INTERNATIONAL TELECOMMUNICATION UNION

CCITT

T.90

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

TERMINAL EQUIPMENT AND PROTOCOLS FOR TELEMATIC SERVICES

CHARACTERISTICS AND PROTOCOLS FOR TERMINALS FOR TELEMATIC SERVICES IN ISDN

Recommendation T.90

Geneva, 1992

FOREWORD

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

The Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation T.90 was prepared by Study Group VIII and was approved under the Resolution No. 2 procedure on the 25th of February 1992.

CCITT NOTES

1) In this Recommendation, the expression “Administration” is used for conciseness to indicate both a telecommunication Administration and a recognized private operating agency.

2) A list of abbreviations used in this Recommendation can be found in Appendix VII.

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Recommendation T.90

CHARACTERISTICS AND PROTOCOLS FOR TERMINALS FOR TELEMATIC SERVICES IN ISDN

(revised 1991)

Summary

This Recommendation defines the functional profile for base standards ISO/IEC 7776, 8208 and 8885 to provide the lower layers of the telematic services protocol stack when operating on the ISDN.

Parameter values are recommended to ensure good throughput when operating via long delay connections such as satellite routes. Backward compatibility with the *Blue Book* version has been maintained.

Three methods of negotiating the lower layer parameter values have been included to satisfy various connection scenarios, e.g. completely within the ISDN or between the ISDN and other digital networks.

This Recommendation supplies the network layer definition in Recommendation T.70 for telematic terminals but not the transport layer definition which is still retained as the telematic transport layer definition.

CONTENTS

1 Scope

1.1 *General*

The Integrated services digital network (ISDN) supports a wide range of voice and non-voice services and applications in the same network via a multipurpose usernetwork interface.

This Recommendation describes the requirements for telematic terminals, developed for ISDN application, and connected to an ISDN via an I-Series interface.

For example, teletex (defined in Recommendation T.60), group 4 facsimile (defined in Recommendation T.563) and videotex [defined in draft Recommendations T.102 and T.103 (see Note)].

Note – Draft Recommendations T.102 and T.103 are currently under study and not yet available.

Telematic terminals supporting both teletex and group 4 facsimile in mixed mode of operation (defined in Recommendation T.561) are also covered by this Recommendation.

Terminal requirements to support other telematic services are for further study.

Terminals developed for the provision of telematic services in circuit switched public data networks (CSPDNs), packet switched public data networks (PSPDNs) and public switched telephone networks (PSTNs), using terminal adaptors to access the ISDN are not covered by this Recommendation (see Note 1).

Interworking with existing telematic terminals connected to CSPDNs, PSPDNs and PSTNs, thereby maintaining the telematic service integrity, should be possible, but is outside the scope of this Recommendation (see Note 2).

This Recommendation includes several negotiation mechanisms for selection of optional parameters.

Note 1 – For implementation guideline, consideration of incoming calls and information elements for facsimile terminals are described in Appendix I.

Note 2 – For rate adaptation function, see Appendix V.

1.2 *Use of bearer capabilities*

This Recommendation is based on the use of bearer capabilities defined for the ISDN, using B-channels for the information transfer and virtual circuit connection control and the D-channel for the connection control.

The use of both circuit-switched and packet-switched information transfer modes is defined.

The use of the frame mode information transfer as defined in Recommendation I.122, is for further study.

1.3 *Protocol architecture*

This Recommendation provides the application rules for other CCITT Recommendations and ISO standards aiming at end-to-end (DTE-DTE) communication through the network as well as DTE-DCE interconnection and support of OSI-network service.

The use of existing protocols for ISDN telematic terminals different from those described in §§ 2 and 3 is optional. In the case of § 2, the use of T.70 CSPDN minimum header is an additional option.

2 ISDN B-channel circuit-switched mode (DTE-DTE communication)

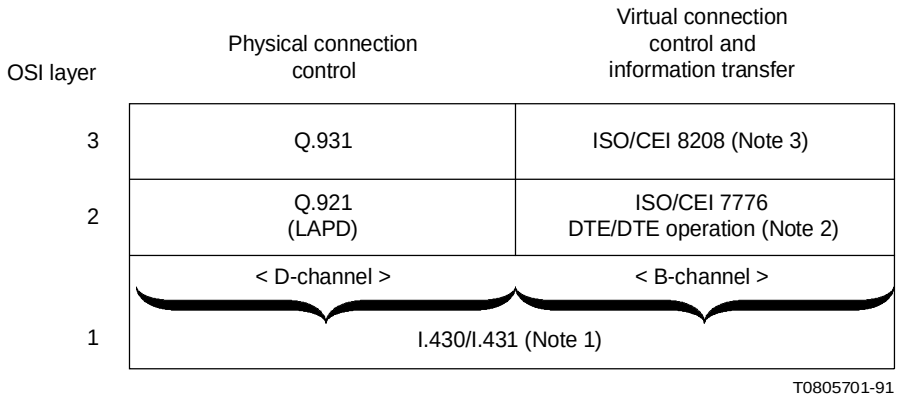
For this mode the circuit-switched 64 kbit/s unrestricted information transfer capability shall be used.

For additional information regarding connection control phase, see § A.1 a).

For additional information regarding the information transfer phase, see § A.1 b).

2.1 *Protocol set*

The protocol set applicable to the ISDN B-channel circuit-switched mode (CS mode) is shown in Figure 1/T.90.



Note 1 – See § 2.2.1.

Note 2 – Full-duplex single link procedures are defined as described in § 2.2.3. For service definitions and state transition diagrams for the data link layer wihtin the B-channel, see Appendix III.

Note 3 – DTE-DTE connection is specified on the basis of ISO/IEC 8208 (March 1990) as described in § 2.2.5. In case of the completion of LLC negotiation, the T.70 NL protocol (CSPDN minimum header, Recommendation T.70, § 3.3) may optionally be supported in addition to the ISO/CEI 8208 and used on a per-call-basis. In case of the failure or the absence of LLC negotiation, ISO/CEI 8208 protocol shall be used. For further information see Appendix II.

FIGURE 1/T.90

2.2 *Application rules*

2.2.1 *Layer 1 – Physical layer interface characteristics*

The physical interface characteristics shall be in accordance with the I-Series Recommendations: I.430 (Basic user-network interface, layer 1 specifications), I.431 (Primary rate user-network interface, layer 1 specifications). This layer provides full duplex transmission capability.

2.2.2 *Layer 2 – D-channel connection control phase*

Recommendation Q.921 shall apply.

2.2.3 *Layer 2 – B-channel link layer procedure*

The link layer procedure shall consist of a fully symmetrical HDLC procedure as defined in ISO/IEC 7776 for DTE-DTE operation compatible with Recommendation X.75 modified by the application rules defined in § 2.2.3.2.2.

2.2.3.1 *Address procedure*

The following describes the application of the link addressing procedures of Recommendation X.75. Link addresses (A and B) shall be assigned dynamically on a per-call-basis according to the following rules:

a) the calling terminal shall take address A;

b) the called terminal shall take address B;

c) commands and responses shall be transferred as shown in Figure 2/T.90;

d) A and B addresses are coded as follows (Note):

Address	bit							
	1	2	3	4	5	6	7	8
A	1	1	0	0	0	0	0	0
B	1	0	0	0	0	0	0	0

Note – The terminal will discard all frames received with an address other than A and B.

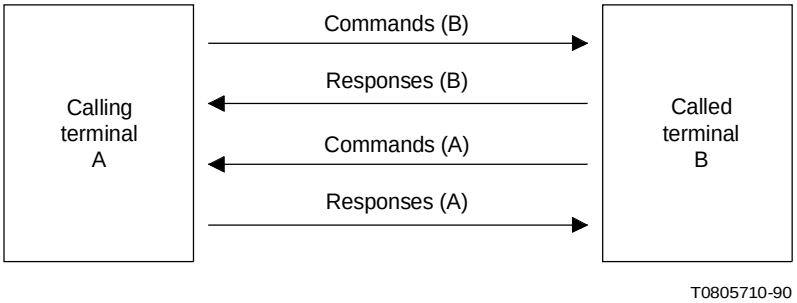


FIGURE 2/T.90

2.2.3.2 *Implementation rules*

In order to achieve full compatibility between different implementations, the rules in this section for the implementation of Recommendation X.75 shall be followed.

2.2.3.2.1 *General rules*

a) The 1988 version *(Blue Book)* of CCITT Recommendation X.75, § 2 shall be used as the reference specification.

b) The term “STE” shall be read as “DTE”.

c) At present the non-extended mode of operation (i.e. modulo 8) and the extended mode of operation (i.e. modulo 128) are defined. For the purpose of this Recommendation, support for modulo 8 is mandatory and modulo 128 is optional. The terminal supporting the extended mode shall also support the non-extended mode. It is strongly recommended that the extended mode of operation (i.e. modulo 128) be supported.

   The evolution towards LAPD (modulo 128 only) in layer 2 of the B-channel is expected to lead to the use of modulo 128 as the common base modulo in the long term.

d) To facilitate interworking between terminal equipments using modulo 8 and modulo 128, negotiation mechanisms specified in this Recommendation shall be used. Layer 2 parameters such as modulo and *k* parameter may be negotiated out-of-band using the LLC-IE.

   In case of failure or absence of out-of-band negotiation, XID and/or SABM/SABME procedures may optionally be used. The XID and SABM/SABME procedures are specified in Annexes C and D respectively. Annex E provides SDL description for negotiation mechanisms between the XID and SABM/SABME procedures.

e) Only the single link procedure (SLP) shall be used.

2.2.3.2.2 *Specific application rules*

The following rules refer to the indicated sections and tables of Recommendation X.75. For the application of the non-extended and extended mode see § 2.2.3.2.1 c) and d).

a)	Table 1/X.75 (non-extended mode) Table 2/X.75 (extended mode)	I-frames should not be sent with an empty I field. Non-extended mode $N \geq 0$ and $N \leq N1\text{-}32$. Extended mode $N \geq 0$ and $N \leq N1\text{-}40$. Received empty I-frames shall be treated as valid I-frames.
b)	§ 2.3.4.9	Items 5), 6) and 7) are not valid (shall not result in the sending of an FRMR). Instead the following actions shall be implemented: – 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) shall be responded to by sending REJ (see § 2.3.5.2.1 of Recommendation X.75). Frames with a FRMR control field shall not be responded by sending a FRMR.
c)	Table 7/X.25 (non-extended mode) Table 8/X.75 (extended mode)	Bits W, X, Y and Z set to 0 indicate that no reason for frame rejection is given.
d)	§ 2.3.5.3	The DTE and the ISDN are not octet aligned and the last paragraph is therefore valid.
e)	§ 2.3.5.5	Higher layers should be notified when timer T3 expires (excessive idle state).
f)	§ 2.4.3	Related to the first paragraph, read instead of "next response" "corresponding response".
g)	§ 2.4.4.1	In the active channel state, the DTE shall transmit contiguous flags independent of the other DTE. The calling DTE shall initiate the link by sending a SABM (non-extended mode) or a SABME (extended mode) command with the P-bit set to 1.
h)	§ 2.4.4.4.1	A condition for entering the disconnected phase is also that no unacknowledged DISC command exists, because of collision cases (refer to Recommendation X.75, § 2.4.4.5). In the disconnected phase, it is the calling DTE which shall initiate link set-up.
i)	§ 2.4.5.9 4th paragraph	If a RNR is received, the DTE shall remain in the time recovery condition (because the other DTE is still in the busy condition).
j)	§ 2.4.5.9 5th paragraph	If a RNR is received, the DTE shall not resume I-frame transmission or retransmission.
k)	§ 2.4.5.9 last paragraph	If the transmission attempt variable is equal to N2, the DTE shall enter the disconnected phase.
l)	§ 2.4.7.3	In the frame rejection condition, the DTE shall only check the commands and react with a FRMR according to the P-bit. The frame rejection is cleared when the DTE receives a SABM (non-extended mode) or a SABME (extended mode), or, receives or transmits a DISC command.
m)	§ 2.4.7.3 2nd paragraph	Only the DTE which caused the FRMR condition may try to reset the link.
n)	§ 2.4.7.3 3rd paragraph (see Note 1)	After N2 attempts to get the other DTE to reset the link, the DTE shall enter the disconnected phase.
o)	§ 2.4.8.1 (see Note 2)	The timer T1 shall be started at the end of frame transmission. The value of T1 depends on the data signalling rate, the frame length, the value of N2, and a fixed time representing both T2 and the transmission delay [see item r)]. A value is recommended between 2.5 and 7 seconds. Consideration of a specific value requires further study.
p)	§ 2.4.8.2 (see Note 2)	$T1 > T2$, $T2 < 1$ second.
q)	§ 2.4.8.3 2nd paragraph	$T3 \leq 60$ seconds, $T3 \geq 30$ seconds.
r)	§ 2.4.8.4	$N2 \geq 60 \text{ seconds} \div T1$.

s)	§ 2.4.8.5	In case of layer 3, modulo = 8,
		non-extended mode N1 = 16 440 bits;
		extended mode N1 = 16 448 bits.
		In case of layer 3, modulo = 128,
		non-extended mode N1 = 16 448 bits;
		extended mode N1 = 16 456 bits.

t)	§ 2.4.8.6 (see Note 2)	Non-extended mode $k \leq 7$ (default value $k = 7$) Extended mode $k \leq 127$ (default value $k = 80$).

Note 1 – It is not meaningful to reset the link if the other DTE has not responded for $N2 \times T1$.

Note 2 – The acknowledgement strategy used by the receiving DTE should be independent of any knowledge about the value of k used by the sending DTE. This can be achieved by acknowledging every correctly received I-frame as soon as possible.

2.2.4 *Layer 3 – D-channel connection control phase*

Recommendation Q.931 shall apply. All encodings should be derived from the relevant section in Recommendation Q.931.

Three information elements (IEs) are of particular interest to terminals accessing telematic services. See Annexes B and L of Recommendation Q.931 for further information.

– Bearer capability (BC) information element. The BC IE is used to carry information of interest to the bearer service providing network. The BC IE is required to be generated by the calling side, and shall be examined by the called side.

– Low layer compatibility (LLC) information element. The LLC IE is used to carry information about protocols at and below the network layer of interest only to the two endsystems and interworking functions (IWFs). The LLC IE shall be generated by the calling side, and shall be examined, if present, by the called side. LLC IEs may be used for negotiation of layer 2 and layer 3 parameters.

– High layer compatibility (HLC) information element. The HLC IE is used to carry information between the endsystems related to protocols above the network layer. The HLC IE shall be generated by the calling side, and shall be examined, if present, by the called side.

Fields in bearer capability (BC), low layer compatibility (LLC), and high layer compatibility (HLC) information elements (IE) to be conveyed at the S/T reference point of the user-network interface during the call establishment phase, shall be set to the following values.

Note – For the coding of BC IE in case of rate adaptation function, see Appendix V.

2.2.4.1 *Bearer capability (BC)*

a) Mandatory fields, to be set to the fixed values (the value to be set is given in parentheses following each field description, see Recommendation Q.931):

   – coding standard – octet 3 (CCITT standardized coding);

   – information transfer capability – octet 3 (unrestricted digital information, see Note);

   – transfer mode – octet 4 (Circuit mode);

   – information transfer rate – octet 4 (64 kbit/s).

b) Fields not required in the default case but may be explicitly encoded:

   – structure – octet 4a;

   – configuration – octet 4a;

   – establishment – octet 4a;

   – symmetry – octet 4b.

c) Fields to be omitted:

   – all other fields.

Note – The selection whether to use unrestricted or restricted information transfer capability is out of the scope of this Recommendation.

2.2.4.2 *Low layer compatibility (LLC)*

The LLC IE shall be encoded as follows:

a) Fields to be set to fixed values (the value to be set is given in parentheses following each field description, see Recommendation Q.931):

- coding standard – octet 3 (CCITT standardized coding);
- information transfer capability – octet 3 (unrestricted digital information);
- LLC negotiation indicator – octet 3a, bit 7 (see Note 1);
- transfer mode – octet 4 (circuit mode);
- information transfer rate – octet 4 (64 kbit/s);
- user information layer 2 protocol – octet 6 (ISO/IEC 7776 DTE-DTE operation compatible with Recommendation X.75 modified by the application rules defined in § 2.2.3.2.2);
- user information layer 3 protocol – octet 7 (ISO/IEC 8208).

b) Fields with variable content:

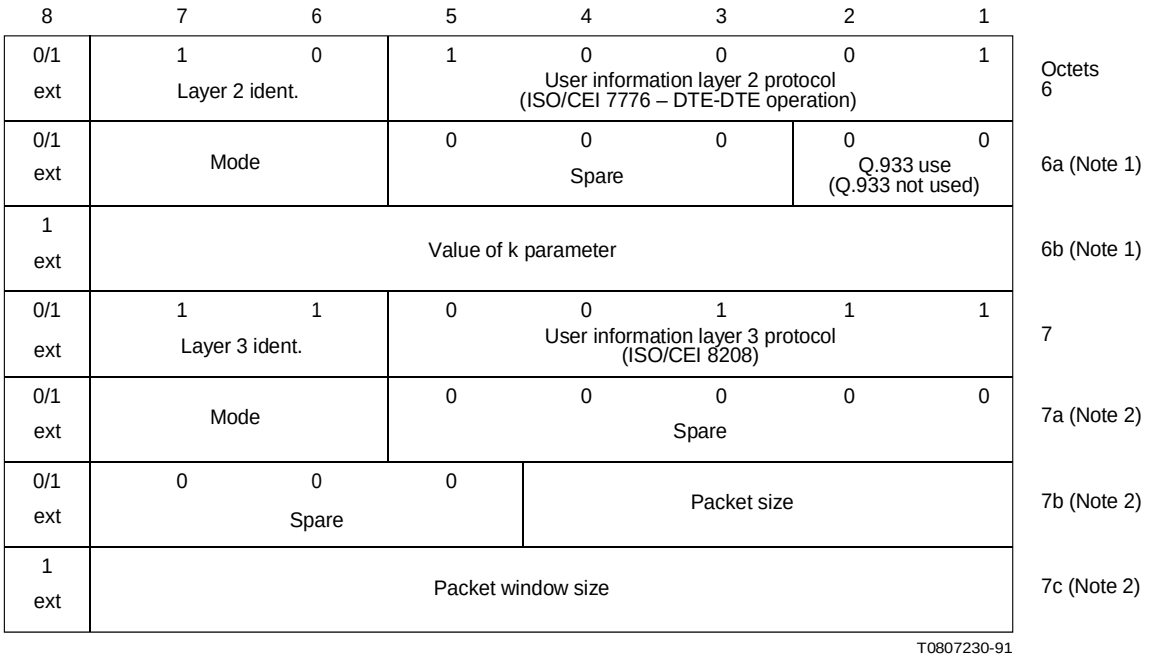
- the LLC IE may be transferred transparently by an ISDN between the called user and the calling user and may be used for parameter negotiation as described in Annex M to Recommen-dation Q.931;
- the calling user may use the optional extension octets 6a, 6b, 7a, 7b and 7c of the LLC IE as encoded in Figure 3/T.90 and Table 1/T.90 to indicate a set of preferred layer 2 and layer 3 parameters. The absence of an extension octet shall indicate the use of the default values of all parameters encoded by that octet. Multiple alternative sets of parameters may be specified by the concatenation of multiple LLC IEs in order of preference (see Note 2);
- Table 1/T.90 defines the codepoints for currently defined protocols and parameter values used by this Recommendation. Additional codepoints will be defined as and when alternate layer 2 and layer 3 protocols are defined. Suggested parameter values are given in Appendix VI.

c) Fields to be omitted:

- all other fields.

