is used over the B-channel(s) for establishing, maintaining and clearing virtual calls, and for the information transfer itself.

The co-ordination function provides the synchronisation mechanism required between the usage of the D-channel protocol stack and the B-channel protocol stack.

4.2.1 Multiple B-channels

If a terminal operates more than one B-channel with one or more than one other end system, the layer 2 and 3 entities shall be processed independently in each B-channel (e.g. Data Link disconnection, active/idle channel state, DTE/DCE role assignment, logical channel range, etc...).

4.2.2 Active B-channel connection

If a B-channel connection is not already established (or if Quality of Service or other considerations dictate that an additional B-channel connection is needed to support the additional traffic), the receipt by layer 3 of an N-CONNECT request primitive shall first cause the ISDN D-channel signalling procedure for full circuit-switched connection to be used as defined in Clause 6, to establish a B-channel connection.

4.2.3 Established B-channel

When a B-channel connection is established in layer 1, the co-ordinating function shall inform the Network Layer entity and the Data Link Layer entity. The Data Link Layer shall then perform synchronisation with the peer Data Link Layer entity as described in subclause 8.1.5 and inform the Network Layer entity after successful synchronisation.

NOTE: The supervision by the co-ordinating function of the B-channel establishment and Data Link initialisation is a local matter.

4.2.4 B-channel disconnection by the network

If one or more OSI Network Service connections are established or in the process of being established on an established B-channel and that B-channel is disconnected, this disconnection shall be indicated to the Network Service user by means of an N-DISCONNECT indication primitive with the originator parameter indicating "Network Service provider" and the reason parameter as defined in table 1, for each OSI Network connection established or in the process of being established.

If a cause different from all causes in table 1 is detected on the D-channel, either a value in table 1 that suits shall be selected, or the cause "Normal, unspecified" shall be chosen.

NOTE 1: Table 1 is compatible to "table 2 - Mapping of CCITT Recommendation Q.931 causes to OSI CONS reasons", contained in ISO/IEC 9574 [28], except for the fact that the "not applicable" causes have been removed and the causes "Normal call clearing" (value = 16), "Call rejected" (value = 21) and "Normal, unspecified" (value = 31) have been appended.

NOTE 2: The Diagnostic field of the CCITT Recommendation Q.931 [6] cause information element may contain an indication of the permanence or transience of the condition. The Network Service reason passed to the Network Service user may be modified to transfer this additional information.

4.3 Mapping of ETS 300 102-1 causes to OSI CONS reasons

Table 1: Mapping of causes to reasons

ETS 300 102-1 [13] cause	Network Service Reason
1 : Unassigned or unallocated number	Connection rejection - NSAP unreachable - permanent
3 : No route to destination	Connection rejection - NSAP unreachable - permanent
6 : Channel unacceptable	Connection rejection - reason unspecified - transient
16 : Normal call clearing	Disconnection - transient
17 : User busy	Connection rejection - reason unspecified - transient
18 : No user responding	Connection rejection - reason unspecified - permanent
21 : Call rejected	Connection rejection - reason unspecified - transient
22 : Number changed	Connection rejection - reason unspecified - permanent
27 : Destination out of service	Connection rejection - reason unspecified - permanent
28 : Invalid number format (incomplete number)	Connection rejection - reason unspecified - permanent
31 : Normal, unspecified	Disconnection - transient
34 : No circuit/channel available	Connection rejection - NSAP unreachable - transient
38 : Network out of order	Connection rejection - reason unspecified - permanent
41 : Temporary failure	Connection rejection - reason unspecified - transient

(continued)

Table 1 (concluded)

ETS 300 102-1 [13] cause	Network Service Reason
42 : Switching equipment congestion	Connection rejection - reason unspecified - transient
44 : Requested circuit or channel not available	Connection rejection - reason unspecified - transient
47 : Resources unavailable, unspecified	Connection rejection - reason unspecified - transient
57 : Bearer capability not authorised	Connection rejection - reason unspecified - permanent
58 : Bearer capability not presently available	Connection rejection - reason unspecified - permanent
63 : Service or option not available	Connection rejection - reason unspecified - permanent
65 : Bearer service not implemented	Connection rejection - reason unspecified - permanent
66 : Channel type not implemented	Connection rejection - reason unspecified - permanent
79 : Service or option not implemented - unspecified	Connection rejection - reason unspecified - permanent
81 : Invalid call reference value	Connection rejection - reason unspecified - permanent
82 : Identified channel does not exist	Connection rejection - reason unspecified - permanent
88 : Incompatible destination	Connection rejection - reason unspecified - permanent
95 : Invalid message	Connection rejection - reason unspecified - permanent
96 : Mandatory information element is missing	Connection rejection - reason unspecified - permanent
97 : Message type non-existent or not implemented	Connection rejection - reason unspecified - permanent
98 : Message not compatible with call state or message type non-existent or not implemented	Connection rejection - reason unspecified - permanent
99 : Information element non-existent or not implemented	Connection rejection - reason unspecified - permanent
100: Invalid information element contents	Connection rejection - reason unspecified - permanent
101: Message not compatible with call state	Connection rejection - reason unspecified - permanent
111: Protocol error - unspecified	Connection rejection - reason unspecified - permanent
127: Interworking - unspecified	Connection rejection - reason unspecified - permanent

5 Layer 1 protocols

5.1 Basic access

For terminals using the basic access to an ISDN, ETS 300 012 [16] shall be applicable without any additional application rules.

5.2 Primary rate access

For terminals using the primary rate access to an ISDN, the ETS 300 011 [15] shall be applicable without any additional application rules.

6 D-channel layer 2

ETS 300 125 [17] shall be applicable without any additional application rules.

7 D-channel layer 3

7.1 The access protocol

ETS 300 102-1 [13] and ETS 300 102-2 [14] shall be applicable without any additional application rules.

7.2 Terminal selection and compatibility checking

To select a terminal correctly, a called terminal shall be served with information generated by the calling terminal and possibly by intermediate ISDN exchanges.

The terminal selection functions and procedures are specified in CCITT Recommendation I.333 [5]. Additional information on terminal selection is given in ETR 026. Compatibility checking for terminals supporting specific basic services is described in ETR 018.

ETS 300 102-1 [13], Annex B specifies the procedure for compatibility checking as part of the access protocol. The information elements to be considered are the address information available, the compatibility information, and the progress indicator.

Subclauses 7.2.1 to 7.3 specify further details on terminal selection and compatibility checking and add requirements for telematic terminals.

The result of this procedure is to decide whether to ignore, to reject or to accept the incoming call.

7.2.1 Compatibility information provided by the calling terminal

A calling terminal shall always provide the full set of information in the compatibility information elements as listed in tables 2 to 4.

7.2.1.1 Bearer capability

A calling telematic terminal shall include octets 1 to 4 in the bearer capability information element. The service specific octets shall be encoded as specified in table 2. The octets 4a to 7 shall be omitted.

Table 2: Bearer capability information elements

oct.	information element field	field value
3	coding standard	CCITT standardised coding
	information transfer capability	unrestricted digital information
4	transfer mode	circuit-mode
	information transfer rate	64 kbit/s

7.2.1.2 Low layer compatibility

A calling telematic terminal shall include octets 1, 2, 3, 4, 6 and 7 in the low layer compatibility information element. The service specific octets shall be encoded as specified in table 3.

Table 3: Low layer compatibility information element

oct.	information element field	field value
3	coding standard	CCITT standardised coding
	information transfer capability	unrestricted digital information
4	transfer mode	circuit-mode
	information transfer rate	64 kbit/s
6	user information layer 2 protocol	ISO 7776 (NOTE)
7	user information layer 3 protocol	ISO/IEC 8208

NOTE: ISO 7776 for DTE-DTE operation compatible with CCITT Recommendation X.75 modified by the application rules defined in CCITT Recommendation T.90.

7.2.1.3 High layer compatibility

A calling telematic terminal shall include octets 1 to 4 in the high layer compatibility information element. The service specific octets shall be encoded as specified in table 4. The other octets shall be omitted.

Table 4: High layer compatibility information element

oct.	information element field	field value
3	coding standard	CCITT standardised coding
	interpretation	first high layer characteristics
	presentation method of protocol profile	high layer protocol profile
4	high layer characteristics identification	for teletex: teletex service, basic mode of operation (F.200) (NOTE 1) OR teletex service, basic and mixed mode of operation (F.230) and facsimile service group 4 classes II and III (F.184) (NOTE 2) OR teletex service, basic and processable mode of operation (F.220) (NOTE 3)
		for facsimile service group 4 class I (F.184)
		for Videotex: ISDN syntax-based Videotex (F.300 and T.102) (NOTE 4) OR international interworking for Videotex services (F.300 and T.101) (NOTE 5)

NOTE 1: This coding shall be used for terminals supporting basic operation only.

NOTE 2: This coding shall be used by terminals which want to operate the mixed mode of operation in the call being established. The same codepoint may be used by terminals which want to operate facsimile Group 4 Class II or III.

NOTE 3: This coding shall be used by terminals which want to operate the processable mode of operation in the call being established.

NOTE 4: This codepoint is applicable to the terminal–to–Videotex access function (where a Videotex access function is either a Videotex service centre, a Videotex access point or a Videotex host). The service dependent part of the octet is coded as "0110010". Note that this use is different from that in ETS 300 102 [13 and 14].

NOTE 5: This codepoint is the only one for Videotex and is applicable to interworking between Videotex access functions. The service dependent part of the octet is coded as "0110011".

7.2.2 Compatibility checking by the called terminal

Compatibility checking as part of the access protocol is specified in ETS 300 102-1 [13], Annex B. This subclause specifies the application rules and additional requirements.

a) Annex B, subclause B.3.1

If a call is offered with address information, this information shall be checked against the local address if available before network-to-user and user-to-user compatibility checking. In this context ETS 300 102-1 [13], Annex B, subclause B.3.1, NOTE 1 is not applicable.

In case of a mismatch of any presented address information no further compatibility checking is required and the call shall be ignored.

If a terminal is configured to support one of these addressing supplementary services, but no address information is offered in a call by the ISDN, then the terminal shall continue with network-to-user and user-to-user compatibility checking. It shall not be allowed to ignore a call for missing address information only.

b) Annex B, subclause B.3.2

A terminal matches the received network-to-user compatibility information if the information in the BC information element offered in the SET-UP message is exactly as specified in table 2 of this ETS.

c) Annex B, subclause B.3.3

All offered user-to-user compatibility information shall be checked.

The user-to-user compatibility information may not be presented in some interworking cases with non-ISDNs, private ISDNs, and non-pan-European ISDNs. Not all of these interworking cases shall be indicated by means of the progress indicator information element. Therefore a terminal need not reject an incoming call due to missing user-to-user information elements independent of the information possibly provided by progress indicators.

If user-to-user compatibility information (contained in the LLC and the HLC information elements) is offered in the SET-UP message, a terminal matches this information if this information is as specified in tables 3 and 4 of this ETS for the relevant telematic services. Additionally a received "T.90-codepoint" or "X.25-codepoint" in the LLC information element shall be interpreted as a matching code.

If the user-to-user compatibility information is not offered or not offered completely, a terminal may act as a compatible terminal independently of whether the progress indicator is present or not.

d) Annex B, subclause B.3.4

This subclause requires user actions to be carried out as a result of compatibility checking. Subclause 6.2.3 of this ETS supersedes Annex B, subclause B.3.4. Lower Layer Compatibility (LLC) negotiation is excluded.

NOTE: The exclusion of LLC negotiation is based on missing parameters to negotiate protocol options and on missing support by all ISDNs.

7.2.3 Call acceptance conditions

A terminal is called compatible for an offered call, if it is a terminal with an address which matches the offered address information and the functions which match the offered compatibility information.

A compatible terminal shall either accept or reject an incoming call.

If a terminal accepts an incoming call, the co-ordination function shall initiate the appropriate Link and Network Layer functions in the B-channel. The upper layer functions are selected by the in-band protocol identification (see subclause 8.2.8).

If a compatible telematic terminal rejects an incoming call, it should indicate a cause from the following list:

a) Cause code # 17: User busy (i.e. already involved in another call);

b) Cause code # 47: Resources unavailable, unspecified;

c) Cause code # 21: Call rejected (e.g. other local reasons apply).

7.3 Service specific use of supplementary services

The use of supplementary services is optional.

Only those supplementary services which shall be provided by the pan-European ISDN are mentioned in subclauses 7.3.1 to 7.3.3.

The procedures which are required for the use of supplementary services are specified in prETS 300 196 [19] and prETS 300 195 [20].

7.3.1 Supplementary services for addressing

Due to the possible limited network capabilities in the case of interworking with networks not supporting LLC and/or HLC information elements used to provide the necessary compatibility information for correct terminal selection, the use of the Multiple Subscriber Number (MSN) or the Direct Dialling In (DDI) supplementary service is a solution to achieve compatibility.

7.3.2 Supplementary services for identification

The Calling Line Identification Presentation (CLIP) and Calling Line Identification Restriction (CLIR) shall be available in the pan-European ISDN. These services may be used by terminals.

How to assess the result of operation of these supplementary services is a local matter.

7.3.3 Other supplementary services

The Terminal Portability (TP) supplementary service shall not be used.

All other supplementary services are for further study.

NOTE: The reaction of a calling or a called terminal to unexpected results of the use of supplementary services is for further study.

8 B-channel protocols

8.1 B-channel Layer 2

8.1.1 Base protocols

One of the following protocols shall serve as the base of the layer 2 protocol on the B-channel:

- CCITT Recommendation X.75 [11], Red Book version; or

- ISO 7776 [21].

In either case, additional rules shall be imposed on the base protocol in subclause 8.1.

In the case of CCITT Recommendation X.75 [11], the rules modify the protocol, while in the case of ISO 7776 [21] the rules are in conformance with the protocol.

NOTE: The two base protocols plus their additional rules are still different, however, it is proved in Annex C that they can interwork.

8.1.2 General rules for base protocol CCITT Recommendation X.75

8.1.2.1 STE - DTE

For the purposes of this ETS, the term "STE" shall be read as "DTE".

8.1.2.2 Single link procedure

Only the single link procedure shall be used.

The "interim solution" in CCITT Recommendation X.75 [11], where frames without sequence numbers may contain a 16-bit control field, shall not be permitted.

8.1.2.3 Data link layer address procedure

The address assignment shall be done dynamically on a per call basis. The terminal which originated the B-channel connection shall be deemed to be the calling terminal. The calling terminal shall take address A and the called terminal shall take address B.

