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Integrated Services Digital Network (ISDN); Support of CCITT Recommendation X.21, X.21 bis and X.20 bis based Data Terminal Equipments (DTEs) by an ISDN; Synchronous and asynchronous terminal adaption functions

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Foreword

This European Telecommunications Standard (ETS) was produced by the Signalling, Protocols and Switching (SPS) Technical Committee of the European Telecommunications Standards Institute (ETSI) and was adopted, having passed through the ETSI standards approval procedure.

This standard is based on the following considerations:

(a) the Integrated Services Digital Network (ISDN) will offer the universal interfaces to connect subscriber terminals according to the reference configurations described in CCITT Recommendation I.411;

(b) during the evolution of ISDN, however, there will exist for a considerable period DTEs conforming to CCITT Recommendations X.21, X.21bis and X.20bis which have to be connected to the ISDN;

(c) D-channel signalling protocol is described in ETS 300 125 and ETS 300 102-1;

(d) the X.21bis DTEs are an evolution of V-series DTEs, which also provide interworking capability with X.21 DTEs over PDN services, and which use the network provided signal element timing and may have specific call control features to comply with the X.21 calling protocol;

(e) the X.20bis based DTEs are an evolution of V-series DTEs, which are operating in the asynchronous mode and which may have call control features to comply with the X.20 calling protocol;

(f) this Standard is an application of CCITT Recommendations X.30 and V.110.

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Scope

(1) The scope of this standard covers the connection of X.21 and X.21bis based terminals of user classes of service 3 to 7 and 19 to the ISDN operating in accordance with circuit-switched or leased circuit services;

(2) The scope of this standard also covers the connection of X.20bis based Terminals of CCITT user classes of service 1 and 2, and 19200 bit/s and of asynchronous data rates of 600, 1200, 2400, 3600, 4800, 7200, 9600, 12000, 14400 to the ISDN operating in accordance with circuit-switched or leased circuit services;

(3) The reference configurations of paragraph 1 of this Standard shall apply;

(4) The terminal adaptor (TA) functions to support X.21, X.21bis and X.20bis based DTEs, including

- bit rate adaption functions,
- call establishment functions,
- mapping functions,
- ready for data alignment,

shall be performed as outlined in section 2.

(5) The scope of this standard only covers the bit rate conversion, which is caused by the connection of existing terminals to the ISDN user/network interface, but does not cover the requirements on bit rate conversion caused by the inter-operation of terminals with different bit rates (ISDN/CSPN interworking);

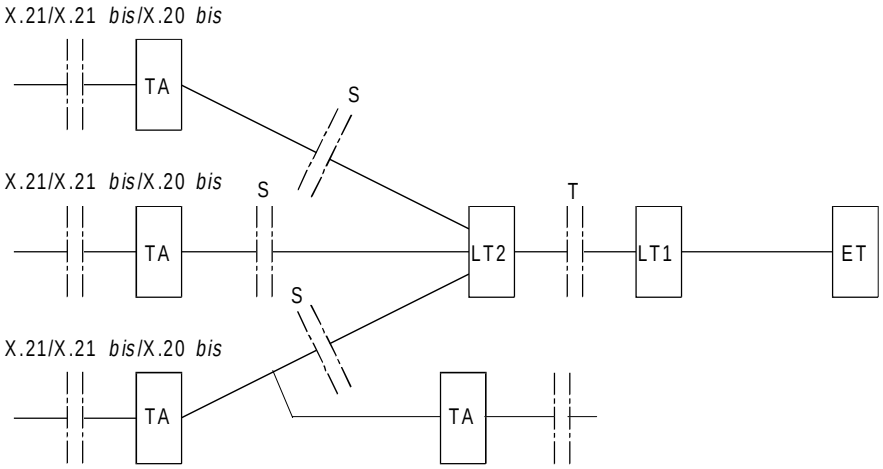
(6) This standard does not specify a particular implementation but specifies how the functions must be implemented when they are supported by a particular Terminal Adaptor equipment.

1 Reference configurations

Figures 1 and 2 show examples of possible configurations and are included simply as an aid to describing the TA functions.

1.1 Customer access configuration

For the connection of X.21, X.21bis and X.20bis based DTEs to the ISDN, figure 1 shows a possible reference configuration.



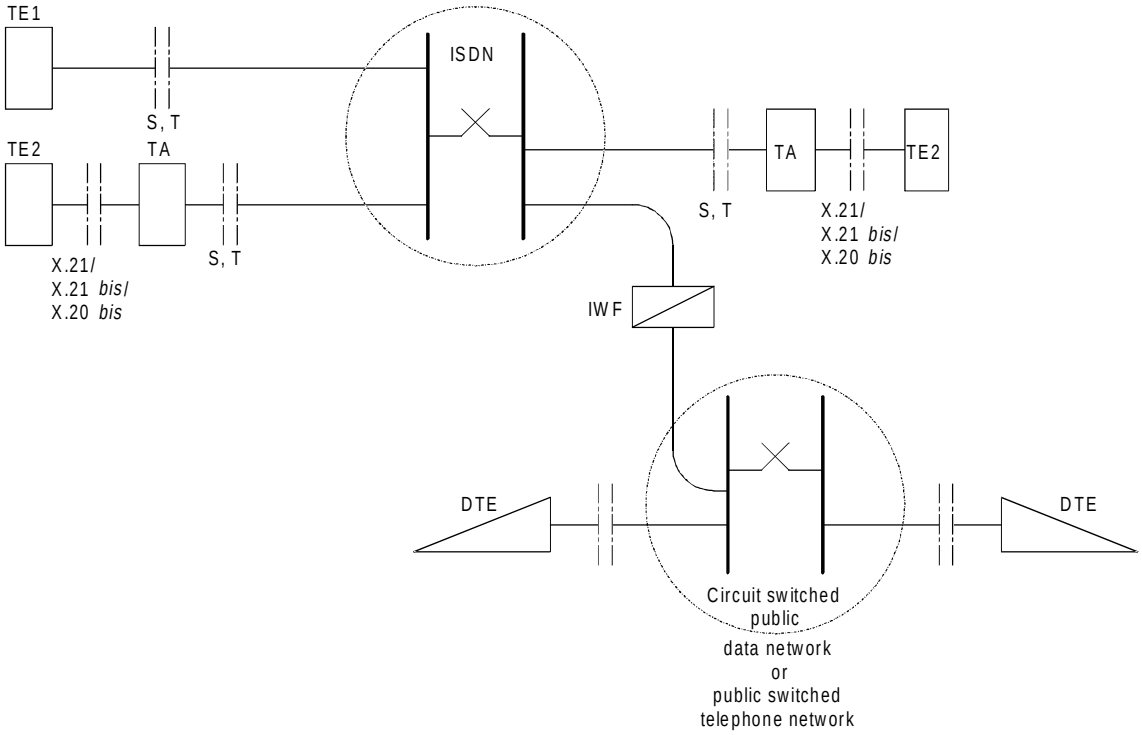
TA: Terminal adaptor
NT: Network termination
ET: Exchange termination

NOTE: The D-channel signalling protocol may operate in a point-to-multipoint fashion as described in ETS 300 102-1.

Figure 1: Customer access configuration example

1.2 Network configuration

The specification of terminal adaption functions takes account of the network configuration and the end-to-end connection types shown in figure 2 in which the associated terminal equipment TE1 and TE2 may be involved. The TA functions are described in section 2.



IWF: Interworking Functions

Figure 2: Network interworking configuration example
(The IWF are outside the scope of this standard)

The terminals TE1 and TE2 are physically and logically connected to the ISDN where the call is handled.

The TA performs the necessary bit rate adaption, the signalling conversion from X.21 signalling to the D-channel signalling and vice-versa (X.21 mapping) and ready for data alignment. Interworking with dedicated networks, e.g. a CSPDN, will be provided on the basis of trunk lines interconnection by using interworking functions (IWF).

The following principles shall apply:

i) The non-voice services within the ISDN should basically not diverge from what is being developed in X-Series of CCITT Recommendations. This refers to the various aspects concerning quality of service, user facilities, call progress signals (see e.g. X.2 and X.96). However existing features would be enhanced and additional features would also be developed if account were taken of the new ISDN customer capabilities (e.g. multiterminal arrangements, user rate at 64 kbit/s, simultaneous multimedia access as well as the possible solution for compatibility checking).

ii) Integration of X.21 based services into the ISDN is applicable to user classes of service 3 to 7 and 19. Integration of X.20bis based services into the ISDN is applicable to user classes of service 1 and 2, and other asynchronous user bit rates.

iii) Terminals TE1 and TE2 connected to an ISDN are using the ISDN numbering scheme (see CCITT Recommendation E.164).

1.3 Interworking situation

Bearing in mind that this ETS defines the functions performed by X.21 terminal adaptors (TA X.21), X.21bis terminal adaptors (TA X.21bis) and X.20bis terminal adaptors (TA X.20bis), the following cases of interworking between these terminal adaptors and between these terminal adaptors and DTEs connected to CSPDN and PSTN may appear :

a) For user class of service 3 to 7:

(1) TA X.21 TA X.21
(2) TA X.21 TA X.21bis
(3) TA X.21bis TA X.21bis
(4) TA X.21 DTE X.21
(5) TA X.21 DTE X.21bis
(6) TA X.21 V-series DTE
(7) TA X.21bis DTE X.21
(8) TA X.21bis DTE X.21bis
(9) TA X.21bis V-series DTE

b) For user class of service 19:

(10) TA X.21 TA X.21
(11) TA X.21 TA X.21bis
(12) TA X.21bis TA X.21bis
(13) TA X.21 TE1 (S/T reference point)
(14) TA X.21bis TE1 (S/T reference point)

c) For user classes of service 1 and 2, and other asynchronous user bit rates.

(15) TA X.20bis TA X.20bis
(16) TA X.20bis DTE X.20bis
(17) TA X.20bis V-series DTE

NOTE 1: This ETS is intended to cover all TA-functions necessary to allow interworking as listed above. Currently, this ETS covers all TA-functions necessary to allow interworking between DTEs connected to ISDN and to CSPDN with the following exceptions:

1) for X.21bis and X.20bis only, the call set-up procedure with direct call has been explicitly covered, but other interface arrangements of X.21bis and X.20bis are not precluded,

2) for X.21bis, the half duplex mode of operation is not specified.

This applies to all the cases listed above, where at least one X.21bis or X.20bis terminal is involved. Alignment with the functions provided by the interworking units may be necessary when the relevant Recommendations are available.

NOTE 2: With the interworking cases 1-17 mentioned above, the functions provided by TA X.21bis, TA X.20bis and the functions provided by TA V.110 should be compatible.

2 Terminal adaption functions

The adaption functions to support X.21, X.21bis and X.20bis based DTEs can be subdivided into three areas, namely:

- bit rate adaption function;
- mapping functions of X.21 to related D-channel call control signalling procedures ;
- ready for data alignment.

Separate TAs may be provided either for each CCITT Recommendation X.1 user class of service or for a group of user classes of service. A universal TA may be provided for all user classes of service 3 to 7 or 19 or 1, 2, or other asynchronous user bit rates. Within this ETS only such functions are described which refer to single rate TAs.

2.1 Adaption function for DTEs conforming to X.1 user classes of service 3 to 6

2.1.1 Bit rate adaption functions

2.1.1.1 General approach

The bit rate adaption functions within the TA are shown in figure 3. The function RA1 adapts the X.1 user rate to the next higher rate expressed by 2k times 8 kbit/s (where k = 0 or 1). RA2 performs a second conversion to 64 kbit/s.

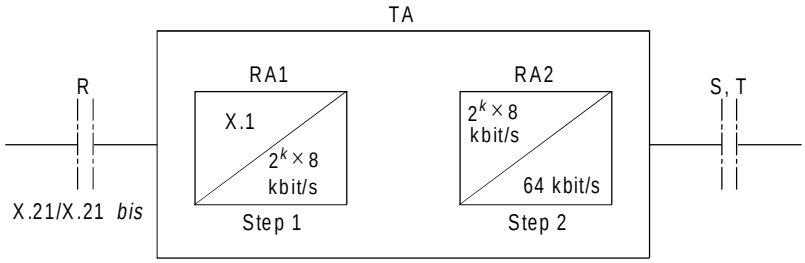


Figure 3: TA bit rate adaption functions

2.1.1.2 First step of rate adaption (RA1) of X.1 rates to the intermediate rates of 8/16 kbit/s

2.1.1.2.1 Frame structure

The conversion of X.1 rates for user classes 3, 4 and 5 to 8 kbit/s, and for user class 6 to 16 kbit/s, shall be implemented by means of the 40-bit frame structure shown in figure 4.

	Bit number							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Octet 0 Odd frames - Even frames -	0 1	0 E1	0 E2	0 E3	0 E4	0 E5	0 E6	0 E7
Octet 1	1	P1	P2	P3	P4	P5	P6	SQ
Octet 2	1	P7	P8	Q1	Q2	Q3	Q4	X
Octet 3	1	Q5	Q6	Q7	Q8	R1	R2	SR
Octet 4	1	R3	R4	R5	R6	R7	R8	SP

NOTE: Spare bit X, if not used for the optional flow control (see paragraph 2.4.2) or for indication of the far end synchronization loss, shall be set to 0 (see CCITT Recommendation I.463/V.110).

Figure 4

Figure 4 shows that in addition to the basic frame, a multiframe consisting of two basic frames is employed. In odd frames, octet 0 contains all zeros, whilst in even frames octet 0 consists of a one followed by seven E bits (see section 2.1.1.2.4). The order of bit transmission of the 40-bit frame is from left-to-right and from top-to-bottom.

2.1.1.2.2 Frame synchronization

The 17 bit frame alignment pattern consists of all 8 bits (set to zero) of octet 0 in odd frames and bit 1 (set to 1) of the following consecutive 9 octets of the 80-bit long multiframe (see also section 2.1.1.4.2). The first bit of octet 0 alternates between one and zero in consecutive frames and therefore provides a multiframe synchronization bit.

2.1.1.2.3 Status bits SP, SQ, SR

The bits SP, SQ and SR are used to convey channel associated status information. The mapping of the information on circuit C of the X.21 interface to S bits and the circuit I in the distant interface should be done in such a way that the SP, SQ and SR bits are associated with the bit-groups P, Q and R. To ensure proper and secure operation the mapping scheme has to be consistent with CCITT Recommendations X.21 and X.24.

The mechanism for mapping is as follows:

- In all cases where X.21-byte timing interchange circuit B is not provided, the status bits SP, SQ and SR of the bit groups R, Q and R are evaluated by sampling the C-lead in the middle of the 8th bit of the respective preceding bit group. On the other hand, the conditions of the status bits SP, SQ and SR are adopted by the I-lead beginning with the transition of the respective 8th bit of a bit-group R, P, and Q to the 1st bit of the consecutive bit group P, Q and R on the R-lead (see figure 5).

- In the case where X.21-byte timing interchange circuit B is provided for character alignment, the circuit C is sampled together with the bit 8 of the preceding character and the circuit I is changing its state at the boundaries between old and new characters at the circuit R. This operation is defined in CCITT Recommendation X.24.

NOTE 1: According to CCITT Recommendation X.21 the provision of the byte timing interchange circuit B is not mandatory.

NOTE 2: The status bits may be used to transfer, during the data transfer phase, information for half-duplex operation, between TA X.21bis and TA X.21 or TA X.21bis (i.e. mapping of the condition of the C-lead of the TA X.21, of the 105 lead of the TA X.21bis, to the condition on the 109 lead of the remote TA X.21bis, and mapping of the condition of the 105 lead of the TA X.21bis to the condition of the I-lead on the remote TA X.21).

NOTE 3: For bits SP, SQ, SR and X, a zero corresponds to the ON condition, a one to the OFF condition.

2.1.1.2.4 Additional signalling capacity (E bit)

The E bits provide the additional signalling capacity for the conveyance of information relating to user rate. The coding of these bits is shown in table 1.

Table 1

User rate (bit/s)	E1	E2	E3	E4	E5	E6	E7
600	1	0	0	X	X	X	0 or 1 (Note 1)
1200	1	0	1	X	X	X	1
2400	1	1	0	X	X	X	1
4800	0	1	1	X	X	X	1
9600	0	1	1	X	X	X	1

X: Indicates spare bits which may be used for the transport of Network Independent Clocking information (see Annex H). Should be set to 1 when not used.

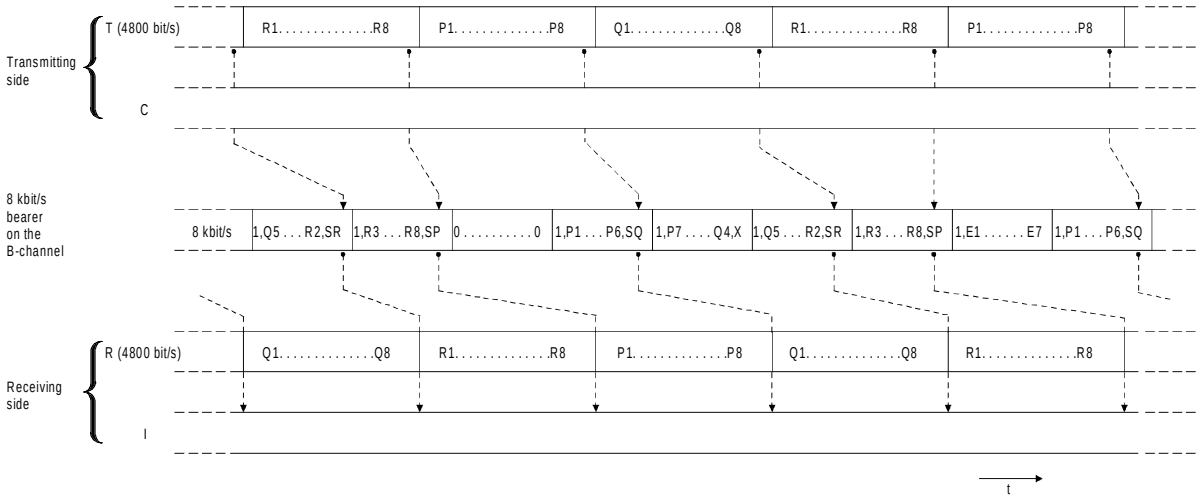


Figure 5: Mapping of status information to the bit stream

NOTE 1: For the 600 bit/s user rate E7 is coded to enable the 8 x 40 bit frame group synchronization. To this aim, E7 in those 40-bit frames which terminate a frame group are set to zero (see section 2.1.1.2.6 and figure 6a).