Note 1 – When octet 3a is omitted, out-of-band negotiation is not possible.

Note 2 – Some networks may not transport multiple LLC IEs. It is recognized that this may limit the ability to negotiate multiple sets of parameters until networks support the transport of multiple LLC IEs.



Note 1 – If octet 6b is present then octet 6a shall also be present.

Note 2 – If octet 7b is present then octet 7a shall also be present. If octet 7c is present then octets 7a and 7b shall also be present. For values not fixed in this Figure, see Table 1/T.90.

FIGURE 3/T.90

Encoding of low layer compatibility information element

TABLE 1/T.90

Encoding of low layer compatibility information element

Mode of operation (octet 6a)

Bits 7 6	
0 1	Normal mode
1 0	Extended mode

All other values are reserved.

Q.933 use (octet 6a)

Bits 2 1	
0 0	For use when the coding defined in Recommendation Q.933 is not used

Value of k parameter (octet 6b)

Bits	
7-1	Binary encoded (1 to 127)

Mode of operation (octet 7a)

Bits 7 6	
0 1	Normal packet sequence numbering
1 0	Extended packet sequence numbering

All other values are reserved.

Packet size (octet 7b)

Bits 4 3 2 1	
0 1 1 1	128 octets
1 0 0 0	256 octets
1 0 0 1	512 octets
1 0 1 0	1024 octets
1 0 1 1	2048 octets

Packet window size (octet 7c)

Bits	
7-1	Binary encoded (1 to 127)

2.2.4.3 *High layer compatibility (HLC)*

The HLC IE shall be encoded as follows:

a) Fields to be set to fixed values (the value to be set is given in parentheses following each field description, see Recommendation Q.931):

   – coding standard – octet 3 (CCITT standardized coding);

   – interpretation – octet 3 (first high layer characteristics identification to be used in the call);

   – presentation method of protocol profile – octet 3 (high layer protocol profile).

b) Fields with variable content:

   – high layer characteristics identification – octet 4 (e.g. facsimile group 4, teletex, videotex).

To maximize the usefulness of HLC checking:

1) the calling telematic terminal shall select the HLC element according to the type of document to be transferred;

2) the called terminal holds a list of HLC elements describing its receiving capabilities. It will accept an HLC element corresponding to any one of these.

An example of such a scheme is illustrated in Table 2/T.90.

TABLE 2/T.90

Use of HLC codes by teletex and group 4 facsimile terminals

Telematic service terminals	HLC codes	
	Sent from calling terminals (Notes 2 and 3)	Accepted by receiving terminals (Note 4)
Basic teletex	Basic teletex	Basic teletex
Teletex mixed mode	Basic teletex Mixed mode (Note 1)	Basic teletex Mixed mode
Group 4 facsimile class 1	Group 4 facsimile	Group 4 facsimile
Group 4 facsimile class 2	Group 4 facsimile	Group 4 facsimile Mixed mode Basic teletex
Group 4 facsimile class 3	Group 4 facsimile Mixed mode Basic teletex (Note 1)	Group 4 facsimile Mixed mode Basic teletex

Note 1 – In case that the calling terminal is teletex mixed mode or group 4 facsimile class 3, only one element is to be sent depending on originating document type.

Note 2 – For multi-service telematic terminals sending more than one document in the same call, the HLC indicates functionality required for that call.

Note 3 – When the calling terminal only wishes to receive a document from a called terminal (polling), HLC IE indicates the preferred functionality of the calling terminals.

Note 4 – Appendix I provides additional information in order to cater for cases where calls for facsimile equipment are incoming from networks not able to convey HLC information.

2.2.5 *Layer 3 – B-channel virtual connection control and information transfer phase*

ISO/IEC 8208 (1990) shall apply.

In particular, the following sections of ISO/IEC 8208 are referred:

– § 3.3: Differences in DTE/DTE and DTE/DCE operation;

– § 3.4: Operating over circuit-switched connections;

– § 4.5: Determining "DTE"or "DCE"characteristics.

In addition, the following points shall be noted when using this protocol:

a) calling DTE shall send a RESTART REQUEST packet, begin the restart procedure, and establish virtual circuits. See § 3.4 of ISO/IEC 8208;

b) the qualifier bit in data packets shall always be set to "0" for teletex and group 4 facsimile and may be set to "0" or "1" for videotex;

c) the delivery confirmation bits in all packets should be set to "0";

d) normal X.25 reset procedures shall apply;

e) each control block or data block of the transport layer shall be carried in a complete data packet sequence;

f) the terminal should not send a DTE REJECT packet;

g) in case of group 4 facsimile and teletex, terminals shall use a specific protocol identifier within CALL REQUEST/INCOMING CALL packets. This identifier is represented by the first octet of the call user data field (the use of remaining octets is for further study) as shown below:

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

The protocol identifier for Videotex shall be as shown below, indicating the use of Recommendation X.29:

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

Other values are for further study;

h) out-of-band negotiation of layer 3 modulo may be performed through the use of the LLC information element;

i) it is recommended that the value chosen for modulo for layer 3 shall be the same as the modulo for layer 2.

2.2.5.1 *Layer 3 – Packet size and packet window size of out-of-band negotiation and in-band negotiation*

Out-of-band negotiation of layer 3 packet size may be performed through the use of the LLC information element. The rules for in-band packet size negotiation are given in § 15.2.2.1.1 of ISO/IEC 8208. The values for this Recommendation are restricted to 128, 256, 512, 1024 and 2048 octets.

Out-of-band negotiation of layer 3 packet window size may be performed through the use of the LLC information element. The rules for in-band packet window size negotiation are given in § 15.2.2.1.2 of ISO/IEC 8208.

The implementation of the flow control parameter negotiation for the packet size and the packet window size is mandatory. In the case when out-of-band negotiation is successful, the use of flow control parameter negotiation facility is optional. In the case of a failure of out-of-band negotiation, the calling terminal shall request the flow control parameter negotiation facility in order to use the recommended combination of parameter values for optimum communications efficiency and/or to maintain compatibility with the terminal based on the 1988 version of this Recommendation.

In case of conflict between negotiated values out-of-band and in-band, the values negotiated later shall prevail.

Default values for normal packet sequence numbering shall be packet size = 128 and packet window size = 2 (see Note). Default values for extended packet sequence numbering shall be packet size = 128 and packet window size = 80.

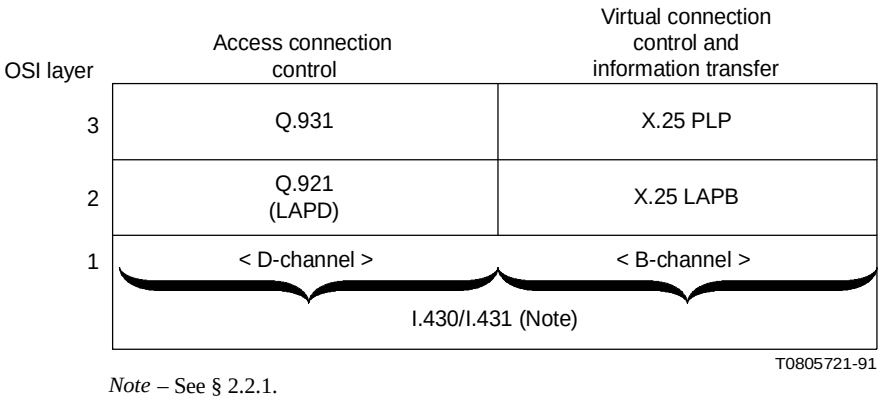
Note – To optimize the efficiency of specific Telematic applications (in particular group 4 facsimile) the negotiation mechanism for packet window size and packet size should lead to other values than packet window size = 2 and packet size = 128. The recommended combinations of parameter values are given in Appendix VI. The segmentation and reassembly are not required.

3 ISDN B-channel packet-switched mode (DTE-DCE communication) (see Note)

Note – For ISDN D-channel packet-switched mode (DTE-DCE communication), see Annex B.

3.1 *Protocol set*

The protocol set applicable to the packet-switched mode (PS mode) is shown in Figure 4/T.90:



Note – See § 2.2.1.

FIGURE 4/T.90

3.2 *Application rules*

3.2.1 *Layer 1 – Physical layer interface characteristics*

See § 2.2.1.

3.2.2 *Layer 2 – Link layer procedure*

Recommendation X.31 (case B) shall apply, so that the applied protocols are as follows:

– connection control is to be achieved using Recommendation Q.921 in the D-channel;

– virtual connection control and information transfer is to be achieved using Recommendation X.25 LAPB in the B-channel.

3.2.3 *Layer 3 – Network layer procedure*

Recommendation X.31 (case B) shall apply, so that protocols to be applied and application rules are as follows:

3.2.3.1 *Connection control phase*

Recommendation Q.931 and the packet layer protocol of Recommendation X.25 shall apply.

Fields in the bearer capability (BC) information element (IE) to be conveyed at the S/T reference point of the user-network interface during the call establishment phase, shall be set to the values defined below.

Recommendation Q.931 shall apply. All encodings should be derived from the relevant section in Recommendation Q.931.

– Bearer capability (BC) information element – the BC IE is used to carry information of interest to the bearer service providing network. The BC IE is required to be generated by the calling side, and shall be examined by the called side.

3.2.3.1.1 *Bearer capability (BC)*

a) Mandatory fields, to be set to the fixed values (the value to be set is given in parentheses following each filed description, see Recommendation Q.931):

   – coding standard – octet 3 (CCITT standardized coding);

   – information transfer capability – octet 3 (unrestricted digital information, see Note);

   – transfer mode – octet 4 (packet mode);

   – user information layer 2 protocol – octet 6 (CCITT Recommendation X.25, link layer);

   – user information layer 3 protocol – octet 7 (CCITT Recommendation X.25, packet layer).

b) Fields not required in the default case but may be explicitly encoded:

   – structure – octet 4a;

   – configuration – octet 4a;

   – establishment – octet 4a;

   – symmetry – octet 4b.

c) Fields to be omitted:

   – all other fields.

Note – The selection whether to use unrestricted or restricted information transfer capability is out of the scope of this Recommendation.

The low layer compatibility information element (LLC) is not used in PS mode. The use of the LLC in future evolutions of the ISDN packet mode service is for further study.

The high layer compatibility information element (HLC) is not used in PS mode. The use of the HLC in future evolutions of the ISDN packet mode service is for further study.

3.2.3.2 *Virtual connection control and information transfer phase*

Recommendation X.25 packet layer protocol applies. Item b) and items d) through g) of the application rules specified in § 2.2.5, apply.

4 Support of the OSI-network service

4.1 *Rationale for considering the OSI-NS*

The evolution and realization of the bearer services and teleservices in the ISDN environment and the recognized protocol base within the CCITT directs – as far as the network layer of the communication architecture is concerned – to the use of the OSI-NS. In order to lay the grounds for the integrity of the services under these conditions, the application rules for the network layer protocol (see Notes 1 and 2) need to be defined.

Note 1 – In the ISDN circuit-switched mode, support of the OSI-NS is provided entirely by the B-channel X.25 packet layer protocol, and is available once the ISDN call has been connected. The provision of the OSI-NS by other means is for further study.

Note 2 – In the case of videotex, the provision of the full OSI-NS is for further study.

4.2 *CCITT Recommendations and ISO standards*

The following CCITT Recommendations and ISO standards are used to provide the OSI-NS:

– CCITT Recommendation X.213;

– ISO/IEC 8208;

– ISO/IEC 8878 and ISO/IEC 9574

The use of the D-channel (see Recommendation Q.931) or the relevant protocols defined for future packet oriented information transfer modes (see Recommendation I.122) for the provision of the OSI-NS, is for further study.

4.3 *Requirements for the OSI-NS*

To balance the expenditure for the development of telematic terminals under the consideration of the OSI-NS, the requirements are limited to the necessary minimum.

This can be achieved by terminating, in the case of an incoming call for both the circuit switched (CS) and packet switched (PS) cases, the layer 3 protocol to provide the obligatory functions of the OSINS only. In the case of an outgoing call, calling terminals can initiate an OSI communication, as long as all the relevant facilities are supported.

4.3.1 *Minimum requirements for the OSI-NS*

Table 3/T.90 shows the list of the X.25 PLP optional user facilities which are proposed as a necessary minimum to support the OSI-NS.

TABLE 3/T.90

X.25 PLP optional user facilities

Optional user facility (Note 4)		Used for support of an incoming call (Note 1)	Used for support of an outgoing call
13.13 (Note 2)	Throughput class negotiation	Yes	Optional (Note 3)
13.16 (Note 2)	Fast select	Yes	Optional (Note 3)
13.27 (Note 2)	Transit delay selection and indication (TDSAI)	Yes	Optional (Note 3)
14.1 (Note 2)	Calling address extension	Yes	Optional (Note 3)
14.2 (Note 2)	Called address extension	Yes	Optional (Note 3)
14.3 (Note 2)	Minimum throughput class negotiation	Yes	Optional (Note 3)
14.4 (Note 2)	End-to-end transit delay negotiation (EETDN)	Yes	Optional (Note 3)
14.7 (Note 2)	Expedited data negotiation	Yes	Optional (Note 3)

Note 1 – To fulfill at least the minimum functionality of the OSI-NS (clarification found, if necessary in § 4.3.2).

Note 2 – Refers to the relevant section in ISO/IEC 8208.

Note 3 – May optionally be invoked for a telematic communication. These shall be supported if initiating a communication with an OSI terminal.

Note 4 – As the D-bit is always set to "0" in the circuit-mode case, the receipt confirmation selection requirement is satisfied for this case.

4.3.2 *Minimum functionality when receiving a call from a system using the OSI-NS*

The following text represents a possible way to achieve the minimum functionality when receiving a call from a system using the OSI-NS (refer to both ISO/IEC 8878 and ISO/IEC 8208):

1) *Throughput class negotiation:* when replying to INCOMING CALL/CALL REQUEST, a throughput class facility request need not be made in the CALL ACCEPTED packet. If a throughput class facility request was not made in the CALL ACCEPTED packet, then this would mean that the throughput classes applying to the call would be those that have been indicated in the INCOMING CALL/CALL REQUEST packet.

2) *Fast select:* fast selection shall be supported for the full OSI-NS (full 128 octets of NS-user data available). The receipt of a CALL REQUEST packet which does not have the values "01" or "02" in the first octet of the call user data field would be considered an error [connection rejection – reason unspecified (permanent condition)]. Receipt of a CALL REQUEST packet which does have the value "02" indicates teletex and facsimile group 4 services operating according to Recommendation T.70 (layer 4 only). If the value "01" is received, this indicates videotex operating according to Recommendation X.29.

3) *Transit delay selection and indication (TDSAI):* this shall be accepted when received. However, if the reply to be coded in the "cumulative transit delay sub-field" of the EETDN facility is "unknown" (i.e. FF hexadecimal), then the value in the TDSAI field could be ignored.

4) *Calling and called address extension:* the use of OSI NSAP addressing is optional.

   The calling and the called terminal shall either insert an OSI NSAP address or set the address extension field length to zero.

   An incoming call shall not be cleared due to a missing OSI NSAP address. If an OSI NSAP address is received, the terminal shall check it and proceed as specified in ISO/IEC 8878 and ISO/IEC 9574.

5) *Minimum throughput class negotiation:* if a terminal reacts to the appearance of a throughput class facility request in the INCOMING CALL packet by not sending a throughput class facility request in the CALL ACCEPTED packet, then the minimum throughput class negotiation facility could be ignored.

6) *End-to-end transit delay negotiation (EETDN):* when replying, this could contain the value "unknown" (i.e. FF hexadecimal).

7) *Expedited data negotiation:* this is used to negotiate the nonuse of expedited data (shall be used in the CALL ACCEPTED packet).

5 Additional X.25 optional user facilities

In addition to the facilities mentioned in § 4 that should be supported by telematic terminals in order to comply with the OSI-NS, additional facilities/functionalities shall be supported as a consequence of:

– the use of X.25 PLP for the provision of the OSI-NS (this protocol allows layer 3 multiplexing and flow control);

– the provision of various X.25 originated user facilities;

– the provision of various service oriented user facilities by some networks (i.e. additional facilities) or by all networks (i.e. essential facilities) as defined by Recommendation X.2.