Addresses A and B are coded as follows:

Bits	8	7	6	5	4	3	2	1
A	0	0	0	0	0	0	1	1
B	0	0	0	0	0	0	0	1

The addresses A and B shall be employed in commands and responses according to the following figure 2 below:

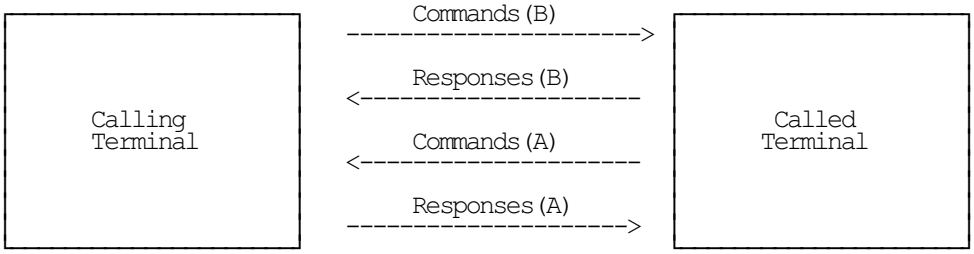

Figure 2: Address assignment

8.1.2.4 Mode of operation

The default mode of operation shall be the basic mode. The Layer 2 entity shall be capable of processing in basic mode of operation.

The usage of extended mode of operation is for further study. As long as no negotiation of the mode of operation is defined and agreed, the usage of the extended mode of operation is not permitted.

8.1.3 Specific rules for base protocol CCITT Recommendation X.75

The following specific rules are based on the specific rules in CCITT Recommendation T.90 [8]. To keep the correspondence to these rules, the indexing is done from a) to t) as in the above CCITT Recommendation.

The related sections and tables of CCITT Recommendation X.75 [11] are indicated with each rule.

The statement of the rule may be different in some cases. If the difference is not only in phrasing, italics are used.

a) Length of I-frames (table 1/CCITT Recommendation X.75 [11])

I-frames should not be sent with an empty I field.

N >= 0 and N <= N1 - 32 in basic mode.

Received empty I-frames shall be treated as valid I-frames.

b) FRMR causes (CCITT Recommendation X.75 [11], § 2.3.4.9)

Clauses 5, 6 and 7 shall not result in FRMR transmission. The following actions shall be implemented instead:

- not expected supervisory frames with the F-bit set to 1 shall be ignored;
- not expected UA or DM response shall be ignored;
- frames with an invalid N(S) (exceeding window size k) shall be responded by sending a REJ frame (see § 2.3.5.2.1).

Frames with a FRMR control field shall not be responded by sending a FRMR frame.

c) Bits X, Y, Z, W (tables 7 and 8/CCITT Recommendation X.75 [11])

Bits X, Y, Z and W in a FRMR frame may all be set to 0 to indicate that no reason for frame rejection is given.

d) Octet alignment (CCITT Recommendation X.75 [11], § 2.3.5.3)

No specific rules.

e) Expiration of T3 (CCITT Recommendation X.75 [11], § 2.3.5.5)

Higher layers should be notified when T3 expires (excessive idle channel state).

f) Next - Corresponding (CCITT Recommendation X.75 [11], § 2.4.3)

Replace "next response" by "corresponding response".

g) Active Channel State (CCITT Recommendation X.75 [11], § 2.4.4.1)

When the B-channel is established and no frames are currently being transmitted, flags shall be sent on the transmit channel independently of whether flags are currently received on the receive channel or not.

Unnumbered command frames shall always be transmitted with the P-bit set to 1.

h) Entering the disconnected phase (CCITT Recommendation X.75 [11], § 2.4.4.4.1)

Except for the conditions indicated in § 2.4.4.4.1, the disconnected phase shall also be entered after the collision of different unnumbered commands according to § 2.4.4.5.2 (only explanatory rule).

The Data link layer entity of the calling terminal is responsible for setting up the link, but the called terminal may also do it.

i) Timer recovery after received RNR (CCITT Recommendation X.75 [11], § 2.4.5.9)

When an RNR frame is received and Timer T1 is already running, it shall be kept running. Otherwise Timer T1 shall be started.

j) Transmission of I-frames after received RNR (CCITT Recommendattion X.75 [11], § 2.4.5.9, paragraph 5)

When an RNR frame is received, I-frame transmission and retransmission shall not be resumed until the busy condition is cleared.

k) N2 unsuccessful transmission attempts (CCITT Recommendation X.75 [11], § 2.4.5.9, last paragraph)

When the transmission attempt variable is equal to N2, the DTE shall initiate appropriate higher layer recovery action and enter the disconnected phase.

l) Check commands in FRMR condition (CCITT Recommendation X.75 [11], § 2.4.7.3)

In the FRMR condition, the Data link layer entity shall only check the received command frames and respond with an FRMR according to the P-bit.

The FRMR condition is cleared when an SABM(SABME) is received, or a DISC command frame is transmitted or received.

In case of a FRMR collision, the FRMR condition is also cleared after having transmitted an SABM(SABME).

m) Originator of reset in FRMR condition (CCITT Recommendation X.75 [11], § 2.4.7.3, 2nd paragraph)

Only the Data link layer entity that caused the FRMR condition may try to reset the link.

n) N2 transmissions of FRMR (CCITT Recommendation X.75 [11], § 2.4.7.3, 3rd paragraph)

When Timer T1 has expired N2 times after having transmitted the FRMR response to get the other terminal to reset the link, the Data link layer entity shall enter the disconnected phase (see NOTE 1).

o) Timer/Parameter T1 (CCITT Recommendation X.75 [11], § 2.4.8.1)

T1 shall be started at the end of frame transmission.

The value of parameter T1 depends on the maximum frame length and a fixed time representing both T2 and the transmission delay (see NOTE 2).

A value is recommended between 2,5 seconds and 7 seconds.

p) Parameter T2 (CCITT Recommendation X.75 [11], § 2.4.8.2)

T2 < 1 second (T2 < T1 by definition)

T2 need not be implemented if the acknowledgement strategy is such that every correctly received I-frame is acknowledged as soon as possible. See also NOTE 2.

q) Parameter T3 (CCITT Recommendation X.75 [11], § 2.4.8.3)

T3 <= 60 seconds

T3 >= 30 seconds

r) Transmission Counter N2 (CCITT Recommendation X.75 [11], § 2.4.8.4)

N2 >= 60 seconds/T1

s) Maximum frame length N1 (CCITT Recommendation X.75 [11], § 2.4.8.5)

N1 shall be according to the largest data packet size that can be negotiated on the Network Layer, or 2112 bits if 128 octets is the maximum data packet size supported on the Network Layer (in this case, the maximum size of the CLEAR REQUEST packet is relevant for N1).

Guidance on the derivation of N1 can be found in Appendix B of CCITT X.25 [10].

t) Window size k (CCITT Recommendation X.75 [11], § 2.4.8.6)

k = 7 in basic mode (see NOTE 3)

NOTE 1: It is not meaningful to reset the link if the other end system is not responding for N2 times T1.

NOTE 2: The acknowledgement strategy used by the receiving layer 2 entity should be independent of any knowledge about the value of k used by the sending entity. This can be achieved by either acknowledging every correctly received I-frame as soon as possible, or by implementing the acknowledgement Timer T2. See item p).

NOTE 3: Further study is needed on a negotiation mechanism for k. When such a mechanism is available, values other than in t) may be used. However, the values in t) then become the default values and the upper limits.

8.1.4 Application rules for base protocol ISO 7776

The following specific rules are based on the additional static conformance requirements for layer 2 of the B-channel contained in section 6.3.2.1 of the Functional Standard T/1112 [20].

a) Single link procedure

Only the single link procedure shall be supported.

b) Independence of LAPB protocols

An independent LAPB protocol shall operate over each B-channel.

c) Timer T1

Timer T1 (retransmission) shall be set to the fixed value of 5 seconds.

d) Timer T2

Timer T2 (acknowledgement) shall be less than or equal to 1 second.

e) Timer T3

If implemented, Timer T3 (disconnected) shall be greater than or equal to 10 times T1.

f) Maximum frame length N1

Parameter N1 (maximum number of bits in an I-frame) shall be such that the Data Link layer is capable of carrying the maximum packet size negotiated at the packet level, plus the related packet level and Data Link layer control information.

NOTE: Guidance on the derivation of N1 can be found in Appendix B of CCITT Recommendation X.25 [10].

g) Window size k

For parameter k (window size), the value 7 is mandatory for basic operation.

h) Unsolicited DM

An unsolicited DM response shall not be used to request a set mode command.

i) Link set-up in FRMR condition

The DTE that sent the FRMR response shall not reset the Data Link unless it receives an FRMR response, or it has transmitted the FRMR response N2 times.

j) Unsolicited UA in information transfer phase

The receipt of an unsolicited UA response frame in the information transfer phase shall be ignored.

k) Basic mode of operation

Basic (modulo 8) operation shall be supported.

l) Extended mode of operation

The usage of extended mode of operation is for further study. As long as no negotiation of the mode of operation is agreed, the usage of the extended mode of operation shall not be permitted.

m) DTE/DCE role

The calling system shall adopt the DTE role and the called system shall adopt the DCE role. The system which originated the B-channel connection shall be deemed to be the calling system.

n) Link set-up responsibility

The end system which is assigned the DTE role is responsible for setting up and disconnecting the Data Link, but the other end system may also do it.

o) Disconnection order

In the normal procedure for disconnection, the Data Link shall be disconnected before disconnecting the B-channel.

8.1.5 Synchronisation

The synchronisation procedure is independent of the base protocol employed by the Data Link Layer entity.

During the time where a Data Link Layer entity is not informed of an established B-channel, it shall close the receiver and transmit continuous "1" bits on the transmit channel.

When the Data Link Layer entity of a calling terminal is informed of B-channel establishment, it shall open the receive channel and enter the active channel state by transmitting flags, and shall remain in the active channel state until it is informed of B-channel disconnection.

If the detection of the active channel state on the receive channel is implemented, the Data Link Layer entity may wait for this indication.

After entering the active channel state of the transmit channel, or alternatively after having detected the receive channel as active, the Data Link Layer entity of the calling terminal shall send an SABM(SABME) to initiate the Data Link.

When the Data Link Layer of a called terminal is informed of B-channel establishment, it shall open the receive channel and enter the active channel state by transmitting flags, wait for the reception of SABM(SABME) from the calling terminal and then continue according to the procedures of the Data Link Layer protocol.

The Data Link Layer entity of the called terminal shall also remain in the active channel state until it is informed of B-channel disconnection.

NOTE: See subclause 4.2.3 for supervision of the synchronisation phase.

8.2 B-channel layer 3

The conformance requirements for the Network Layer in the B-channel shall be in accordance with ISO/IEC 8208 [25], with respect to the DTE/DTE case in a circuit-switched environment, and subject to the additional requirements as detailed in the remainder of this subclause.

NOTE: The additional requirements are in accordance with those given in CCITT Recommendation T.90 [8] in sections 2.5, 2.6, 4 and 5.

After successful B-channel establishment including entering the data transfer phase at layer 2, the full ISO/IEC 8208 [25] layer 3 procedures apply, with mapping to support the OSI CONS in accordance with ISO/IEC 8878 [27]. For interoperation with terminals that do not conform with this ETS, incoming calls with missing facility fields used to support the OSI CONS shall not be rejected.

NOTE: For the application Videotex, the provision of the full OSI CONS is for further study.

The Network Layer entity that originated the B-channel establishment shall be deemed to be the calling Network Layer entity.

8.2.1 DTE/DCE role

The Network Layer entity shall be capable of adopting the DTE role as well as the DCE role for a given Network Connection as specified in ISO/IEC 8208 [25], subclause 3.3.

If the DTE/DCE role is not determined prior to the call, the calling Network Layer entity shall transmit a RESTART REQUEST packet after the B-channel has been established and the Data Link has been initialised. Then the restart procedure as described in ISO/IEC 8208 [25], shall be used to determine assignment of DTE or DCE role.

8.2.2 Logical channels to be used

The logical channel ranges (LIC, HIC, LTC, HTC, LOC and HOC) to be used are determined by local knowledge. If local knowledge is not available, then by default only a single two-way logical channel shall be used (i.e. LTC and HTC shall be set to 1, while LIC, HIC, LOC and HOC shall be set to zero. If more than one channel is available, a higher value of HTC may be negotiated using the On-line Facility Registration facility.

If a DTE is capable of initiating a REGISTRATION REQUEST packet, then the Registration parameter fields shall be set as follows:

- the LIC, HIC, LOC, HOC parameter shall be set to zero. The LTC shall be set to the value 1. The value in the total number of logical channels parameter field shall be set equal to the value in the HTC parameter field;

- no other Optional User Facility shall be identified in the REGISTRATION REQUEST packet, and may be ignored by the responder if they are present;

- if a DTE is capable of responding with a REGISTRATION CONFIRMATION packet, the maximum number of two way logical channels allowed between the two DTEs shall be indicated in the HTC parameter field. The value in the HTC parameter field shall be less than or equal to the value requested in the HTC parameter field in the REGISTRATION REQUEST packet.

Registration of facilities normally applies in one direction only for the DTE/DTE case (i.e. registration of facilities is performed independently for each direction, but for the logical channel range negotiation it applies to both directions.

NOTE: REGISTRATION REQUEST packets may be ignored by a responder. However, it is recommended that DTEs are capable of responding with a REGISTRATION CONFIRMATION packet even if they support only a single two-way logical channel. This is to prevent unnecessary delays for the initiator in transmitting a CALL REQUEST packet. Such delays are determined by the initiator's values for Timer T28 and retry counter R28.

8.2.3 Packet sizes

The Network Layer entity shall be capable of supporting the standard default packet size of 128 octets. The only permitted maximum data packet sizes are 128, 256, 512, 1 024 and 2 048 octets. Packet sizes other than the standard default packet size may be negotiated on a per call basis using the "Flow Control Parameter Negotiation" facility.

8.2.4 Default packet level window size

The Network Layer entity shall be capable of supporting the standard default window size of 2. Other window sizes may be negotiated on a per call basis, using the "Flow Control Parameter Negotiation" facility. See also subclause 8.2.12, "Optional User Facilities and CCITT Specified DTE Facilities".

8.2.5 Default throughput class

The default throughput class assigned to each direction of transmission shall be 64 kbit/s. Other throughput classes may be negotiated on a per call basis, using the "Throughput Class Negotiation" facility. See also subclause 8.2.12, "Optional User Facilities and CCITT Specified DTE Facilities".