NOTE 2: Different user rates with the same coding are distinct by different intermediate rates.

NOTE 3: The coding of the user rates provides also for user rates specified for the TA recommended in CCITT Recommendation V.110.

NOTE 4: It should be noted that possible future use of bits E4 to E6 may be used in CCITT Recommendation V.110 for the transport of network independent checking information (see Annex H).

NOTE 5: Asynchronous rate information must be determined by the use of out-of-band (D-channel) signalling. Synchronous rate information may be determined by the use of E1, E2, E3 bits in conjunction with the intermediate rate.

2.1.1.2.5 Data bits

Data is conveyed in P, Q and R bits, i.e. 24 bits per frame.

2.1.1.2.6 Repetition strategy

For the adaption of user rates 600, 1200, 2400, 4800 bit/s to the 8 kbit/s intermediate rate and of the 9600 bit/s user rate to the 16 kbit/s intermediate rate, the sequence of even and odd octet 0 shall be maintained as defined in figure 6. In order to achieve both short frame synchronization as well as short transfer delay times a user-bit repetition method is defined. Figures 6a and 6b contain a scheme for the adaption of the 600 bit/s user rate and of the 2400 bit/s rate respectively on to the 8 kbit/s bearer rate. Figures 6c and 6d show the adaption of the 4800 bit/s user rate to the 8 kbit/s bearer rate and of the 9600 bit/s user rate to the 16 kbit/s bearer rate.

In the case of a 600 bit/s user rate, an explicit frame group synchronization pattern using bit E7 is provided to ensure preservation of user-octet boundaries and associated status bit. The coding for the E7 bit shall be as follows :

... 1110111011101 ...

where the value 0 is marking the last 40-bit frame of each 8 x 40 bit frame group which contains three integer user octets.

0	0	0	0	0	0	0	0
1	P1	P1	P1	P1	P1	P1	SP
1	P1	P1	P2	P2	P2	P2	X
1	P2	P2	P2	P2	P3	P3	SP
1	P3	P3	P3	P3	P3	P3	SP
1	1	0	0	E4	E5	E6	1
1	P4	P4	P4	P4	P4	P4	SP
1	P4	P4	P5	P5	P5	P5	X
1	P5	P5	P5	P5	P6	P6	SP
1	P6	P6	P6	P6	P6	P6	SP
0	0	0	0	0	0	0	0
1	P7	P7	P7	P7	P7	P7	SP
1	P7	P7	P8	P8	P8	P8	X
1	P8	P8	P8	P8	Q1	Q1	SQ
1	Q1	Q1	Q1	Q1	Q1	Q1	SQ
1	1	0	0	E4	E5	E6	1
1	Q2	Q2	Q2	Q2	Q2	Q2	SQ
1	Q2	Q2	Q3	Q3	Q3	Q3	X
1	Q3	Q3	Q3	Q3	Q4	Q4	SQ
1	Q4	Q4	Q4	Q4	Q4	Q4	SQ
0	0	0	0	0	0	0	0
1	Q5	Q5	Q5	Q5	Q5	Q5	SQ
1	Q5	Q5	Q6	Q6	Q6	Q6	X
1	Q6	Q6	Q6	Q6	Q7	Q7	SQ
1	Q7	Q7	Q7	Q7	Q7	Q7	SQ
1	1	0	0	E4	E5	E6	1
1	Q8	Q8	Q8	Q8	Q8	Q8	SR
1	Q8	Q8	R1	R1	R1	R1	X
1	R1	R1	R1	R1	R2	R2	SR
1	R2	R2	R2	R2	R2	R2	SR
0	0	0	0	0	0	0	0
1	R3	R3	R3	R3	R3	R3	SR
1	R3	R3	R4	R4	R4	R4	X
1	R4	R4	R4	R4	R5	R5	SR
1	R5	R5	R5	R5	R5	R5	SR
1	1	0	0	E4	E5	E6	0
1	R6	R6	R6	R6	R6	R6	SR
1	R6	R6	R7	R7	R7	R7	X
1	R7	R7	R7	R7	R8	R8	SR
1	R8	R8	R8	R8	R8	R8	SP

Figure 6a: Adaption of the 600 bit/s user rate to the 8 kbit/s bearer rate

0	0	0	0	0	0	0	0
1	P1	P1	P2	P2	P3	P3	SP
1	P4	P4	P5	P5	P6	P6	X
1	P7	P7	P8	P8	Q1	Q1	SQ
1	Q2	Q2	Q3	Q3	Q4	Q4	SQ
1	1	1	0	E4	E5	E6	E7
1	Q5	Q5	Q6	Q6	Q7	Q7	SR
1	Q8	Q8	R1	R1	R2	R2	X
1	R3	R3	R4	R4	R5	R5	SR
1	R6	R6	R7	R7	R8	R8	SP

Figure 6b: Adaption of the 2400 bit/s user rate to the 8 kbit/s bearer rate

0	0	0	0	0	0	0	0
1	P1	P2	P3	P4	P5	P6	SQ
1	P7	P8	Q1	Q2	Q3	Q4	X
1	Q5	Q6	Q7	Q8	R1	R2	SR
1	R3	R4	R5	R6	R7	R8	SP
1	0	1	1	E4	E5	E6	E7
1	P1	P2	P3	P4	P5	P6	SQ
1	P7	P8	Q1	Q2	Q3	Q4	X
1	Q5	Q6	Q7	Q8	R1	R2	SR
1	R3	R4	R5	R6	R7	R8	SP

Figure 6c: Adaption of the 4800 bit/s user rate to the 8 kbit/s bearer rate

0	0	0	0	0	0	0	0
1	P1	P2	P3	P4	P5	P6	SQ
1	P7	P8	Q1	Q2	Q3	Q4	X
1	Q5	Q6	Q7	Q8	R1	R2	SR
1	R3	R4	R5	R6	R7	R8	SP
1	0	1	1	E4	E5	E6	E7
1	P1	P2	P3	P4	P5	P6	SQ
1	P7	P8	Q1	Q2	Q3	Q4	X
1	Q5	Q6	Q7	Q8	R1	R2	SR
1	R3	R4	R5	R6	R7	R8	SP

Figure 6d: Adaption of the 9600 kbit/s user rate to the 16 kbit/s bearer rate

0	0	0	0	0	0	0	0
1	P1	P1	P1	P1	P2	P2	SP
1	P2	P2	P3	P3	P3	P3	X
1	P4	P4	P4	P4	P5	P5	SP
1	P5	P5	P6	P6	P6	P6	SP
1	0	1	0	E4	E5	E6	E7
1	P7	P7	P7	P7	P8	P8	SQ
1	P8	P8	Q1	Q1	Q1	Q1	X
1	Q2	Q2	Q2	Q2	Q3	Q3	SQ
1	Q3	Q3	Q4	Q4	Q4	Q4	SQ

0	0	0	0	0	0	0	0
1	Q5	Q5	Q5	Q5	Q6	Q6	SQ
1	Q6	Q6	Q7	Q7	Q7	Q7	X
1	Q8	Q8	Q8	Q8	R1	R1	SR
1	R1	R1	R2	R2	R2	R2	SR
1	0	1	0	E4	E5	E6	E7
1	R3	R3	R3	R3	R4	R4	SR
1	R4	R4	R5	R5	R5	R5	X
1	R6	R6	R6	R6	R7	R7	SR
1	R7	R7	R8	R8	R8	R8	SP

Figure 6e: Adaption of the 1200 bit/s user rate to the 8 kbit/s bearer rate

2.1.1.3 Second step of rate adaption (RA2)

As rate adaption of a single substream (8/16 kbit/s) to 64 kbit/s and multiplexing of several substreams to 64 kbit/s have to be compatible to enable interworking, a common approach is needed for second step rate adaption and for subchannel multiplexing. It complies with CCITT Recommendation I.460 and is as follows.

The procedure will be used to adapt the rate of a single stream at 8,16 or 32 kbit/s into a 64 kbit/s B-channel. Bit positions in the B-channel octet are assumed to be numbered from 1 to 8 with bit position 1 being transmitted first.

The procedure requires that:

i) the 8 kbit/s stream occupies bit position 1; the 16 kbit/s stream occupies bit positions (1, 2); the 32 kbit/s stream occupies bit positions (1, 2, 3, 4);

ii) the order of transmission of the bits of the subrate stream is identical before and after rate adaption; and

iii) all unused bit positions be set to binary 1.

2.1.1.4 Framing/reframing method and user rate identification

For framing/reframing and user rate identification, the following strategies shall be applied.

2.1.1.4.1 Search for frame alignment

The following 17 bit alignment pattern is searched for:

```
000000   1XXXXXXX 1XXXXXXX 1XXXXXXX 1XXXXXXX
XXXXXX   1XXXXXXX 1XXXXXXX 1XXXXXXX 1XXXXXXX
```

No errors shall be tolerated in the defined bit positions (i.e. all bit position excluding those denoted by "X").

It is assumed that the error rate will be sufficiently low to expect alignment following the detection of one 80-bit multiframe.

In the case of X.1 user class of service 3 (600 bit/s), a further search for the frame group synchronization pattern contained in bit position E7 shall be performed.

2.1.1.4.2 Alignment monitoring/recovery

The monitoring of the alignment shall be a continuous process. The alignment is assumed to be correct if there is no error in the 17 bit alignment pattern of the 80-bit multiframe.

Loss of alignment is assumed following the detection of N (provisional value: 3) consecutive multiframes each with at least one alignment error.

Following loss of alignment the TA shall enter a recovery state which is indicated at the X.21 interface by r = 1 and i = ON. In the transmitted frame, bit X, if used for the indication of the frame synchronization to the far end, shall be set to OFF.

If the recovery of alignment is achieved, r and i leads give the data and status information respectively from the received frames; bit X, if used in the transmitted frames, must be set to the ON condition.

If the recovery of alignment is not achieved within a fixed period, the TA shall indicate state DCE not ready by signalling r = 0, i = OFF. The duration of this period is network dependent (as in CCITT Recommendation X.21, paragraph 2.6.2). In case of a circuit switched service this leads to the clearing of the connection.

In the case of an X.21bis TA, the signalling procedure defined in paragraph 4.1.5.(e) of CCITT Recommendation V.110 shall be used at the R-reference point.

2.1.1.4.3 Identification of intermediate bit rate

As a basic approach the intermediate bit rate is derived from the X.1 user rate contained in the SETUP message of the D-channel protocol.

2.1.2 X.21/X.21bis to D-channel protocol mapping

The D-channel signalling capabilities of the ISDN customer-access as defined in ETS 300 102-1 have to include the requirements arising from the mapping of the X.21 and X.21bis interface signalling procedures to the D-channel protocol at the S/T reference point.

The logical representation of these mapping functions is shown in Figure 7:

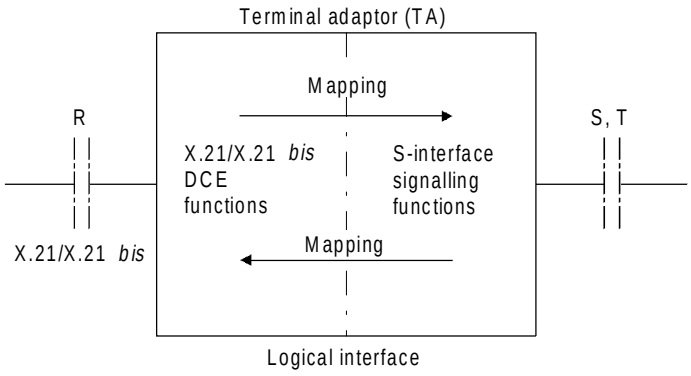


Figure 7

The D-channel signalling capabilities provided to X.21 and X.21bis based terminals shall comprise the signalling messages as defined in ETS 300 102-1, supported by a data link layer as specified in ETS 300 125.

The following description and figures depict examples of X.21 and X.21bis mapping to the ISDN call control procedures. It is recognized that other possibilities and user options exist but this section is intended to provide general guidelines on X.21 and X.21bis support. Only the normal call establishment and clearing procedures are shown.

NOTE 1: Annex F contains an SDL description of the mapping of the R-interface procedures to the S-interface procedures. However, the TA-internal processes and states contained in the SDL-diagrams are understood not to be binding for implementation.

NOTE 2: Manual direct or addressed calls and manual disconnection from the TA should also be possible through the mapping of standard DTE/TA interface procedures with manual operations at the TA. In addition, automatic addressed calls may be possible by the DTE employing a V.25/V.25bis interface between the DTE and TA (see CCITT Recommendation V.110).

Annex C to this Standard gives the list of messages that must be implemented by the TA, and the various information elements that may be contained in these messages and which, as a minimum, must be recognised by a TA, without creating a protocol error.

2.1.2.1 D-channel protocol to X.21 mapping (see figures 8 and 9)

The following sections are titled with the names of signalling messages at the S-interface.

2.1.2.1.1 SETUP (from terminal adaptor to the network)

In the Ready state (state 1) both DTE and TA transmit (1,OFF) across the X.21 interface.

When the calling DTE indicates a call request (state 2, t = 0, c = ON) at X.21 interface, the TA transmits a proceed to select signal (state 3) to the DTE (+,OFF). The DTE begins to send selection signals to the TA (state 4).

When an end of selection (t = +, c = ON) is received at the X.21 interface, the TA transmits a SETUP message via the D-channel of the S-interface, requesting for the unrestricted 64 kbit/s bearer capability. The DCE waiting state (state 6A r = SYN, i = OFF) is then entered at the X.21 interface.

The Bearer capability information element included in the SETUP message shall be coded with:

- information transfer capability set to "unrestricted digital information"
- transfer mode set to "circuit mode"
- information rate set to "64 kbit/s".

NOTE: Bearer capability information element octets 4a and 4b shall not be included.

The user may also specify the layer 1 (e.g. rate adaption), layer 2 (e.g. LAPB) and layer 3 (e.g. X.25) information transfer protocols in the Low layer compatibility information element in the SETUP message (see ETS 300 102-1 annex L entitled "Low Layer information coding principles").

NOTE: See also Annex I for further information on BC, LLC and HLC coding.

En-bloc sending shall be used, i.e. the complete address of the called party shall be included in the Called party number information element of the SETUP message. If the Sending complete information element is included in the SETUP message, SETUP ACKNOWLEDGE is not allowed as a response (see sections 5.1.1 and 5.1.3 of ETS 300 102-1).

2.1.2.1.2 SETUP ACKNOWLEDGE/CALL PROCEEDING (from network)

When the SETUP ACKNOWLEDGE or the CALL PROCEEDING message is received on the D-channel of the S-interface, the B-channel will be allocated and TA connects to the B-channel and transmits (1, OFF) (within the 80-bit multiframes in the case of user classes 3 to 6) via the B-channel at the S/T reference point.

When a CALL PROCEEDING message is received subsequently to the SETUP ACKNOWLEDGE message, no further action is entailed in the TA.

2.1.2.1.3 ALERTING (from network)

The ALERTING message is only used with manual answering, but all TA's must be able to receive it.

When an ALERTING message is received on the D-channel at the S/T reference point, the TA transmits call progress signals (state 7) to the calling DTE.

Afterwards the state DCE waiting (state 6A, r = SYN, i = OFF) is entered at the X.21 interface.

2.1.2.1.4 CONNECT (from network)

When a CONNECT message is received on the D-channel at the S/T reference point, the TA connects to the B-channel if not yet connected and transmits any DCE provided information (state 10, r = IA5, i = OFF) to the calling DTE. Afterwards the state Connection in progress (state 11) is entered at the X.21 interface.

When the frame alignment pattern of the 80-bit multiframe (in the case of CCITT Recommendation X.1 user classes 3 to 6) is received on the B-channel at the S/T reference point, the TA performs switch-through.

When the calling DTE receives (1, ON) via the through-connected B-channel at the X.21 interface, the calling DTE enters the state Ready for data (state 12) and data transfer (state 13) can begin.

2.1.2.1.5 SETUP (from network)

The TA shall not accept a SETUP message unless the X.21 interface is in the Ready state. When SETUP message is received on the D-channel at the S/T reference point the TA shall follow the procedures for determining compatibility checking (e.g. data signalling rate) found in ETS 300 102-1. If the TA determines that it can respond to the incoming call, it follows the procedures of ETS 300 102-1. It is expected that ALERTING message would only be used with terminals that answer manually.

The TA transmits an incoming call (r = Be1, i = OFF) via the X.21 interface to the called DTE, and the Incoming call state (state 8) is entered.

Call offering procedure in a multiterminal configuration is described in section 2.1.3.

For the coding of the BC, HLC and LLC information elements see Annex I.

Within the TA the provision of terminal selection function using addressing information is optional. If terminal selection is not provided, the TA shall respond to every incoming SETUP message for which the compatibility checking has been successful (see ETS 300 102-1, Annex B).