There is no need for the provision of the additional service oriented user facilities in the circuit-switched case. The X.25 originated user facilities may be used in the circuit-switched case.

5.1 *Categories of additional functions* (see Note)

– X.25 originated user facilities

  13.1 On-line facility registration

  13.12 Flow control parameter negotiation

– Service oriented user facilities (network based)

  13.14 Closed User Groups (CUG) selection

  13.14 CUG with outgoing access selection

  13.18 Reverse charging

  13.21 Network user identification

  13.22 Charging information

  13.23 Recognized private operating agency (RPOA) selection

  13.25 Call redirection notification

  13.26 Called line address modified notification

Note – D-bit modification is not supported.

5.2 *Functions*

5.2.1 *X.25 originated user facilities*

1) *On-line facility registration*

The use of this facility shall be restricted to the modification of the range of logical channels. For the default values, Telematic terminals support a single two-way logical channel (i.e. LTC=HTC=1, LIC=HIC=0, LOC=HOC=0).

2) *Flow control parameter negotiation*

The support of this facility is mandatory. Packet size and packet window size parameters may be negotiated (see Note).

When the parameter negotiation is indicated in an INCOMING CALL packet, they shall respond properly in the CALL ACCEPTED packet.

Note – Transport protocol data units (TPDUs) should be contained in single packets/frames to avoid segmentation (e.g. if TPDU is equal to 2048 octets, then packets/frames must be greater than 2048 octets).

5.2.2 *Service oriented user facilities (network based)*

1) *Closed User Group selection* (essential in Recommendation X.2) *and CUG with outgoing access selection* (additional in Recommendation X.2) (13.14)

These facilities may optionally be requested from telematic terminals (i.e. outgoing call only). CUG information received in an INCOMING CALL packet may be ignored.

2) *Reverse charging* (13.18)

This facility may be supported by the same networks, and applies on a per-call-basis. The possibility of requesting reverse charging in outgoing calls is optional for telematic terminals, but they shall be able to properly handle and respond to the incoming call at the called side.

(As a default, calls should be rejected.)

3) *Network user identification* (13.21)

This facility may be applied by networks on a per-call-basis, following subscription made by prior arrangement for the agreed period of time.

4) *Charging information* (13.22)

This facility may be provided by some networks on a per-call-basis, following subscription made by prior arrangement for the agreed period of time. The information may be handled or processed normally.

As a minimum requirement, it may be ignored.

5) *RPOA selection* (13.23)

This facility may be provided by some networks on a per-call-basis, following subscription made by prior arrangement for the agreed period of time.

As a minimum requirement, it may be ignored.

6) *Call redirection notification* (13.25)

This facility may be provided by some networks on a per-call-basis, without any particular user request. This information may be processed normally.

As a minimum requirement, it may be ignored.

7) *Called line address modified notification* (13.26)

This facility may be provided by some networks on a per-call-basis, without any particular user request. This information may be processed normally.

As a minimum requirement, it may be ignored.

6 Interactions between the D-channel and B-channel

Communication between the D-channel and B-channel is not synchronized in relation to each other by the ISDN and therefore information exchange via these channels can be accomplished independently and simultaneously. As a consequence of this, messages sent in the D-channel and B-channel in a distinct relationship to each other may be received in a different order.

In order to achieve an orderly operation of the protocols in all telematic equipment, it is necessary to have an additional procedure to maintain the timing relationship.

This model, architecture, and primitives of this additional procedure is left for further study. One possible approach is described in Appendix IV.

7 Supplementary services

For application and description see Recommendations F.184, F.200, F.300, I.240-Series and I.250-Series (depending on the type of supplementary service).

If the ISDN provides date/time information in the CONNECT message to the ISDN telematic terminal, this information shall take precedence over any other local available corresponding information (at least for call identification line).

8 Terminal response time

For further study.

9 Synchronization

The ISDN guarantees that the B-channel will be open for data traffic as soon as the CONNECT message has been received at the terminals. However, due to propagation delay the two CONNECT messages may not arrive at each terminal at the same time.

Therefore the following procedure shall be used.

The calling side and called side follow the sequence (see Note 3):

1) the calling side and called side send “1”-bits until notified of B-channel establishment;

2) the called side sends CONNECT signal to the network when it activates the receiver circuit. The calling side activates the receiver circuit when CONNECT signal arrives from the network;

3) the calling side and called side send flags to the peer entity (see Note 1);

4) the calling side and called side start communication, i.e. the calling side sends SABM/SABME the called side (see Note 2) and the called side responds UA command to the calling side when SABM/SABME and arrives from the calling side.

Note 1 – If possible, the following sequence may be useful for reliable synchronization:

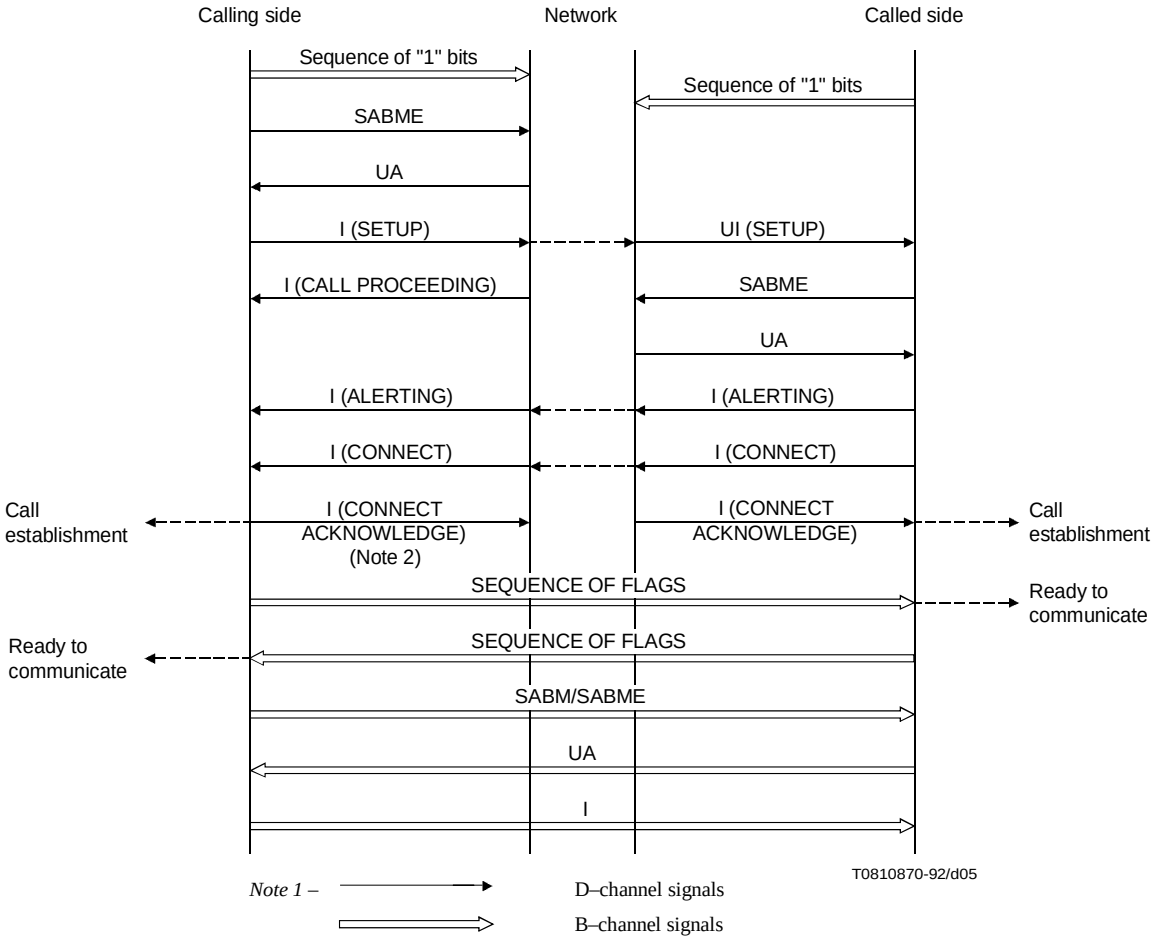
a) the calling side sends at least 64 concatenated flags aligned so that two adjacent “0”s occur between each string of “1”s until the first flag arrives from the called side and the called side sends at least 64 concatenated flags of the same type until SABM/SABME command arrives from the calling side;

b) the calling side and called side consider the peer entity as active when the first flag arrives from the peer entity.

Note 2 – Flag detection before sending SABM/SABME may make more reliable synchronization.

Note 3 – Terminal adaptor connected by the existing telematic terminal should support the above sequence.

The sequence diagram describing the operation of the calling side and called side is shown in Figure 5/T.90.



Note 2 – The provision of the CONNECT ACKNOWLEDGE signal is optional.

FIGURE 5/T.90

The sequence of synchronization on layer 2

10 Higher layer protocols

10.1 *Group 4 facsimile*

See Recommendations F.184 (see Note), T.563 and T.561 including mixed-mode of operation.

10.2 *Teletex*

See Recommendations F.200 (see Note), T.60 and T.561 including mixed-mode of operation.

Note – The rules given in § 5.3.2. of Recommendation T.70 regarding transport protocol data unit (TPDU) block length are adopted, in principle, but with the additional provision that the negotiation mechanism is mandatory (e.g. for more efficient communication via satellite links).

10.3 *Videotex*

The requirements for the videotex service are described in Recommendation F.300. The videotex coded information conforms to the data syntaxes defined in Recommendation T.101. The higher layer protocols to be used in the ISDN videotex are defined in draft Recommendation T.105 (based on Recommendation X.29). Additional communication requirements are defined in Recommendations T.102 and T.103. However, terminal characteristics and service/application functions of current systems are system provider dependent.

ANNEX A

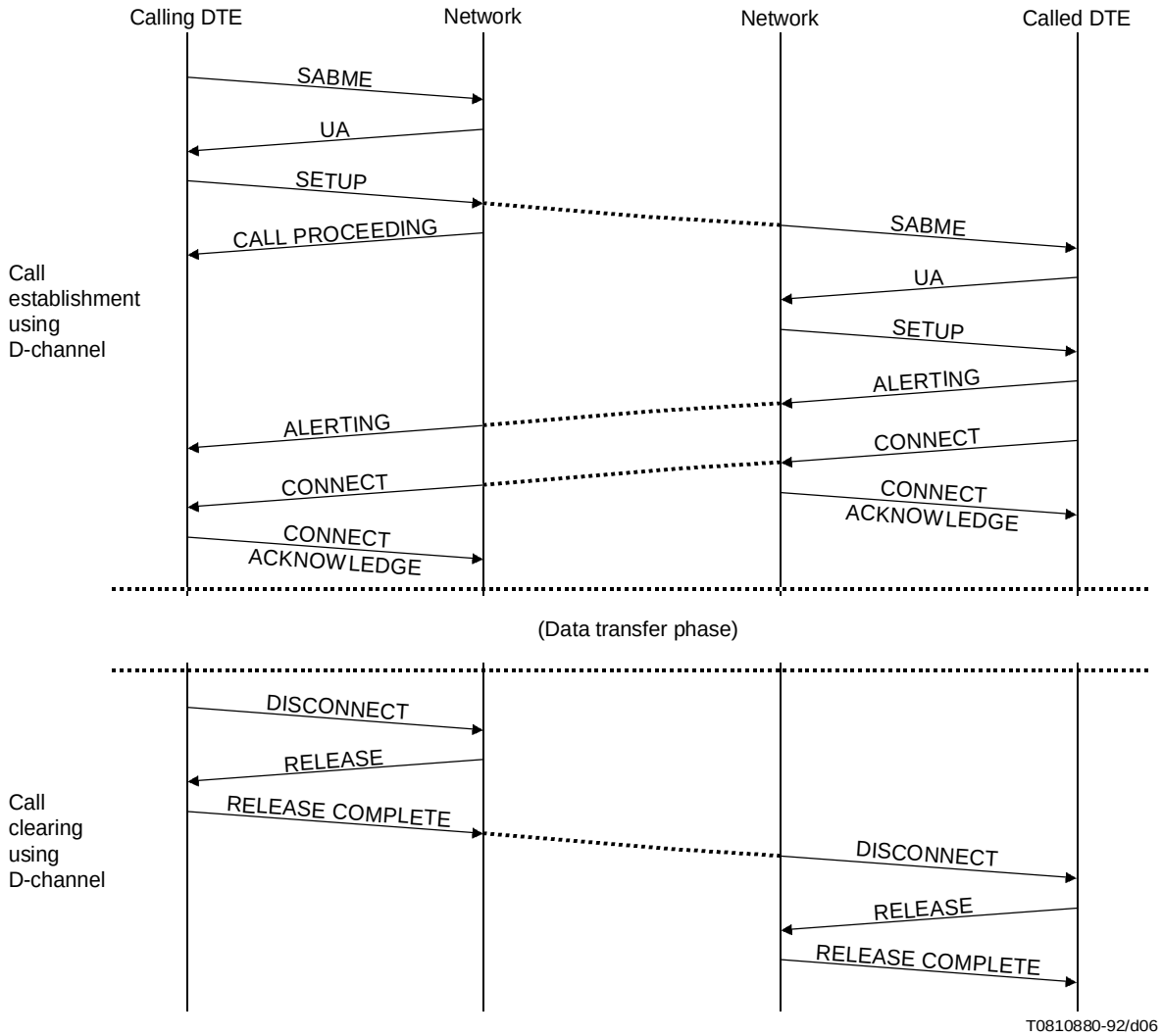
(to Recommendation T.90)

Procedures for connection establishment, connection release and information transfer

Procedures shown below are not the requirements to the terminals for telematic services, but for reference only.

A.1 *ISDN circuit-switched mode*

a) *D-channel connection control phase*

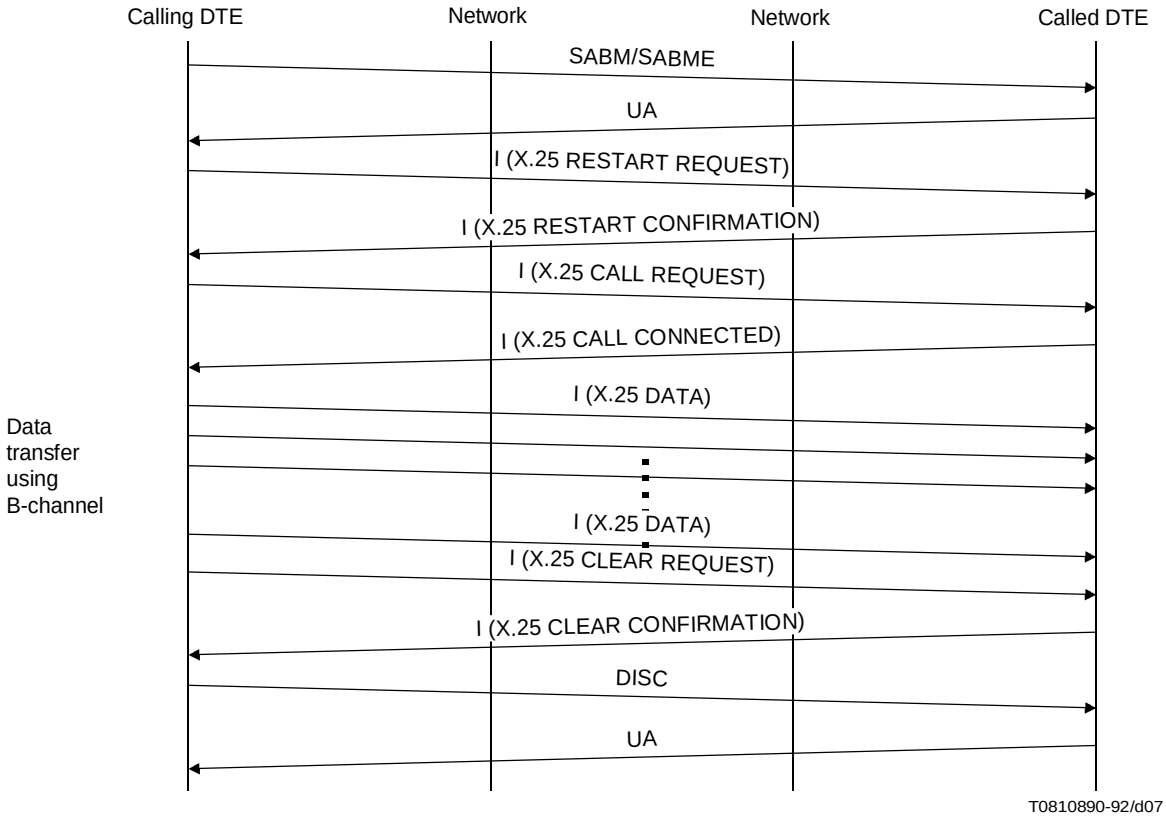


Note 1 – This example shows the procedure in the case where the configuration is point-to-point, and the layer 2 link has not been established. Some signals can be omitted in this situation.

Note 2 – SABME and UA are specified by Recommendation Q.921 (layer 2). All others are specified by Recommendation Q.931 (layer 3).

FIGURE A-1/T.90

b) *B-channel virtual connection control and information transfer phase*



Note – SABM/SABME, DISC and UA are specified by Recommendation X.75 (layer 2). All others are specified by Recommendation X.25 PLP (layer 3).

FIGURE A-2/T.90

A.2 *ISDN B-channel packet-switched mode*

See relevant signal procedures described in Recommendation X.31.