8.2.6 D-bit

The D-bit shall always be set to 0.

The Network Layer shall either ignore the D-bit in a received DATA packet, or treat as an error the occurrence of the D-bit set to 1 in a received DATA packet. If the Network Layer chooses to treat it as an

error, it shall reset the logical channel indicating the cause "DTE Originated" and the diagnostic "D-bit Procedure Not Supported" (value = 166).

8.2.7 Q-bit

The Q-bit shall always be set to 0 in transmitted DATA packets, except in the application for Videotex which is using a CCITT Recommendation X.29-like procedure.

If the application is Videotex, received DATA packets with the Q-bit set to 1 shall be accepted, except in the case where the Q-bit is not the same in all DATA packets of a complete packet sequence. In this case, the Network Layer shall reset the logical channel, indicating the cause "DTE Originated" and the diagnostic "Inconsistent Q-bit Settings" (value = 83).

NOTE: The information to upper layers entities, that user data has been received by a Network Layer entity in a complete data packet sequence with the Q-bit set to 1, is not an element of the OSI CONS.

8.2.8 Protocol identifier

The protocol identification in the Network Layer is described in the ISO/IEC/TR 9577. In ISO/IEC 8208 [25], the layer 3 protocol employed in this ETS, the first octet of the call user data field within a CALL REQUEST/INCOMING CALL packet contains the "Subsequent Protocol Identifier" (SPI).

In the case of group 4 facsimile and teletex, the following value shall be inserted as a protocol identifier into the first octet of the call user data field of a CALL REQUEST packet:

bit	8	7	6	5	4	3	2	1
	0	0	0	0	0	0	1	0

This bit pattern is "Reserved - in use by CCITT Recommendation T.70 Transport Layer procedure" according to table 4 in ISO/IEC/TR 9577.

In the case of Videotex, the following value shall be inserted into the first octet of the call user data field of a CALL REQUEST packet:

bit	8	7	6	5	4	3	2	1
	0	0	0	0	0	0	0	1

This bit pattern corresponds to "CCITT Recommendation X.29" in table 4 of ISO/IEC/TR 9577.

A call shall be cleared on the B-channel, if a different higher layer protocol is identified during compatibility checking on the D-channel and in the first octet of the call user data field of an INCOMING CALL packet respectively.

Remaining octets (besides the first octet) of the call user data field in an INCOMING CALL packet should be ignored by the Network Layer entity.

8.2.9 INTERRUPT packet

Except for Videotex applications, no expedited data shall be used.

According to the fact that expedited data shall not be used, an INTERRUPT packet shall not be transmitted. When an INTERRUPT packet is received, the logical channel shall be reset with cause "DTE Originated" and diagnostic "Unauthorised Interrupt" (value = 44).

8.2.10 Packet Data Units (PDUs)

Packet Data Units (PDUs), (e.g. Transport Protocol Data Units (TPDUs)) shall be transmitted in a complete data packet sequence.

8.2.11 Encoding of Network Service Access Point (NSAP) addresses

Encoding of the calling, called and responding Network Service Access Point (NSAP) addresses in the address and address extension fields of call set-up and clear packets shall be as specified in ISO/IEC 8878 [27] for explicitly conveying the full NSAP address.

NOTE: For the use in Videotex, this requirement is for further study.

8.2.12 Optional user facilities and CCITT specified DTE facilities

In the following subclauses, only those facilitiest that apply to the DTE/DTE operation are considered.

The facilities applying to the DTE/DTE case are divided into facilities that shall be implemented, facilities that are not permitted to be used and facilities that are allowed but not recommended to be used, according to tables 5, 6 and 7 below.

Facilities not considered here or facilities that are not permitted to be used, but which are:

- being invoked in an incoming REGISTRATION REQUEST, shall be ignored;

- contained in a facility field of an INCOMING CALL packet, shall be treated as an error, i.e. a CLEAR REQUEST packet shall be transmitted with cause "DTE Originated" and the diagnostic "Facility Code Not Allowed".

  NOTE: The question of whether such received facility fields, or at least some of them, may be ignored is for further study.

8.2.12.1 Facilities that shall be implemented

These facilities shall, as a minimum, be implemented to handle incoming calls successfully.

Those facilities whose fields must be inserted in any CALL REQUEST packet (to provide the OSI CONS) are indicated in ISO/IEC 8878 [27].

Table 5: Mandatory facilities

Facility	§ in ISO 8208
Default Throughput Classes Assignment	13.11
Flow Control Parameter Negotiation	13.12
Throughput Class Negotiation	13.13
Fast Select	13.16
Transit Delay Selection and Indication	13.28
Calling Address Extension	14.1
Called Address Extension	14.2
Minimum Throughput Class Negotiation	14.3
End to End Transit Delay Negotiation	14.4
Expedited Data Negotiation	14.5

8.2.12.1.1 On-line facility registration

A REGISTRATION REQUEST packet shall only be transmitted to negotiate the range of logical channels, using the "Logical Channel Types Ranges" registration-facility. In fact, since only two-way logical channels are allowed (see subclause 8.2.2), the value of HTC is negotiated.

In the transmitted REGISTRATION REQUEST packet, the registration parameter fields shall be set as follows:

- the LIC, HIC, HOC and LOC parameters shall be set to 0;
- the LTC parameter shall be set to 1;
- the value in the total number of logical channels shall be set equal to the value in the HTC parameter field;
- no other registration-facilities shall be identified in the REGISTRATION REQUEST packet.

When a Network Layer entity receives a REGISTRATION REQUEST packet:

- all registration-facilities other than "Logical Channel Types Ranges" may be ignored;
- a REGISTRATION CONFIRMATION packet indicating the maximum number of two-way logical channels that are allowed between the two Network Layer entities shall be transmitted.

  The value in the HTC parameter field shall be less than or equal to the value requested in the HTC field in the REGISTRATION REQUEST packet.

8.2.12.1.2 Fast select facility

The Network Layer entity shall indicate "no restriction on response" when using this facility.

8.2.12.1.3 Expedited data negotiation facility

Except for Videotex applications, the expedited data negotiation facility shall only be used to negotiate "non use of expedited data".

8.2.12.2 Facilities that shall not be used

Table 6: Not permitted facilities

Facility	§ in ISO 8208
Extended Packet Sequence Numbering	13.2
One Way Logical Channel Outgoing	13.7
One Way Logical Channel Incoming	13.8
Nonstandard Default Packet Sizes	13.9
Nonstandard Default Window Sizes	13.10

8.2.12.3 Allowed Facilities which are not recommended

Table 7: Not recommended facilities

Facility	§ in ISO 8208
Packet Retransmission	13.4
Incoming Calls Barred	13.5
Outgoing Calls Barred	13.6

9 Layer 4 transport protocol

Teletex and facsimile group 4 terminals shall use the transport class 0 either as specified in CCITT Recommendation T.70 [7], or as specified in ISO/IEC 8073 [23] or CCITT Recommendation X.224 [12] together with the application rules stated in the following subclauses. As ISO/IEC 8073 [23] and CCITT Recommendation X.224 [12] do not show any differences for Class 0 (see Annex D), the application rules are divided into those for CCITT Recommendation T.70 [7] and those for ISO/IEC 8073 [23]. The latter ones are also valid for CCITT Recommendation X.224 [12].

This Clause shall not be applicable to Videotex applications.

9.1 Additional application rules for the transport protocol in CCITT Recommendation T.70 (layer 4)

9.1.1 Transport Protocol Data Unit (TPDU) size negotiation

The rules given in subclause 5.3.2 of CCITT Recommendation T.70 [7] regarding Transport Protocol Data Unit (TPDU) size apply, the calling and the called terminal shall support the TPDU size negotiation function.

9.1.2 Timer values

Timer values shall be tuneable. The Timers shall be capable of taking values of the order of magnitude of 60 seconds.

9.1.3 Handling of Transport Service Access Point Identifier (TSAP-ID) as initiator of a transport connection establishment

An end system shall be capable of:

1) transmitting a Called TSAP-ID field in a Call Receive (CR) TPDU and receiving a Called TSAP-ID field in the Call Connect (CC) TPDU that can convey a transport selector of variable length up to and including 32 octets in any encoding; and

2) receiving a Calling TSAP-ID field in a CC TPDU and, when necessary, transmitting a Calling TSAP-ID field in a CR TPDU that can convey each of the transport selectors implemented by the system.

9.1.4 Handling of TSAP-ID responding to a transport connection establishment attempt

An end system shall be capable of:

1) transmitting a Calling TSAP-ID field in a CC TPDU and receiving a Calling TSAP-ID field in a CR TPDU that can convey a transport selector of variable length up to and including 32 octets in any encoding; and

2) receiving a Called TSAP-ID field in a CR TPDU and, when necessary transmitting a Called TSAP-ID field in a CC TPDU that can convey each of the transport selectors implemented by the system.

9.1.5 Use of N-CONNECT primitives for transport protocol identification

The use of the user data N-CONNECT primitives for the purpose of transport protocol identification is the following:

1) sending case:
   the end system shall operate the default protocol identification mechanism as defined in Annex B of CCITT Recommendation X.224 [12];

2) receiving case:
   the end system shall accept only hexadecimal 02 (protocol identifier for teletex and facsimile group 4) in the NS user data parameter of the N-CONNECT indication primitive.

9.2 Specification of the additional application rules for the transport protocol in ISO/IEC 8073 and CCITT Recommendation X.224 (layer 4)

9.2.1 Protocol classes

The end system shall use transport protocol class 0 only.

9.2.2 Timer supervision

Timer supervision shall be implemented for the states employed during transport connection establishment and transport connection termination (including the disconnection of the Network Connection).

9.2.3 Timer values

Timer values shall be tuneable. The Timers shall be capable of taking values of the order of magnitude of 60 seconds.

9.2.4 Basic length indicator value

The basic Length Indicator (LI) value shall be restricted to 127, i.e. the binary value of 0111 1111 (see CCITT Recommendation T.70 [7], § 5.5.2.2.2).

9.2.5 Handling of TSAP-ID as initiator of a transport connection establishment

An end system shall be capable of:

1) transmitting a Called TSAP-ID field in a CR TPDU and receiving a Called TSAP-ID field in the CC TPDU that can convey a transport selector of variable length up to and including 32 octets in any encoding; and

2) receiving a Calling TSAP-ID field in a CC TPDU and, when necessary, transmitting a Calling TSAP-ID field in a CR TPDU that can convey each of the transport selectors implemented by the system.

9.2.6 Handling of TSAP-ID responding to a transport connection establishment attempt

An end system shall be capable of:

1) transmitting a Calling TSAP-ID field in a CC TPDU and receiving a Calling TSAP-ID field in a CR TPDU that can convey a transport selector of variable length up to and including 32 octets in any encoding; and

2) receiving a Called TSAP-ID field in a CR TPDU and, when necessary, transmitting a Called TSAP-ID field in a CC TPDU that can convey each of the transport selectors implemented by the system.

9.2.7 Use of N-CONNECT primitives for transport protocol identification

The use of the user data N-CONNECT primitives for the purpose of transport protocol identification is the following:

1) sending case:
   the end system shall operate the default protocol identification mechanism as defined in Annex B of CCITT Recommendation X.224 [7];

2) receiving case:
   the end system shall accept only hexadecimal 02 (protocol identifier for teletex and facsimile group 4) in the NS user data parameter of the N-CONNECT indication primitive.

Annex A (informative): Comparison between ISO 7776 and CCITT Recommendation X.75 Layer 2

A.1 Referenced documents

A.1.1 ISO 7776

Information processing systems - Data communications - High-level data link control procedures - Description of the X.25 LAPB-compatible DTE data link procedures.

First edition - 1986-12-15.

Ref. No. ISO 7776-1986(E).

A.1.2 ISO/IEC JTC 1/SC 6 N 5571

Defect Report on ISO 7776 [21].

A.1.3 CCITT Recommendation X.75 (1988)

Packet-switched signalling system between public networks providing data transmission services.

Taken from document AP IX-51-E, May 1988.

A.1.4 CCITT Recommendation X.75

Packet-switched signalling system between public networks providing data transmission services.

A.2 Introduction

This annex contains the description of differences of the above referenced ISO document and the CCITT Blue Book Version (1988) of CCITT Recommendation X.75 [11].

Excluded are descriptions of:

- verbal differences, that lead to the same result in both cases;
- if in ISO a statement is different for the DTE/DTE case and the DTE/DCE case, only the DTE/DTE case is considered.

Only layer 2 and the single link procedure are considered. The allowed interim solution in CCITT Recommendation X.75 [11], where frames without sequence numbers may contain a 16 bit control field, is indicated as difference, but not further considered.

Instances of **will** in CCITT Recommendation X.75 [11], especially in § 2.4.4 and § 2.4.5, are interpreted as **shall**.

The term STE in the CCITT documents should be read as DTE.

In Annex B, the differences between the 1984 Red Book version and the 1988 Blue Book version of CCITT Recommendation X.75 [11] are listed and the relation to the corresponding ISO statement is commented upon.

A.3 Table of differences

Table A.1

No	Key words	Related paragraph in: 7776 [21]	Related paragraph in: X.75 [11]	Described in:
1	Unnumbered frames mod 128	-	2.2.1 Table 2	A.4.1
2	Invalid frame	3.8	2.3.5.3	A.4.2
3	SABM control byte encoding	Table 6	-	A.4.3
4	DM as mode set request	4.3.8	-	A.4.4
5	FRMR conditions	4.3.9 Table 7 Table 8	2.3.4.9 Table 7 Table 8	A.4.5
6	Busy condition/ Receiving an RNR	4.4.1 5.4.7	2.3.5.1 2.4.5.7	A.4.6
7	N(S) sequence error recovery	4.4.2	2.3.5.2	A.4.7
8	Start T1 after transmitted REJ	4.4.2.2	2.3.5.2.1	A.4.8
9	Answer to received REJ	4.4.2.2	2.3.5.2.1	A.4.9
10	Receiving frames in FRMR condition	4.4.4	2.3.5.4	A.4.10
11	Excessive idle channel state	3.11.2	2.3.5.5	A.4.11
12	SABM with P=1	5.3.1	-	A.4.12
13	Info phase/T4	5.3.2	-	A.4.13
14	DISC with P=1	5.3.3	-	A.4.14
15	Transmitted DISC	5.3.3 ..	2.4.4.3	A.4.15
16	Collision of un-numbered commands	5.3.5 .. 5.3.7	2.4.4.5	A.4.16
17	Retransmission using kmax	5.5	2.4.6	A.4.17
18	Waiting for I-frame acknowledgement	5.4.9	2.4.5.9	A.4.18
19	Conditions for link reset	5.5	2.4.6	A.4.19
20	Request for Link reset by FRMR	5.6.2	2.4.7.3	A.4.20
21	Timer T1	5.7.1.1	2.4.8.1	A.4.21
22	Timer T2	5.7.1.2	2.4.8.2	A.4.22
23	Timer T3	5.7.1.3	2.4.8.3	A.4.23
24	Timer T4	5.7.1.4	-	A.4.24
25	N1	5.7.3	2.4.8.5	A.4.25
26	Window size k	5.7.4	2.4.8.6	A.4.26

A.4 Details of the differences

A.4.1 Unnumbered frames modulo 128 (CCITT Recommendation X.75, table 2)

In the note of table 2, CCITT allows for an interim period, unnumbered frames to have a 16 bit control field.