2.1.2.1.6 CONNECT (from terminal adaptor)

When a call accepted (state 9, t = 1, c = ON) is received from the called DTE, the TA transmits a CONNECT message via the D-channel at the S/T reference point.

The use of LLC in the CONNECT message for LLC negotiation according to ETS 300 102-1 Annex M is optional.

2.1.2.1.7 CONNECT ACKNOWLEDGE (from network)

When a CONNECT ACKNOWLEDGE message is received on the D-channel at the S/T reference point, the TA, selected by message, transmits 1/OFF via the allocated B-channel and signals Connection in progress (state 11, r = 1 , i = OFF) to the DTE after delivering DCE provided information if any.

The TA performs switch-through after the frame alignment pattern (80-bit multiframe in the case of user classes 3 to 6) has been received via the B-channel at the S/T reference point.

When the called DTE receives 1, ON via the switched through B-channel on the X.21 interface, the Ready for data state (state 12) is entered and data transfer (state 13) can begin.

2.1.2.1.8 RELEASE (from network)

In the case of a multiterminal configuration, the exchange termination sends a RELEASE message to each TA that had signalled CALL PROCEEDING, ALERTING or CONNECT but which was not selected for the call. Subsequently the TA performs the DCE clear indication procedure at the X.21 interface and sends a RELEASE COMPLETE message to the network.

2.1.2.1.9 DISCONNECT (from terminal adaptor)

A DTE clear request (state 16, t = 0, c = OFF) is transmitted via the B-channel from the clearing to the cleared DTE.

The TA at the clearing DTE recognizes the state 16 at the X.21 interface, separates the R and I leads from the B-channel and transmits a DCE clear confirmation (state 17, r = 0, i = OFF) to the clearing DTE. It transmits also a DISCONNECT message via the D-channel at the S/T reference point (see figure 8), and then releases the B-channel.

After reception of a RELEASE message on the D-channel, the TA tears down the B-channel, sends a RELEASE COMPLETE message to the network, transmits DCE ready (r = 1, i = OFF) to the DTE and the DTE enters the state DTE ready (t = 1, c = OFF).

When the DTE initiates DTE clear request (t = 0, c = OFF) this status is transmitted in-slot within the B-channel and received as a DCE clear indication (r = 0, i = OFF) in the DTE (see figure 9).

After the TA to be cleared has received DTE clear confirmation (t = 0, c = OFF) from the DTE, it transmits a DISCONNECT message via the D-channel and clears the B-channel.

After reception of a RELEASE message on the D-channel the TA releases the call reference, sends a RELEASE COMPLETE message to the network, transmits DCE ready (state 21, r = 1, i = OFF) to the DTE, and the DTE enters the state DTE ready (t = 1, c = OFF).

2.1.2.1.10 DISCONNECT (from network)

In the case of clearing by the network the local exchange transmits the DISCONNECT message via the D-channel to the terminal which has to be cleared. After reception of the DISCONNECT message in the TA, the TA transmits a RELEASE message on the D-channel to the network.

If the X.21 interface is in the call establishment phase and has not yet reached state 11 or 12, and if the DISCONNECT message contains the reason for clearing, the TA moves to state 7 and transmits the corresponding call progress signal prior to signalling the DCE clear indication (see section 2.1.5).

Otherwise the TA transmits the state DCE clear indication (r = 0, i = OFF) via the X.21 interface to the DTE, which sends back to the TA the state DTE clear confirmation (t = 0, c = OFF).

The procedure described above is not shown in the figures 8 and 9.

2.1.2.1.11 RELEASE COMPLETE (from network)

When the RELEASE COMPLETE message is received via the D-channel at the S/T reference point in the TA of clearing or cleared DTE, THE DCE ready state (state 21 = 1,OFF) and the DTE ready state (state 1 = 1,OFF) are entered. The B-channel and the call reference are then released.

2.1.2.2 X.21bis (direct call), V.25 and V.25bis

See figures 10 and 11.

NOTE: The figures 10 and 11 depict some examples of X.21bis support. Only the conditions on principal interchange circuits have been shown and options such as the use of circuits 105/109, 108.2, etc., have not been included.

2.1.3 Call offering procedure in a multiterminal configuration.

For a call offering procedure in a multiterminal configuration the following general description applies.

In case of a multiterminal configuration, an incoming call (SETUP message containing appropriate service indication information) is offered according to ETS 300 102-1.

When a SETUP message is received on the D-Channel at the S/T reference point the TA shall follow the procedures for determining compatibility checking (e.g. data signaling rate) found in ETS 300 102-1. It is expected that the ALERTING message would only be used by terminals that answer manually.

If the TA supports a compatible terminal, but cannot accept the call, because the terminal is not in the Ready state, a RELEASE COMPLETE message has to be returned by the TA (see figure 13). If the state of the terminal is:

a) - Controlled not Ready, then the RELEASE COMPLETE message has cause # 21, "call rejected";

b) - Uncontrolled not Ready, then the RELEASE COMPLETE message has cause # 27, "destination out of order"

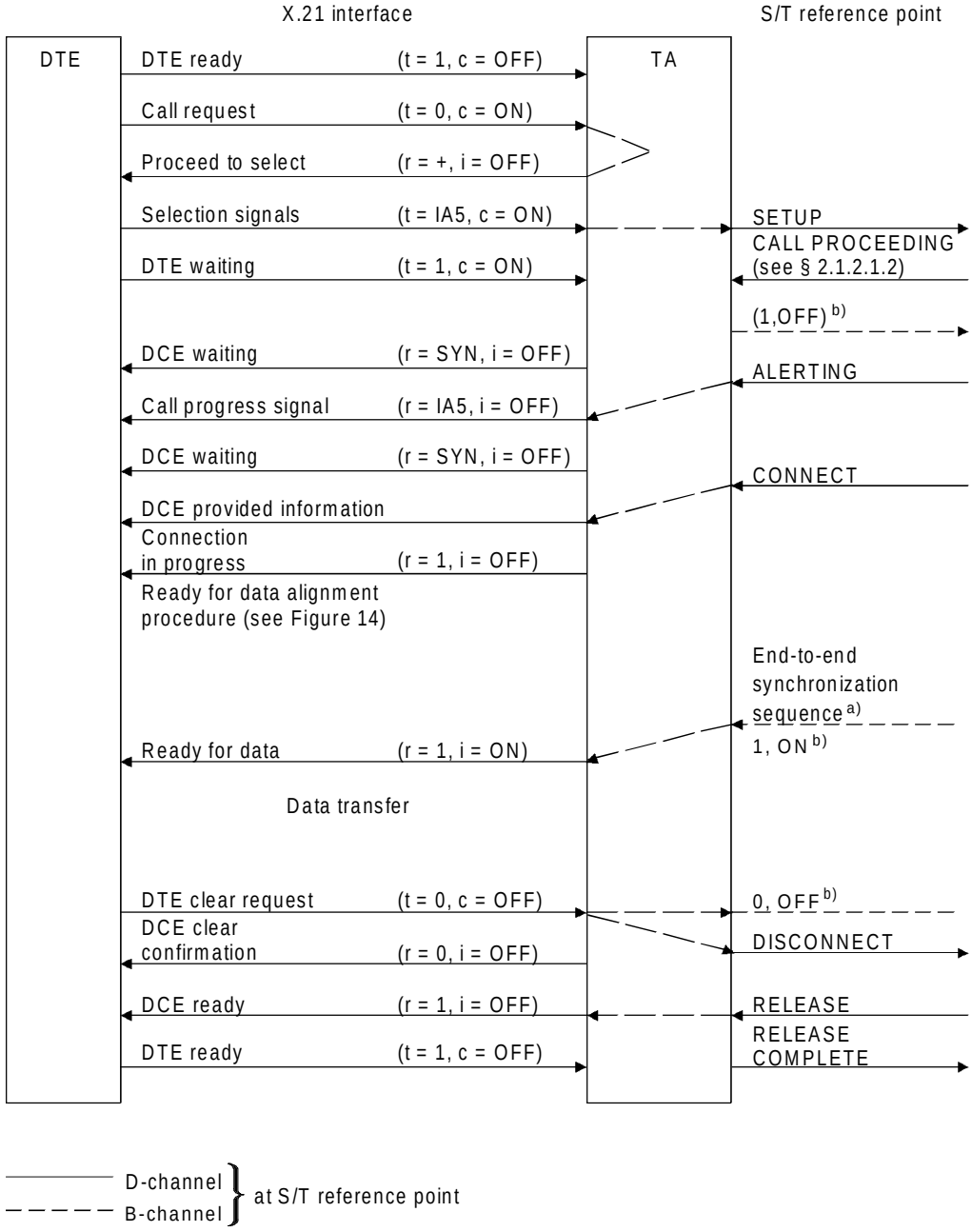
c) - Busy, when the RELEASE COMPLETE message has cause # 17", user busy".

This message is forwarded to the calling side to provide the appropriate X.21 call progress signals. Its mapping in the calling TA is described in section 2.1.5.

If more than one TA have responded, the message to be forwarded, including the cause to be indicated, is derived according to the priority rules of ETS 300 102-1.

In case several TAs have accepted the incoming call by returning a CONNECT message, the TA selected by the network receives the CONNECT ACKNOWLEDGE message. The TAs not selected for the call are cleared by the network by means of a RELEASE message.

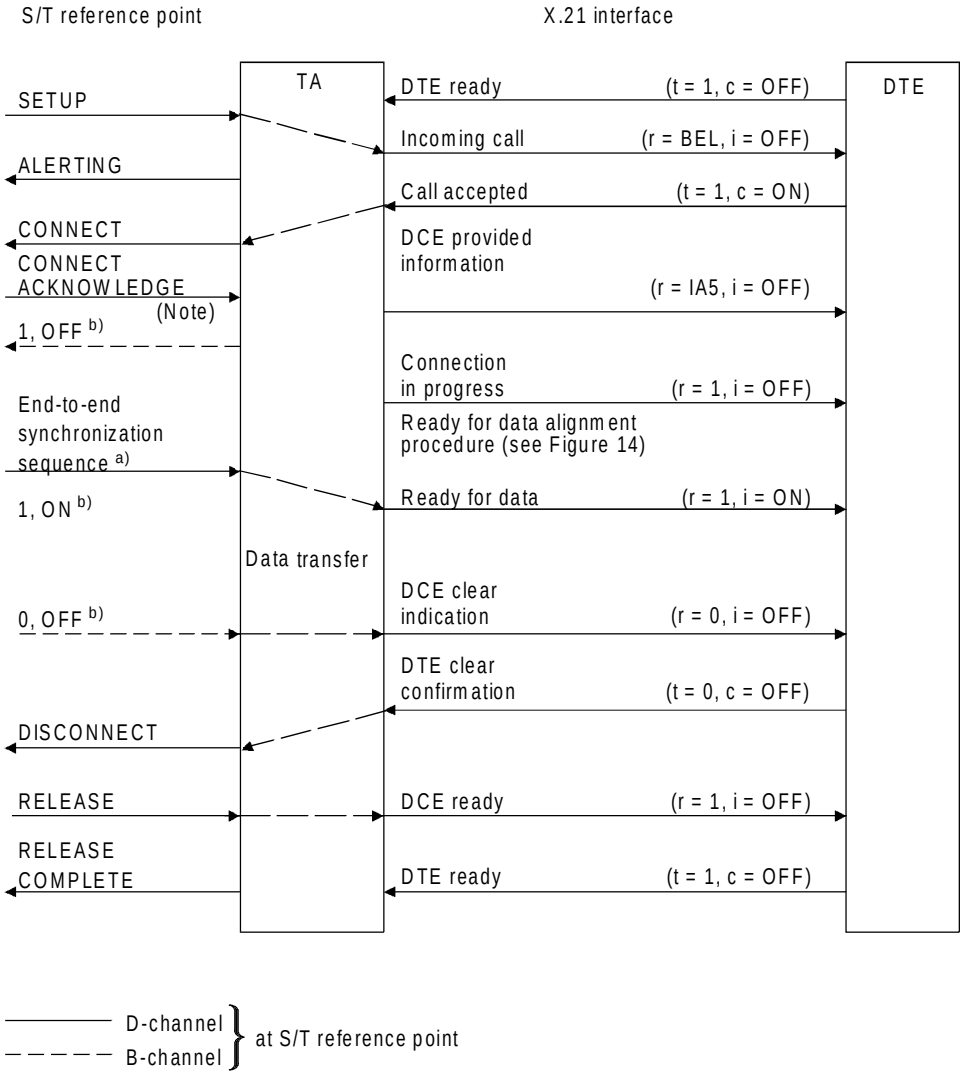
In multiterminal configuration, a number of terminals and terminal adaptors can be contending for access to the D-channel. The contention resolution mechanism may result in delays of the outgoing signalling messages and could therefore affect the call set-up time. Call failure information transmission to the calling side may be delayed also by the priority rule procedure mentioned above.



(a) For user class 19, see figure 15
(b) Not applicable for user class 19

NOTE: The above and following figures do not show the case of outgoing-incoming call collision. This is described in section 2.1.6.

Figure 8: X.21 - calling and clearing DTE example



(a) For user class 19, see figure 15
(b) Not applicable for user class 19.

NOTE: In the case of a multiterminal configuration, the network sends a RELEASE message to each TA that has signalled CALL PROCEEDING, ALERTING, or CONNECT, but which was not selected for the call.