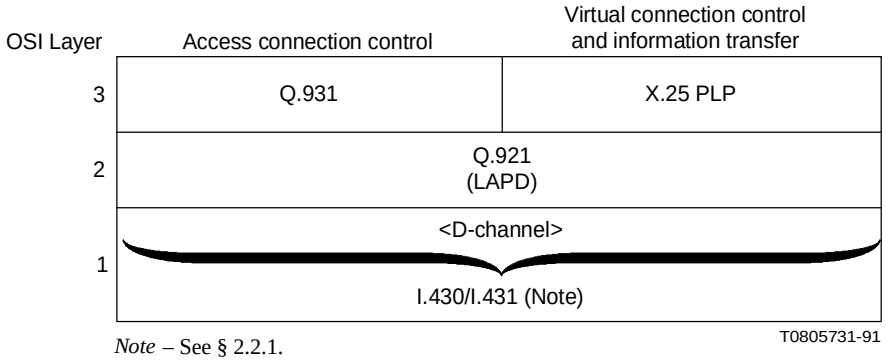
ANNEX B

(to Recommendation T.90)

ISDN D-channel packet-switched mode (DTE-DCE communication)

B.1 *Protocol set*

The protocol set applicable to the packet-switched mode (PS mode) is shown in Figure B-1/T.90:



Note – See § 2.2.1.

FIGURE B-1/ T.90

B.2 *Application rules*

B.2.1 *Layer 1 – Physical layer interface characteristics*

See § 2.2.1.

B.2.2 *Layer 2 – Link layer procedure*

Recommendation X.31 (case B) shall apply, so that the applied protocols are as follows:

– connection control is to be achieved using Recommendation Q.921 on SAPI 0;

– virtual connection control and information transfer is to be achieved using Recommendation Q.921 on SAPI 16.

B.2.3 *Layer 3 – Network layer procedure*

Recommendation X.31 (case B) shall apply, so that protocols to be applied and application rules are as follows:

B.2.3.1 *Connection control phase*

Recommendation Q.931 and the packet layer protocol (PLP) of Recommendation X.25 shall apply.

Fields in the bearer capability (BC) information element (IE) to be conveyed at the S/T reference point of the user-network interface during the call establishment phase, shall be set to the values defined below.

Recommendation Q.931 shall apply. All encodings should be derived from the relevant section in Recommendation Q.931.

– *Bearer capability (BC) information element* – The BC IE is used to carry information of interest to the bearer service providing network. The BC IE is not required to be generated by the calling side. However, when an incoming call is offered to packet mode user equipment at user interface, the channel selection procedures described in the following BC IE shall be used.

B.2.3.1.1 *Bearer capability (BC)*

a) When the channel indication information element indicates channel indication – No channel, exclusive, and D-channel indication – Yes, then mandatory fields should be encoded as follows (the value to be set is given in parentheses following each field description, see Recommendation Q.931):

   – coding standard – octet 3 (CCITT standardized coding);

   – information transfer capability – octet 3 (unrestricted digital information);

   – transfer mode – octet 4 (packet mode);

   – user information layer 2 protocol – octet 6 (CCITT Recommendation Q.921);

   – user information layer 3 protocol – octet 7 (CCITT Recommendation X.25, packet layer).

b) In all other cases, mandatory fields should be encoded as follows (the value to be set is given in parentheses following each field description, see Recommendation Q.931):

   – coding standard – octet 3 (CCITT standardized coding);

   – information transfer capability – octet 3 (unrestricted digital information);

   – transfer mode – octet 4 (packet mode);

   – user information layer 2 protocol – octet 6 (CCITT Recommendation X.25, link layer);

   – user information layer 3 protocol – octet 7 (CCITT Recommendation X.25, packet layer).

c) Fields not required in the default case but may be explicitly encoded:

   – structure – octet 4a;

   – configuration – octet 4a;

   – establishment – octet 4a;

   – symmetry – octet 4b.

d) Fields to be omitted:

   – all other fields.

The low layer compatibility (LLC) information element is not used in PS mode. The use of the LLC in future evolutions of the ISDN packet mode services is for further study.

The high layer compatibility (HLC) information element is not used in PS mode. The use of the HLC in future evolutions of the ISDN packet mode service is for further study.

B.2.3.2 *Virtual connection control and information transfer phase*

Recommendation X.25 packet layer protocol applies. Item b) and Items d) through g) of the application rules specified in § 2.2.5, apply.

ANNEX C

(to Recommendation T.90)

Procedures for B-channel negotiation of layer 2 parameters for telematic terminals

C.1 *Introduction*

This annex outlines XID procedures for negotiation of layer 2 parameters modulo and k parameter. This annex makes use of elements for the ISO-standardized high-level data link control procedures (HDLC), as realized in CCITT Recommendations Q.920/Q.921 (LAPD). One of these elements is the exchange identification (XID) frame used for exchanging data link information. The data link information to be exchanged is carried in the information field of the XID frame as explained in ISO 8885 (Note 1) and in this annex. Further discussion on XID is found in § C.2 and C.3.

The procedures outlined in this annex can be used for negotiation of layer 2 parameters (i.e. modulo and k parameter) when LLC procedures are not supported by an ISDN to which the calling and/or the called telematic terminals are connected. In addition, these procedures can be used when the calling and/or the called terminal does not support the LLC procedures. These procedures can also be used if the transit network (if any) does not support the LLC procedures.

Note 1 – ISO 8885 – Information processing systems – Data communication – High-level data link control procedures – General purpose XID frame information field content and format, 1987.

Note 2 – This Recommendation does not preclude the use of other elements discussed in ISO 8885.

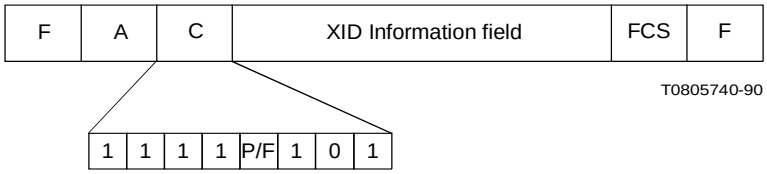
C.2 *General*

The XID frame can be used to exchange data link information between the calling and the called telematic terminal. Data link information includes any and all essential characteristics, such as identification, authentication, and/or selection of optional functions concerning each terminal, such as parameter values.

ISO 8885 also describes the content of the information field of the XID frame when it is encoded according to the "general purpose" format identifier.

C.2.1 *XID command/response frame*

Figure C-1/T.90 shows the XID frame, as standardized in ISO 8885. The XID Frame is identified by the specific encoding of the control field as shown.

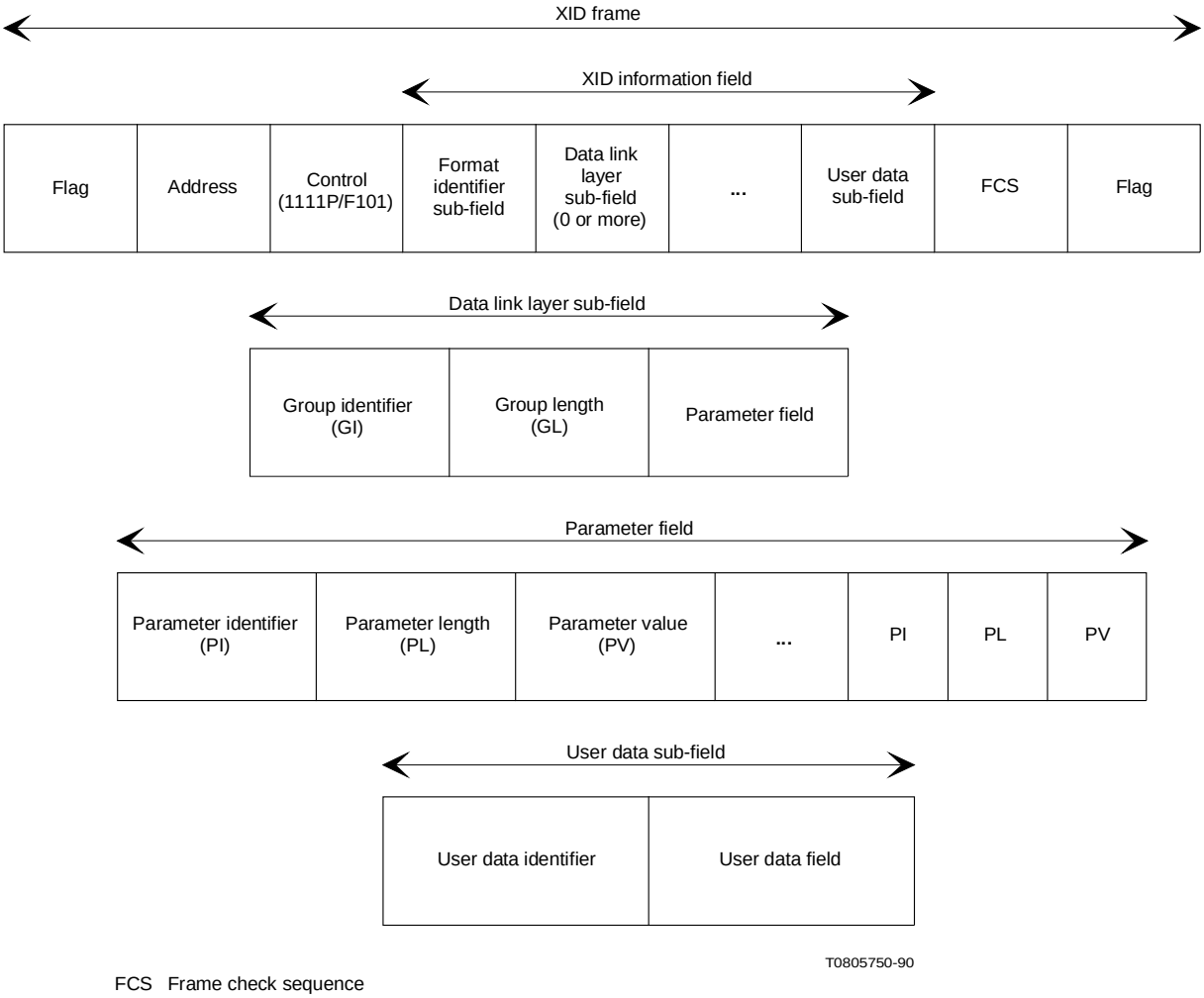


F Flag
A Address field
C Control field
FCS Frame check sequence
P/F Poll or final bit

FIGURE C-1/T.90
XID command/reponse frame

C.2.2 *XID frame information field structure*

The general structure of the information field of an XID frame, as standardized in ISO 8885, is shown in Figure C-2/T.90. The information field is composed of a number of sub-fields. These sub-fields are a format identifier sub-field, zero or more data link sub-fields, and possibly, a user data sub-field.



FCS Frame check sequence
P/F Poll or final bit

FIGURE C-2/T.90
XID frame and various sub-fields

C.2.2.1 *Format identifier sub-field*

The format identifier (FI) sub-field is one octet in length and is the first octet of the information field of the XID frame. In general, the FI is encoded such that it can designate 128 different formats standardized by ISO and 128 different formats defined by users. Each ISO-standardized format is associated with a different FI value and is to be identified in ISO/IEC Standard 4335 (see Note). Two such formats have been defined at this time. The "general purpose" FI is the only FI that is discussed in ISO/IEC Standard 8885.

Note – ISO 4335 – Information processing systems – Data communications – High-level data link control elements of procedures, 1987.

C.2.2.2 *Data link layer sub-fields*

Data link layer sub-fields are used to specify various data link layer characteristics, such as operational parameters. In terms of Figure C-2/T.90, a data link layer sub-field consists of a group identifier (GI) which is one octet in length, a group length (GL) which is two octets in length, and a parameter field (whose length is given by GL). The parameter field, in turn, is similarly decomposed into one or more sets of a parameter identifier, a parameter length, and a parameter value (the parameter length, however, is only one octet in length).

Note – A group length value of zero indicates that there is no associated parameter field and that all parameters within the sub-field specified by the associated group identifier should assume their default values.

Currently, there are three GIs standardized for data link layer sub-fields used with the "general purpose" FI. These are for parameter negotiation, address resolution and multilink parameter negotiation. For the purposes of this Recommendation, data link layer sub-fields associated with parameter negotiation shall be used.

C.2.2.3 *User data sub-field*

A fourth GI, the user data identifier, is defined to specify a user data sub-field used in conjunction with the "general purpose" FI. the user data sub-field contains data link user information to be transferred during XID frame interchange. This data link user information is transported transparently across the data link and passed to the user of the data link. This sub-field follows all data link layer sub-fields, as Figure C-2/T.90 shows. The subsequent information (i.e. user data field), which is bounded by the frame's FCS field, is not constrained in ISO/IEC Standard 8885.

Note – This Recommendation does not make use of the user data sub-field.

C.3 Single-frame exchange negotiation procedures

The single-frame exchange process discussed in ISO 8885 shall be used to negotiate modulo and k parameter.

Prior to the establishment of the data link layer the calling terminal sends an XID command frame with a poll (P) bit set to "1" with an information field containing an offered profile of supportable parameters and shall start a system defined timer. The called terminal then initiates an XID response frame with the final (F) bit set to "1" to acknowledge the receipt of a command frame with P bit set to "1" with an information field that indicates the parameter selection from the profile. These procedures shall be in accordance with ISO 4335.

Note – This system defined timer is the same as T1.

C.4 *Encodings for XID information field for negotiation of modulo and k parameter*

The following are the encodings for negotiation/indication of parameter values and optional procedures for the calling and the called terminals.

The calling terminal shall indicate the modulo and the transmit and the receive k parameters. The called terminal, similarly, shall indicate the modulo and the receive k parameters.

The information field shall be encoded as specified in Figure C-3/T.90. Fields that are not recognized shall be ignored.

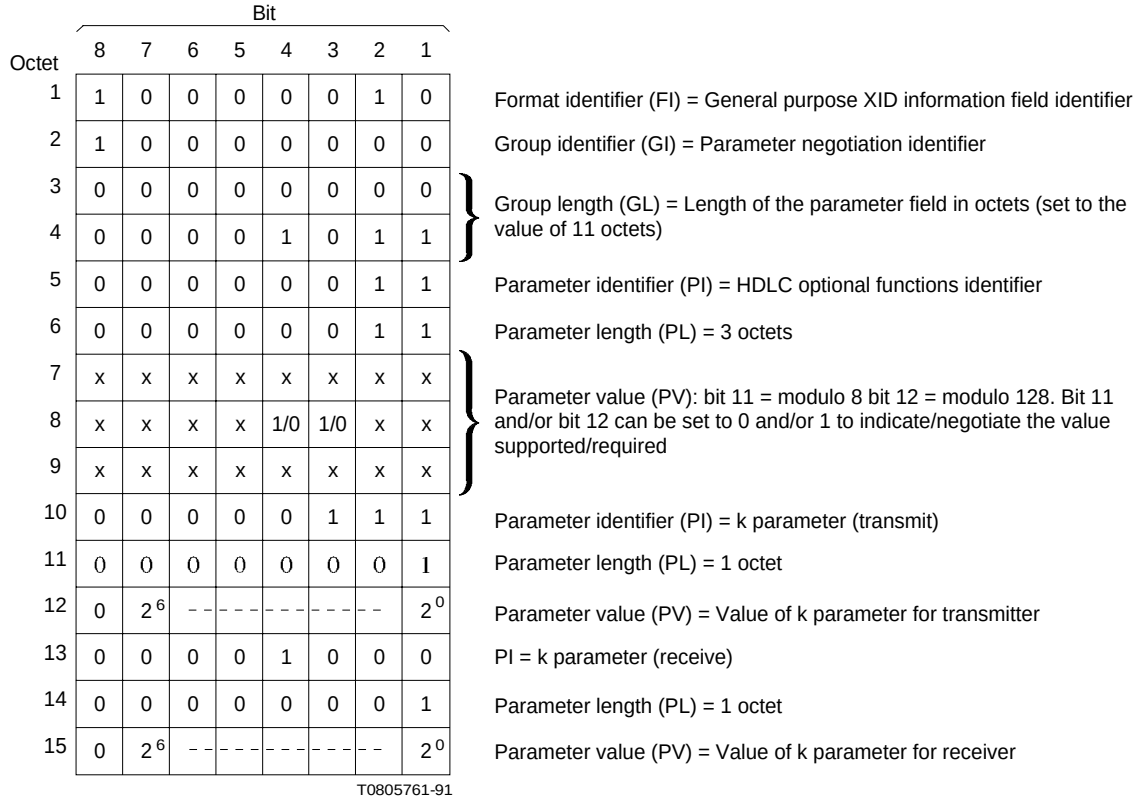


FIGURE C-3/T.90
XID command information field encodings for negotiation of layer 2 parameters: modulo and k parameter

C.4.1 *Format identifier sub-field*

For negotiation/indication of parameter values and optional procedures, the FI sub-field shall be encoded as "10000010" to indicate the ISO-standardized "general purpose" FI.

C.4.2 Data link layer sub-fields

Only the data link layer sub-field associated with “parameter negotiation” shall be present. This sub-field has a GI value of “10000000”. The length of this sub-field (GL) is dependent on the actual information to be transmitted and is eleven octets (maximum) in length.

Each item to be negotiated and/or indicated is identified by a PI. The first PI shall be encoded with the HDLC optional functions identifier. The first PL field shall be encoded to indicate the length of the parameter field. The PV field shall be set to the desired value for modulo.

The second PI field shall be encoded with the k parameter (transmit) identifier. The second PL field shall be encoded to indicate the length of the parameter field. The PV field shall be set to the desired value of transmit k parameter.

The third PI field shall be encoded with the k parameter (receive) identifier. The third PL field shall be encoded to indicate the length of the parameter field. The PV field shall be set to the desired value of receive k parameter.

Table C-1/T.90 shows the items and their PI values.

TABLE C-1/T.90

Parameters/procedures

Parameter identifier (PI)		Parameter/procedure	Units
Decimal	Binary		
3	00000011	HDLC optional functions	(Note 1)
7	00000111	k parameter: transmit direction	(Note 2)
8	00001000	k parameter: receive direction	(Note 2)

Note 1 – The length of parameter value (PV) is three octets (i.e. PL = 3). The bits in these octets constitute a 24-bit mask, each for a particular HDLC optional function (as defined in ISO 8885). Bit 1 of this mask is the lower-order bit of octet 1 and is transmitted first; bit 9 is the lower-order bit of octet 2; etc.