ISO does not allow a 16 bit control field in this case.

A.4.2 Invalid frame (ISO 7776, subclause 3.8 - CCITT Recommendation X.75, § 2.3.5.3)

In subclause 3.8b, ISO requires at least 32 bits between flags for a valid frame.

In § 2.3.5.3, CCITT requires 32 bits at least for frames modulo 8 or for frames without sequence numbers mod 128, and 40 bits at least for frames modulo 128 containing sequence numbers.

This difference leads to the possibility, that in extended mode of operation:

- a terminal according to ISO would regard a received S/I-frame containing 32 bits as being valid but leading to FRMR condition d) in ISO subclause 4.3.9;

- an STE according to CCITT would regard such a frame as being invalid and ignore it.

A.4.3 SABM control byte encoding (ISO 7776, table 6)

Bit 7 of the control byte of the SABM in the extended operation is indicated to be a 0 instead of a 1 (considered to be a type error).

A.4.4 DM as mode set request (ISO 7776, subclause 4.3.8)

" ..The DM response may be sent in this phase [disconnected phase] to request a set mode command .."

CCITT does not allow to use the DM for this purpose. This leads to some other differences (see subclauses A.4.12, A.4.14 and A.4.16 in this annex).

A.4.5 Conditions to send FRMR (ISO 7776, subclause 4.3.9 - CCITT Recommendation X.75, § 2.3.4.9)

In subclause 4.3.9 a) .. d), ISO lists four conditions for sending a FRMR response.

These four conditions coincide with the first four conditions, CCITT specifies for a FRMR response in § 2.3.4.9 1) .. 4).

If one of the conditions 5) and 6) described by CCITT occurs for an ISO terminal, this may be understood as a condition for a link reset. See ISO 7776 [21], subclause 5.5 and subclause A.4.19 in this annex.

Condition 7) of CCITT describes the receipt of an invalid N(S) in the sense that the window size k is exceeded. ISO does not require any specific action on this situation. This may come from the fact, that at least for DTE/DTE operation, the values of k may be different for the 2 sides.

ISO explicitly allows, that the bits w, x, y and z in the information field of the FRMR response are all 0, indicating an unspecified rejection reason.

According to tables 7 and 8 in the CCITT Recommendation, for each FRMR condition, at least one of the bits w, x, y and z is 1.

A.4.6 Busy condition/Receiving a RNR

ISO 7776 [21] defines the busy condition and the actions to be taken in subclauses 4.4.1, 5.4.7 and 5.4.8.

CCITT Recommendation X.75 [11] defines the busy condition and the actions to be taken in § 2.3.5.1, § 2.4.5.7, § 2.4.5.8 and § 2.4.5.9.

The definition of the busy condition is the same in both cases, the actions may however be different.

According to ISO, no I-frame will be sent after recognising a remote busy condition, until the busy condition is cleared. When an I-frame becomes available for sending and there are no unacknowledged I-frames outstanding, the timer T1 is started.

According to CCITT, no I-frame will be sent after recognising a busy condition on the other side, except the received RNR that defined the busy condition has acknowledged all previously transmitted I-frames. In this case, one I-frame with the P bit set to 0 may be sent. The Timer T1 is then started.

The T1-supervision of the busy condition is the same in both cases.

See also subclause A.4.18 of this annex, regarding the situation where an RNR with F=1 is received while waiting for the acknowledgement of a transmitted I-frame and B1 for the deviation in the Red Book (1984) case.

A.4.7 N(S) sequence error recovery

ISO 7776 [21] provides 3 methods for N(S) sequence error recovery:

- checkpoint recovery (subclause 4.4.2.1);
- REJ recovery (subclause 4.4.2.2);
- time-out recovery (subclause 4.4.2.3).

CCITT Recommendation X.75 [11] provides only the 2 methods:

- REJ recovery (§ 2.3.5.2.1);
- time-out recovery (§ 2.3.5.2.2).

A terminal according to ISO may start a checkpoint cycle, and a following checkpoint retransmission, if necessary, at any time in the information transfer phase.

The procedures for REJ recovery are the same in both cases, except that ISO describes the possible interaction with a checkpoint recovery.

The procedure that a terminal according to ISO or CCITT follows after timeout waiting for acknowledgement of a transmitted I-frame is the same, except for the fact, that a terminal according to ISO may not retransmit the unacknowledged I-frame with the P bit set to 1, but must send a supervisory frame with the P bit set to 1. See also subclause A.4.18 in this annex.

A.4.8 Start T1 after transmitted REJ (ISO 7776, subclause 4.4.2.2 - CCITT Recommendation X.75, § 2.3.5.2.1)

ISO states implicitly (end of 2nd paragraph), that Timer T1 may be started after a transmitted REJ:

> *"a REJ frame may be retransmitted (up to N2 transmissions) if the REJ exception condition is not cleared within time-out T1 following transmission of a REJ frame".*

CCITT does not indicate this possibility.

A.4.9 Answer to received REJ (ISO 7776, subclause 4.4.2.2 - CCITT Recommendation X.75, § 2.3.5.2.1)

ISO states (end of 3rd paragraph), that the retransmission of the I-frames after a received REJ has to be done .. before or concurrent with the transmission of the next command frame with the P bit set to 1.

CCITT does not require this.

A.4.10 Receiving frames in FRMR condition (ISO 7776, subclause 4.4.4/5.6.2 - CCITT Recommendation X.75, § 2.3.5.4/2.4.7.3)

In the 2nd paragraph of subclause 4.4.4, ISO 7776 [21] states: *".. Once the DTE has established the FRMR condition, no additional I-frames shall be accepted .."*. CCITT does not allow to accept additional I or S format frames under the same conditions.

However as well CCITT (in § 2.4.7.3) as ISO (in subclause 5.6.2) state, that *"received I-frames and supervisory frames shall (CCITT says:will) be discarded except for the observance of the P bit".*

A contradiction has been identified in ISO 7776 [21], 2nd and 4th paragraph of subclause 5.6.2. It has been amended in ISO/IEC JTC 1/SC 6 N 5571. The 2nd paragraph of subclause 5.6.2 indicates, that any received command frame except SABM/SABME, DISC and DM shall be responded by retransmitting a FRMR frame, while the 4th paragraph indicates, that a FRMR has only then to be retransmitted, if the P-bit is set to 1 in such a received command frame and that Timer T1 shall not be stopped or restarted in this case.

Paragraph 4 has been changed such that it does not contradict paragraph 2, and the statement on Timer T1 has been removed.

There is a similar contradiction between paragraphs 1 and 3 of § 2.4.7.3 in CCITT Recommendation X.75 [11]. Additionally, the 1st paragraph requires, that any received frame except SABM/SABME and DISC (not only command frames) shall be answered by retransmission of a FRMR frame.

A.4.11 Excessive idle channel state (ISO 7776, subclause 3.11.2 - CCITT Recommendation X.75, § 2.3.5.5)

Paragraph 2 of subclause 3.11.2 states, that a *"DTE may interpret the idle condition as an indication, that the DCE is not able to support set up of the link".*

No corresponding statement is contained in CCITT Recommendation X.75 [11].

In the NOTE to subclause 3.11.2, ISO states, that the DTE should consider the data link to be in the disconnected phase, if the idle channel condition persists for at least time T3. It is not required explicitly, that the higher layers have to be informed in this case.

According to CCITT, the MLP or packet layer have to be informed in this case. It is stated implicitly, that the link might be considered to be in the disconnected phase:

> *".. but shall not preclude the other STE from establishing the link ..*" (end of 1st paragraph).

A.4.12 SABM with P=1 (ISO 7776, subclause 5.3.1, 3rd paragraph)

" ..In order to avoid misinterpretation of a DM response received during link-setup, the DTE shall always send its SABM/SABME command with the P bit set to 1. .." (See also subclause A.4.4 in this annex).

According to CCITT, SABM/SABME are allowed with P=0.

A.4.13 Information phase/T4 (ISO 7776, subclause 5.3.2, 2nd paragraph)

" .. During the information phase, whenever there has been no activity on the data link for a period of time T4, it is strongly recommended that the DTE transmit an appropriate supervisory command frame with the P bit set to 1 to query the status of the DCE/remote DTE. .. "

No Timer T4 is defined by CCITT nor is such a supervision provided by CCITT using a different Timer.

A.4.14 DISC with P=1 (ISO 7776, subclause 5.3.3, 2nd paragraph)

" ..In order to avoid misinterpretation of a DM response received during link-setup, the DTE shall always send its DISC command with the P bit set to 1. .." (See also subclause A.4.4 in this document).

According to CCITT, DISC is allowed with P=0.

A.4.15 Transmitted DISC (ISO 7776, subclause 5.3.3 - CCITT Recommendation X.75, § 2.4.4.3)

Paragraph 3 of subclause 5.3.3 tells, that *a DTE having sent a DISC command, shall ignore and discard any frames except SABM/SABME, DISC, UA or DM .*

A corresponding prescription for an STE in this situation is missing in CCITT Recommendation X.75 [11].

A.4.16 Collision of unnumbered commands (ISO 7776, subclause 5.3.5 - CCITT Recommendation X.75, § 2.4.4.5)

The procedures are the same according to ISO and CCITT in the case of a collision of different unnumbered commands.

When the same kinds of unnumbered command frames collide, the prescriptions for entering the indicated phase are different.

According to CCITT (§ 2.4.4.5.1), each STE has to enter the indicated phase after receiving the UA response.

According to ISO, the DTE shall enter the indicated phase either

a) after receiving the UA response;

b) after sending the UA response; or

c) after timing out waiting for the UA response having sent a UA response.

In case of b), the DTE shall accept a subsequent UA response to the unnumbered command it issued without considering it an unsolicited UA response if received within the time-out interval.

Due to the fact that ISO allows an unsolicited DM response to request a mode setting command (see also subclause A4.4 in this annex), there are separate chapters in the ISO document to describe the collisions DM:SABM/SABME/DISC and DM:DM (subclauses 5.3.6 and 5.3.7), which have no correspondence in CCITT Recommendation X.75 [11].

A.4.17 Retransmission using k_{max} (ISO 7776, subclause 5.4.1 - CCITT Recommendation X.75, § 2.4.5.1)

In the 4th paragraph of subclause 5.4.1, ISO states:

> *"in order to insure integrity of data transfer, the DTE shall not transmit any I-frame if its send state variable V(S) is equal to the last value N(R) it has received from the DCE/remote DTE plus 7 in basic (modulo 8) operation or 127 in extended (modulo 128) operation".*

The corresponding rule is missing in CCITT Recommendation X.75 [11].

This might lead to the situation, that a terminal according to ISO 7776 [21] must reset the link before it can retransmit k=7 or k=127 unacknowledged I-frames, while an STE according to CCITT Recommendation X.75 [11] could retransmit them e.g. after timeout of Timer T1.

A.4.18 Waiting for I-frame acknowledgement (ISO 7776, subclause 5.4.9 - CCITT Recommendation X.75, § 2.4.5.9)

If the Timer T1 runs out in the Timer recovery condition after having transmitted an I-frame, a DTE according to ISO shall transmit an appropriate supervisory command frame with the P bit set to 1, while an STE according to CCITT may alternatively retransmit the transmitted I-frame with the P bit set to 1.

In ISO 7776 [21] as well as in CCITT Recommendation X.75 [11], the text seems to indicate, that after receiving the supervisory response frame with F=1, I-frames may be transmitted or retransmitted, even if this frame was an RNR frame.

It is assumed, that this is not the intended understanding, but that the DTE/STE continues as described in the chapter "Receiving an RNR frame" (subclause 5.4.7/§ 2.4.5.7 respectively).

A.4.19 Conditions for link reset (ISO 7776, subclause 5.5 - CCITT Recommendation X.75, § 2.4.6)

When a DTE, according to ISO receives an FRMR response during the information transfer phase, it initiates a link reset procedure or send a DM response to ask the DCE/remote DTE to initiate the link set-up procedure (see subclause 5.5, paragraph 2).

An STE according to CCITT shall initiate the link reset procedure when it receives a FRMR response during the information transfer phase (see § 2.4.6.2).

When a DTE according to ISO receives a UA response or an unsolicited response with the F bit set to 1 during the information transfer phase, it may initiate a link reset procedure or send a DM response to ask the DCE/remote DTE to initiate the link set-up procedure (subclause 5.5, paragraph 3).

For an STE according to CCITT, these are conditions to send a FRMR. See also subclause A.4.5 in this annex.

When a DTE according to ISO receives an unsolicited DM response during the information transfer phase, it shall initiate a link reset procedure or send a DM response to ask the DCE/remote DTE to initiate the link set-up procedure (subclause 5.5, paragraph 3).

For an STE according to CCITT, this is again a conditions to send a FRMR.

A.4.20 Request for link reset by FRMR (ISO 7776, subclause 5.6.2 - CCITT Recommendation X.75, § 2.4.7.3)

After having transmitted a FRMR response, the FRMR condition is cleared for a DTE according to ISO and for an STE according to CCITT, when an SABM/SABME or a DISC is transmitted or received. Additionally, for an ISO terminal the FRMR condition is cleared when a DM response is transmitted or received.

Upon reception of a FRMR response, a DTE according to ISO shall initiate the reset procedure by transmitting an SABM/SABME command or shall ask the DCE/remote DTE to initiate the link set-up procedure by transmitting a DM response and entering the disconnected phase.

Upon reception of a FRMR response, an STE according to CCITT shall initiate the reset procedure by transmitting an SABM/SABME command.