Figure 9: X.21 - Called and cleared DTE example

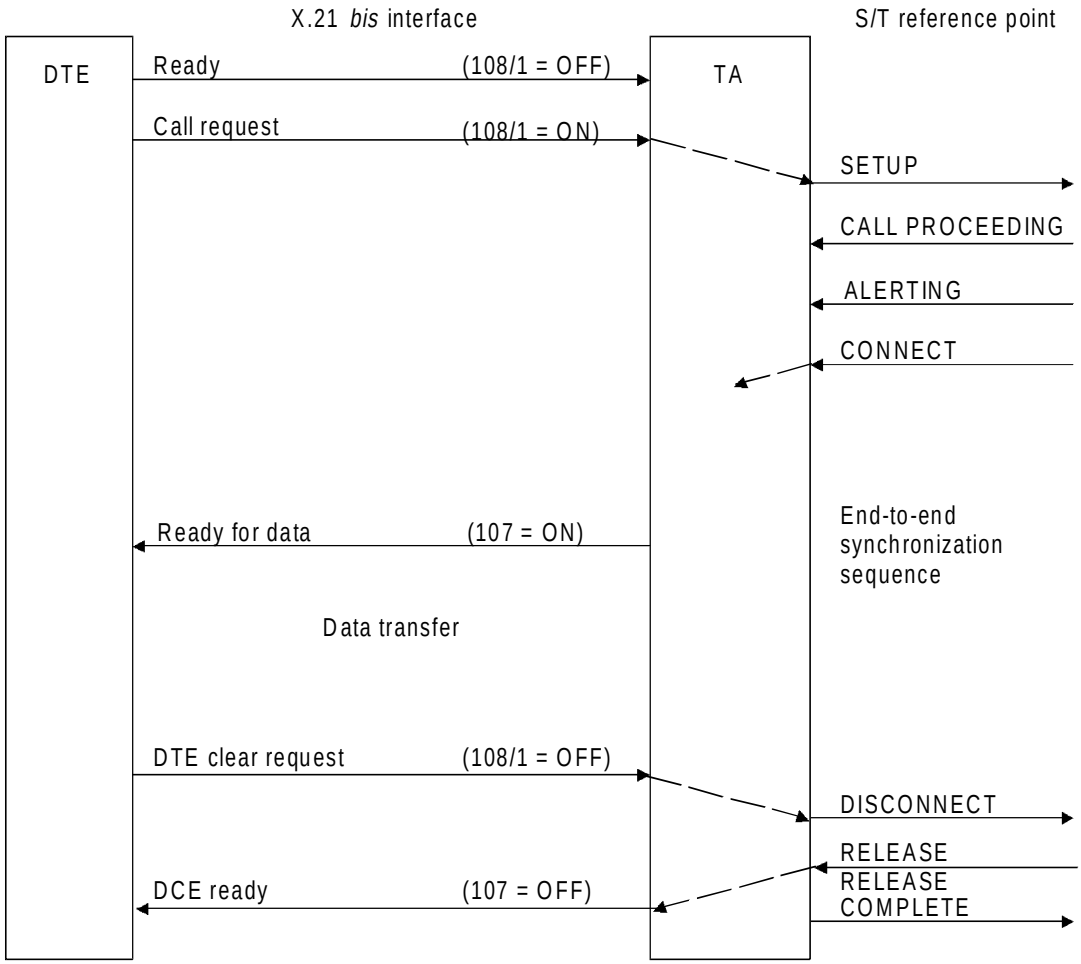
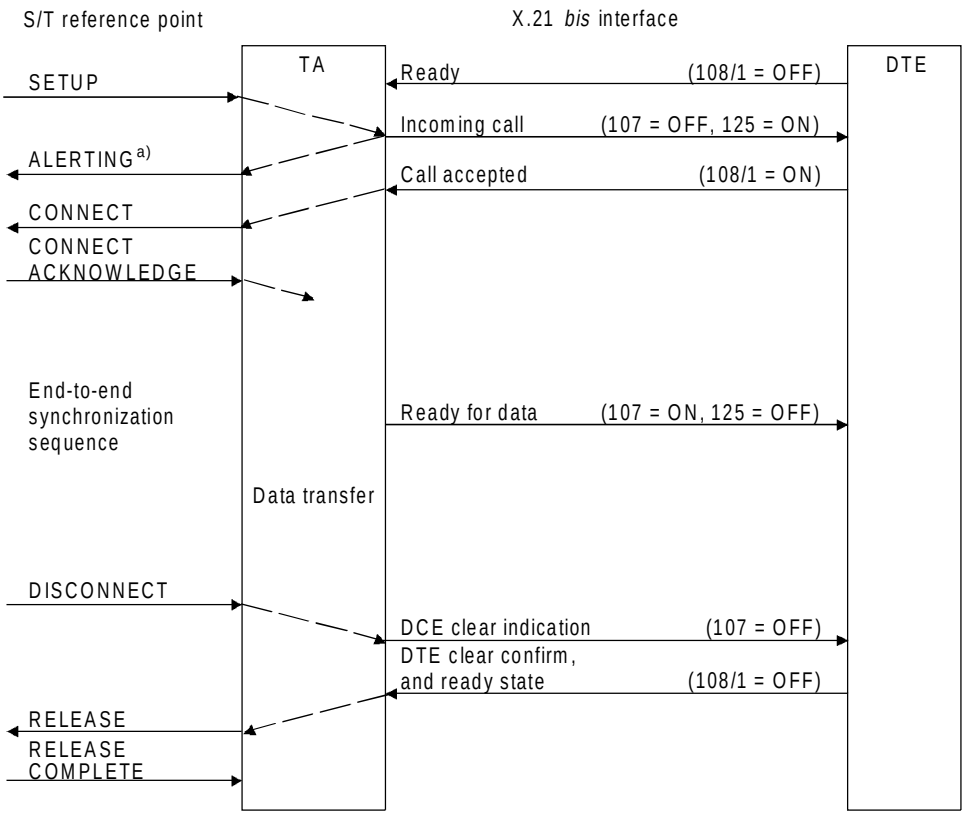
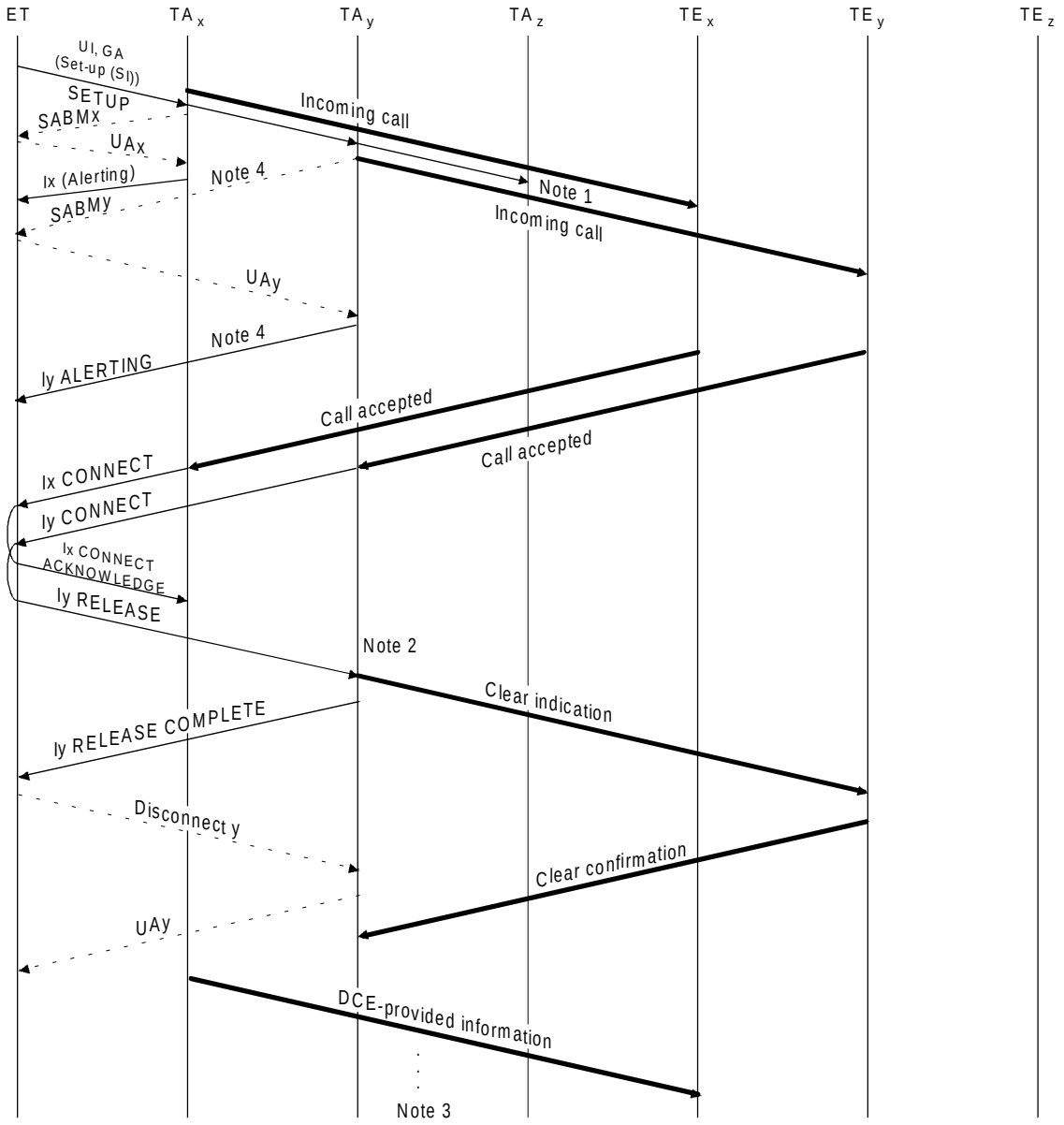


Figure 10: X.21bis - calling and clearing DTE example



(a) Use only with manual answering

Figure 11: X.21bis - called and cleared DTE example



GA	Global Address
SI	Service Indication information

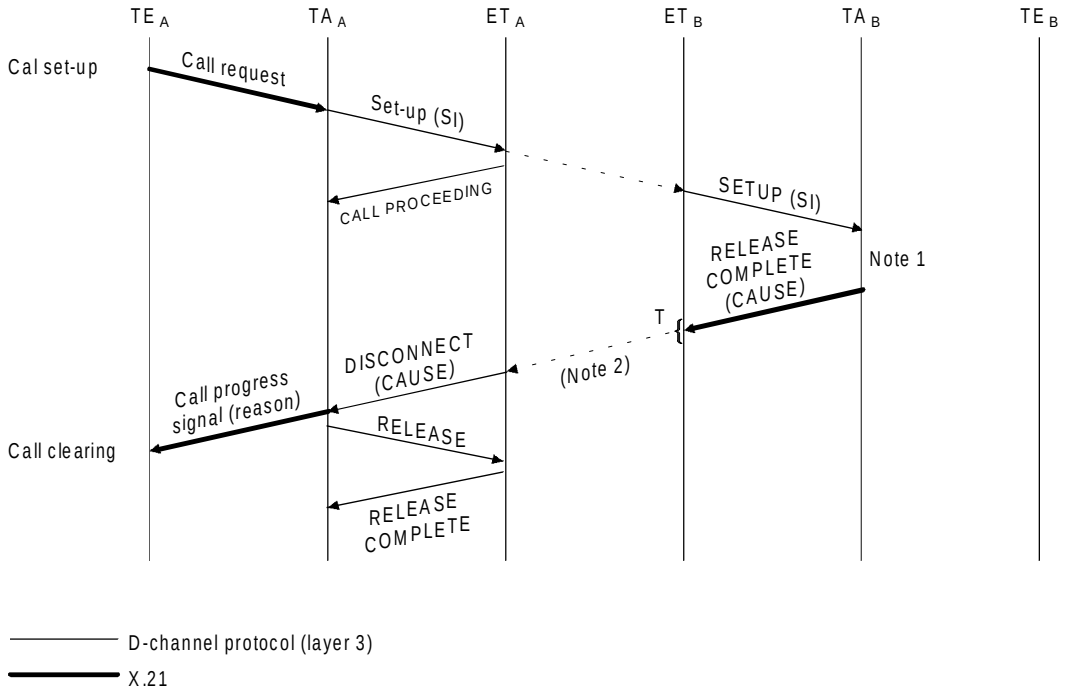
NOTE 1: TAz does not respond to the SETUP message because it is supporting a terminal which is not compatible with the calling terminal. However, TAz may alternatively respond with a RELEASE COMPLETE message with the cause #88, "incompatible destination".

NOTE 2: The TA's which had sent an ALERTING or CONNECT message but were not selected for the call by the exchange are notified by a RELEASE message.

NOTE 3: For further mapping of X.21 to D-channel protocol refer to figure 9.

NOTE 4: ALERTING messages are only used for the manual answering case.

Figure 12: Call offering procedure in a multiterminal configuration (example)



SI: Service Indication information

NOTE 1: RELEASE COMPLETE message including the appropriate cause code is sent by a TA supporting a terminal which is compatible with the information contained in the SETUP message, to indicate that the call cannot be accepted at this time for the following reasons: controlled not ready, uncontrolled not ready, busy condition of the called terminal, etc.

NOTE 2: In the case of ETB receiving a RELEASE COMPLETE message indicating an unsuccessful call or rejected call, the ETB will wait a period T before forwarding an unsuccessful call indication to the calling end. If during this period T, ETB receives further responses it will take the following action:

- if an ALERTING or CONNECT message is received, only the positive response will be forwarded to the calling side;

- if other clearing messages are received, then only one negative response will be forwarded to the calling side, the selection of the negative response being made according to the procedures in ETS 300 102-1, giving priority to causes as follows:

1) Cause # 17, "user busy",
2) Cause # 21, "call rejected",
3) Any other cause

The value of T is defined as timer T303 in ETS 300 102-1.

Figure 13: Negative response to incoming call (example)

2.1.4 Ready for data Alignment

The task of synchronizing the entry to and exit from the data transfer phase between two subscriber terminals shall be performed by the terminal adaptors and subscriber terminals. For this purpose the X.21 procedure with in-slot handshaking shall be used.

Two cases exist, one where the called TA supports only one data user rate and the other where the called TA will adapt to the data user rate of the calling TA.

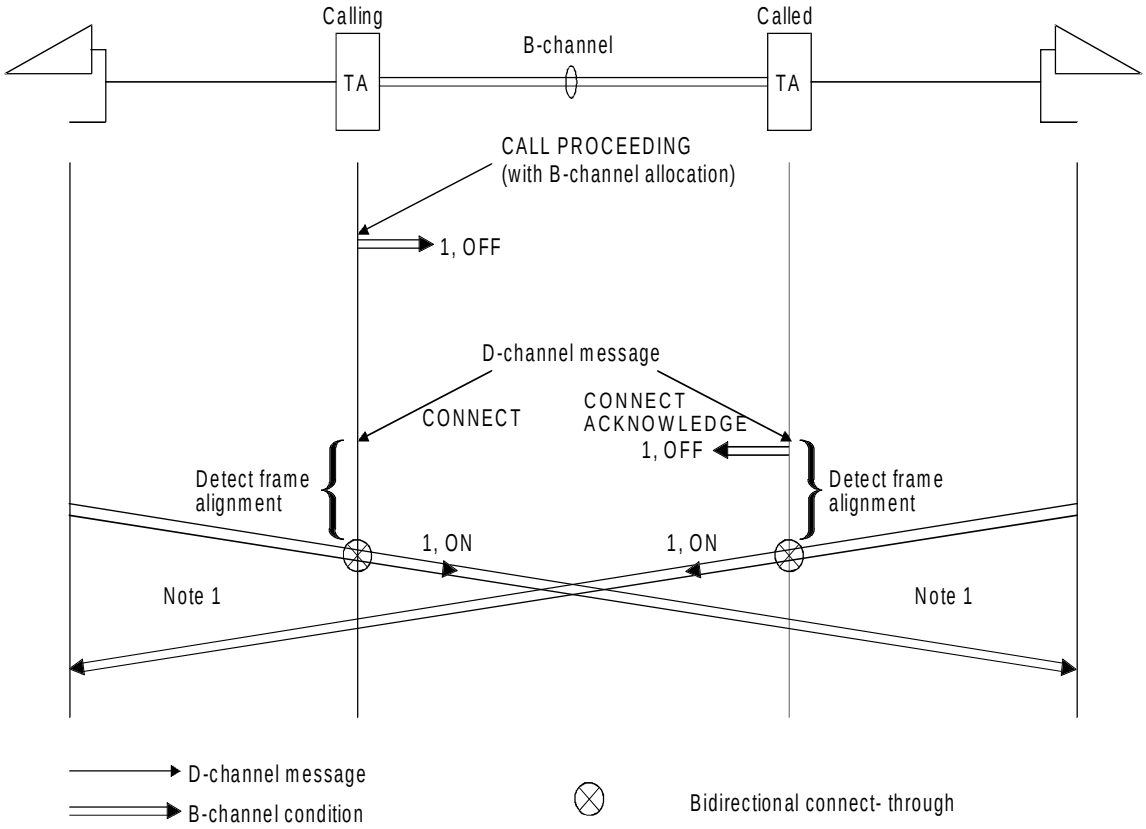
In the following only the case of single rate TA is described.

For a single rate TA a symmetrical procedure is performed (see figure 14).

Both TAs shall check the signal of their received B-channel for the frame alignment bit pattern.

After frame alignment detection in the B-channel, the TA shall connect the B-channel through to its terminal (DTE) immediately before the C-lead is scanned. From this point onwards the 1, ON condition from the DTE will be transmitted towards the distant DTE. Depending on the state of the distant end, either 1, OFF is received from the distant TA or (1, ON) from the distant DTE. Reception of r = 1, i = OFF denotes the state Connection in progress, (state 11) reception of r = 1, i = ON denotes the state Ready for data (state 12).

After switching through the B-channel by the TA, transmission of data and status in the data phase is continued and clearing down can be synchronized between the subscriber terminals by means of clear request. Annex E gives further details on the Ready for data alignment procedures for both X.21 switched and leased interface terminal adaptors.



NOTE 1: The TA will perform connect-through after detecting frame alignment and completing delivery to the terminal of any DCE-provided information. To guarantee the correct ready for data alignment, through-connection must be performed immediately before the C-lead is scanned.

NOTE 2: Only those conditions necessary to effect ready for data alignment are shown.

NOTE 3: The bi-directional switch-through in the TA can also be performed in transition of states 12 to 13 in CCITT Recommendation X.21, if the TA is transmitting 1, ON during state 12.

Figure 14: Single rate TA operation to effect ready for data Alignment at rates < 64 kbit/s.

2.1.5 Mapping of ETS 300 102-1 causes to X.21 call progress signals

In several cases it will be necessary to map causes from ETS 300 102-1 to X.21. TA shall use table 2 to map the causes from ETS 300 102-1 messages to X.21 call progress signals.

Table 2: Mapping of ETS 300 102-1 cause fields to X.21 call progress signals

Item	Q.931 cause	Cause value	X.21 call progress signal significance	Code
1	Unassigned or unallocated number	1	Not obtainable	43
2	No route to destination	3	Not obtainable	43
3	Channel unacceptable	6	Not obtainable	43
4	Normal clearing	16	Not applicable	
5	User busy	17	Number busy	21
6	No user responding	18	No connection	20
7	User alerting, no answer	19	No connection	20
8	Call rejected	21	Controlled not ready	45
9	Number changed	22	Changed number	42
10	Destination out of order	27	Uncontrolled not ready	46
11	Invalid number format (incomplete number)	28	Selection signals procedure error	22
12	Normal, unspecified	31	Not applicable	
13	No circuit/channel available	34	No connection	20
14	Network out of order	38	Out of order	44
15	Temporary failure	41	Out of order	44
16	Switching equipment congestion	42	Network congestion	61
17	Requested circuit or channel not available	44	No connection	20
18	Resources unavailable, unspecified	47	Network congestion	61
19	Quality of service unavailable	49	Not applicable	
20	Bearer capability not authorized	57	Incompatible user class of service	52
21	Bearer capability not presently available	58	Network congestion	61
22	Service or option not available, unspecified	63	No connection	20
23	Bearer service not implemented	65	Invalid facility request	48
24	Channel type not implemented	66	Invalid facility request	48
25	Service or option not implemented, unspecified	79	Invalid facility request	48
26	Invalid call reference value	81	Not obtainable	43
27	Identified channel does not exist	82	Not obtainable	43

Table 2 (continued)

Item	Q.931 cause	Cause value	X.21 call progress signal significance	Code
28	Incompatible destination	88	Not obtainable	43
29	Invalid message	95	Selection signal transmission error	23
30	Mandatory information element is missing	96	Selection signal procedure error	22
31	Message type non existent or not implemented	97	Selection signal procedure error	22
32	Message not compatible with call state, message type non existent or not implemented	98	Selection signal procedure error	22
33	Information element non existent or not implemented	99	Selection signal procedure error	22
34	Invalid information element contents	100	Selection signal transmission error	23
35	Message not compatible with call state	101	Selection signal procedure error	22
36	Recovery on timer expiry	102	Not obtainable	43
37	Protocol error, unspecified	111	Selection signal procedure error	42
38	Interworking, unspecified	127	ROA out of order	72

2.1.6 Additional information for handling of exception situations

When a call is cleared prematurely or a call failure occurs, the rules of section 5.8 of ETS 300 102-1 and of CCITT Recommendation X.21 apply. The following procedures are derived for the mutual mapping between the R interface and the S/T reference point.

2.1.6.1 Call collision

Call collision may occur at both sides of the TA, at the X.21 interface and at the S/T reference point.

NOTE: Call collision for X.21bis and X.20bis interfaces require further study.