Only bits 11 and 12 are applicable to modulo negotiation. Bit 11 when set to “1” indicates support of modulo 8, bit 12 when set to “1” indicates support of modulo 128 (see Note 3). When both bits (11 and 12) are set to “1”, it indicates that the terminal supports both modulo 8 and 128. A-bit position set to “1” indicates request/agreement to use the procedure. A bit position set to “0” indicates no request/no agreement to use the procedure.

The terminal responding to an XID command frame will negotiate modulo value as follows. The XID command frame may have bit 11 set to “1”, bit 12 set to “1” or both bits 11 and 12 set to “1”. The XID response frame shall only have bit 11 or bit 12 set to “1” (but not both). The bit chosen to be set to “1” in the XID response frame must have been set to “1” in the XID command frame.

Note 2 – The lenght of the parameter value (PV) is one octet (i.e. PL = 1). The parameter value is encoded in binary. Within an octet, the first bit transmitted shall be the lowest-order bit.

Note 3 – The XID command frame is not allowed to have bit 11 set to “0”, bit 12 set to “1”, because modulo 8 is mandatory.

The terminal responsing to an XID command frame will negotiate k parameter as follows. The k parameter value for the transmit direction sent in the XID response frame shall be equal to or less than the k parameter value for the receive direction received in the XID command frame. Similarly, the k parameter value for the receive direction sent in the XID response frame shall be equal to or less than the k parameter value for the transmit direction received in the XID command frame.

C.5 *Connectivity with terminals not supporting XID procedures*

For the purposes of this Recommendation, the following procedures shall be adopted by a called terminal that does not support the XID procedures.

a) called terminal receives an XID command frame from the calling terminal in the disconnected phase:

   – the called terminal shall transmit a disconnected mode (DM) frame with an F bit set to "1" to acknowledge the receipt of an XID command with a P set to "1";

   – the calling terminal then shall set up the connection using default values for modulo and the k parameter;

b) called terminal receives an XID command from the calling terminal in information transfer phase:

   – the called terminal shall transmit a frame reject (FRMR) frame with the F bit set to "1" and shall reset the connection under these conditions;

   – if further communication is necessary, the calling terminal shall re-establish connection with the called terminal (with default values for modulo and k parameter).

C.6 *Protocol errors*

For the purposes of this Recommendation, the following shall be considered as protocol errors:

– a terminal receives an XID command frame (for HDLC optional functions) with both bit 11 and bit 12 set to "0";

– a terminal receives an XID command frame with transmit or receive k parameter value of "0";

– a terminal receives an XID command frame with the modulo as 8 and the value of either k parameter greater than 7;

– a calling terminal receives an XID response frame (for HDLC optional functions) with both bit 11 and 12 set to "0";

– a terminal receives an XID response frame (for HDLC optional functions) with both 11 and 12 set to "1";

– a terminal receives an XID response frame with transmit or receive k parameter value of "0";

– a terminal receives an XID response frame with the modulo as 8 and the value of the transmit k parameter field greater than 7;

– a terminal receives an XID response frame with a k parameter violating the negotiation rules;

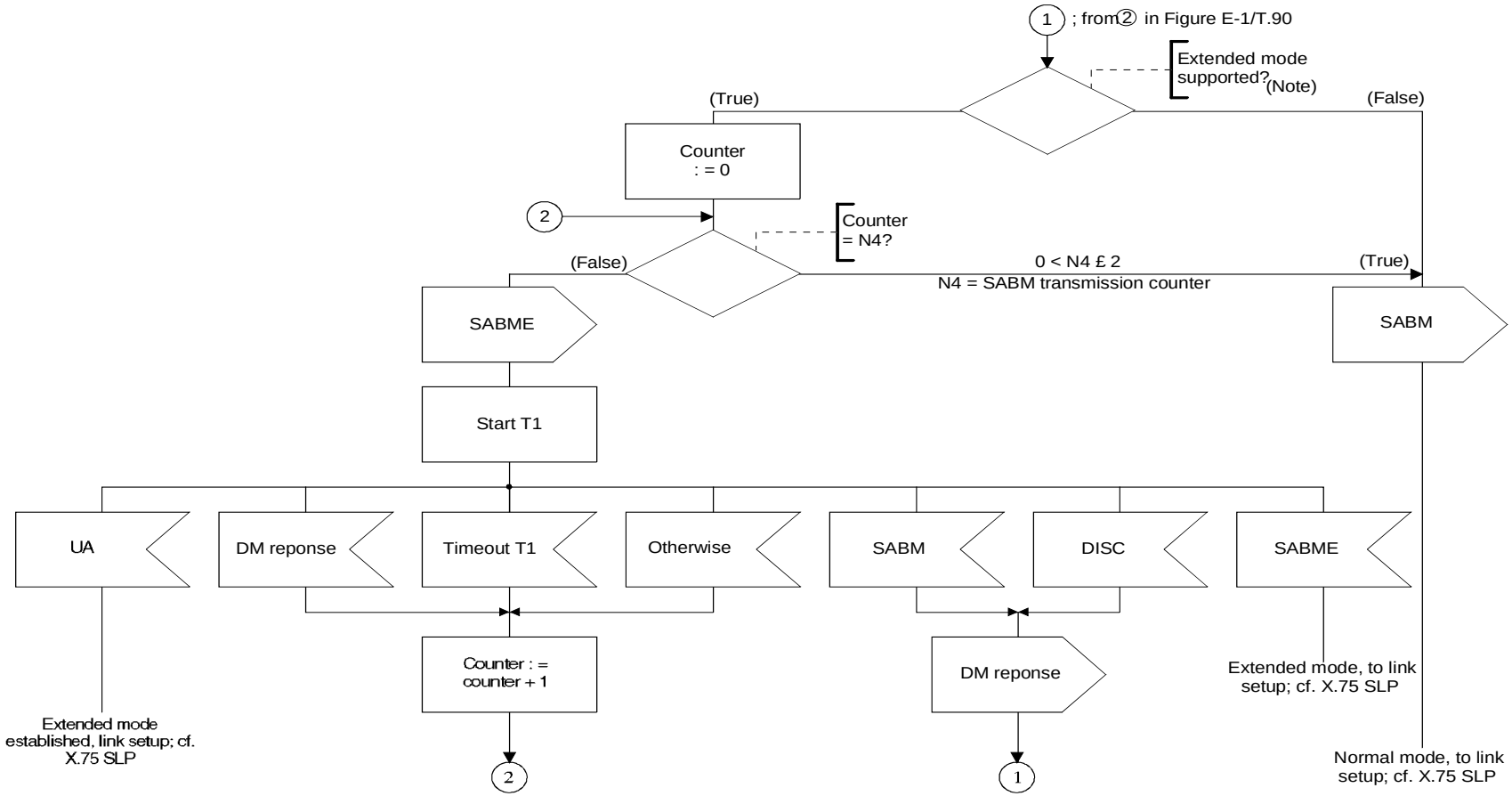
– a terminal receives an XID response frame with a modulo value violating the negotiation rules.

When a protocol error occurs, the receiving terminal shall transmit a disconnected mode (DM) frame with an F bit set to 1 and exit XID procedures.

ANNEX D

(to Recommendation T.90)

SDL diagram for link set up for SABM/SABME procedures



SLP Single link procedure

Note – It is strongly recommended to use the extended mode of operation.

FIGURE D-1/T.90
Calling side

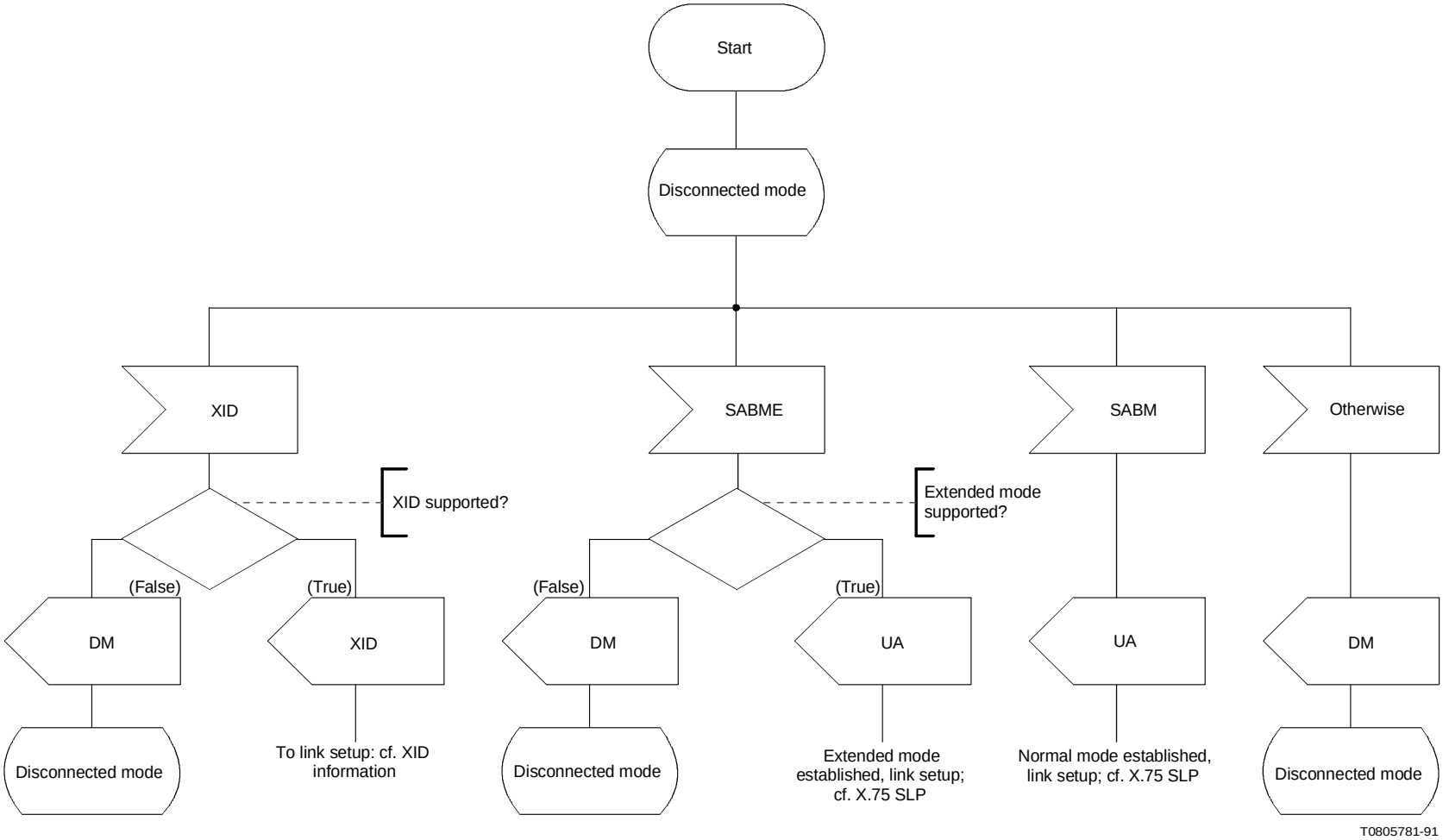
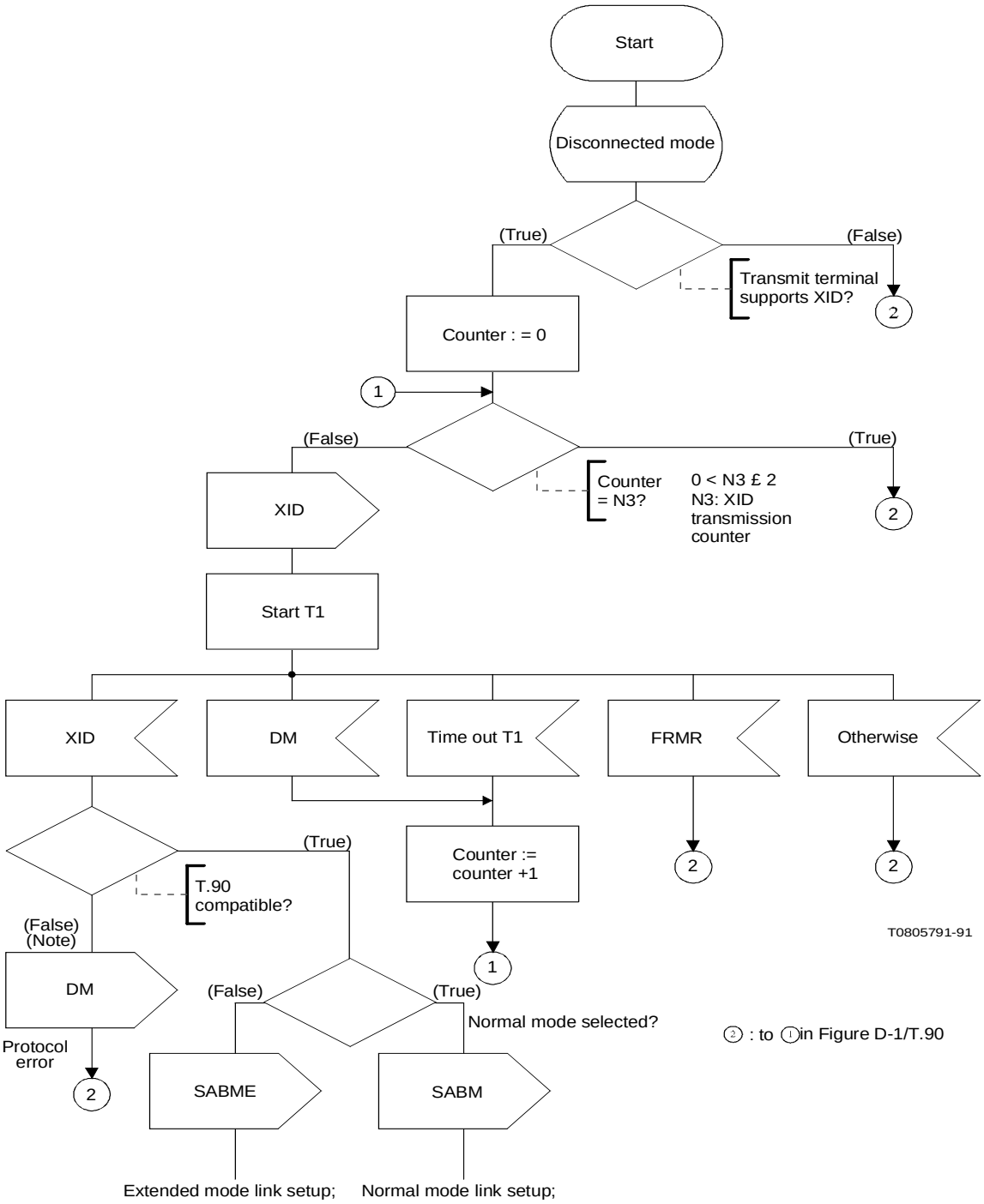


FIGURE D-2/T.90
Called side

ANNEX E

(to Recommendation T.90)

SDL diagram for link set up to a T.90 compatible terminal for XID procedure



Note – Further analysis of the "non-T.90 compatible case" may lead to terminal characteristics suitable for the intended communication.

FIGURE E-1/T.90
Calling side

APPENDIX I

(to Recommendation T.90)

Facsimile terminals in the ISDN

I.1 *Outgoing calls*

In accordance with Recommendation I.333, § I.2.2.1.1, a terminal which supports both G2/G3 and G4 facsimile function or a G4 facsimile terminal attempting a G4 facsimile call (either polling or sending) should use the bearer capability according to the capabilities of the network, which may be either "circuit-mode 64 kbit/s unrestricted 8 kHz structured" (category Recommendation I.231.1) or "virtual call" (category Recommendation I.232.1), or both of them, and provide the HLC information element with high layer characteristics identification "facsimile Group 4".

In accordance with Recommendation I.333, § I.2.2.1.1, a terminal adaptor (TA) supporting a G2/G3 facsimile terminal should use the 3.1 kHz audio bearer capability and should provide the HLC information element with high layer characteristics identification "facsimile Group 2/3".

The actions to be taken by the calling facsimile terminal following an unsuccessful call attempt where incompatibility has been indicated (e.g. cause "incompatible destination" for calls within the ISDN, or call rejection with a suitable cause indication in the case of interworking with a dedicated network) require further study. The optimum condition to achieve compatibility in a call re-attempt greatly depends on the cause indication provided to the calling facsimile terminal and its capability to divert to the requested characteristics for the call re-attempt (see note). For a certain type of facsimile terminal these actions may include:

i) A G2/G3 facsimile terminal should release the call and take no further action.

ii) A G4 facsimile terminal should release the call.

- The G4 facsimile terminal may initiate a call re-attempt, if a mismatch of the bearer capability has been indicated and it can match the requested characteristics, e.g. in the case where the "virtual call" (category Recommendation I.232.1) bearer capability has been requested by the calling facsimile terminal and interworking with switched 64 kbit/s non-ISDN network takes place. Otherwise, it cannot take further actions and is unable to communicate with the called facsimile terminal.

iii) A terminal which supports both G2/G3 and G4 facsimile function should release the call.

- If interworking ISDN to PSTN has been indicated, or cause "incompatible destination" for calls within the ISDN, when the call has been rejected, the terminal which supports both G2/G3 and G4 facsimile function may initiate a re-attempt in the G2/G3 mode. It should use the 3.1 kHz audio bearer capability and should provide the HLC information element with high layer characteristics identification "facsimile Group 2/3".

- If interworking ISDN, to switched 64 kbit/s non-ISDN network, has been indicated when the call has been rejected, actions according to item ii) may be appropriate.

Note – For evolution, further study is also required to eliminate the method which may result in unsuccessful calls caused by incompatibility.