A DTE according to ISO may start Timer T1 after transmission of a FRMR response. If T1 expires before the other side initiates a link reset, the DTE shall retransmit the FRMR response and restart T1. When T1 has expired N2 times, the DTE shall reset the link itself.

A DTE according to CCITT may start Timer T1 after transmission of a FRMR response. If T1 expires before the other side initiates a link reset, the DTE may retransmit the FRMR response and restart T1. When T1 has expired N2 times, the DTE may reset the link itself.

A.4.21 Timer T1 (ISO 7776, subclause 5.7.1.1 - CCITT Recommendation X.75, § 2.4.8.1)

ISO states that the values of T1 may be different for DTE and DCE/remote DTE respectively. The values must be made known to both parties.

CCITT states that the value of T1 is a system parameter, agreed between the administrations.

A.4.22 Timer T2 (ISO 7776, subclause 5.7.1.2 - CCITT Recommendation X.75, § 2.4.8.2)

ISO states that the values of T2 may be different for DTE and DCE/remote DTE respectively. The values must be made known to both parties.

CCITT does not comment on an agreement.

A.4.23 Timer T3 (ISO 7776, subclause 5.7.1.3 - CCITT Recommendation X.75, § 4.8.3)

T3 is an optional Timer in ISO 7776 [21] and ISO does not comment on an agreement between DTE and DCE/remote DTE concerning the value of T3.

Implementation of T3 is mandatory in CCITT Recommendation X.75 [11]. CCITT does not comment on equality/non-equality of the values of T3 for both STEs, but the corresponding value must be made known to the other party.

A.4.24 Timer T4 (ISO 7776, subclause 5.7.1.4)

Timer T4 is not defined in CCITT Recommendation X.75 [11].

A.4.25 N1 (ISO 7776, subclause 5.7.3 - CCITT Recommendation X.75, § 2.4.8.5)

ISO states that the values of N1 may be different for the DTE and the DCE/remote DTE, but must be made known to both sides.

CCITT states that N1 is a system parameter, and does not explicitly exclude different values for the communicating STEs.

A.4.26 Window size k (ISO 7776, subclause 5.7.4 - CCITT Recommendation X.75, § 2.4.8.6)

ISO states that for DTE/DTE operation the values of k shall be agreed for both parties, but may be different.

CCITT states that the values of k shall be agreed and equal.

Annex B (informative): Comparison of the Red Book (1984) and Blue Book (1988) version of CCITT Recommendation X.75, Layer 2

B.1 Introduction

Except for different phrasing and text insertions/modifications for clarity's sake in the Blue Book, the following two differences have been identified while comparing the two versions of the protocol specification.

B.2 Receiving acknowledgement (§ 2.4.5.5)

The last sentence of the 1st paragraph states conditions under which Timer T1 has to be stopped.

Red Book (1984): *"The STE will stop Timer T1 when it correctly receives an I-frame or a supervisory frame with the N(R) higher than the last received N(R) (actually acknowledging some I-frames)".*

Blue Book (1988): *"The STE will stop Timer T1 when it correctly receives an I-frame or a supervisory frame with the N(R) higher than the last received N(R) (actually acknowledging some I-frames) or a REJ frame with an N(R) equal to the last received N(R)".*

So in the case of reception of a REJ frame with an N(R) equal to the last received N(R):

- according to the Blue Book (1988), T1 will be stopped and restarted with the retransmission of the rejected frame;

- according to the Red Book (1984), T1 will be kept running.

The ISO specification coincides with the Blue Book specification in this respect.

B.3 Receiving an RNR frame (§ 2.4.5.7)

According to the Red Book (1984), after receiving an RNR frame, the I-frame with the send sequence number equal to the N(R) indicated in the RNR frame may be transmitted/retransmitted. Transmission/retransmission with P bit set to 1 is not excluded.

According to the Blue Book (1988), after receiving an RNR frame the I-frame with the send sequence number equal to the N(R) indicated in the RNR frame may only then be transmitted, if the N(R) has acknowledged all previously transmitted frames. The P bit in this I-frame must be set to 0.

According to ISO, no I-frame may be transmitted after receiving an RNR frame until the busy condition is cleared. See also subclause A.4.6 in this ETS.

Annex C (informative): Valuation of the application rules for the layer 2 protocols

C.1 Introduction

The basic question to be answered in this annex is, whether two terminals behaving according to FS T/1112 [20] and CCITT Recommendation T.90 [8] respectively, can interwork on layer 2 of the B-channel.

The result can be found in subclause C.4.2

C.1.1 Referenced documents

- ETSI Functional Standard T/1112 (Sixth Draft - September 1989):

"Provision of the OSI Connection-Mode Transport Service and the OSI Connection-Mode Network Service by using an ISDN Circuit -Mode 64 kbit/s unrestricted Bearer Service: Demand Case".

- CCITT Recommendation T.90 [8] (Version 89/10/01):

"Characteristics and protocols for terminals for telematic services in ISDN"

Both documents specify a protocol stack for the lower layer protocols to be used on the D-channel and the B-channel. This annex deals with the layer 2 protocol to be used on the B-channel in either case.

The Functional Standard T/1112 [20] uses the ISO 7776 [21] protocol on layer 2 of the B-channel (see T/1112 [20], subclause 5.2: Model Description), as modified in the Additional Static Conformance Requirements for the Data Link Layer on the B-channel (T/1112 [20], subclause 6.3.2.1), and the Additional Dynamic Conformance Requirements for the Data Link Layer on the B-channel (T1112 [20], subclause 7.3.2.1).

CCITT Recommendation T.90 [8] employs the CCITT Recommendation X.75 [11] protocol, (see T.90, subclause 2.1: Protocol set), as modified in the application rules for the layer 2 protocol on the B-channel:

- address procedure (T.90 [8], subclause 2.2.3.1);

- general rules (T.90 [8], subclause 2.2.3.2.1);

- specific rules (T.90 [8], subclause 2.2.3.2.2).

In the following, the Additional Conformance Requirements in FS T/1112 [20] are referenced as application rules too.

C.1.2 Procedure

A table of application rules is constructed, which contains one row for each rule. If two rules in FS T/1112 [20] and CCITT Recommendation T.90 [8] refer to the same subject, they correspond to the same row.

Each row has:

- a key word, indicating the rule;

- an index referring to the section of CCITT Recommendation T.90 [8] where the rule is stated (if applicable);

- one or more section numbers of CCITT Recommendation X.75 [11] that are affected by the rule (if applicable);

- an index referring the Clause of FS T/1112 [20] where the rule is stated (if applicable);

- one or more Clause numbers of ISO 7776 [21] that are affected by the rule (if applicable);

- the number of a paragraph in this annex, where the rule is evaluated.

Since the application rules are numbered to a deep level in CCITT Recommendation T.90 [8], a shorter form is applied in the table. The general rules in § 2.2.3.2.1 a) .. e) of CCITT Recommendation T.90 [8] are indicated by ga) .. ge), the specific rules in § 2.2.3.2.2 a) .. t) are indicated by a) .. t) and the additional static conformance requirements in subclause 6.3.2.1 of FS T/1112 [20] are indicated by 1) .. 15).

Since some rules of CCITT Recommendation T.90 [8] relate to subjects being referenced in the Implementation Recommendations in subclause 6.3.2.2 of FS T/1112 [20], the table contains references to the subclauses of this Clause, indicated by Rec 1) .. Rec 4).

The evaluations of the rules, starting in subclause C.3.1, describe the kind of difference of CCITT Recommendations T.90 [8]/X.75 [11] and FS T/1112 [20]/ISO 7776 [21] respectively with the rule being imposed, or they state achieved equality.

Whenever CCITT Recommendation X.75 [11] or ISO 7776 [21] is mentioned, it means the Recommendation without any application rule being imposed. Reference to CCITT Recommendation T.90 [8] or FS T/1112 [20] is understood as application rules being imposed.

Following the evaluation of the application rules, Clause C.4 contains the overall valuation of the interworking on layer 2, additionally taking into account the results of the comparison of CCITT Recommendation X.75 [11] and ISO 7776 [21], contained in Annexes A and B of this document.

C.2 Table of application rules

Table C.1: Application rules

Keywords	T.90 rule	X.75 ref	T/1112 rule	ISO ref	evaluation in:
Link layer address procedure	2.2.3.1	2.4.2	13)	5.1	C.3.1
Recommendation version	ga)	-	-	-	C.3.2
STE/DTE	gb)	0	-	-	C.3.3
Parameter negotiation	gc)	-	-	-	C.3.4
Mode of operation	gd)	2.3.2.2.1	11), 12)	4.1.2.1	C.3.5
Single link procedure	ge)	-	1)	-	C.3.6
Information field length	a)	Table 1 X.75 Table 2 X.75	-	Table 1 Table 2	C.3.7 in:
FRMR causes	b)	2.3.4.9	10)	4.3.9	C.3.8
Bits X, Y, Z, W	c)	Table 7 X.75 Table 8 X.75	-	Tables 7/8	C.3.9

(continued)

Table C.1 (concluded)

keywords	T.90 rule	X.75 ref	T/1112 rule	ISO ref	evaluation in:
Octet alignment	d)	2.3.5.3	-	3.8	C.3.10
Expiration of T3	e)	2.3.5.5	-	3.11.2	C.3.11
"Corresponding response"	f)	2.4.3	-	5.2	C.3.12
Active channel state	g)	2.4.4.1	-	5.3.1	C.3.13
SABM with P=1	g)	2.4.4.1	-	5.3.1	C.3.14
Condition for entering the disconnected phase	h)	2.4.4.4.1 2.4.4.5.2	-	5.3.5	C.3.15
Initiator of link setup	h)	2.4.4.4.1	14)	-	C.3.16
Timer recovery after received RNR	i)	2.4.5.5 2.4.5.9	-	5.4.5 5.4.9	C.3.17
Transmission of I-frames after received RNR	j)	2.4.5.7 2.4.5.9	-	5.4.7 5.4.9	C.3.18
N2 unsuccessful transmission attempts	k)	2.4.5.9	-	5.4.9	C.3.18
Check commands in FRMR condition	l)	2.4.7.3	-	5.6.2	C.3.20
Clearing of FRMR condition	l)	2.4.7.3	-	5.6.2	C.3.21
Originator of reset in FRMR condition	m)	2.4.7.3	9)	4.4.4 5.5	C.3.22
N2 unsuccessful transmissions of FRMR	n)	2.4.7.3	-	4.4.4	C.3.23
Timer T1	o)	2.4.8.1	3)	5.7.1.1	C.3.24
Timer T2	p)	2.4.8.2	4)	5.7.1.2	C.3.25
Timer T3 Timer T4	q) -	2.4.8.3 -	5) Rec 3)	5.7.1.3 5.7.1.4	C.3.26 C.3.27
Maximum repetition number N2	r)	2.4.8.4	Rec 1)	5.7.2	C.3.28
Maximum frame length N1	s)	2.4.8.5	6)	5.7.3	C.3.29
Window size k	t)	2.4.8.6	7)	5.7.4	C.3.20
Independent LAPB protocol on each channel	-	-	2)	-	C.3.31
Use of unsolicited DM as request for mode setting command	-	-	8)	4.3.8	C.3.32
Disconnecting the B-channel	-	-	15)	-	C.3.33
Synchronising the activation of the B-channel	chapter 9	-	Rec 2)	-	C.3.34
Acknowledging I-frames	Note 2	-	Rec 4)	-	C.3.35

C.3 Evaluation of the application rules

C.3.1 Link layer address procedure

The assignment of the addresses A and B is done on a per call basis and the same in both cases. The calling terminal adopts the DTE role as described, e.g. in ISO 7776 [21], subclause 5.1 and the called terminal adopts the DCE role (for address assignment).

C.3.2 Recommendation version

The Red Book Version of the CCITT Recommendation X.75 [11] is selected in CCITT Recommendation T.90 [8]. This has a general impact on the comparison between X.75 [11] - ISO 7776 [21], as given in Annex B of this ETS. Another candidate would be the Blue Book (1988) version of CCITT Recommendation X.75 [11] which is closer to ISO 7776 [21].

The version of ISO 7776 [21] indicated in FS T/1112 [20] is the version referenced in Annex A of this ETS and taken as a basis here.

C.3.3 STE/DTE

CCITT Recommendation X.75 [11] was not developed for a DTE, but for use on interconnecting links between networks (signalling terminal), whereas ISO 7776 [21] is intended (originally and for the current application) for a DTE.

C.3.4 Parameter negotiation

Rule gc) in CCITT Recommendation T.90 [8] states, that *"layer 2 parameters such as mode of operation and window size k should be negotiated via out-band. In case of the failure or the absence of negotiation, default values shall be used".*

The default values in CCITT Recommendation T.90 [8] are:

- 8 for the mode of operation, as indicated in gd);

- k=7 in basic mode of operation, as indicated in t);

- no default value currently defined for extended mode, as indicated in t).

FS T/1112 does not indicate out-band negotiation for the above parameters, but defines a "fall back value" of 8 for the modulo and mandatory values of 7(15) for k in the basic(extended) mode of operation. See also the subclauses "Mode of operation" and "Window size k".

CAUTION: It is assumed, that a terminal according to CCITT Recommendation T.90 [8], attempting the negotiation of the above mentioned parameters, is able to detect the failure in any case.

C.3.5 Mode of operation

Rules gc) and gd) in CCITT Recommendation T.90 [8] say, that an out-band negotiation of the mode of operation using low layer compatibility checking should be used, but if compatibility checking fails or is absent, basic mode of operation shall be employed.

FS T/1112 [20] does not indicate out-band negotiation, but states that the basic mode shall be supported by a terminal. To use extended mode, the in-band negotiation mechanism as described in figure 3 in subclause 7.3 of FS T/1112 [20] shall be used. In this mechanism, an SABME is transmitted to initialise the link. If this fails for some retries or after some timeouts, the fall back modulo of 8 is employed.

A terminal according to CCITT Recommendation T.90 [8], communicating with a terminal according to T/1112, preferring to use extended mode, will fall back to basic mode because the other side will not negotiate the mode (see the **CAUTION** in subclause C.3.4!). The terminal according to FS T/1112 [20] could then try the in-band negotiation and might then fail, falling back to modulo 8, too. So the interworking may be ineffective, but is possible.

C.3.6 Single link procedure

According to CCITT Recommendation T.90 [8] and FS T/1112 [20], the single link procedure is mandatory and the multilink procedure is excluded.