2.1.6.1.1 Call collision at the X.21 interface

The TA shall accept an incoming SETUP message when the X.21 interface is in the Ready state. When a collision is detected at the X.21 interface (TA sends incoming call, X.21 DTE sends call request) the TA will indicate Proceed-to-select and cancel the incoming call.

NOTE: As an alternative the TA may send a DCE clear indication and, when in the Ready state, resend the incoming call.

2.1.6.1.2 Call collision at the S/T reference point

In the event of a call collision at the S/T reference point the procedure defined in ETS 300 102-1 shall apply.

2.1.6.2 No channel available

If no channel, including no B-channel, at the S/T reference point is available for connection establishment, an outgoing SETUP message is answered from the ET by a RELEASE COMPLETE message with cause #34, no channel available. This is mapped at the X.21 interface into the call progress signal 20 (no connection), followed by DCE clear indication.

2.1.6.3 Premature clearing

A DTE may initiate the clearing procedure at any time by transmitting a DTE clear request at the X.21 interface, as described in section 2.1.2.1.9. If no connection exists between DTEs, at the distant station, the procedure described in section 2.1.2.1.11 will apply.

2.1.6.4 No answer to outgoing SETUP

If an outgoing SETUP is not answered by the ET, the DTE will, at the expiration of timer T2 (20 s.), initiate the clearing procedure by transmitting DTE clear request. The TA, on its S/T reference point, will send a RELEASE COMPLETE message with cause #31, normal, unspecified. On its X.21 interface, it will transmit DCE clear confirmation.

On the other hand, if a TA is provided with the optional timer T303 (as defined in ETS 300 102-1) it may start the clearing procedure at the S/T reference point as above by transmitting RELEASE COMPLETE with cause #102, recovery on timer expiry. At the X.21 interface, the TA sends the call progress signal 43 (destination not obtainable) followed by DCE clear indication.

2.2 Adaption functions for DTEs conforming to X.1 user class service 7

2.2.1 Bit rate adaption functions

For rate adaption from X.1 user classes of services 3-6 to 64 kbit/s a 40-bit frame has been adopted (see figure 4). Within this frame 24 data bits can be transmitted which may be allocated to three characters P, Q and R each character containing 8 bits.

An equivalent approach, with the optional possibility of character Alignment also for the X.1 user rate of 48 kbit/s, shall be used. To implement this approach an appropriate frame structure for this rate is defined. Table 3 shows this frame which contains the octets 1, 2, 3 and 4 (framing of 24 data bits).

Octet Alignment is performed by means of the 8 kHz timing.

Table 3: Adaption of 48 kbit/s user rate to 64 kbit/s

	Bit number							
	1	2	3	4	5	6	7	8
Octet 1	1	P1	P2	P3	P4	P5	P6	SQ
Octet 2	0	P7	P8	Q1	Q2	Q3	Q4	X
Octet 3	1	Q5	Q6	Q7	Q8	R1	R2	SR
Octet 4	1	R3	R4	R5	R6	R7	R8	SP

The frame Alignment pattern consists of 10111011 in bit 1 of consecutive octets which are received from the 64 kbit/s stream. This frame Alignment pattern also will be used for ready for data Alignment (see section 2.1.4) and for user rate identification.

For user rate identification the following algorithm shall be applied (see also CCITT Recommendation V.110):

- search for the bit pattern ... 101110111 ... in bit 1 of consecutive octets which are received from the 64 kbit/s stream;

- if this search is successful then the user rate is 48 kbit/s.

NOTE: For international operation over restricted 64 kbit/s bearer capabilities, bit X must be set to 1.

2.2.2 X.21/X.21bis to D-channel protocol mapping

The X.21/X.21bis mapping functions are given in section 2.1.2.

2.2.3 Call offering procedure in a multiterminal configuration

As per section 2.1.3.

2.2.4 Ready for data Alignment

As per section 2.1.4.

2.2.5 Mapping of Q.931 causes to X.21 call progress signals

As per section 2.1.5

2.2.6 Additional information for handling of exceptional situations

As per section 2.1.6.

2.3 Rate adaption functions for DTEs conforming to X.1 user class of service 19

2.3.1 Rate adaption functions

It is assumed that in the case of a TA supporting only 64 kbit/s, no rate adaption and no user rate identification is necessary.

NOTE: It is recognised that the all 1's condition could be produced by the alarm indication signal (AIS). The implication of this on D-channel signalling requires further study.

2.3.2 X.21/X.21bis to D-channel protocol mapping (see figures 8 and 9)

The following sections are titled with the names of the ETS 300 102-1 signalling messages at the S/T reference point.

2.3.2.1 SETUP (from terminal adaptor)

In the ready state (state 1) both DTE and TA transmit (1,OFF) across the X.21 interface.

When the calling DTE indicates a call request (state 2, t = 0, c = ON) at the X.21 interface, the TA transmits a proceed to select signal (state 3) to the DTE (r = +, i = OFF). The DTE begins to send selection signals to the TA (state 4).

When an end of selection signal (t = +, c = ON) is received at the X.21 interface, the TA transmits a SET-UP message via the D-channel at the S/T reference point.

The Bearer capability information element included in the SETUP message shall be coded with:

- information transfer capability set to "unrestricted digital information"
- transfer mode set to "circuit mode"
- information rate set to "64 kbit/s".

NOTE: Bearer capability information element octets 4a and 4b shall not be included.

The user may also specify the layer 1 (e.g. rate adaption), layer 2 (e.g. LAPB) and layer 3 (e.g. X.25) information transfer protocols in the Low layer compatibility information element in the SETUP message (see ETS 300 102-1 annex L entitled "Low Layer information coding principles").

NOTE: See also Annex I for further information on BC, LLC and HLC coding.

En-bloc sending shall be used, i.e. the complete address of the called party shall be included in the Called party number information element of the SETUP message. If the Sending complete information element is included in the SETUP message, SETUP ACKNOWLEDGE is not allowed as a response (see sections 5.1.1 and 5.1.3 of ETS 300 102-1).

2.3.2.2 SET-UP ACKNOWLEDGE/CALL PROCEEDING (from network)

When the CALL PROCEEDING or SETUP ACKNOWLEDGE message is received on the D-channel of the S-interface, the B-channel will be allocated and the TA transmits all zeros via the B-channel at the S/T reference point.

2.3.2.3 ALERTING (from exchange)

ALERTING is generally used with manual answering.

When an ALERTING message is received on the D-channel of the S-interface, the TA transmits call progress signals (state 7) to the calling DTE.

Afterwards the state DCE waiting (state 6A, r = SYN, i = OFF) is entered at the X.21 interface.

2.3.2.4 CONNECT (from network)

When a CONNECT message is received on the D-channel at the S/T reference point, the TA transmits a DCE-provided information (state 10) to the calling DTE. Afterwards the Connection in progress state (state 11) is entered at the X.21 interface.

The Alignment pattern procedure is entered as described in section 2.3.4.1.

2.3.2.5 SETUP (from network)

The TA shall not accept a SETUP message unless the X.21 interface is in the Ready state (state 1).

When a SET-UP message is received on the D-channel of the S-interface, the TA shall follow the procedures for determining compatibility checking (e.g. data signalling rate) defined in ETS 300 102-1. If the TA determines that it can respond to the incoming call, it follows the procedures of ETS 300 102-1. It is expected that the ALERTING message would only be used by terminals that answer manually.

The TA transmits an incoming call signal (BEL,OFF) via the X.21 interface to the called DTE, and the Incoming call state (state 8) is entered.

In the case of multiterminal configuration the incoming call point-to-multipoint operation is described in section 2.1.3.

For the coding of the BC, HLC and LLC information elements see Annex I.

Within the TA the provision of terminal selection function using addressing information is optional. If terminal selection is not provided, the TA shall respond to every incoming SETUP message for which the compatibility checking has been successful (see ETS 300 102-1, Annex B).

2.3.2.6 CONNECT (from terminal adaptor)

When a call accept (state 9, t = 1, c = ON) is received from the called DTE, the TA transmits a CONNECT message via the D-channel at the S/T reference point.

The use of LLC in the CONNECT message for LLC negotiation according to ETS 300 102-1 Annex M is optional.

2.3.2.7 CONNECT ACKNOWLEDGE (from network)

When a CONNECT ACKNOWLEDGE message is received on the D-channel at the S/T reference point the TA, selected by this message, signals connection in progress (state 11, r = 1, i = OFF) to the DTE after delivering DCE-provided information if any.

The Alignment pattern procedure is entered as described in section 2.3.4.1.

2.3.2.8 RELEASE (from network) (multipoint configuration)

In the case of multiterminal configuration the exchange sends the RELEASE message to each TA that had signalled CALL PROCEEDING ALERTING or CONNECT but which was not selected for the call. Subsequently the TA performs the DCE clear indication procedure at the X.21-interface and sends a RELEASE COMPLETE message to the network.

2.3.2.9 DISCONNECT (from terminal adaptor)

When a DTE indicates DTE clear request (state 16, t = 0, c = OFF) the TA transmits DCE clear confirmation (state 17, r = 0, i = OFF) via the X.21-interface and transmits a DISCONNECT message via the D-channel of the S-interface and tears down the B-channel.

After reception of the RELEASE message on the D-channel, the TA releases the call reference, sends RELEASE COMPLETE to the network on the D-channel and transmits DCE ready (r = 1, i = OFF) to the DTE. The DTE then enters the DTE ready state (t = 1, c = OFF).

2.3.2.10 DISCONNECT (from network)

In the case of clearing by the network the local exchange transmits a DISCONNECT message via the D-channel to the terminal which has to be cleared. After reception of the DISCONNECT message in the TA, the TA transmits a RELEASE message on the D-channel to the network.

On the other hand the TA transmits the state 19, r = 0, i = OFF (DCE clear indication) via the X.21 interface to the DTE, which sends back to the TA the state 20, t = 0, c = OFF (DTE clear confirmation).

2.3.2.11 RELEASE COMPLETE (from network)

When a RELEASE COMPLETE message is received via the D-channel at the S/T reference point in the TA, the DCE ready state (state 21, r = 1, i = OFF) and the DTE ready (state 1, t = 1, c = OFF) is entered.

The procedure described above is not shown in figures 8 and 9.

2.3.3 Call offering procedure in a multiterminal configuration

As per paragraph 2.1.3.

2.3.4 Ready for data Alignment

For Ready for data Alignment on entering and leaving the data transfer phase between two terminals operating at 64 kbit/s the following procedure shall apply (see figure 15).

2.3.4.1 Entering the data transfer phase

At the time the called TA has received the CONNECT ACKNOWLEDGE message and delivered the DCE provided information, if any, the called terminal is in the state 11 (connection in progress). The ready for data Alignment procedure begins by continuous sending of the Alignment pattern "all 1's" at the called side.

All zeros should be returned via the allocated B-channel to the calling party while DCE-provided information is sent to the called party. Following the completion of DCE-provided information the all 1's signals should be transmitted via the B-channel.

After the calling TA has received a CONNECT message and delivered the DCE provided information to the calling DTE, if any, the X.21 interface is in the state Connection in progress (state 11). If the calling TA now has recognized 24 bits of the Alignment pattern, it knows that the through-connections are established in the network and it sends the same pattern in the forward direction. After 24 bits have been sent, the calling TA indicates ready for data state 12 (r = 1, i = ON) for exactly 16 bits, then performs the connection of the B-channel to the T- and R-leads.

NOTE: As an option, in order to enhance the Ready for Data Alignment, on receipt of the CONNECT message the calling TA may start a timer T (set with a value in the order of 100 msec) at the expiry of which the TA shall scan the B-channel, searching for 24 consecutive one bits; after having recognized the Alignment pattern the calling TA sends the same pattern towards the called TA and indicates the Ready for Data state (ie. r = 1, i = ON) at the X.21 interface during a time period of 16 bits before performing the through-connection of the B-channel to the T- and R-leads. This mechanism reduces the probability of interpreting spurious bits received on the B-channel as the Alignment pattern.

When the called TA, while sending the Alignment pattern, has recognized 24 bits of the Alignment pattern from the calling TA, it indicates to the DTE ready for data (state 12, r = 1, i = ON) for exactly 16 bits, then performs the connection of the B-channel to the T- and R-leads.

When the byte timing is provided at the X.21 interface, the transmission from OFF to ON on the I-lead is performed on an octet boundary, complying with CCITT Recommendation X.24.

If the Alignment pattern has not been received by the calling TA before expiry of timer T1, the calling terminal adaptor indicates Ready for data (r = 1, i = ON) for exactly 16 bits, then performs the connection of the B-channel to T- and R-leads.

If the Alignment pattern has not been received by the called TA before expiry of timer T2, the called TA indicates ready for data (r = 1, i = ON) for exactly 16 bits and then performs the connection of the B-channel to the T- and R-leads.

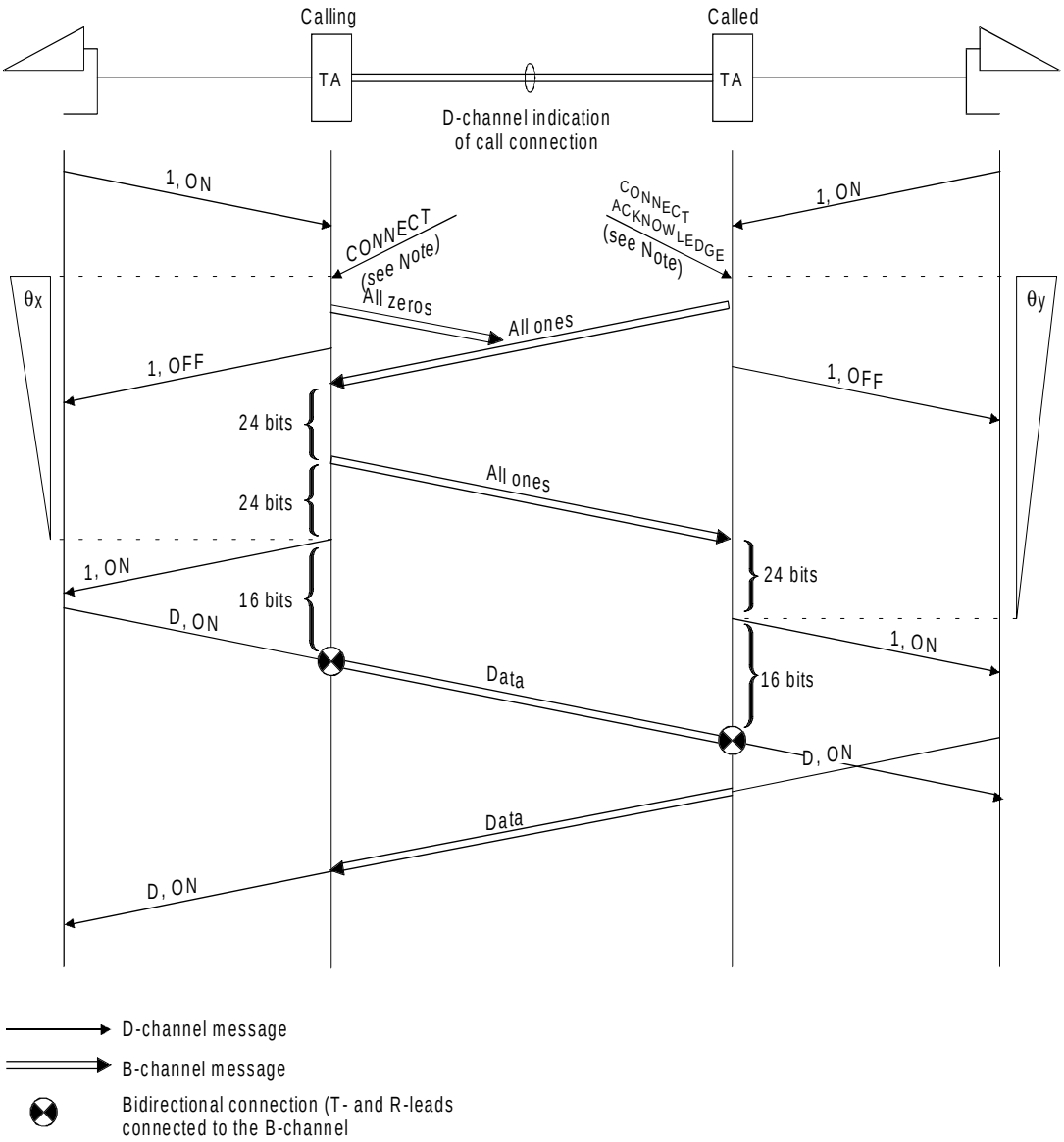
The value of timers T1 and T2 should cater for time propagation delays on the longest hypothetical reference connection and is specified in Annex E.

Optionally, earlier switch-through may occur in the TAs (i.e. the TA does not wait for the expiry of timers T1 and T2).

In this case DTE information sent after the Ready for data state is entered on the X.21 interface may be lost due to the lack of end-to-end Alignment. Since no ready for data Alignment takes place after the connect-through in the TAs, a DTE to DTE synchronization must be performed by an end-to-end procedure between the two DTEs at higher layers.

2.3.4.2 Leaving the data transfer phase

It is not possible to leave the data transfer phase using the synchronization method, because transparency is needed. The cleared terminal should see the end of its communication before the clear message is received. However, anything it sends at this stage would be ignored. Higher level procedures are necessary to resolve these problems.



NOTE: The TA will only indicate ready for data after completing delivery to the DTE of any DCE-provided information.

The receipt of a CONNECT message by the calling TA may occur before or after the receipt of a CONNECT ACKNOWLEDGE message by the called TA.

Figure 15: The operational sequence to effect ready for data Alignment at a user rate of 64 kbit/s

2.3.5 Mapping of Q.931 causes to X.21 call progress signals

As per section 2.1.5.