I.2 *Incoming calls*

For incoming calls originated within ISDN, the facsimile terminal should function as described for terminals supporting teleservices in Recommendation I.333, § I.2.2.

For incoming calls from non-ISDN networks not able to convey high layer compatibility information such as the public switched telephone network (PSTN) or switched 64 kbit/s network, the facsimile terminal will receive the appropriate information indicating an interworking situation (call progress information). It should rely on the call

progress information element to accept calls which are offered without the explicit information specifying high layer protocols, if it matches other elements describing the incoming call. Otherwise it should release or ignore the call (user options).

In this case the directory number (see Recommendation E.164) should be the overriding determinant of whether the terminal responds (provided the bearer capability is appropriate). In this case the use of Multiple Subscriber Number (MSN) supplementary service could be advisable because it is the only means to avoid having facsimile terminal accept calls which are not appropriate to it, e.g. incoming call from non-ISDN networks such as telephone calls or data calls.

The rules below are applicable to a certain type of facsimile terminal. They define the criteria which should be used by the terminal to determine whether, and in what mode, it should answer the call:

i) A TA supporting a G2/G3 facsimile terminal should answer the call if the following criteria are fulfilled:

   a) the called party number information element, if present, contains a number which matches the number assigned to the TA; and

   b) the bearer capability information element indicates the information transfer capability "3.1 kHz audio";

   and for incoming call from PSTN:

   c1) the progress indicator information element (in Recommendation Q.931 SETUP) indicates the progress description "call is not end-to-end ISDN" (incoming call from PSTN);

   d1) the high layer compatibility information element is not present; and

   e1) the called party sub-address information element is not present;

   or for incoming call from ISDN [instead of c1), d1), e1)]:

   c2) the progress indicator information element is not present (incoming call from ISDN);

   d2) the high layer compatibility information element indicates high layer characteristics identification "facsimile Group 2/3"; and

   e2) the called party sub-address information element, if present, contains a number which matches the sub-address assigned to the terminal.

ii) A terminal which supports both G2/G3 and G4 facsimile function should answer the call in the G2/G3 mode (including modem and codec functions) if the following criteria are fulfilled (incoming call from PSTN):

   a) the called party number information element, if present, contains a number which matches the number assigned to the terminal;

   b) the bearer capability information element indicates the information transfer capability "3.1 kHz audio";

   c) the progress indicator information element indicates the progress description "call is not end-to-end ISDN";

   d) the high layer compatibility information element is not present; and

   e) the called party sub-address information element is not present.

iii) A terminal which supports both G2/G3 and G4 facsimile function (or a G4 facsimile terminal) should answer the call in the G4 mode (neither modem nor codec functions) if the following criteria are fulfilled (incoming call from switched 64 kbit/s network (non-ISDN):

   a) the called party number information element, if present, contains a number which matches the number assigned to the terminal;

b) the bearer capability information element indicates the information transfer capability "unrestricted digital information" and transfer mode "circuit mode";

c) the progress indicator information element indicates the progress description "call is not end-to-end ISDN (see Note);

d) the high layer compatibility information element is not present; and

e) the called party sub-address information element is not present.

Note – It may not always be possible to determine whether source is ISDN or 64 kbit/s switched network.

iv) A terminal which supports both G2/G3 and G4 facsimile function (or a G4 facsimile terminal) should answer the call in the G4 mode (neither modem not codec functions) if the following criteria are fulfilled (incoming call from ISDN):

a) the called party number information element, if present, contains a number which matches the number assigned to the terminal;

b) the bearer capability information element indicates the information transfer capability "unrestricted digital information" and a transfer mode which is supported by the called facsimile terminal ("circuit mode" or "packet mode");

c) the progress indicator information element is not present;

d) the high layer compatibility information element indicates high layer characteristics identification "facsimile Group 4"; and

e) the called party sub-address information element, if present, contains a number which matches the sub-address assigned to the terminal.

I.3 *Information elements for the provision of G2/G3 facsimile transmission*

In this section the protocol and use of information elements (BC, LLC, HLC) for the provision of G2/G3 facsimile transmission at the S/T reference point are specified for D-channel connection control phase.

I.3.1 *Application rules*

1) *Layer 1 – Physical layer interface characteristics*

Paragraph 2.2.1 should be used.

2) *Layer 2 – D-channel connection control phase*

Paragraph 2.2.2 should be used for connection control phase.

3) *Layer 3 – D-channel connection control phase*

Recommendation Q.931 should be used for connection control phase. All encodings should be derived from the relevant section in Recommendation Q.931.

Fields in bearer capability (BC), low layer compatibility (LLC) and high layer compatibility (HLC) information elements to be conveyed at the S/T reference point of the user-network interface during the call establishment phase, should be set to the values defined below. Any other information element of BC, LLC or HLC not defined in the below tables is not used.

– *Bearer capability (BC)*

See Table I-1/T.90.

– *Low layer compatibility (LLC)*

See Table I-2/T.90.

– *High layer compatibility (HLC)*

See Table I-3/T.90.

4) For B-channel, see the relevant Recommendation of G2/G3 facsimile.

TABLE I-1/T.90

Bearer capability for G2/G3 facsimile transmission

Octet number	Information elements	G2/G3 facsimile		
		Contents	Condition for calling side (Note 1)	Condition for called side (Note 1)
1	Bearer capability information element identifier	Identifier	M	M
2	Length of the bearer capability contents	Length	M	M
3	Extension Coding standard Information transfer capability	Extension CCITT standardized coding 3.1 kHz audio (Note 2)	M M M	M M M
4	Extension Transfer mode Information transfer rate	Extension Circuit mode 64 kbit/s	M M M	M M M
5	Extension Layer 1 identification User information layer 1 protocol	Extension Layer 1 identifier G.711 μ-law or G.711 A-law (Note 3)	M M M	O O O
6	Extension Layer 2 identification User information layer 2 protocol		N N N	N N N
7	Extension Layer 3 identification User information layer 3 protocol		N N N	N N N

Note 1 – M: Sending is mandatory for calling side, and checking of its presence and contents is mandatory for called side.

O: If present, called side checks the information element.

N: Calling side does not send the information element, and called side does not care for the information element.

Note 2 – Basically, G2/G3 facsimile should respond to the incoming call of which information transfer capability is 3.1 kHz audio. However, it should be noted that in some case there may be G2/G3 incoming call of which information transfer element is speech.

Note 3 – Either μ-law or A-law is used.

TABLE I-2/T.90

Low layer compatibility for G2/G3 facsimile transmission

Octet number	Information elements	G2/G3 facsimile		
		Contents	Condition for calling side (Note 1)	Condition for called side (Note 1)
1	Low layer compatibility information element identifier	Identifier	M	O
2	Length of the low layer compatibility contents	Length	M	O
3	Extension Coding standard Information transfer capability	Extension CCITT standardized coding 3.1 kHz audio (Note 2)	M M M	O O O
4	Extension Transfer mode Information transfer rate	Extension Circuit mode 64 kbit/s	M M M	O O O
5	Extension Layer 1 identification User information layer 1 protocol	Extension Layer 1 identifier G.711 μ-law or G.711 A-law (Note 3)	M M M	O O O
6	Extension Layer 2 identification User information layer 2 protocol		N N N	N N N
7	Extension Layer 3 identification User information layer 3 protocol		N N N	N N N

Note 1 – M: Sending is mandatory for calling side, and checking of its presence and contents is mandatory for called side.

O: If present, called side checks the information element.

N: Calling side does not send the information element, and called side does not care for the information element.

In case that the received information elements of LLC are different from that of BC, information elements of BC have priority.

Note 2 – Basically, G2/G3 facsimile should respond to the incoming call of which information transfer capability if 3.1 kHz audio. However, it should be noted that in some case there may be G2/G3 incoming call of which information transfer element is speech.

Note 3 – Either μ-law or A-law is used.

TABLE I-3/T.90

High layer compatibility for G2/G3 facsimile transmission

Octet number	Information elements	G2/G3 facsimile		
		Contents	Condition for calling side (Note)	Condition for called side (Note)
1	High layer compatibility information element identifier	Identifier	M	O
2	Length of high layer compatibility contents	Length	M	O
3	Extension coding standard Interpretation Presentation method of protocol profile	Extension CCITT standardized coding First high layer characteristics identification High layer protocol profile	M M M M	O O O O
4	Extension High layer characteristics identification	Extension Facsimile group 2/3	M M	O O
4a	Extension Extended high layer characteristics identification		N N	N N

Note – M: Sending is mandatory for calling side, and checking of its presence and contents is mandatory for called side.

O: If present, called side checks the information element.

N: Calling side does not send the information element, and called side does not care for the information element.

APPENDIX II

(to Recommendation T.90)

Optional usage of T.70 network layer (NL) protocol

II.1 *Information transfer phase*

The T.70 NL option being used by the calling DTE and supported by the called DTE.

The network layer for the connection control phase should be as defined in § 2.2.5. The information transfer phase should be implemented as defined in CCITT Recommendation T.70, § 3.3.3.

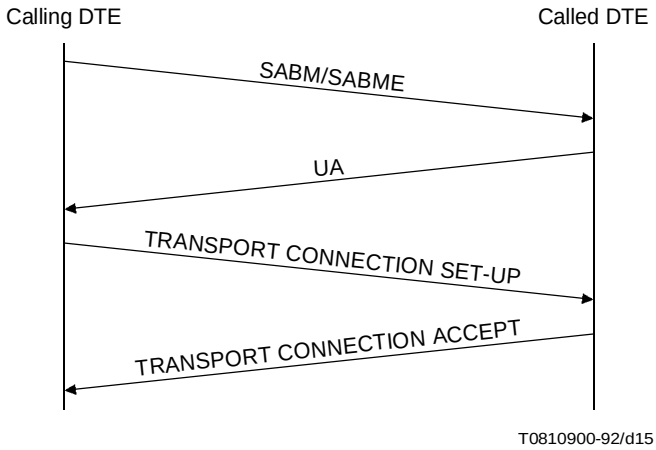


FIGURE II-1/T.90

II.2 *Information transfer phase*

The T.70 NL option being proposed by the calling DTE but not supported by the called DTE.

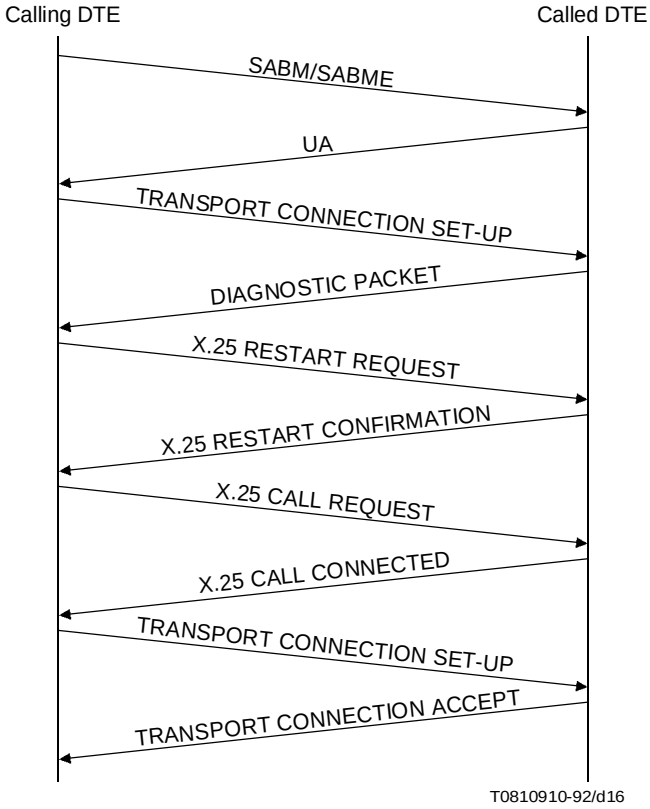


FIGURE II-2/T.90

APPENDIX III

(to Recommendation T.90)

Service definitions and state transition diagrams for the data link layer within the B-channel (CS-mode)

This Appendix contains the result of experience of several implementations of the prescribed link layer for telematic services. This description has been found to be useful in some Administrations for support of conformance testing.

Additional work may be needed in the area of ISDN management and maintenance, however, no clear set of requirements is available at this time. The support of the management and maintenance work is left for further study.

In addition, depending on the further work on the link layer, particularly related to the base modulus for I-frames, some editing may be required (e.g. SABM may become SABME).

Note – Reference to the appropriate section of Recommendation T.70 or an additional explanation is needed.