C.3.7 Length of information field

The conditions for the length N of the information field stated in a) of CCITT Recommendation T.90 [8] are equal to those stated in ISO 7776 [21]. In fact, combining the information in table 1/X.75 [11] and table 2/X.75 [11] and the definition of N1 in § 2.4.8.5, there is no new information.

It is not explicitly stated in ISO 7776 [21] or FS T/1112 [20] that I-frames with an empty I-field should not be transmitted.

Received I-frames with empty I-fields are considered as valid frames in both cases since they do not fulfil one of the conditions for invalid frames in CCITT Recommendation X.75 [11] (§ 2.3.5.3) or ISO 7776 (subclause 3.8).

C.3.8 FRMR causes

In b) of CCITT Recommendation T.90 [8] , the FRMR causes 5), 6) and 7) of CCITT Recommendation X.75 [11], § 2.3.4.9 are removed. The remaining conditions for tramsmitting a FRMR are equal to those specified in subclause 4.3.9 of ISO 7776 [21]. See also Annex A, subclause A.4.5 in this ETS.

Additionally the new actions to be performed, when the conditions 5), 6) and 7) occur, are specified.

- Unexpected supervisory frames with F=1, unexpected UA and DM shall be ignored.

According to ISO 7776 [21], these conditions may lead to a link reset (see also Annex A, subclause A.4.5), however rule 10) of FS T/1112 [20] states that a received unsolicited UA response in the information transfer phase shall be ignored.

The following difference remains: according to CCITT Recommendation T.90 [8], received not expected supervisory frames with F=1 and DM in the information transfer phase are ignored, while according to FS T/1112 [20]/ISO 7776 [21] received not expected supervisory frames with F=1 may be - and a received DM shall be - a condition for a link reset.

Frames with an "invalid N(S)" shall be responded by sending a REJ. "Invalid N(S)" in the sense of CCITT Recommendation X.75 [11], § 2.3.4.9 is a received N(S) that exceeds the window size k, but is valid in the sense that its N(S) equals V(R).

FS T/1112 [20]/ISO 7776 [21] does not specify any action on the reception of such an "invalid N(S)". See also Annex A, subclause A.4.5 of this ETS.

C.3.9 Bits X, Y, Z, W

CCITT Recommendation T.90 [8] c) states that the bits X, Y, Z and W in a FRMR response may all be set to "0" to indicate, that no cause for the transmission of the FRMR is given. This coincides with the ISO 7776 [21] specification. See also Annex A, subclause A.4.5 of this ETS.

C.3.10 Invalid frame condition

CCITT Recommendation T.90 [8] d) is only a remark and valid for CCITT Recommendation X.75 [11] as well as for ISO 7776 [21].

C.3.11 Expiration of T3

CCITT Recommendation T.90 [8] d) requires that higher layers shall be notified when the excessive idle channel condition occurs. This is not required by FS T/1112 [20]. See also Annex A, subclause A.4.11 of this ETS.

This is a local problem for a terminal according to FS T/1112 [20], however it is assumed in this evaluation, that in case the B-channel is released before the data link is disconnected (and maybe before virtual calls are cleared ..), all layers of the B-channel are informed. See also subclause C.3.33 of this annex.

C.3.12 "Corresponding response"

CCITT Recommendation T.90 [8] f) is only a remark and valid for CCITT Recommendation X.75 [11], § 2.4.3 as well as ISO 7776 [21], subclause 5.2.

C.3.13 Active channel state

Paragraph 1 of CCITT Recommendation T.90 [8] g) contains no new information if read literally. The active channel state is defined in § 2.4.4.1 as the state where contiguous flags are transmitted (if no frame is currently being transmitted) and no dependence on the channel state of the other DTE is indicated. The definition of the active channel state is the same as in ISO 7776 [21].

This rule could be intended to mean: a DTE should enter the active channel state, i.e. send contiguous flags on its transmit channel, without waiting to receive flags on the receive channel, because this could produce a lock up situation. This corresponds to the remark in subclause B.3.2b) in Appendix B of FS T/1112 [21]. See also subclause C.34 of this annex "Synchronising the activation of the B-channel".

C.3.14 SABM with P=1

Paragraph 2 of CCITT Recommendation T.90 [8] g) states that the calling DTE shall initiate the link by sending an SABM(SABME) with P=1.

It is understood that this condition does not disallow the called DTE to initiate/reset the link and that no prescription for the usage of the P bit in the SABM(SABME) is given in this case.

According to ISO 7776 [21], each SABM(SABME)/DISC has to be transmitted with P=1 (to differentiate between the DM response to such a command, using F=1, and the DM response as request for a mode-setting command, using F=0). Since rule 8) in FS T/1112 [20] excludes the usage of a DM response as request for a mode-setting command, there is no need for always setting P=1 in an unnumbered command, but the interworking between terminals using always/not always P=1 in SABM(SABME)/DISC is not affected.

C.3.15 Condition for entering the disconnected phase

The contents of the first paragraph of CCITT Recommendation T.90 h) [8] does not seem to be understandable if read literally.

It is understood that the first paragraph of CCITT Recommendation T.90 [8] h) indicates the fact, that in the collision case SABM(SABME):DISC, the DTE having transmitted the DISC enters the disconnected phase though the DISC, is not acknowledged by a UA and that this possibility is not indicated in the first paragraph of CCITT Recommendation X.75 [11], § 2.4.4.4.1.

Essentially, there is no new information, no restriction and no contradiction to FS T/1112 [20]/ISO 7776 [21].

C.3.16 Initiator of link setup

The second paragraph of CCITT Recommendation T.90 [8], h) states, that "in the disconnected phase it is the calling DTE which may initiate link setup".

It is understood that this does not disallow the called DTE to initiate link setup.

Rule 14) in FS T/1112 [20] says, that *"the end system which is assigned the DTE role (the calling system) is responsible for setting up and disconnecting the data link, but the other end system may also do it".* So interworking is not affected.

C.3.17 Timer recovery after received RNR

Rule i) in CCITT Recommendation T.90 [8] says, that if an RNR frame with F=1 is received under the conditions of § 2.4.5.9, paragraph 4, the DTE shall remain in the Timer recovery condition.

This rule needs further clarification.

The expression "Timer recovery condition" is defined as expiration of T1 waiting for the acknowledgement of a transmitted I-frame. This expression occurs only in CCITT Recommendation X.75 [11] and not in ISO 7776 [21] , however the same situation is described in subclause 5.4.9 of ISO 7776 [21].

If the received RNR with F=1 actually acknowledges all transmitted I-frames and there are no new I-frames available for sending, there seems to be no reason for keeping the Timer recovery condition or starting T1 or keeping it running.

If the received RNR with F=1 acknowledges some transmitted I-frames, but not all, there seems to be a reason for restarting T1, waiting for the acknowledgement of the next unacknowledged transmitted I-frame, but not for staying in the Timer recovery condition. This condition would be entered, if T1 expires again. See also Annex A, subclause A.4.18.

C.3.18 Sending I-frames after received RNR

Rule j) in CCITT Recommendation T.90 [8] says, that after a received RNR (with F=1) in the Timer recovery condition (§ 2.4.5.9), no I-frame shall be transmitted or retransmitted.

When receiving an RNR outside the Timer recovery condition, it would be permitted according to CCITT Recommendation X.75 [11] (see also Annex B, Clause B.2 in this ETS) to transmit/retransmit the I-frame with the send sequence number equal to the N(R) indicated in the RNR. In the corresponding situation, a terminal according to ISO 7776 [21] is not permitted to transmit any I-frame.

However in 5.4.9 of ISO 7776 [21], which corresponds to CCITT T.90 [8], § 2.4.5.9 and describes the situation of the Timer recovery condition, it is stated:

> *"If the DTE receives correctly the supervisory response frame with the F bit set to "1", ... may ..resume with I-frame transmission or retransmission, as appropriate."*

Taken this literally for the supervisory frame RNR, it would be allowed for a terminal to transmit/retransmit I-frames in the above described situation, but it would not be allowed in the corresponding situation outside the Timer recovery condition (see ISO 7776 [21], subclause 5.4.7) or after a checkpoint cycle, terminated by a received RNR with F=1 (see ISO 7776 [21], subclause 4.4.2.1).

This seems to be a wording error in ISO 7776 [21] and it is assumed, that a terminal according to ISO 7776 [21] will not send any I-frame having received an RNR with F=1 in the situation described in subclause 5.4.9. See also Annex A, subclause A.4.18 of this ETS.

C.3.19 N2 unsuccessful transmission attempts

Rule k) in CCITT Recommendation T.90 [8] says that after N2 unsuccessful transmission attempts in the Timer recovery condition, the DTE will enter the disconnected phase.

This is understood such that the DTE considers itself to be in the disconnected phase without sending any unnumbered command. This means especially: without any attempt to reset the link.

A terminal according to ISO 7776 [21] shall initiate a link reset (last paragraph of subclause 5.4.9). This causes no interworking problem, but may be inefficient.

C.3.20 Check commands in FRMR condition

The original statement in § 2.4.7.3 of CCITT Recommendation X.75 [11] is, that every received frame except SABM(SABME) and DISC in the FRMR condition shall be responded by sending an FRMR. See also Annex A, subclause A.4.10 of this ETS for the contradiction in § 2.4.7.3.

The first paragraph of rule l) of CCITT Recommendation T.90 states, that *"in the FRMR condition, the DTE shall only check commands and react with a FRMR according to the P bit".*

It is understood, that this rule resolves the contradiction and equals to the corresponding prescription given in subclause 5.6.2 of ISO 7776 [21].

C.3.21 Clearing of FRMR condition

The second paragraph of rule l) of CCITT Recommendation T.90 [8] states, *"that the FRMR condition is cleared when the DTE receives an SABM or receives or transmits a DISC command*".

This contradicts the last paragraph of § 2.4.7.3 in CCITT Recommendation X.75 [11]. It may happen, that a DTE receives a FRMR while being in the FRMR condition and then shall reset the link by transmitting an SABM(SABME).

It is assumed, that CCITT Recommendation T.90 [8] does not exclude the transmission of SABM(SABME) in this situation and that this rule has to be seen in connection with the following rule: see subclause C.3.22.

C.3.22 Originator of reset in FRMR condition

CCITT Recommendation X.75 [11] and ISO 7776 [21] allow a DTE to reset (or disconnect) the link after having transmitted the FRMR response.

Rule m) of CCITT Recommendation T.90 [8] and rule 9) in FS T/1112 [20] state that only the DTE that caused the FRMR may try to reset the link.

The possibility to try to reset the link after N2 unsuccessful retransmissions of the FRMR as indicated in 9) of FS T/1112 [20] is neither helpful nor does it prevent from interworking. See also NOTE 1 in § 2.2.3.2.2 (specific rules) of CCITT Recommendation T.90 [8].

C.3.23 N2 unsuccessful transmissions of FRMR

Rule n) of CCITT Recommendation T.90 [8] states that a "DTE will enter the disconnected phase after N2 unsuccessful transmissions of a FRMR (without sending an unnumbered command)".

This has to be seen in connection with the previous rule m), which allows only the DTE that caused the FRMR to try to reset the link.

C.3.24 Timer T1

Rule o) of CCITT Recommendation T.90 [8] contains 2 specifications:

- T1 shall be started at the end of frame transmission;

- there is no specific value defined for T1, however a value between 2,5 and 7 seconds is recommended.

Rule 3) of FS T/1112 [20] defines the value of T1 to be 5 seconds. It is not specified in FS T/1112 [20], whether T1 shall be started at the end of frame transmission or not.

Considering the values of N1 defined in CCITT Recommendation T.90 [8] and FS T/1112 [20] respectively, transmission delay and transmission rate, interworking is not affected if the terminal, according to CCITT Recommendation T.90 [8], adopts a recommended value for T1 in the range between 2,5 and 7 seconds.

It is assumed in this evaluation, that a terminal according to CCITT Recommendation T.90 [8] will not employ a value lower than 2 seconds for T1. In this case, interworking between 2 terminals (maybe even both according to CCITT Recommendation T.90 [8]), may be affected in some situations.

C.3.25 Timer T2

Rule p) of CCITT Recommendation T.90 [8] specifies the value of T2 (if implemented) to be less than 1 second.

The corresponding rule 4) in FS T/1112 [20] specifies the value of T2 to be less than or equal to 1 second. This is effectively the same.

C.3.26 Timer T3

Timer T3 is optional for a terminal according to ISO 7776 [21] and mandatory for a terminal according to CCITT Recommendation X.75 [11].

Rule q) of CCITT Recommendation T.90 [8] specifies the value of T3 to be in the range between 30 seconds and 60 seconds.

Rule 5 of FS T/1112 [20] specifies the value of T3, if implemented, to be greater than or equal to 10*T1.

Correct interworking is not affected if the terminal according to ISO 7776 [21] has not implemented T3 or uses a value larger than 60 seconds for T3.

C.3.27 Timer T4

Timer T4 is not defined in CCITT Recommendation X.75 [11] and optional in ISO 7776 [21]. If there is no activity on the data link for a period of Timer T4, it is strongly recommended in ISO 7776 [21], subclause 5.3.2, to query the status of the data link.

Correct interworking is not affected if T4 is not implemented or not used.

C.3.28 Maximum transmission number N2

Rule r) of CCITT Recommendation T.90 [8] specifies the value of N2 to be greater than or equal to 60 seconds/T1. According to the recommended value for T1 in rule o), this would be a number between 9 and 24.

FS T/1112 [20] does specify the value of N2, but it recommends a value of 10 in Recommendation 1). The total time N2*T1 would be 50 seconds in this case, which is fairly near to 60 seconds for a terminal according to CCITT Recommendation T.90 [8].

Correct interworking is not at risk.

C.3.29 Maximum frame length N1

Rule s) of CCITT Recommendation T.90 [8] defines N1 to be the number of bits in a frame according to the maximum allowed packet size of 2048 octets, taking into account whether modulo 8/modulo 128 is used on layer 2 and on layer 3.

So even a terminal that does not support the maximum allowed packet size on layer 3, will support the maximum frame size on layer 2.

Rule 6) in FS T/1112 [20] says, that *"Parameter N1 shall be such, that the Data Link Layer is capable of carrying the maximum packet size negotiated at the packet level ..."*.

According to both specifications, the frame size corresponding to the minimal allowed packet size of 128 octets shall be supported.

Interworking is not affected (for a call), if the maximum packet size (for the call) is negotiated at layer 3. It may be affected (at layer 2 already), if the 2 terminals use different default maximum packet sizes and do not negotiate the size at layer 3.