2.3.6 Additional information for handling of exception situations

As per section 2.1.6., except section 2.1.6.3. dealing with premature clearing.

2.4 Adaption function for DTEs conforming to X.1 user classes of service 1 and 2 or other asynchronous user bit rates

2.4.1 Rate adaption functions

2.4.1.1 General approach

The rate adaption functions within the TA are shown in figure 16. A three-stage method is employed with the functional blocks RA0, RA1 and RA2. The RA0 function is an asynchronous-to- synchronous conversion stage using the same technique as defined in CCITT Recommendation V.14 for support of X.1 user rates. It produces a synchronous bit stream defined by (2 to power n) times 600 bit/s (where n = 0 to 5). The function RA1 adapts the X.1 user rate to the next high rate expressed by 2k times 8 kbit/s (where k = 0 or 1). RA2 performs a second conversion to 64 kbit/s.

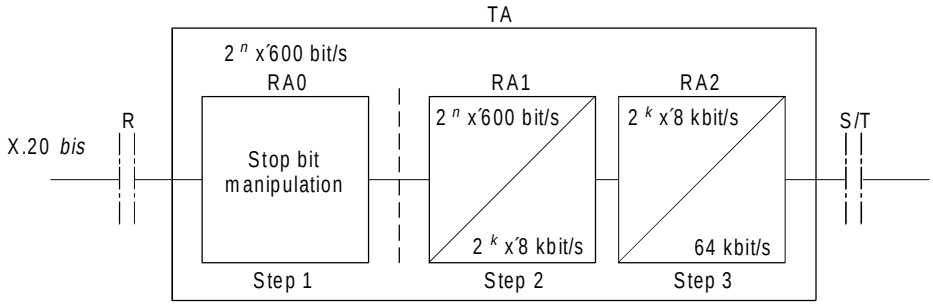


Figure 16

2.4.1.2 Supported asynchronous user rates

Table 4: Asynchronous user rates

X.1 user class of service	Data Rate kbit/s	Rate Tolerance in %	N° of data bits	N° of stop bits	RA0/RA1 rate bit/s	RA1/RA2 rate kbit/s
(	50	+/- 2.5	5	1.5	600	8
(	75	+/- 2.5	5,7or8	1,1.5,2	600	8
(	110	+/- 2.5	7or8	1or2	600	8
(	150	+/- 2.5	7or8	1or2	600	8
(	200	+/- 2.5	7or8	1or2	600	8
2 (						
1	300	+/- 2.5	7or8	1or2	600	8
NOTE 3	600	+1 - 2.5	7or8	1or2	600	8
NOTE 3	1200	+1 - 2.5	7or8	1or2	1200	8
NOTE 3	2400	+1 - 2.5	7or8	1or2	2400	8
	3600	+1 - 2.5	7or8	1or2	4800	8
NOTE 3	4800	+1 - 2.5	7or8	1or2	4800	8
	7200	+1 - 2.5	7or8	1or2	9600	16
NOTE 3	9600	+1 - 2.5	7or8	1or2	9600	16
	12000	+1 - 2.5	7or8	1or2	19200	32
	14400	+1 - 2.5	7or8	1or2	19200	32
	19200	+1 - 2.5	7or8	1or2	19200	32

NOTE 1: Where flow control is used the RA0 and RA1 intermediate rates selected may be different (see Annex G, section 3).

NOTE 2: Number of data bits includes possible parity bits

NOTE 3: The use of asynchronous data rates of 600, 1200, 2400, 4800 and 9600 bit/s is in accordance with CCITT Recommendation X.1.

2.4.1.3 Asynchronous-to-synchronous conversion (RAO)

The RA0 function is only used with asynchronous V-series (X.20bis) interfaces. Incoming asynchronous data is padded by the addition of stop elements to fit the nearest channel defined by (2 to the power n) times 600 bit/s. Thus a 300 bit/s user data signalling rate shall be adapted to a synchronous 600 bit/s stream. The resultant synchronous stream is fed to RA1.

2.4.1.4 Adaption to the B-channel rate

Second step, RA1 : Adaption of RAO to the intermediate rates at 8/16 kbit/s, see section 2.1.1.2.

Third-step, RA2 : Adaption of intermediate rates to the bearer rate 64 kbit/s, see section 2.1.1.3.

2.4.1.5 Break signal

The terminal adaptor shall detect and transmit the break signal in the following fashion :

If the convertor detects M to 2M + 3 bits, all of Start polarity, where M is the number of bits per character in the selected format including Start and Stop bits, the convertor shall transmit 2M + 3 bits of Start polarity.

If the convertor detects more than 2M + 3 bits all of Start polarity, the convertor shall transmit all these bits as Start polarity.

The 2M + 3 or more bits of Start polarity received from the transmitting side shall be output to the receiving terminal.

The terminal must transmit on Circuit 103 at least 2M bits Stop polarity after the Start polarity break signal before sending further data characters. The convertor shall then regain character synchronism from the following Stop to Start transition.

2.4.1.6 Overspeed/underspeed

A Terminal Adaptor shall insert additional Stop elements when its associated terminal is transmitting with a lower than nominal character rate. If the terminal is transmitting characters with an overspeed of up to 1% (or 2.5% in the case of nominal speeds lower than 600 bit/s), the asynchronous-to-synchronous converter may delete Stop elements as often as is necessary to a maximum of one for every eight characters at 1% overspeed. The converter on the receiving side shall detect the deleted Stop elements and re-insert them in the received data stream (Circuit 104).

The nominal length of the Start and Data elements shall be the same for all characters. The length of the Stop elements may be reduced by as much as 12.5% for nominal speeds exceeding 300 bit/s to allow for overspeed in the transmitting terminal. For nominal speeds less than or equal to 300 bit/s a 25% reduction in Stop element is allowed.

2.4.1.7 Parity bits

Possible parity bits included in the user data are considered as data bits by the RA0 function.

2.4.2 Flow control

A flow control option, for use with TA supporting asynchronous DTE's is described in Annex G.

3 Test loops

This subject requires further study. However in principle the concepts of CCITT Recommendations X.150, X.21 and X.21bis should apply, in particular with respect to the interface condition associated with the activation of the loops.

Annex A (normative): Interchange circuits used in this specification

1 Essential and optional interchange circuits

The essential and optional interchange circuits are listed in the table below.

2 Timing arrangement

The TA shall derive ISDN timing from the received bit stream of the ISDN's basic user/network interface (see section 5 and 8 of CCITT Recommendation I.430). This network timing shall be used by the TA to provide the DTE with transmitter signal element timing on circuit 114 and receiver signal element timing on circuit 115.

3 Circuit 106

After the start-up and retrain synchronization sequences, the ON state of circuit 106 shall be delayed relative to the ON state of circuit 105 (where implemented) by an interval of at least N bits (a value of N equal to 24 has been proposed, but the value is for further study). ON to OFF state transitions of circuit 106 shall follow ON to OFF state transitions of circuit 105 (when implemented) by less than 2 ms. Where circuit 105 is not implemented, the initial circuit 106 transition to the ON state shall be delayed by an interval greater than or equal to N bits relative to the corresponding transition in the state of circuit 109. Subsequent transitions in the state of circuit 106 should occur solely in accordance with the operating sequence defined in Annex D.

4 Circuit 109

OFF to ON and ON to OFF transitions of circuit 109 should occur solely in accordance with the operating sequence defined in Annex D.

Table A.1

Interchange circuit		
N°	Description	Notes
102	Signal ground or common return	
102a	DTE common return	2
102b	DCE common return	2
103	Transmitted data	
104	Received data	
105	Request to send	3
106	Ready for sending	
107	Data set ready	
108/1	Connect data set to line	4
108/2	Data terminal ready	4
109	Data channel received line signal detector	
111	Data signalling rate selector (DCE source)	5
112	Data signalling rate selector (DCE source)	5
113	Transmitter signal element timing (DTE source)	6
114	Transmitter signal element timing (DCE source)	
115	Receiver signal element timing (DCE source)	
125	Calling indicator	7
140	Loopback/maintenance test	8
141	local loopback	8
142	Test indicator	8
NOTE 1:	All essential circuits and any other which are provided shall comply with the functional and operational requirements of CCITT Recommendation V.24. All interchange circuits provided shall be properly terminated in the data terminal equipment and in the data circuit-terminating equipment in accordance with the appropriate CCITT Recommendation for electrical characteristics (see section 5 below).	
NOTE 2:	Interchange circuits 102a and 102b are required when the electrical characteristics defined in CCITT Recommendation V.10 are used at data signalling rates above 20 kbit/s.	
NOTE 3:	Not required for DTEs that operate with DCEs in the continuous carrier mode.	
NOTE 4:	This circuit shall be capable of operating as circuit 108/1 or 108/2, depending on its use (by the associated DTE).	
NOTE 5:	The use of this circuit is for further study.	
NOTE 6:	The use of circuit 113 is for further study, since its application is restricted by the synchronous nature of ISDN.	
NOTE 7:	This circuit is used with the automatic answering terminal adaptor function.	
NOTE 8:	The use for loopback testing is for further study.	

5 Electrical/mechanical characteristics of interchange circuits

5.1 Basic ISDN user/network interface

The electrical and mechanical characteristics of the basic ISDN user/network interface are described in sections 8 and 10 of CCITT Recommendation I.430.

5.2 TE2/TA (DTE/DCE) interface

5.2.1 Rates less than or equal to 19.2 kbit/s

Use of electrical characteristics conforming to CCITT Recommendation V.28 is recommended together with the connector and pin assignment plan specified by ISO 2110.

NOTE: Manufacturers may wish to note that the long-term objective is to replace electrical characteristics specified in CCITT Recommendation V.28, and that Study Group XVII has agreed that the work shall proceed to develop a more efficient, all-balanced, interface for the V-series application which minimizes the number of interchange circuits (see CCITT Recommendation V.230).

5.2.2 Rates greater than 19.2 kbit/s

Use of electrical characteristics conforming to CCITT Recommendations V.10 and/or V.11 is recommended together with the use of the connector and pin assignment plan specified by ISO 4902.

i) - Concerning circuits 103, 104, 113, 114 and 115, both the generators and the receivers shall be in accordance with CCITT Recommendation V.11.

ii) - In the case of circuit 105, 106, 107 and 109, generators shall comply with CCITT Recommendation V.10 or alternatively with CCITT Recommendation V.11. The receivers shall comply with CCITT Recommendation V.10, category 1, or V.11 without termination.

iii) - In the case of all other circuits, CCITT Recommendation V.10 applies, with receivers configured as specified by CCITT Recommendation V.10 for category 2.

Alternatively the interface defined in Appendix II to recommendation V.35 together with connector and pin assignment plan specified by ISO 2593 may be used.

6 Fault Conditions on interchange circuits

(See section 7 of CCITT Recommendation V.28 for association of the receiver failure detection types).

6.1 The DTE should interpret a fault condition on circuit 107 as an OFF condition using failure detection type 1.

6.2 The DCE should interpret a fault condition on circuit 105 and 108 as an OFF condition using failure detection type 1.

6.3 All other circuits not referred to above may use failure detection types 0 or 1.

Annex B (normative): X.21 Terminal adaptors - Ready for data alignment procedures

This Annex describes call establishment and call clearing procedures between X.21 leased and X.21 switched DTE's and specifies the details of the Ready for Data alignment procedures. However some network provider may not allow communications between X.21 leased and X.21 switched interface DTE's since a called X.21 leased interface DTE is unable to initiate call clearing.

1 General

Calls between X.21 terminals over the ISDN must be synchronised to ensure that both terminals enter cleanly into the data transfer state. In particular the procedures within the terminal adaptors must ensure as far as is possible that:

- the distant terminal adaptor has synchronised to the frame structure of the rate adaption scheme being used; and that
- no confusion between in-band signalling and user data is caused over the X.21 interface, causing for example the loss of "Ready for data".

This Annex describes the Ready for Data alignment procedures for TA's to offer both X.21 switched and leased circuit interfaces to the terminal, in the following connection configurations:

X.21 switched: X.21 switched connections for data rates permitting status information to be conveyed across the network (600, 1200, etc):

Figure B.1 ... call establishment,
Figure B.2 ... call release;

X.21 leased: X.21 leased connections for data rates permitting status information to be conveyed across the network (600, 1200, etc):

Figure B.3 ... call establishment,
Figure B.4 ... call release;

X.21 switched X.21 leased connections for data rates permitting status information to be conveyed across the network (600, 1200, etc):

Figure B.5 ... call establishment,
Figure B.6 ... call release;

X.21 leased: X.21 switched connections for data rates permitting status information to be conveyed across the network (600, 1200, etc):

Figure B.7 ... call establishment
Figure B.8 ... call release;

X.21 switched: X.21 leased connections for data rates NOT allowing status information to be conveyed across the network (8, 16, 32 and 64 kbit/s):

Figure B.9 ... call establishment

X.21 leased: X.21 switched connections for data rates NOT allowing status information to be conveyed across the network (8, 16, 32 and 64 kbit/s):

Figure B.10 ... call establishment

2 Ready for data alignment for user rates of 600, 1200, 2400, 4800, 7200, 9600, 14400, 19200 and 48000 bit/s

The Ready for Data alignment procedures are described for both an X.21 switched and leased circuit interface. Figures B-1 and B-3 show the procedures used to enter the data transfer state in the case of X.21 switched and leased circuit interfaces respectively and figures B-2 and B-4 illustrate the clearing procedures for these interfaces. Figures B-5 to B-8 show the case of interworking when the terminal at one end of the connection has an X.21 switched circuit interface while the terminal at the other end has an X.21 leased circuit interface. Figures B-9 and B-10 illustrate the Ready for data alignment procedures for an X.21 leased and X.21 switched circuit interfaces at bit rates, not allowing the conveyance of status information across the network.

2.1 X.21 switched circuit interface

The Ready for Data alignment procedures are described below and are shown in figure B-1. The same procedures are used when interworking with an X.21 leased circuit interface at the remote end and this is shown in figures B-5 and B-7. The clearing procedures are shown in figures B-2, B-6 and B-8.

2.1.1 Procedures at calling TA

The following procedures apply at the calling TA:

1 - Following the receipt of the SETUP ACKNOWLEDGE or CALL PROCEEDING (i.e. the first message to indicate to the TA the B-channel to be used) message by the calling TA, it will transmit to the network the appropriate rate adaption frame structure for the user rate (as defined in section 2 of this ETS) with all user data bits set to binary 1 and all status bits set to OFF.

2 - Upon receipt of the CONNECT message, the TA will simultaneously:

a) monitor the in-band signals received from the network for frame synchronisation, and

b) start timer T1 for failure to detect frame alignment.

3 - Upon detection of frame synchronisation, the TA will stop timer T1 and after completing the delivery to the terminal on any DCE Provided information, bidirectionally switch-through the T and R-leads to the ISDN channel. The mapping of the condition on the C-lead to the transmitted status bit and from the received status bit to the setting of the I-lead starts at this point. Switch-through at the TA occurs immediately before the C-lead of the terminal is scanned.

4 - If timer T1 expires, the TA will clear the network connection and signal DCE Clear Indication to the terminal.

5 - After switching through the B-channel by the TA, the user data on the T-lead and the status of the C-lead is transmitted to the distant terminal. The Ready for data signal (1, ON) will be received from the called end.

NOTE: In the case where the called terminal has an X.21 leased circuit interface, then following the Ready for Data signal the calling terminal should be prepared to accept the signal (1, OFF) without causing the terminal to change the state since the X.21 leased circuit interface may still be in the Ready state following switch-through (i.e. the terminal is signalling t = 1, c = OFF - see figure B-5). The signal t = 1 or 0, c = ON, r = 1, i = OFF is an undefined state for an X.21 switched circuit interface, but must be accepted as valid (see CCITT Recommendation X.21, section 5.1 regarding interworking with X.21bis terminals using half-duplex operation).

6 - Leaving the data transfer phase is achieved by means of X.21 DTE Clear Request (see figure B-2) which is conveyed across the network prior to the network connection being released.

2.1.2 Procedures at Called TA

The following procedures apply at the called TA:

1 - Upon receipt of the CONNECT ACKNOWLEDGE message, the TA will simultaneously:

a) transmit to the network the appropriate rate adaption frame structure for the user rate (as defined in section 2 of this ETS) with all user data bits set to binary 1 and all status bits set to OFF;

b) monitor the in-band signals received from the network for frame synchronisation; and

c) start timer T2 for failure to detect frame alignment.

2 - Upon detection of frame synchronisation, the TA will stop timer T2 and after completing the delivery to the terminal of any DCE Provided Information, bidirectionally switch-through the T and R-leads to the ISDN channel. The mapping of the condition on the c-lead to the transmitted status bit and from the received status bit to the setting of the I-lead starts at this point. Switch-through at the TA occurs immediately before the C-lead of the terminal is scanned.

3 - If timer T2 expires, the TA will clear the network connection and signal DCE Clear Indication to the terminal.

4 - After switching through the B-channel by the TA, the user data on the T-lead and the status of the C-lead is transmitted to the distant terminal. The Ready for Data signal (1, ON) will be received from the called end.

NOTE: In the case where the calling terminal has an X.21 leased circuit interface, then following the Ready for Data signal the called terminal should be prepared to accept the signal (1, OFF) without causing the terminal to change state since the X.21 leased circuit interface may still be in the Ready state following switch-through (i.e. the terminal is signalling t = 1, c = OFF - see figure B-7). The signal t = 1 or 0, c = ON, r = 1, i = OFF is an undefined state for an X.21 switched circuit interface, but must be accepted as valid (see CCITT Recommendation X.21, section 5.1 regarding interworking with X.21bis terminals using half-duplex operation).