III.1 *Service definitions*

III.1.1 *Physical service (PHS) used by HDLC*

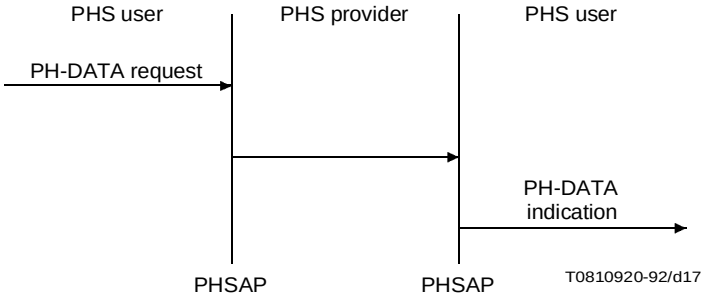


FIGURE III-1/T.90

PH-data transfer

III.1.2 *Data link service*

III.1.2.1 *Data link connection establishment*

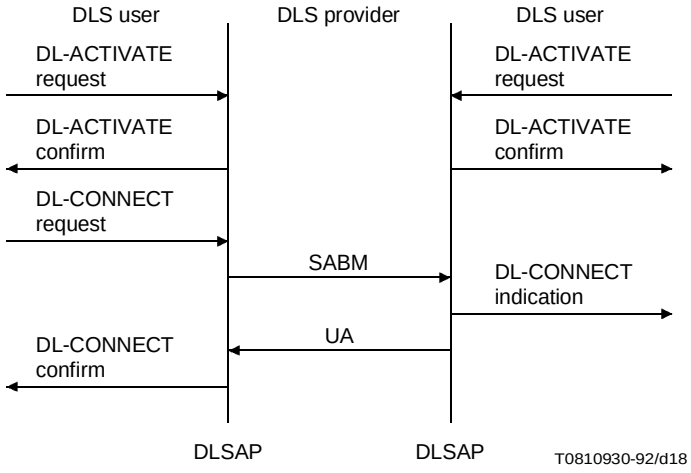


FIGURE III-2/T.90

Successful DLC-establishment

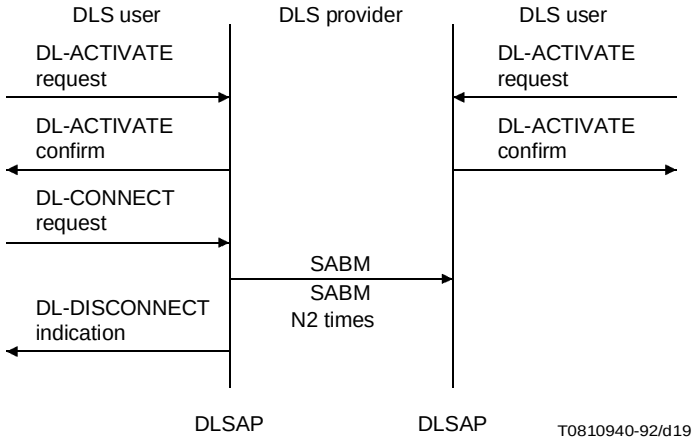


FIGURE III-3/T.90

Not successful DLC-establishment

III.1.2.2 *Data link transfer phase*

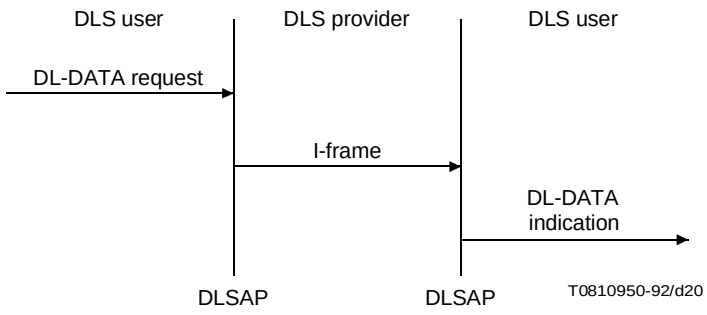


FIGURE III-4/T.90

DL-data transfer

III.1.2.3 *Data link release*

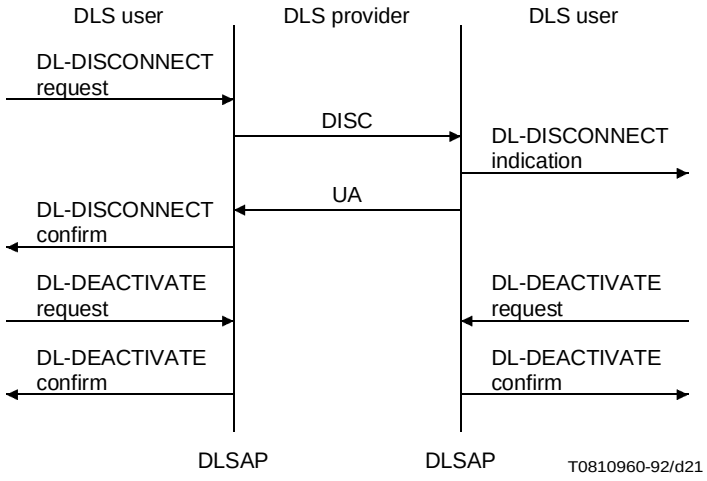


FIGURE III-5/T.90

DL-release initiated by DL-user

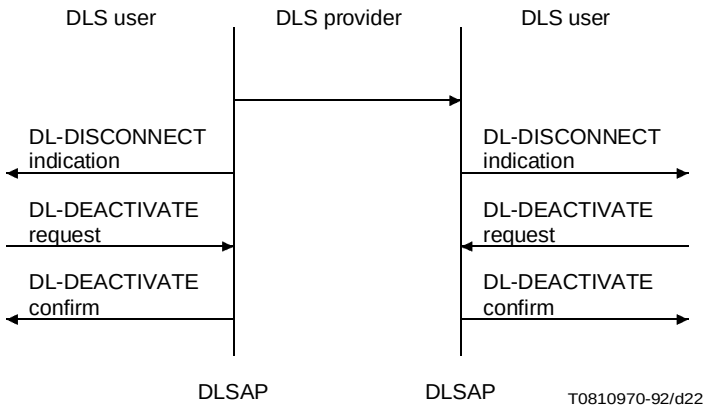


FIGURE III-6/T.90

DL-release initiated by DL-provider

III.1.2.4 *Data link resetting*

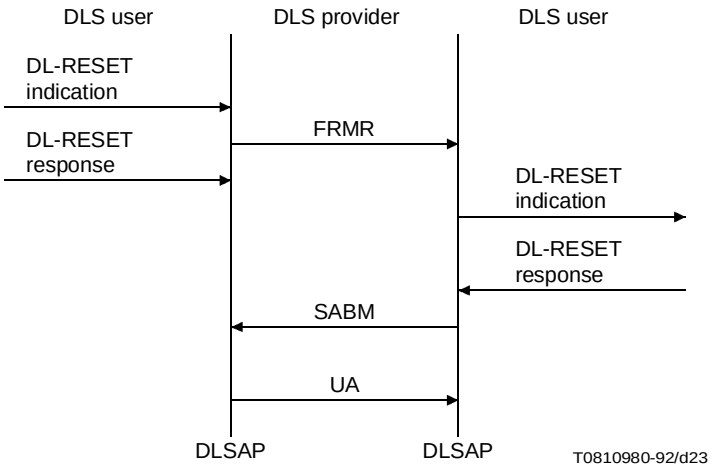


FIGURE III-7/T.90

Successful resetting

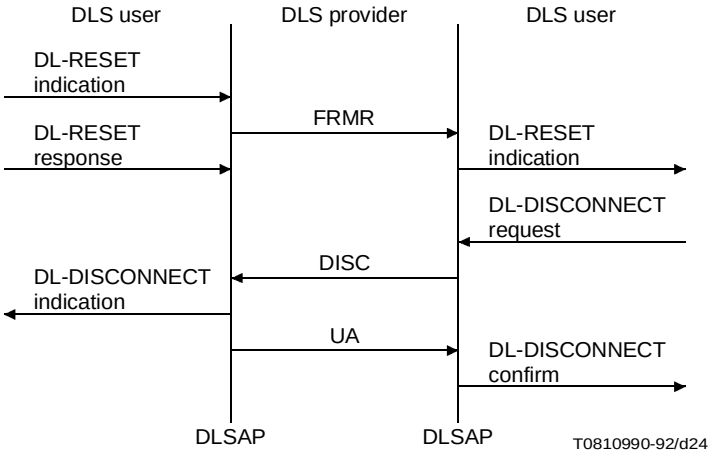


FIGURE III-8/T.90

Resetting not accepted by the receiver of FRMR

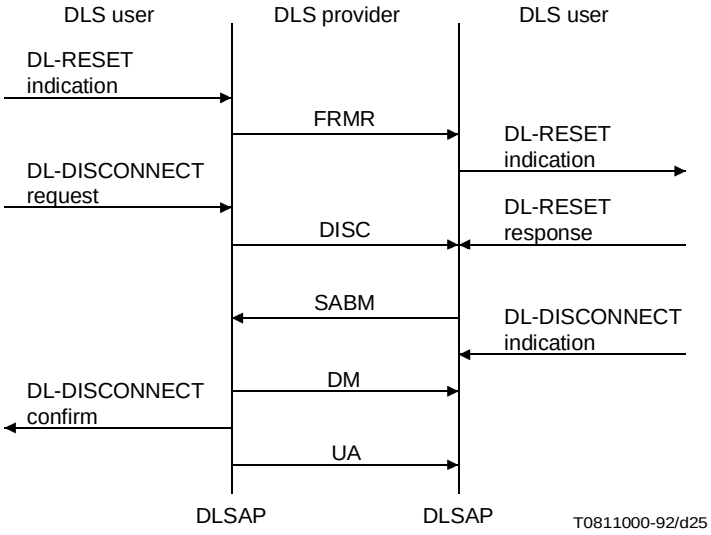


FIGURE III-9/T.90

Resetting not supported by the transmitter of FRMR

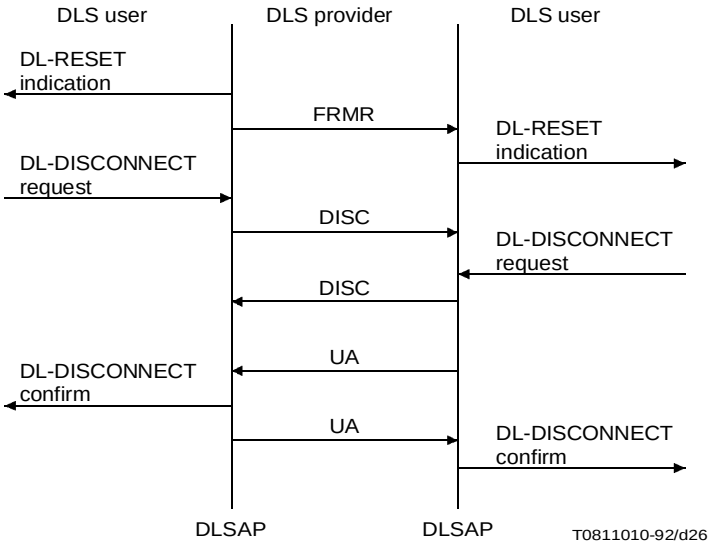


FIGURE III-10/T.90

Resetting not accepted by both

III.2 *State transition disgrams HDLC*

III.2.1 *The relation between the diagrams*

The following diagrams describe the HDLC procedure as one functional unit. The first page comprises the whole protocol and the following pages give the details to specific states.

III.2.2 *Abbreviations*

ABM Asynchronous balanced mode

ADM Asynchronous disconnected mode

R:xxx Receive xxx (command or response)

R:Cxxx Receive A command

R:Rxxx Receive A response

S:xxx Send xxx

F Final bit

P Poll bit

XXX Not this condition

RC Redrive counter

RCB Redrive counter busy

IC I-Frame counter

V_{su} Variable for sequence updating

III.3 *Summary of frame definitions*

III.3.1 *Invalid frames*

– frames not properly bounded by flags;

– frames containing addresses other than A or B;

– frames with frame check sequence (FCS) error;

– frames containing less than 32 bis between flags.

III.3.2 *Valid frames*

III.3.2.1 *Not expected frames*

NEF, not expected frames (for the receiver) which lead to a frame reject condition (excluding frames with an FRMR control field):

– a command or response control field that is undefined or not implemented — Type W

– a frame with an information field which is not permitted or supervisory or unnumbered frame with incorrect length — Type X

– an I-frame with an information field which exceeds the maximum established length — Type Y

– a frame with an invalid N(R) — Type Z

III.3.2.2 *Expected frames*

– frames which must lead to a reaction (in accordance to the Recommendation) on the receiving station,

– frames which must be ignored only in determined states on the receiving station.

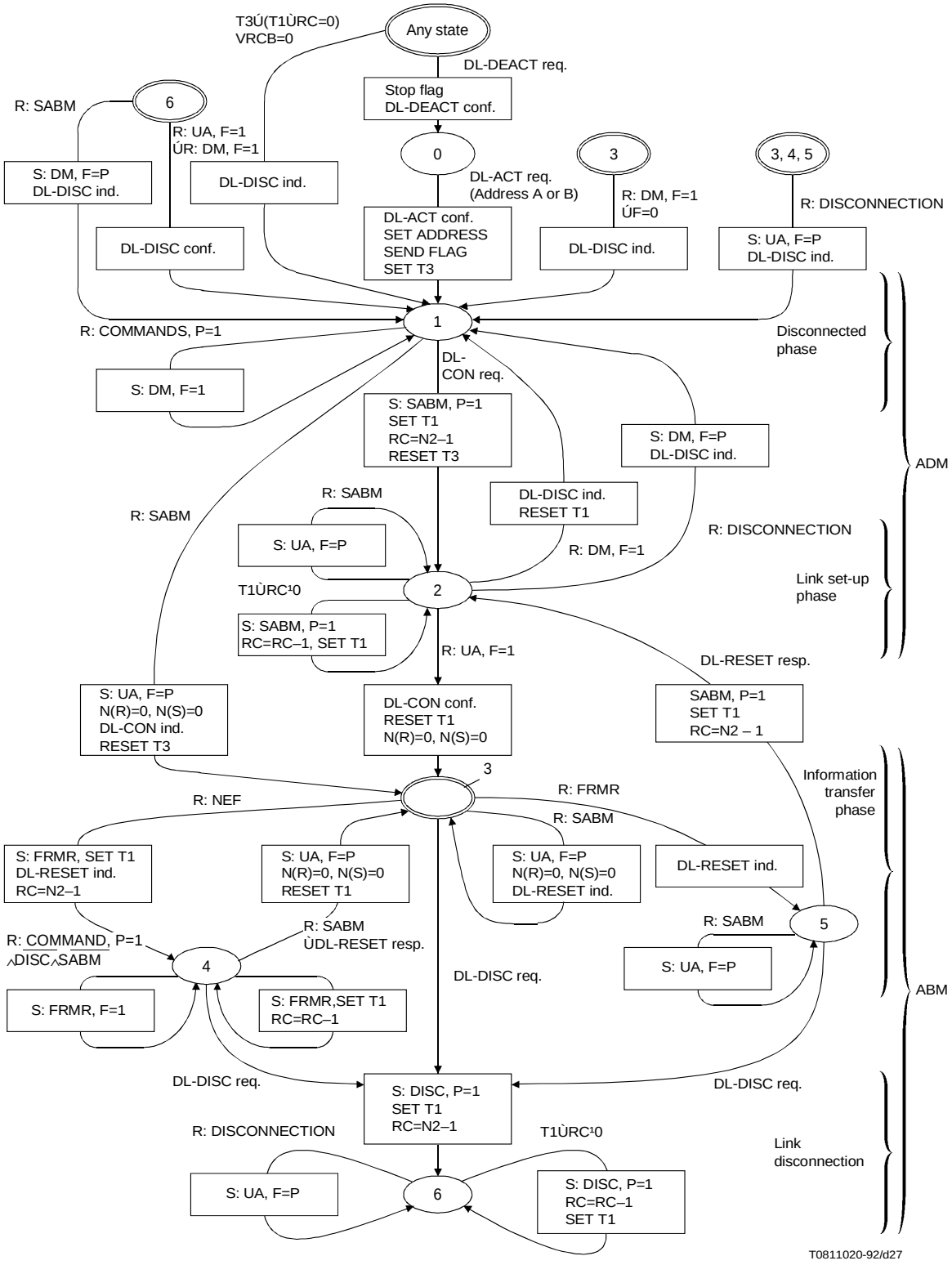
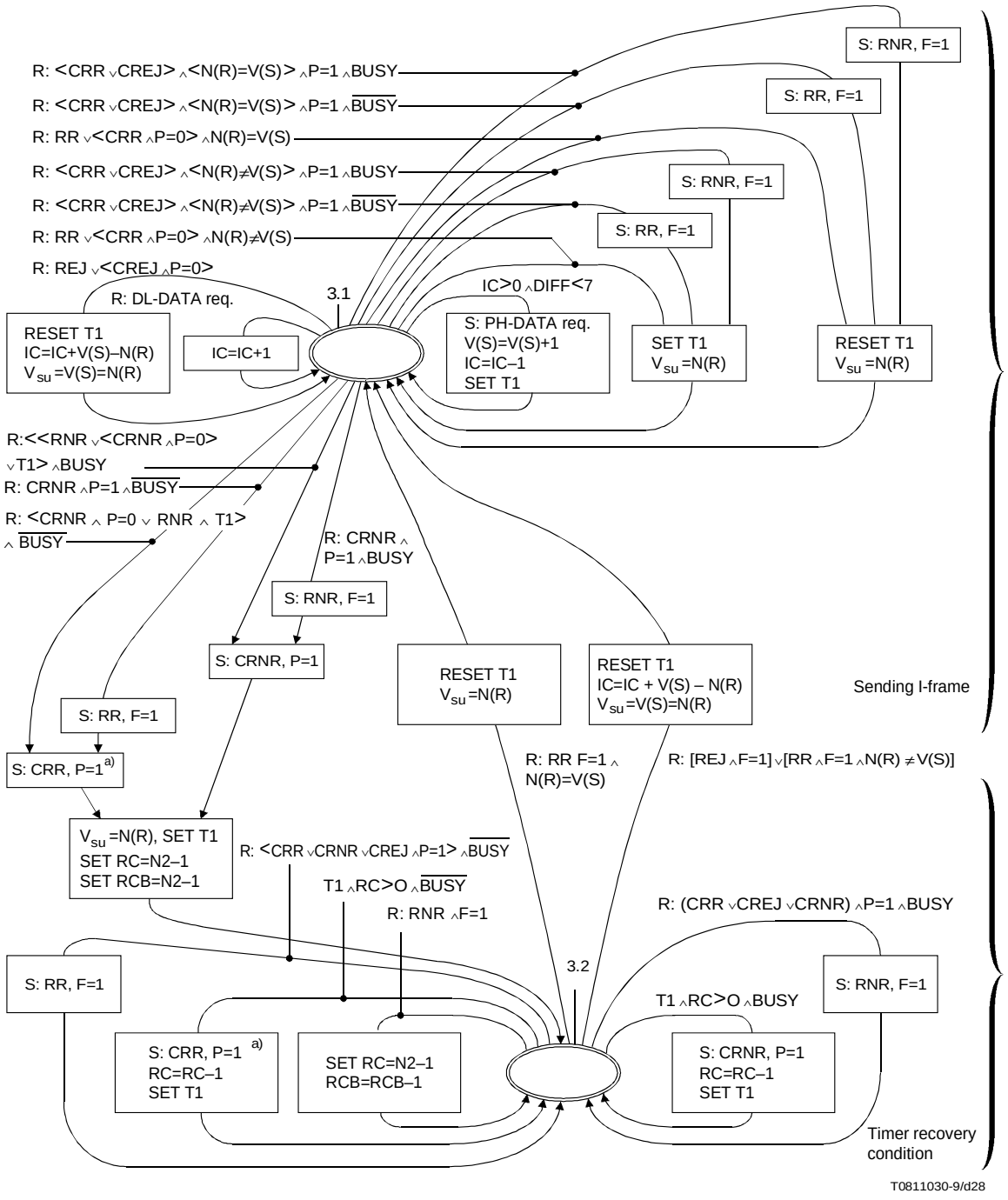


FIGURE III-11/T.90

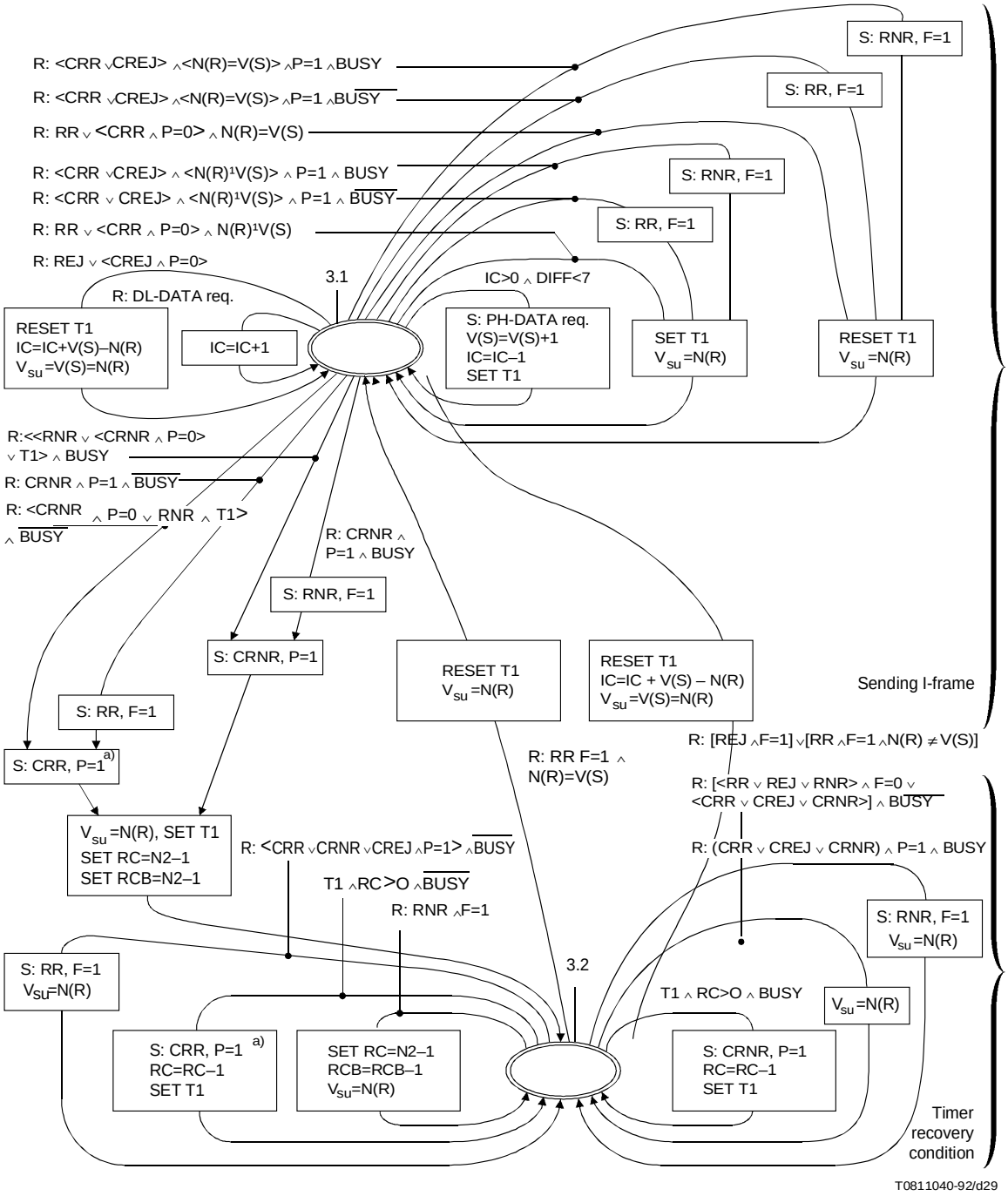
State transition diagram HDLC



a) Alternatively to RR, P = 1 it is allowed to send PH-DATA req. P = 1 or CREJ, P = 1.