C.3.30 Window size k

Rule t) of CCITT Recommendation T.90 [8] specifies the value of k:

basic mode: k <= 7 (default value k=7);

extended mode: k <= 32 (default value presently undefined).

In Note 2 to the specific rules in CCITT Recommendation T.90 [8] it is recommended, that each received I-frame should be acknowledged as soon as possible or that acknowledgement Timer T2 should be implemented.

Note 3 says, that further study is needed on a mechanism for negotiation of k.

In rule 7), FS T/1112 [20] specifies k:

"For parameter k (window size), the value 7 is mandatory for basic operation. The value 15 is mandatory for the extended operation. Other values may be provided for both basic and extended operation".

As there is no possibility of negotiation of k indicated in FS T/1112 [20] or generally defined, the last sentence is not considered in the evaluation.

If:

- there is a connection between a terminal according to CCITT Recommendation T.90 [8] and a terminal according to FS T/1112 [20] in extended mode;

- the terminal according to CCITT Recommendation T.90 [8] uses a value of k < 15;

- this terminal employs T2 for acknowledgement.

then the terminal according to CCITT Recommendation T.90 [8] could receive more than k unacknowledged I-frames and would then react by sending a REJ frame according to rule b) in CCITT Recommendation T.90 [8]. This makes the connection less efficient than could be, but interworking is not at risk.

If a terminal according to FS T/1112 [20] receives more than k=15 I-frames, it need not even send a REJ frame; it may accept the frames if it can. See also subclause C.3.8 of this annex.

C.3.31 Independent LAPB protocol on each channel

Rule 2) in FS T/1112 [20] states *"that an Independent LAPB procedure shall operate over each B-channel"*.

CCITT Recommendation T.90 [8] does not state this explicitly, but there is no conflicting rule.

It is assumed in this evaluation, that CCITT Recommendation T.90 [8] intends the same in this respect, though not explicitly stating it.

C.3.32 Use of unsolicited DM as mode setting command

Rule 8) in FS T/1112 [20] states that *"an unsolicited DM response shall not be used to request a set mode command"*.

This coincides with CCITT Recommendations X.75 [11]/T.90 [8].

C.3.33 Disconnecting the B-channel

Rule 15) in FS T/1112 [20] states that *"in the normal procedure for disconnection, the Data Link shall be disconnected before disconnecting the B-channel"*.

CCITT Recommendation T.90 [8] does not state this explicitly.

Violation of rule 15) would not prevent from correct interworking during call setup or in the data phase, but it might be unefficient. See subclause C.3.11 of this annex.

C.3.34 Synchronising the activation of the B-channel

Chapter 9 of CCITT Recommendation T.90 [8] and Recommendation 2) in FS T/1112 [20] describe procedures to synchronise 2 entities that are going to use the same B-channel for a data link connection.

According to CCITT Recommendation T.90 [8], the transmission of the connect message is the starting point for the called side to open the receiver and send flags on the B-channel, and the received connect message is the starting point for the calling side to open the receiver, send flags and then send the SABM(SABME).

CCITT Recommendation T.90 [8] recommends the calling side to wait for the reception of the first flag before sending the SABM(SABME).

FS T/1112 [20] recommends a sequence like the one defined in CCITT Recommendation T.90 [8], including the recommended waiting for the flag.

If a terminal according to FS T/1112 [20] does not use the recommendation, the setup of the data link might be inefficient.

C.3.35 Acknowledging I-frames

Rec 4) in FS T/1112 [20] states that *"it is recommended, that an RR frame be used as a response, unless an outgoing I-frame is available"*.

This statement needs further clarification.

It is understood, that Recommendation 4) means, that a received I-frame in the information transfer phase should be acknowledged without delay, even if there is currently no I-frame available for transmission.

This corresponds to the first part of NOTE 2 in CCITT Recommendation T.90 [8], but Note 2 is weaker in fact, because it recommends alternatively the implementation of Timer T2.

C.4 Overall valuation of the interworking

The overall valuation of the interworking of a terminal according to FS T/1112 [20] and a terminal according to CCITT Recommendation T.90 [8] on layer 2 in the B-channel is done by using a qualification table.

Each of the differences listed in the Annexes A and B of this ETS and each application rule is given one of the following qualifications with respect to the possibly different behaviour of a terminal according to CCITT Recommendation T.90 [8] or to FS T/1112 [20]:

EQ Equal behaviour with respect to current subject. This qualification will be given if an application rule makes a previously existing difference vanish, or has only a descriptional meaning.

NA Indicates a not applicable rule. This qualification is given, e.g. to a subject in Annex A or Annex B of this ETS, recognised as different, but being changed according to the application rule(s). The application rule is then indicated in the comment field of the qualification table by giving the chapter where it is evaluated. A comment is given in any case.

UE Uneffective interworking. This qualification is given, if the behaviour is different and may lead to an uneffective communication in some circumstances, but interworking is not at risk.

DI Slight difference which is not qualified as being e.g. uneffective.

NI No interworking. This qualification is given if the difference in the current subject may lead to a lock-up situation, or recovery from an error situation cannot be achieved, using the available mechanisms.

Considering all the qualifications given in table C.2, a general statement on the interworking is given in subclause C.4.2.

C.4.1 Qualification table

Table C.2

Keyword	Qual.	§§	Comment
Unnumbered frames mod 128	NA	A.4.1	Option not mentioned in T.90 [8] or T/1112 [20].
Invalid frame	DI	A.4.2	-
SABM control byte	NA	A.4.3	Type error.
DM as set mode request	NA	A.4.4	See C.3.32
Conditions to send FRMR	NA	A.4.5	See C.3.8
Receiving an RNR	NA	A.4.6	See Red Book version in B.2
N(S) sequence error recovery	DI	A.4.7	Usage of checkpoint recovery seems from the other side like the procedure after Timeout of T1, waiting for acknowledgement of I-frames.
Start T1 after REJ	DI	A.4.8	Only a "may" condition for a terminal according to ISO, which may even increase the effectivity of communication.
Answer to received REJ	DI	A.4.9	The condition has been imposed on a terminal according to ISO to prevent from mixing answer to a received REJ and start of checkpoint cycle. Interworking is not affected.
Receiving frames in FRMR condition	EQ	A.4.10	-
Excessive Idle Channel State	DI	A.4.11	The first part of A.4.11 is not applicable to the DTE/DTE case. See also C.3.13
SABM with P=1	NA	A.4.12	See C.3.14
T4 in info phase	DI	A.4.13	See C.3.27
DISC with P=1	DI	A.4.14	-
Transmitted DISC	UE	A.4.15	It seems to be unefficient to react to received supervisory frames according to the rules in the information transfer phase, after having sent a DISC command, but according to X.75 [11] it is allowed. The interworking problem exists also for 2 terminals according to X.75 [11].
Collision of unnumbered commands	DI	A.4.16	-
Retransmission using kmax	UE	A.4.17	The interworking problem indicated in A.4.17 exists also between two terminals according to ISO 7776 [21].
Waiting for I-frame acknowledgement	DI	A.4.18	The DTE according to ISO 7776 [21] will not poll an answer after Timeout T1 using an I-frame with P=1, but will act upon receipt of such a frame like a terminal according to X.75 [11].
Conditions for link reset	NA	A.4.19	See C.3.22.
Request for link reset	NA	A.4.20	See C.3.22 and C.3.23.

(continued)

Table C.2 (continued)

Keyword by FRMR	Qual.	§§	Comment
Receiving acknowledgement	UE	B.1	Timeout T1 may occur earlier for the terminal according to X.75 [11] than for the terminal according to ISO 7776 [21].
Receiving an RNR frame	EQ	B.2	Equality achieved by j) in T.90. See also C.3.18.
Link layer address procedure	EQ	C.3.1	-
Recommendation version	NA	C.3.2	Not comparable in this respect.
STE/DTE	NA	C.3.3	Not comparable in this respect.
Parameter negotiation	DI	C.3.4	-
Mode of operation	UE	C.3.5	Uneffective only in extended mode.
Single link procedure	EQ	C.3.6	-
Information field length	EQ	C.3.7	-
FRMR causes	UE	C.3.8	The conditions for sending FRMR are not more different, but the actions after upon the deleted FRMR reasons may be different. Especially the fact that a REJ shall be transmitted by a terminal according to T.90 [8] if the window size k is exceeded on the receive side may lead to ineffective communication. See also C.3.30.
Bits X, Y, Z, W	EQ	C.3.9	-
Octet alignment	EQ	C.3.10	-
Expiration of T3	UE	C.3.11	May lead to inefficiency especially on higher layers. See also C.3.13.
Corresponding response	EQ	C.3.12	-
Active channel state	EQ	C.3.13	Equal if understood as indicated in C.3.13.
SABM with P=1	DI	C.3.14	Not specified for the called side in T.90 [8].
Conditions to enter disconnected phase	EQ	C.3.15	Equal if understood as indicated in C.3.15.
Initiator of link setup	EQ	C.3.16	Equal if understood as indicated in C.3.16.
Timer recovery after received RNR	EQ	C.3.17	Equal if understood as indicated in C.3.17.
Sending I-frames after received RNR	EQ	C.3.18	Equal if understood as indicated in C.3.18.
N2 unsuccessful transmissions	UE	C.3.19	-
Check commands in FRMR condition	EQ	C.3.20	-
Clearing of FRMR condition	EQ	C.3.21	Equal if understood as indicated in C.3.21 and C.3.22
Originator of reset in FRMR condition	EQ	C.3.22	-

(continued)

Table C.2 (concluded)

Keyword	Qual.	§§	Comment
N2 unsuccessful transmissions of FRMR	UE	C.3.23	-
Timer T1	DI	C.3.24	-
Timer T2	EQ	C.3.25	-
Timer T3	DI	C.3.26	-
Timer T4	DI	C.3.27	-
Maximum transmission number N2	DI	C.3.28	-
Maximum frame length N1	DI	C.3.29	-
Window size k	UE	C.3.30	-
Independent LAPB protocol on each channel	EQ	C.3.31	See assumption in C.3.31.
Unsolicited DM as request for mode setting command	EQ	C.3.32	-
Disconnecting the B-channel	DI	C.3.33	-
Synchronising the activation of the B-channel	UE	C.3.34	Equal if the recommended procedures are implemented.
Acknowledging I-frames	DI	C.3.35	Equal if first option in Note 2 of T.90 [8] is implemented.

C.4.2 Statement of interworking

Looking at the evaluations of the application rules, it can be seen that some of the rules might not be uniquely expressed, but the understanding on which the evaluation bases is expressed.

Assuming that the expressed understanding is correct, and considering the fact that no entry in the qualification table is NI ("no interworking", as defined above), the following statement of interworking is expressed:

> The communication of a terminal conforming with this ETS or ENV 41 112 which uses the ISO 7776 [21] option and a terminal conforming with this ETS or CCITT Recommendation T.90 [8] which uses the CCITT Recommendation X.75 [11] option may be inefficient in some situations, but interworking is possible.

Annex D (informative): Differences between the CCITT Recommendation X.224 and the International Standard ISO/IEC 8073

D.1 General

CCITT Recommendation X.224 [12] and the ISO/IEC 8073 [23] documents deal with the same subject and coincide nearly word for word, however there are some differences (of different "quality").

Some differences come from obvious typographical errors; they are listed separately and not contained in this ETS. Occasionally, sentences have been extended or parts of a sentence have been interchanged to express the same meaning more clearly. These instances are not listed and are not considered as essential.

According to the general usage of the two standardisation organisations, different expressions may be used for a subject, e.g Recommendation - International Standard, Clause - Section, suggested - recommended. Sometimes "must" is used in the ISO document instead of "shall" in the CCITT document. These differences are not considered as meaningful and are not listed in this document, too.

ISO/IEC 8073 [23] contains only references to ISO documents, while CCITT Recommendation X.224 [12] refers to CCITT documents.

Differences which may come from a typographical error, but where this cannot be decided uniquely, are listed in Clause D.3 together with other differences.

D.2 Additional items in CCITT Recommendation X.224

D.2.1 Additional annexes and appendices

CCITT Recommendation X.224 [12] contains two annexes and two appendices.

ISO/IEC 8073 [23] contains two annexes.

Annex A in both documents are equal up to the differences listed in Clause D.3. Annex B of ISO/IEC 8073 [23] appears in CCITT Recommendation X.224 [12] as Appendix I, Annex B and Appendix II of CCITT Recommendation X.224 [12] have no counterpart in the ISO/IEC document. Annex B contains information about Transport protocol identification, and Appendix II contains a list of defect reports and differences to ISO 8073 (1986) [23]. The differences listed there will appear as part of the list of differences in Clause D.3 of this annex.

D.2.2 Additional notes and paragraphs

The following additional notes appear in CCITT Recommendation X.224 [12]:

- NOTE 3 to table 2.

The corresponding NOTES 1 and 2 appear in subclause 5.2 in ISO/IEC 8073 [23] and after table 2 in the CCITT document.

- NOTE 5 in § 6.1.3;

- NOTE 2 in § 6.2.3;

- NOTE 1 in § 6.5.4.

The last paragraph of § 5.5 in CCITT Recommendation X.224 [12] contains a hint to figure 2, which is missing in ISO/IEC 8073 [23].

Subsection 6.9.2 contains the network service primitives related to "Associations of TPDUs with transport connections". The primitives N-RESET request and N-DISCONNECT request are missing in CCITT Recommendation X.224 [12].

The last paragraph of subclause 12.2.1.1.6 in ISO/IEC 8073 [23] is missing in CCITT Recommendation X.224 [12]. The paragraph contains the definition of period L. However, there is information about L contained in figure 4 of both documents.

D.3 Other differences

D.3.1 Protocol identifier

Table 8 contains TPDU codes. In CCITT Recommendation X.224 [12], there is an additional row in this table for PI: Protocol identifier.

The additional NOTES 1 and 2 indicated in § 2.2 of this document also relate to the protocol identifier. See also annex B of CCITT Recommendation X.224 [12], which has no counterpart in ISO/IEC 8073 [23].

D.3.2 Sending a DC TPDU

In the note of § 6.9.4.2 a) of CCITT Recommendation X.224 [12] it is stated, that no DC TPDU shall be sent, if a DR TPDU is received with a SRC-REF field set to zero, while the term "should" is used in ISO/IEC 8073 [23].

D.3.3 Conformance statements

Section 14 contains requirements for implementations of transport protocol classes and procedures to be in conformance with ISO/IEC 8073 [23] and CCITT Recommendation X.224 [12] respectively.