5 - Leaving the data transfer phase is achieved by means of X.21 DTE Clear Request (see figure B-2) which is conveyed across the network prior to the network connection being released.

The values of timers T1 and T2 are given in Annex E.

2.2 X.21 Leased circuit interface

The procedures specified below are designed to ensure that it is possible to interwork between an X.21 switched and leased circuit interface at either end of the connection and meet the specification given in this ETS for X.21 switched circuit interfaces. However, it is not possible to define a procedure which synchronises entry into the data transfer state and which allows interworking between X.21 switched and leased circuit interfaces. Hence, for terminals having an X.21 leased circuit interface, a higher level terminal-to-terminal protocol is required to ensure correct entry into the data transfer state.

Figure B-3 shows the switch-through procedures, figure B-4 shows the clearing procedures and figures B-5 to B-8 show that the same procedures are used when interworking with a terminal having an X.21 switched circuit interface at the remote end.

In addition it should be noted that in case of X.21 leased interface DTE an incoming call shall not be accepted by the TA if the DTE is not Ready state (ie. 0,OFF condition) exists. Furthermore, if during the data transfer phase (DTE Ready,state 13) the DTE not Ready state occurs, the TA shall initiate call clearing.

2.2.1 Procedures at Calling TA

The following procedures apply at the calling TA:

1 - Following the receipt of the SET-UP ACKNOWLEDGE or CALL PROCEEDING (i.e. the first message to indicate to the TA the B-channel to be used) message by the calling TA, it will transmit to the network the appropriate rate adaption frame structure for the user rate (as defined in section 2 of this Standard) with all user data bits set to binary 1 and all status bits set to OFF.

2 - Upon receipt of the CONNECT message, the TA will simultaneously :

a) monitor the in-band signals received from the network for frame synchronisation, and

b) start timer T1 for failure to detect frame alignment and (X, ON) condition.

3 - Upon detection of frame synchronisation, the TA will simultaneously:

a) transmit to the network the appropriate rate adaption frame structure for the user rate (as defined in section 2 of this standard) with all user data bits set to binary 1 and all status bits set to ON. This condition must persist for at least 24 bits period at the user data rate before point 4 is executed;

b) monitor the in-band signals received from the network for the condition (X, ON) (i.e. user data bits set to any binary value and the status bits set to ON). Detection of this condition shall be recognised if this condition persists for 16 bit period at the user data rates. Loss off frame alignment while searching for the (X, ON) condition will cause the suspension of the search for (X, ON) until frame alignment is recovered or timer T1 expires.

4 - Upon detection of this (X, ON) condition from the remote end and having met the minimum time requirement of point 3a, the TA will stop timer T1 and bidirectionally switch-through the T- and R-leads to the ISDN channel. The mapping of the condition on the C-lead to the transmitted status bit and from the received status bit to the setting of the I-lead starts at this point.

5 - If timer T1 expires, the TA will clear the network connection and maintain the signal DCE Not Ready towards the terminal.

6 - After switching through the B-channel by the TA, the user data on the T-lead and the status of the C-lead are transmitted to the distant terminal.

7 - To ensure that no user data is lost during clearing the terminals need to leave the data transfer phase before the network connection is released. If both the subscriber terminals involved in the connection have an X.21 leased circuit interface, then this may be achieved by signalling the Ready state (i.e. t = 1, i = OFF) prior to clearing the call by manual action at the TA (see figure B-4). If the terminal not initiating the clearing has an X.21 switched circuit interface (see figure B-8) then it is not possible for both terminals to leave the data transfer state prior to the network connection being released and in this case a terminal-to-terminal protocol is required to ensure no user data is lost.

2.2.2 Procedures at called TA

The following procedures apply at the called TA :

1 - Upon receipt of the CONNECT ACKNOWLEDGE message the TA will simultaneously:

a) transmit to the network the appropriate rate adaption frame structure for the user rate (as defined in section 2 of this standard) with all user data bits set to binary 1 and all status bits set to OFF;

b) monitor the in-band signals received from the network for frame synchronisation; and

c) start timer T2 for failure to detect frame alignment and (X,ON) condition.

2 - Upon detection of frame synchronisation, the TA will simultaneously:

a) transmit to the network the appropriate rate adaption frame structure for the user rate (as defined in section 2 of this standard) with all user data bits set to binary 1 and all status bits set to ON. This condition must persist for at least 24 bit period at the user data rate before point 3 is executed;

b) monitor the in-band signals received from the network for the condition (X, ON) (i.e. user data bits set to any binary value and the status bits set to ON). Detection of this condition shall be recognised if this condition persists for 16 bit period at the user data rates. Loss of frame alignment while searching for the (X, ON) condition will cause the suspension of the search for (X, ON) until frame alignment is recovered or timer T2 expires.

3 - Upon detection of this (X, ON) condition from the remote end and having met the minimum time requirement of point 2a, the TA will stop timer T2 and bidirectionally switch-through the T- and R-leads to the ISDN channel. The mapping of the condition on the C-lead to the transmitted status bit and from the received status bit to the setting of the I-lead starts at this point.

4 - If timer T2 expires, the TA will clear the network connection and maintain the signal DCE Not Ready towards the terminal.

5 - After switching through the B-channel by the TA, the user data on the T-lead and the status of the C-lead are transmitted to the distant terminal.

6 - To ensure that no user data is lost during clearing, the terminals need to leave the data transfer phase before the network connection is released. If both the subscriber terminals involved in the connection have an X.21 leased circuit interface, then this may be achieved by signalling the Ready state (i.e. t = 1, i = OFF) prior to clearing the call by manual action at the TA (see figure B-4). If the terminal not initiating the clearing has an X.21 switched circuit interface (see figure B-8) then it is not possible for both terminals to leave the data transfer state prior to the network connection being released and in this case a terminal-to-terminal protocol is required to ensure no user data is lost.

The value of timers T1 and T2 are given in Annex E.

3 Ready for data alignment for user rates of 64 Kbit/s

The alignment procedures cannot be guaranteed to work on all international connections as in some circumstances imitation of the alignment pattern may occur. For this reason, a timer is required which, if it expires, causes the TA to bidirectionally switch-through. In the case of switch-through occurring due to expiry of the timer there will be no synchronisation of entering the data transfer state and in this case a terminal-to-terminal protocol is required to ensure correct entry into the data transfer phase. Figures B-9 and B-10 illustrate the procedures for switch-through in the case of interworking between X.21 switched and leased circuit interfaces.

The procedures defined below apply to TAs supporting both X.21 switched circuit and X.21 leased circuit interfaces.

3.1 Procedures at calling TA

The following procedures apply at the calling TA:

1 - Following the receipt of the SET-UP ACKNOWLEDGE or CALL PROCEEDING (i.e. the first message to indicate to the TA the B-channel to be used) message by the calling TA, it will transmit to the network contiguous binary 0 in the bit position(s) appropriate for the user rate as specified in Section 2 of this standard.

2 - Upon receipt of the CONNECT message, the TA will start timer T1 for failure to detect the all 1's alignment pattern and monitor the in-band signals received from the network for detection of "all 1's alignment pattern. The alignment pattern shall be considered as having been detected after receipt of 24 contiguous binary 1's in the bit position(s) appropriate for the user rate as specified in Section 2.1.

3 - On detection of the "all 1's" alignment pattern, the TA will simultaneously:

a) stop timer T1;

b) stop monitoring in-band signals for all 1's alignment pattern;

c) transmit to the network contiguous binary 1 in the bit position(s) appropriate for the user rate as specified in Section 2.1 (see note below);

d) wait for 24 bit periods at the user rate and then indicate to the terminal for at least 16 bit periods the signal Ready for Data (r = 1, i = ON) in the case of X.21 switched circuit interface and Ready (r = 1, i = OFF) for X.21 leased circuit interface. In the case of X.21 leased circuit interface, the TA may optionally continue to signal DTE Not Ready (r = 0, i = OFF) for at least 16 bits instead of Ready.

NOTE 1: Actions 3(c) and 3(d) must start at the same time.

NOTE 2: In the case of X.21 switched circuit interface, actions 3(c) and 3(d) will be executed only after completing the delivery to the terminal of any DCE Provided Information.

4 - Bidirectionally switch-through the T- and R-leads to the ISDN B-channel and set the I-lead in the ON condition.

5 - On expiry of timer T1, the TA will indicate to the terminal for at least 16 bit periods the signal Ready for Data (r = 1, i = ON) in the case of X.21 switched circuit interface and Ready (r = 1, i = OFF) for X.21 leased circuit interface and then bidirectionally switch-through the T- and R-leads to the ISDN B-channel and set the I-lead in the ON condition. Optionally, in the case of X.21 leased circuit interface, the TA may immediately bidirectionally switch-through following the expiry of timer T1 without indicating the Ready state.

6 - It is not possible to ensure that both terminals leave the data transfer state prior to release of the network connection as the DTE Clear Request signal cannot be conveyed in-band across the net- work. Hence higher level procedures are necessary to ensure that no user data is lost or gained during the clearing procedure.

The value of T1 is given in Annex E.

3.2 Procedures at called TA

The following procedures apply at the called TA:

1 - Upon receipt of the CONNECT ACKNOWLEDGE message (and in the case of X.21 switched circuit interface, after completing the delivery to the terminal on any DCE provided information - see note below) the TA will simultaneously :

a) transmit to the network contiguous binary 1 in the bit position(s) appropriate for the user rate as specified in Section 2.1.

b) start timer T2 for failure to detect the all 1's alignment pattern;

c) monitor the in-band signals received from the network for detection of the all 1's alignment pattern. The alignment pattern shall be considered as having been detected after receipt of 24 contiguous binary 1's in the bit position(s) appropriate for the user rate as specified in Section 2.1.

NOTE: For X.21 switched circuit interface, during the interval between the receipt of the CONNECT ACKNOWLEDGE message and the completion of delivery to the terminal of any DCE Provided Information, the TA will transmit to the network contiguous binary 0 in the bit position(s) appropriate for the user rate as specified in Section 2.1.

2 - On detection of the all 1's alignment pattern (i.e. after detection of 24 contiguous binary 1's, the TA will simultaneously:

a) stop timer T2;

b) stop monitoring in-band signals for all 1's alignment pattern;

c) indicate to the terminal for at least 16 bits periods the signal Ready for Data (r = 1, i = ON) in the case of X.21 switched circuit interface and Ready (r = 1, i = OFF) for X.21 leased circuit interface. In the case of X.21 leased circuit interface, the TA may optionally continue to signal DCE Not Ready (r = 0, i = OFF) for at least 16 bits instead of Ready.

NOTE: There must be no delay between the detection of the all 1's alignment pattern and the start of action 2(c).

3 - Bidirectionally switch-through the T- and R-leads to the ISDN B-channel and set the I-lead in the ON condition.

4 - On expiry of timer T2, the TA will indicate to the terminal for at least 16 bit periods the signal Ready for Data (r = 1, i = ON) in the case of X.21 switched circuit interface and Ready (r = 1, i = OFF) for X.21 leased circuit interface and then bidirectionally switch-through the T and R-leads to the ISDN B-channel and set the I-lead in the ON condition. Optionally, in the case of X.21 leased circuit interface, the TA may immediately bidirectionally switch-through following the expiry of timer T2 without indicating the Ready state.

5 - It is not possible to ensure that both terminals leave the data transfer state prior to release of the network connection as the DTE Clear Request Signal cannot be conveyed in-band across the network. Hence higher level procedures are necessary to ensure that no user data is lost or gained during the clearing procedure.

The value of T2 is given in Annex E.

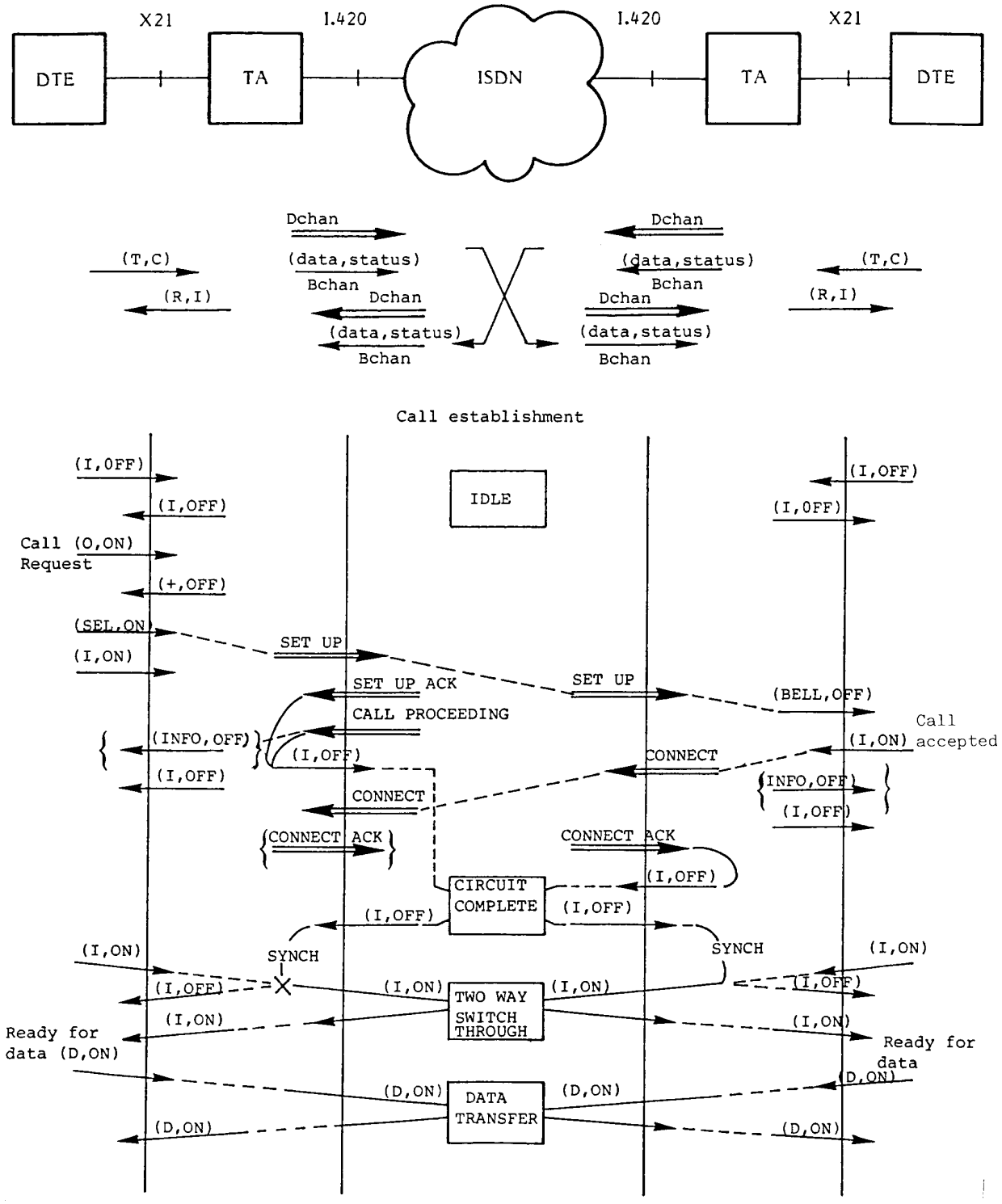
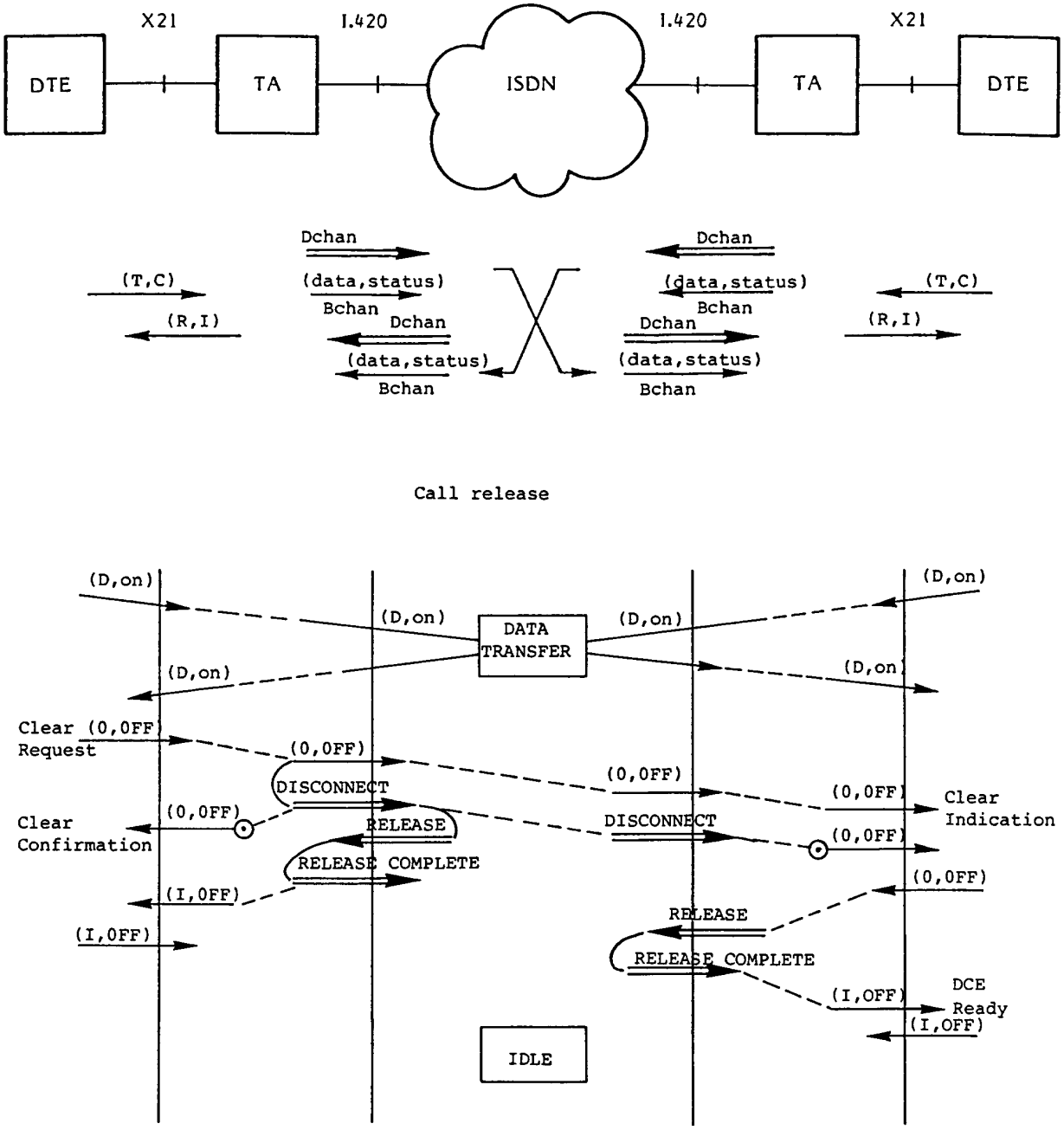


Figure B-1: X.21 switched - X.21 switched call establishment (Status information conveyed across the network)



NOTE: The figure shows call clearing initiated by the calling TA. The called TA may also initiate clearing in the same manner.