FIGURE III-12/T.90

State transition diagram HDLC
(3 Information transfer phase, I-frame control)



a) Alternatively to RR, P = 1 it is allowed to send PH-DATA req. P = 1 or CREJ, P = 1.

FIGURE III-13/T.90

State transition diagram HDLC
(3 Information transfer phase, I-frame control with update of N(R)
in timer recovery condition)

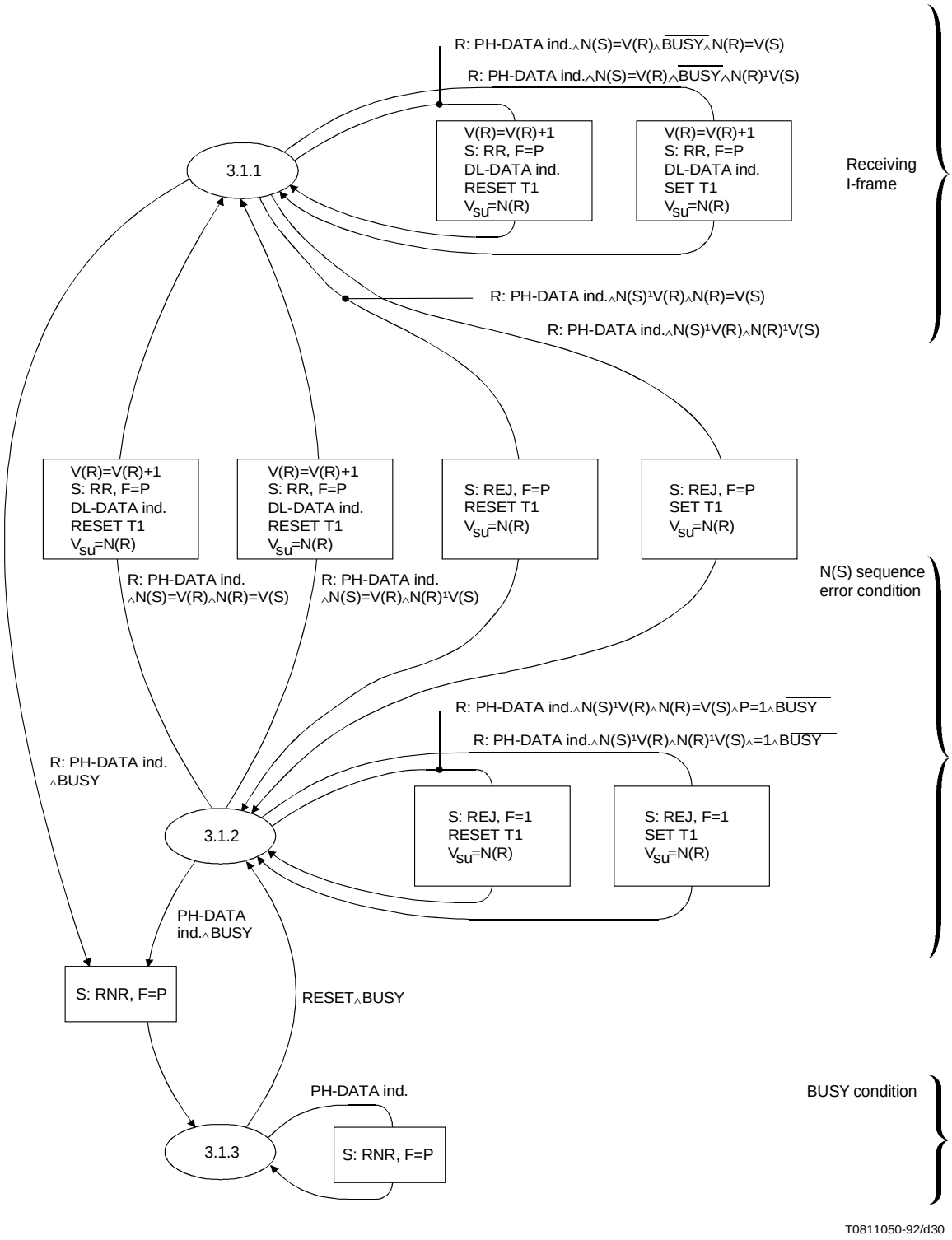


FIGURE III-14/T.90

State transition diagram HDLC
(3.1 Information transfer phase, I-frame acknowledgement)

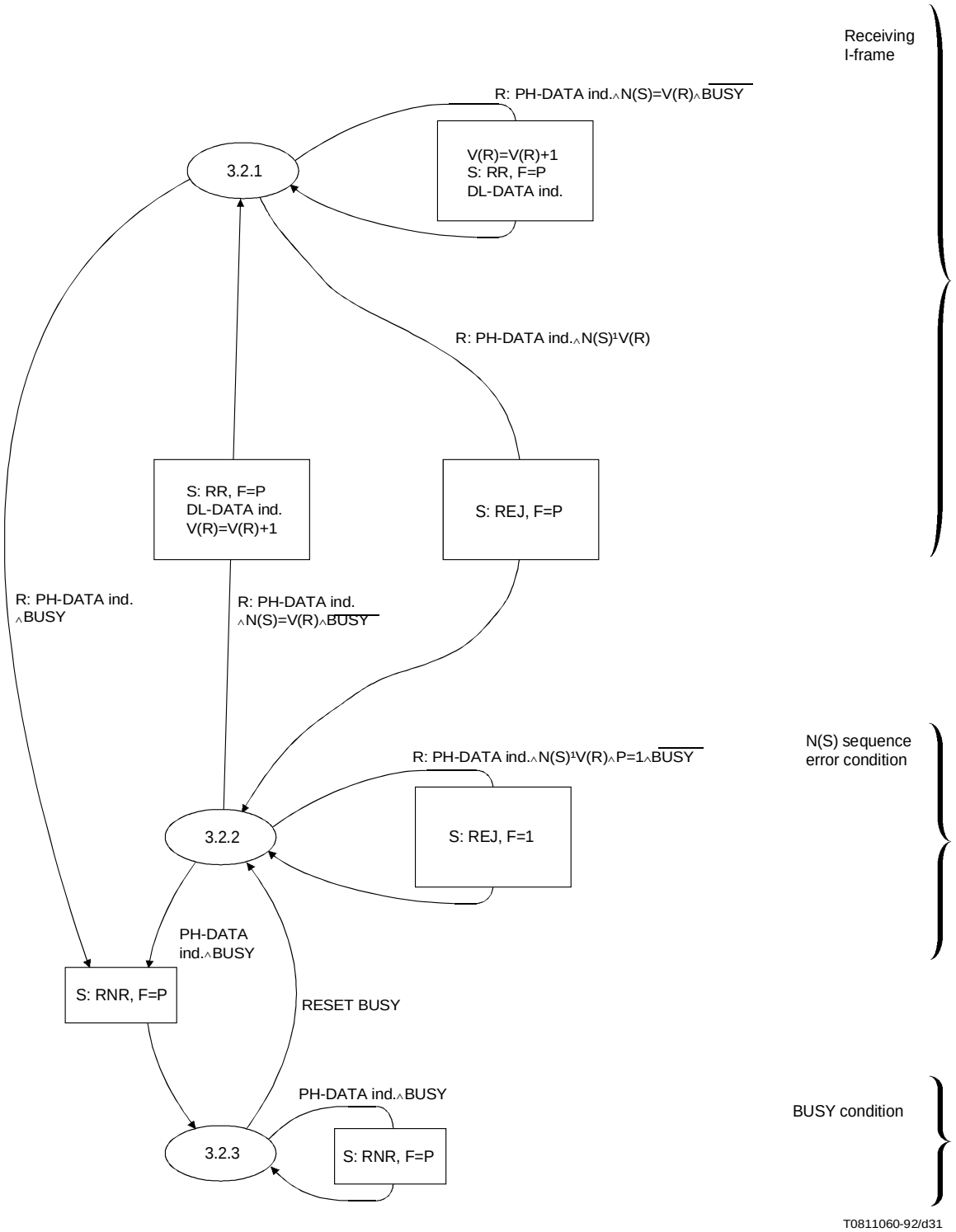


FIGURE III-15/T.90

State transition diagram HDLC
(3.2 Information transfer phase, I-frame acknowledgement
in exception conditions)

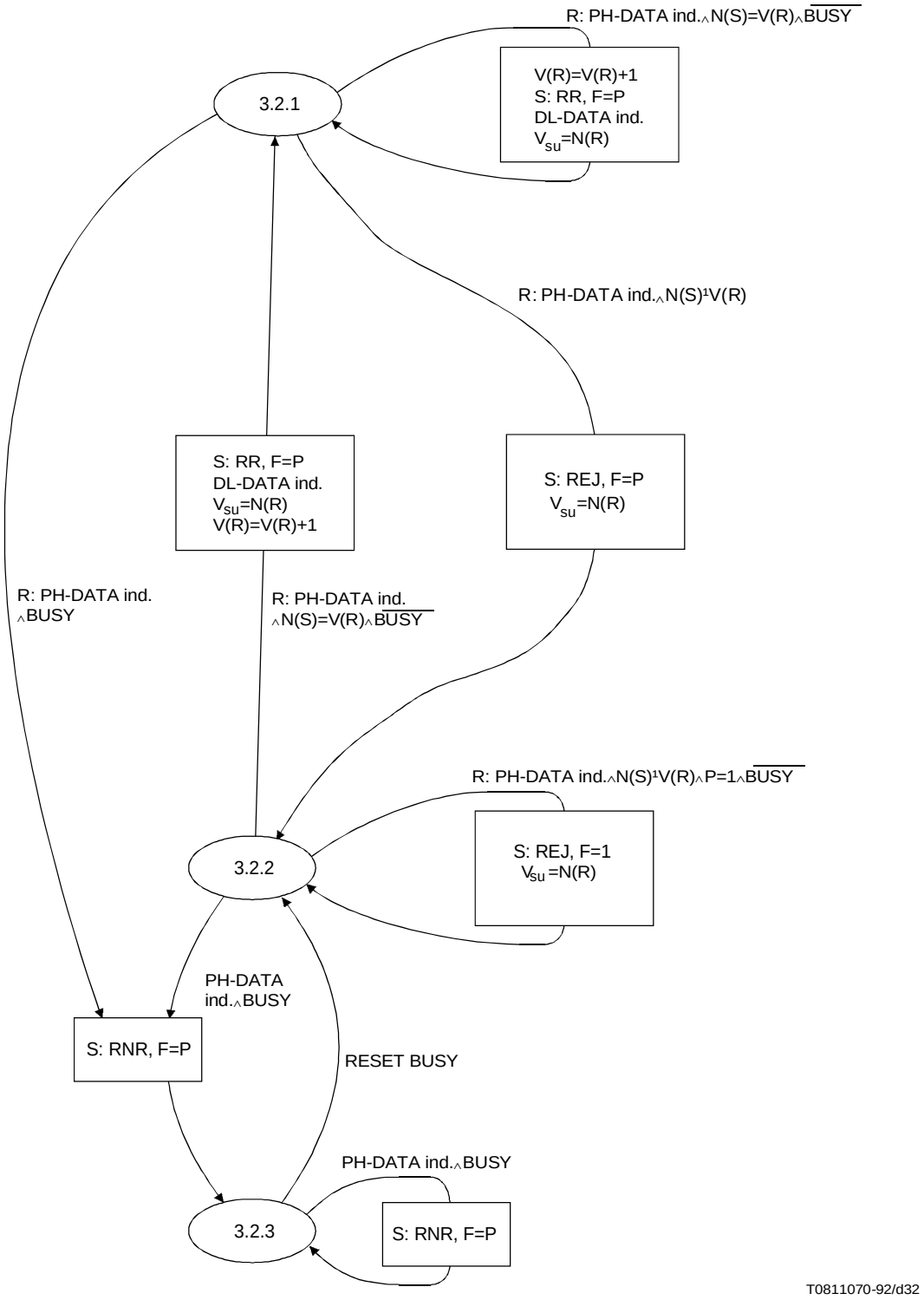


FIGURE III-16/T.90

State transition diagram HDLC
[3.2 Information transfer phase, I-frame acknowledgement
in exception conditions with update of N(R)]

APPENDIX IV

(to Recommendation T.90)

Possible model for telematic endsystems taking into account the D-channel/B-channel coordination function

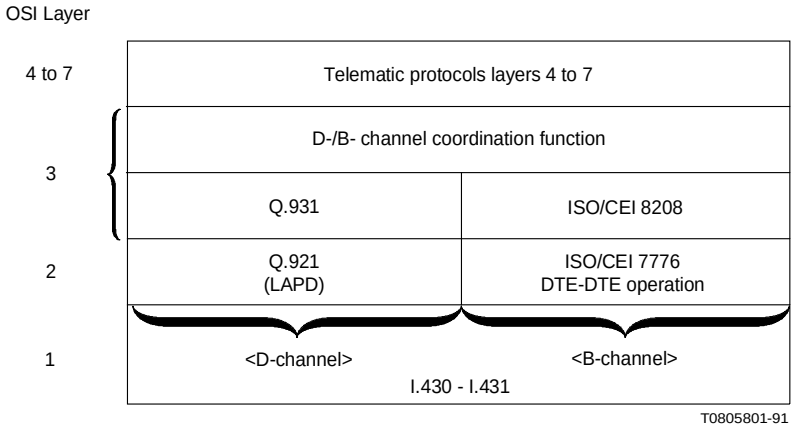


FIGURE IV-1/T.90

Model for telematic endsystems taking into account the D-channel/B-channel coordination function

There are various ways of specifying the layer 3 coordination function. In principe, the layer 3 can either be specified as a monolith or as a set of individual modules.

The structuring into the three modules:

– layer 3 D-channel;

– layer 3 B-channel, and

– layer 3 D-/B-channel coordination,

is obvious, as the first two modules are almost ready-made, available thus leaving the coordination module to be specified from the functionality point of view. The implementation itself is the responsibility of the manufacturer.

APPENDIX V

(to Recommendation T.90)

Rate adaptation function

Circuit switched mode with 64 kbit/s digital bearer capability will have many chances to interwork with CSPDNs and other digital networks. In such cases, ISDN terminal may need rate adaptation function. Rate adaptation function can be achieved by procedure defined in Recommendation V.110. The following is the example of invoking rate adaptation in SETUP message (see Recommendation Q.931) when telematic terminal interworks with existing terminal using Recommendation V.110 rate adaptation.

Coding example for bearer capability
(circuit switched mode, user rate = 56 kbit/s)

Octet	Field	Calling side	Called side
1	IE identifier	Bearer capability	
2	Length		
3	Coding standard	CCITT	Requisite
	Information transfer capability	Unrestricted digital	(Note 1)
4	Transfer mode	Circuit mode	(Note 1)
	Information transfer rate	64 kbit/s	(Note 2)
5	Layer 1 identifier	"0 1"	(Note 1)
	User information layer 1 protocol	V.110/X.30	(Note 2)
5a	Synchronous/Asynchronous	Synchronous	(Note 2)
	Negotiation	Not possible	(Note 2)
	User rate	56 kbit/s	(Note 2)

Note 1 – Called side recognizes the value and changes its mode.

Note 2 – If this field exists, called side responds only when it has the capability indicated by the calling side.

APPENDIX VI

(to Recommendation T.90)

Recommended combinations of parameter values to ensure optimum throughput

	LLC IE							
	Octet	Bits	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Layer 2 mode	6a	7-6	Extended	Extended	Extended	Extended	Extended	Normal
k parameter	6b	7-1	80	40	20	10	7	7
Layer 3 mode	7a	7-6	Extended	Extended	Extended	Extended	Extended	Normal
Packet size	7b	4-1	128	256	512	1024	2048	2048
Layer 3 packet window size	7c	7-1	80	40	20	10	7	7

Note – The implementation of case 1 is strongly recommended.

APPENDIX VII

(to Recommendation T.90)

Alphabetical list of abbreviations used in this Recommendation

ABM Asynchronous balanced mode

ADM Asynchronous disconnected mode

BC Bearer capability

CS Circuit switched

CSPDN Circuit switched public data network

CUG Closed user group

DM Disconnected mode

EETDN End-to-end transit delay negotiation

FCS Frame check sequence

FI Format identifier

FRMR	Frame reject
GI	Group identifier
GL	Group length
HDLC	High-level data link control
HLC	High layer compatibility
IC	I-frame counter
IE	Information element
ISDN	Integrated services digital network
IWF	Interworking function
LLC	Low layer compatibility
LLC-IE	Low layer compatibility information element
MSN	Multiple subscriber number
NEF	Not expected frame
NL	Network layer
PHS	Physical service
PI	Parameter identifier
PL	Parameter length
PLP	Packet layer protocol
PS	Packet switched
PSPDN	Packet switched public data network
PSTN	Public switched telephone network
PV	Parameter value
RC	Redrive counter
RCB	Redrive counter busy
RPOA	Recognized private operating agency
SLP	Single link procedure
TA	Terminal adaptor
TDSAI	Transit delay selection and indication
TPDU	Transport protocol data unit
V_{su}	Variable for sequence updating
XID	Exchange identification