D.3.3.1 Class 0/Class 2

According to subclause 14.2 of ISO/IEC 8073 [23], a system shall implement Class 0 or Class 2 or both, while according to § 14.2 of CCITT Recommendation X.224 [12], a system shall implement Class 0.

A system having implemented only Class 2 (complying to the ISO/IEC Standard) cannot interwork with a system having implemented only Class 0 (complying to the ISO/IEC Standard and the CCITT Recommendation) on the transport layer.

D.3.3.2 Class 0/Class 1

According to subclause 14.4 of ISO/IEC 8073 [23], a system shall implement Class 0 if it has implemented Class 1. This requirement is not contained in the CCITT Recommendation.

However, this requirement follows from table 3 - Valid responses to the preferred class and any alternative class proposed in the CR TPDU.

If a calling transport entity indicates preferred Class 1 and no alternative Class in the CR TPDU, Class 0 is a valid response according to the table. This only makes sense if Class 0 can be expected to be implemented on the calling side.

D.3.3.3 Explicit indication of alternative class

Subsection 14.4 of CCITT Recommendation X.224 [12] corresponds to subclause 14.5 of ISO/IEC 8073 [23]. 14.4 a) of CCITT Recommendation X.224 [12] contains the additional requirement, that Class 0 must be indicated as alternative class (with defined exceptions) if the preferred class is Class 2 or Class 3 or Class 4 in a CR TPDU.

D.3.4 Tables in Annex A

In ISO/IEC 8073 [23] it is stated in the first paragraph of Annex A, that in the case of a discrepancy between the description in a table and that contained in the text, the text takes precedence. This statement is not contained in CCITT Recommendation X.224 [12].

D.3.4.1 Table 17 (ISO/IEC) - table A-8 (CCITT)

- Specific action {2}.

  In the first sentence, ISO/IEC requires to retransmit unacknowledged expedited data, while CCITT more generally requires to process TDT and TEX requests.

- Specific action {8}.

  The second sentence of ISO/IEC 8073 [23], dealing with sending credit, is missing in the CCITT Recommendation.

D.3.4.2 Table 19 (ISO/IEC) - table A-10 (CCITT)

Some corresponding fields event/state in the tables contain a different sequence of specific actions {x}, specific notes (x) and state transitions, which are not indicated here.

If in the following the term "missing" is used for a specific action or note, this means that the subject appears in the counterpart, not precluding which version is "correct".

- Part 1, The event "TCON req" must be "TCON resp".

  Part 1, DR/WBOC-WR.

  Specific note (6) is missing after CLOSED in ISO/IEC 8073 [23].

- Part 1, DC/CLOSING BOC.

  Specific note (6) is missing after CLOSED in ISO/IEC 8073 [23].

- Part 2, NDISind/WFNC.

  Specific action {2} is missing in ISO/IEC 8073 [23].

- Part 2, NDISind/WFNC.

  After predicate P2:, specific action {8} appears in ISO/IEC 8073 [23] and {5} appears in CCITT Recommendation X.224 [12].

  Part 2, NDISind/WCC-R.

  The fields are completely different.

- Part 2, Timeout TTR/WCC-R.

  Specific action {9} is missing in ISO/IEC 8073 [23].

- Part 3, NDISind/OPEN.

  CCITT Recommendation X.224 [12] contains the sequence {8} {2} {8}, which seems to be erroneous. According to ISO/IEC 8073 [23], the specific action {8} belongs to the predicate "P6 and not P4 and P2", while the sequence {2} {8} belongs to the following predicate "P6 and not P4 and P3".

- Part 3, event RJ in ISO/IEC 8073 [23].

  The corresponding row in CCITT Recommendation X.224 [12] contains the events "RJ or ED". The event ED does not appear in ISO/IEC 8073 [23] .

D.3.5 Annex B (ISO/IEC 8073) - Appendix I (CCITT Recommendation X.224)

In B1), ISO/IEC 8073 [23] contains the wrong reference to subclause 12.1. The correct reference is 13.2 as contained in CCITT Recommendation X.224 [12].

D.4 Conclusion for Class 0

The formats and procedures described in ISO/IEC 8073 [23] and CCITT Recommendation X.224 [12] respectively, do not show any difference for Transport Class 0.

Annex E (informative): Differences between the CCITT Recommendation T.70 and ISO/IEC 8073

E.1 Referenced documents

a) CCITT Recommendation T.70 [7]

Network-independent basic transport service for the telematic services, February 1988.

Taken from Document AP IX-24-E.

b) International Standard ISO/IEC 8073 [23]

Information Processing Systems - Open Systems Interconnection - Connection oriented transport protocol specification.

Second Edition 1988 - 12-15.

c) CCITT Recommendation X.224 [12]

Transport protocol specification for Open Systems Interconnection for CCITT Applications.

E.2 Introduction

ISO/IEC 8073 [23] and CCITT Recommendation X.224 [12] have a nearly equal structure and the contents are approximately identical for Class 0 (see Annex D), therefore only ISO/IEC 8073 [23] is referenced in the following.

CCITT Recommendation T.70 [7] defines a network independent basic transport service and transport protocol applicable to teletex and facsimile group 4 terminals.

ISO/IEC 8073 [23] specifies a number of classes of transport protocols. Class 0 provides the simplest type of transport connection and is compatible with that depicted in CCITT Recommendation T.70 [7].

A comparison of the transport protocol Class 0 of ISO/IEC 8073 [23] with the transport service and transport protocol of CCITT Recommendation T.70 [7] is carried out to find any significant differences in the technical contents.

This annex contains the result of the comparison.

E.3 Structure and terminology of the documents

Both, CCITT Recommendation T.70 [7] and ISO/IEC 8073 [23], are divided into a main part containing the description of Transport Protocol (ISO/IEC 8073 [23]) and the transport protocol and service (CCITT Recommendation T.70 [7]) respectively, and annexes with further information concerning states and state transitions. However, they have a different structure, i.e. a comparison word by word, or paragraph by paragraph is not possible.

In Annex A of CCITT Recommendation T.70 [7] relationships between valid sequences of transport service primitives and the appropriate protocol elements are shown additionally in several figures. Furthermore the relationships of network service primitives at both sides of a network connection are shown. The figures correspond to the network service primitive time diagrams given in CCITT Recommendation X.213 and the transport service primitive time diagrams given in CCITT Recommendation X.214.

Nothing similar is shown in ISO/IEC 8073 [23] according to the fact that ISO/IEC 8073 [23] is a protocol specification and not a service definition. However, a reference to ISO/IEC 8072 (transport service definition) and ISO/IEC 8348 (Network service definition) is given.

The terminology and abbreviations used for the transport data protocol elements in CCITT Recommendation T.70 [7] and ISO/IEC 8073 [23] respectively are different. Table E.1 below shows a list of the TPDUs, valid in Class 0, their different names and their abbreviations which are used in the above mentioned documents. References to the subclauses or subsections (§) of their descriptions are given.

Table E.1: Class 0 TPDUs and their abbreviations

CCITT T.70 term	§§	ISO/IEC 8073 term	sub-clause
Block, Transport Layer Protocol Element	5.1.3.2 5.1.4.1	Transport Protocol Data Unit (TPDU)	4.2
Transport Connection Request (TCR) block	5.1.3.3 5.1.3.4 5.2.2	Connection Request (CR) TPDU	13.3
Transport Connection Accept (TCA) block	5.1.3.3 5.1.3.4 5.2.3	Connection Confirm (CC) TPDU	13.4
Transport Connection Clear (TCC) block	5.1.3.3 5.1.3.4 5.2.4	Disconnect Request (DR) TPDU	13.5
Transport Data (TDT) block	5.1.3.3 5.1.3.4 5.3.2	Data (DT) TPDU	13.7
Transport Block Reject (TBR) block	5.1.3.3 5.5.7	TPDU Error (ER)	13.12

E.4 Differences in the contents of CCITT Recommendation T.70 and ISO/IEC 8073

E.4.1 Invalid TPDUs and protocol errors

ISO/IEC 8073 [23] contains a list of definitions including the definitions of the terms "invalid TPDU" and "protocol error". However, there is no list of possible invalid TPDUs and protocol errors. These must be extracted from the description of the formats and procedures.

CCITT Recommendation T.70 [7] gives a list of "invalid TPDUs" under event E 5 in table B.4 of CCITT Recommendation T.70 [7], divided into those received TPDUs whose validity check fails due to syntactical errors (corresponding to "invalid TPDU" in the sense of ISO/IEC 8073 [23]) and those TPDUs considered as erroneous due to procedure errors (corresponding to protocol errors in the sense of ISO/IEC 8073 [23]).

E.4.1.1 Invalid TPDUs

Except for the fact that CCITT Recommendation T.70 [7] restricts the maximum value of the length indicator (LI) field of a TPDU to 127, whereas ISO/IEC 8073 [23] allows 254 octets, no difference exists between the notion of "invalid TPDU" according to ISO/IEC 8073 [23] and "syntactical error" according to CCITT Recommendation T.70 [7].

E.4.1.2 Protocol errors

The reception of an invalid TPDU is treated as a protocol error in both cases, except that CCITT Recommendation T.70 [7] includes the following in subsection 5.4.1:

> *"During the establishment of a transport connection, terminals shall not send a TBR block upon the receipt of a TCR block whose parameters or parameter values are invalid or not implemented. In this case, terminals shall act as if no errors have occurred and send the appropriate response (if any)."*

This exception is not included in ISO/IEC 8073 [23].

In all other cases, the reaction to a protocol error is the same: a TBR block is transmitted or the Network Connection is released. If a TBR block is transmitted, it is expected that the peer entity releases the Network Connection. Timer supervision (using TS2) is only optional according to ISO/IEC 8073 [23], while it is mandatory in CCITT Recommendation T.70 [7] (using T0.3). See also subclause E.4.3 "Handling of Timers" of this annex.

E.4.2 Description of transport protocol by state tables and state transition diagrams

In both CCITT Recommendation T.70 [7] and ISO/IEC 8073 [23], state tables and further information concerning the transport protocol are given in annexes.

In CCITT Recommendation T.70 [7] the information is more exhaustive and precise. In addition to the state tables, state transition diagrams are provided, and Timers which survey some states are treated in the state tables.

E.4.3 Handling of Timers

In CCITT Recommendation T.70 [7] three Timers (T1.1, T0.3, T0.2) are defined, which are mandatory.

Timer T1.1 surveys state 1.1 (waiting for a TCA block). It is started during transition from state 0.2 to 1.1 after sending a TCR.

Timer T0.3 surveys state 0.3 (waiting for an N-DISCONNECT indication). It is started during transition from state 1.1 respectively state 2.1 to state 0.3 after sending a TBR.

Timer T0.2 surveys state 0.2 of the called side (waiting for an N-DISCONNECT indication). It is started during transition from state 1.1 to state 0.2 after sending a TCC.

To provide supervision of the actions taken during connection establishment and error handling, optional Timers TS1 and TS2 are recommended in ISO/IEC 8073 [23], but their values are not specified.

The correspondence of Timers in CCITT Recommendation T.70 [7] and ISO/IEC 8073 [23] can be seen in table E.2. The Timer T0.2 of CCITT Recommendation T.70 [7] does not have any corresponding Timer in ISO/IEC 8073 [23].

Table E.2: Correspondence of Timers

ISO/IEC 8073	CCITT T.70
TS1	T1.1
TS2	T0.3
-	T0.2

("-" = no corresponding Timer)

In the state tables of CCITT Recommendation T.70 [7] Timer expirations are explicitly indicated as local events.

Timer supervision is not treated in the state tables of ISO/IEC 8073 [23]. Especially the supervision of a network connection is not provided explicitly in ISO/IEC 8073 [23].

E.4.4 Correspondence of transport layer states in CCITT Recommendation T.70 and ISO/IEC 8073

As shown in table E.3, for some states defined in ISO/IEC 8073 [23] and CCITT Recommendation T.70 [7] respectively, direct correspondences can be found.

For states 0.3 of calling and called side and for state 0.2 called side of CCITT Recommendation T.70 [7], there is no correspondence in ISO/IEC 8073 [23].

Table E.3: Correspondence of States

ISO/IEC 8073	CCITT T.70	
	calling side	called side
CLOSED	0.1	0.1
WFNC	0.2	
-		0.2 NOTE 1
WFCC	1.1	
WFTRESP		1.1
-	0.3 NOTE 2	0.3 NOTE 2
OPEN	2.1	

NOTE 1: This state is entered by the called side to wait for an incoming TCR or an N-DISCONNECT indication. Timer T0.2 surveys this state.

NOTE 2: This state is entered on the called and calling side to wait for an N-DISCONNECT indication. Timer T0.3 provides its supervision. If a situation occurs for a transport connection, where in CCITT Recommendation T.70 [7] state 0.3 is entered, CLOSED is entered according to ISO/IEC 8073 [23], i.e. a supervision of the network connection does not occur in ISO 8073 [23].

("-" = no corresponding state)

Although a differentiation between called and calling side is made in CCITT Recommendation T.70 [7], the states 0.1 and 0.3 respectively must be concatenated to one state 0.1 (idle) and one state 0.3 (wait for network connection release after transmitted TBR).

Annex F (informative): Bibliography

ISO/IEC/TR 9577:

"Information technology; Telecommunications and information exchange between systems; Protocol identification in the Network Layer".

ETR 018:

"Integrated Services Digital Network (ISDN); Application of the BC-, HLC- and LLC-information elements by terminals supporting ISDN services".

ETR 026:

"Terminal Selection principles for priority 1 and 2 services of MOU - ISDN applicable in multiterminal environments at customer premises".

CCITT Recommendation X.612:

"Provision of the OSI connection-mode network service by packet mode terminal equipment connected to an Integrated Services Digital Network (ISDN) for CCITT applications".

CCITT Recommendation X.213 (1988):

"Network service definition for open systems interwoven for CCITT applications".

CCITT Recommendation X.214 (1988):

"Transport service definition for open systems interconnection for CCITT applications".

ISO 8072 (1986):

"Information processing systems - Open Systems Interconnection - Transport service definition".

ISO 8348 (1987):

"Information processing systems - Data communications - Network service definition".

ENV 41112 (1991):

"Information systems interconnection - ISDN - Provision of the OSI connection-mode transport service over the OSI connection-mode network service by using an ISDN circuit-mode 64 kbit/s unrestricted bearer service - Demand case".

History

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