Figure B-2: X.21 switched - X.21 switched call clearing (Status information conveyed across the network)

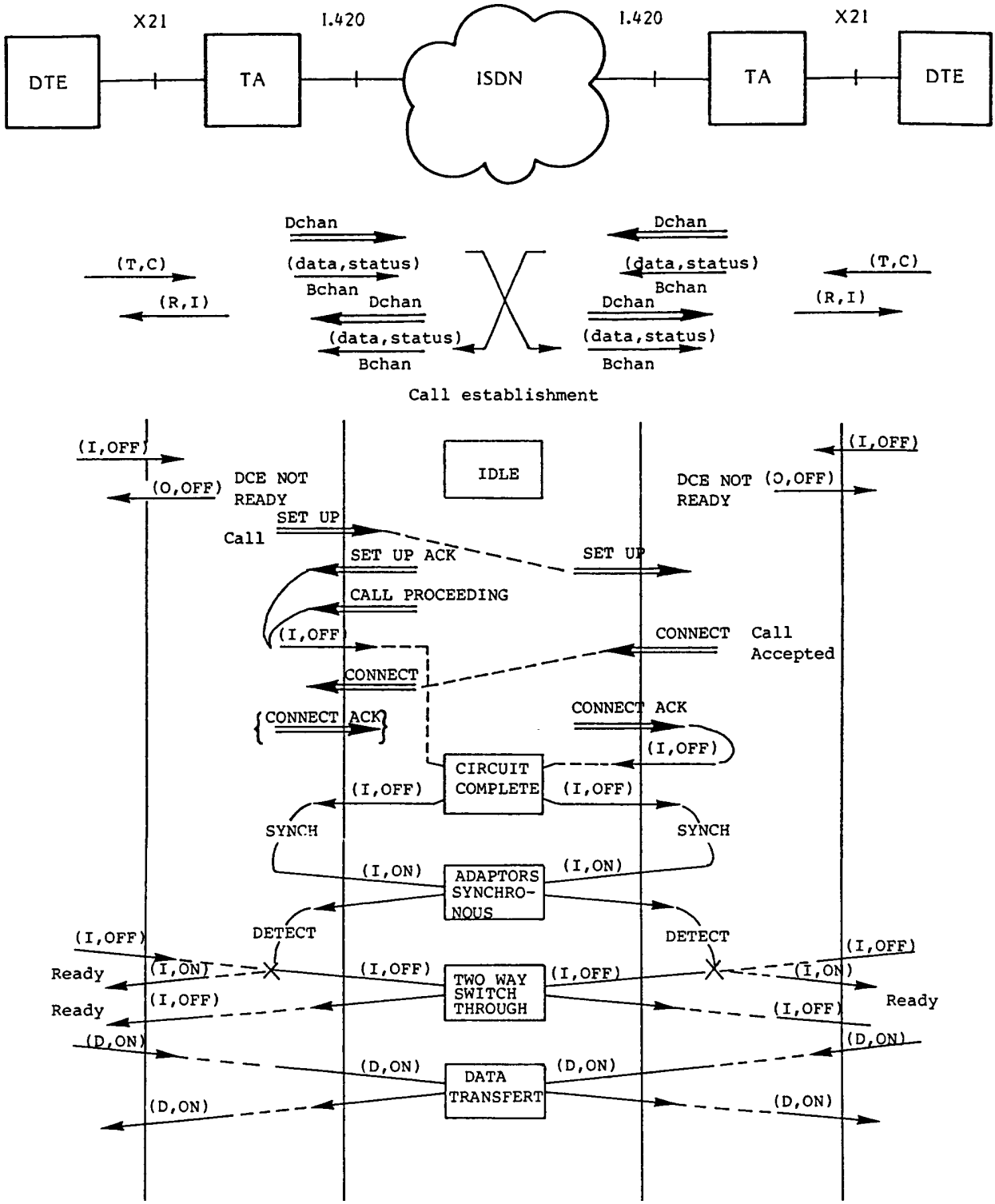
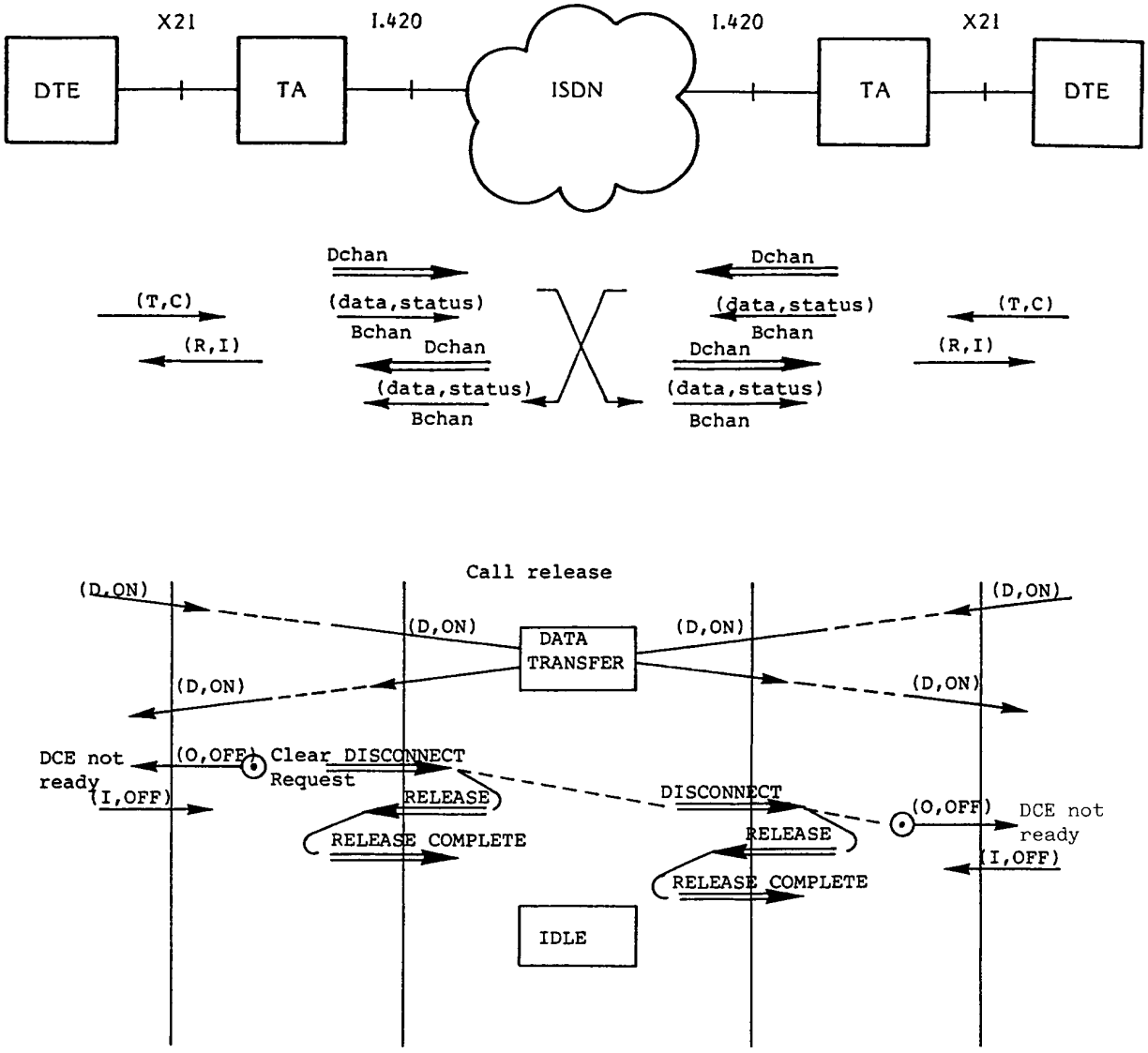


Figure B-3: X.21 leased - X.21 leased call establishment (Status information conveyed across the network)



NOTE: The figure illustrates call clearing initiated by a manual intervention at the calling TA. The call clearing may also be initiated by a manual intervention at the called TA.

Figure B-4: X.21 leased - X.21 leased call clearing
Status information conveyed across the network

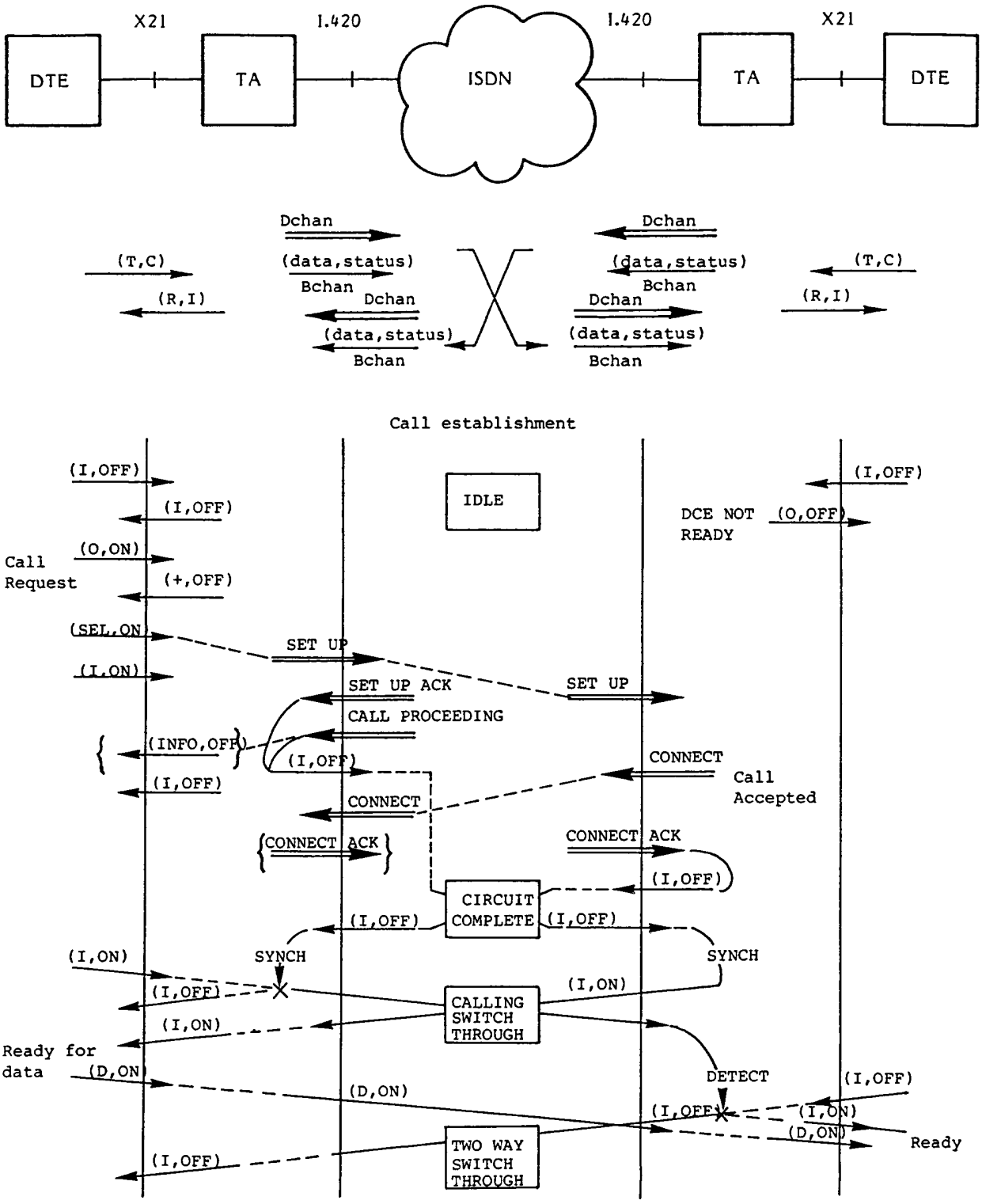
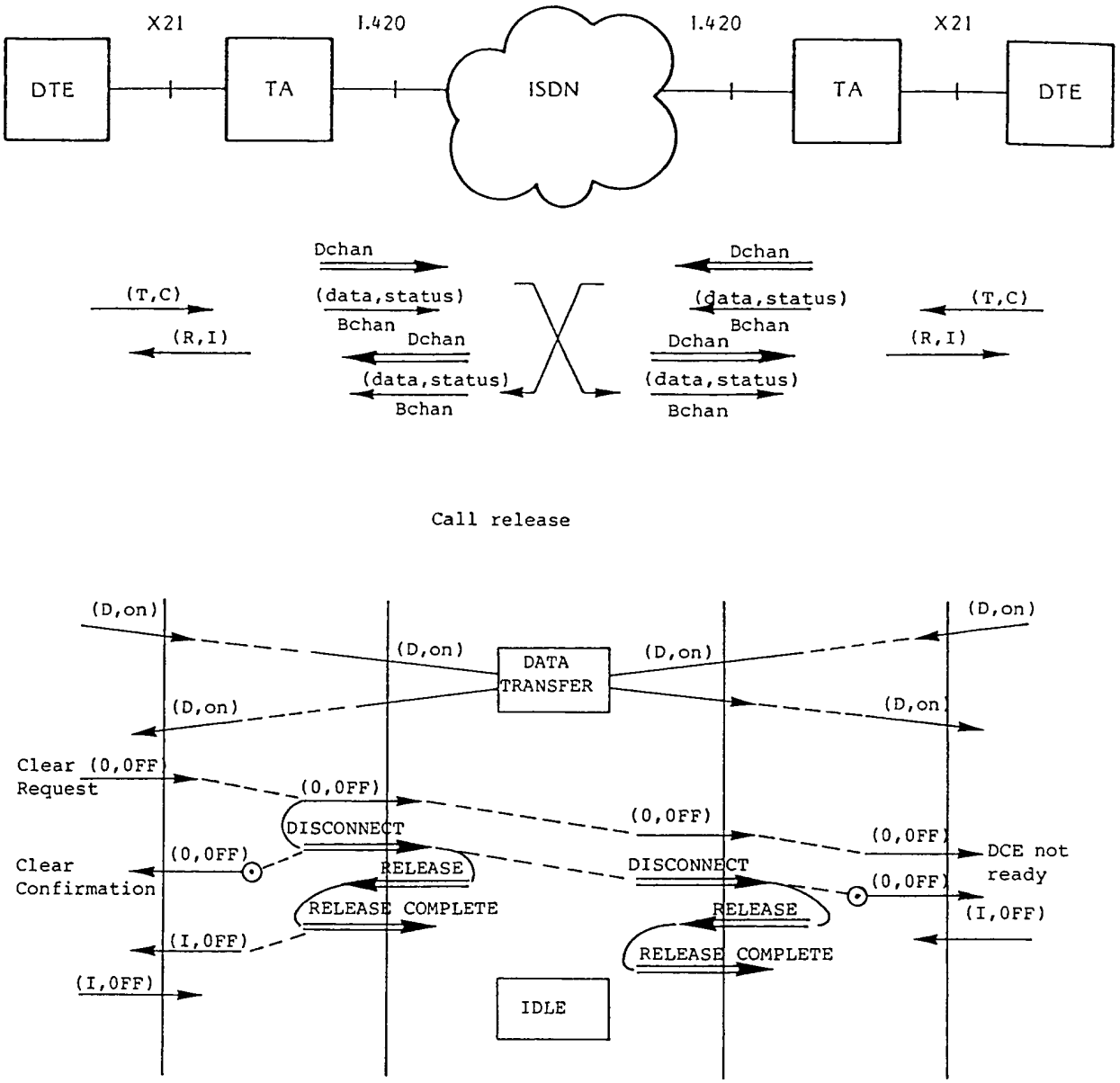


Figure B-5: X.21 switched - X.21 leased call establishment (Status information conveyed across the network)



NOTE: The figure depicts the case of call clearing initiated by the calling DTE. Call clearing cannot be initiated by the called DTE, but could be initiated by a manual intervention at the called TA.

Figure B-6: X.21 switched - X.21 leased call clearing (Status information conveyed across the network)

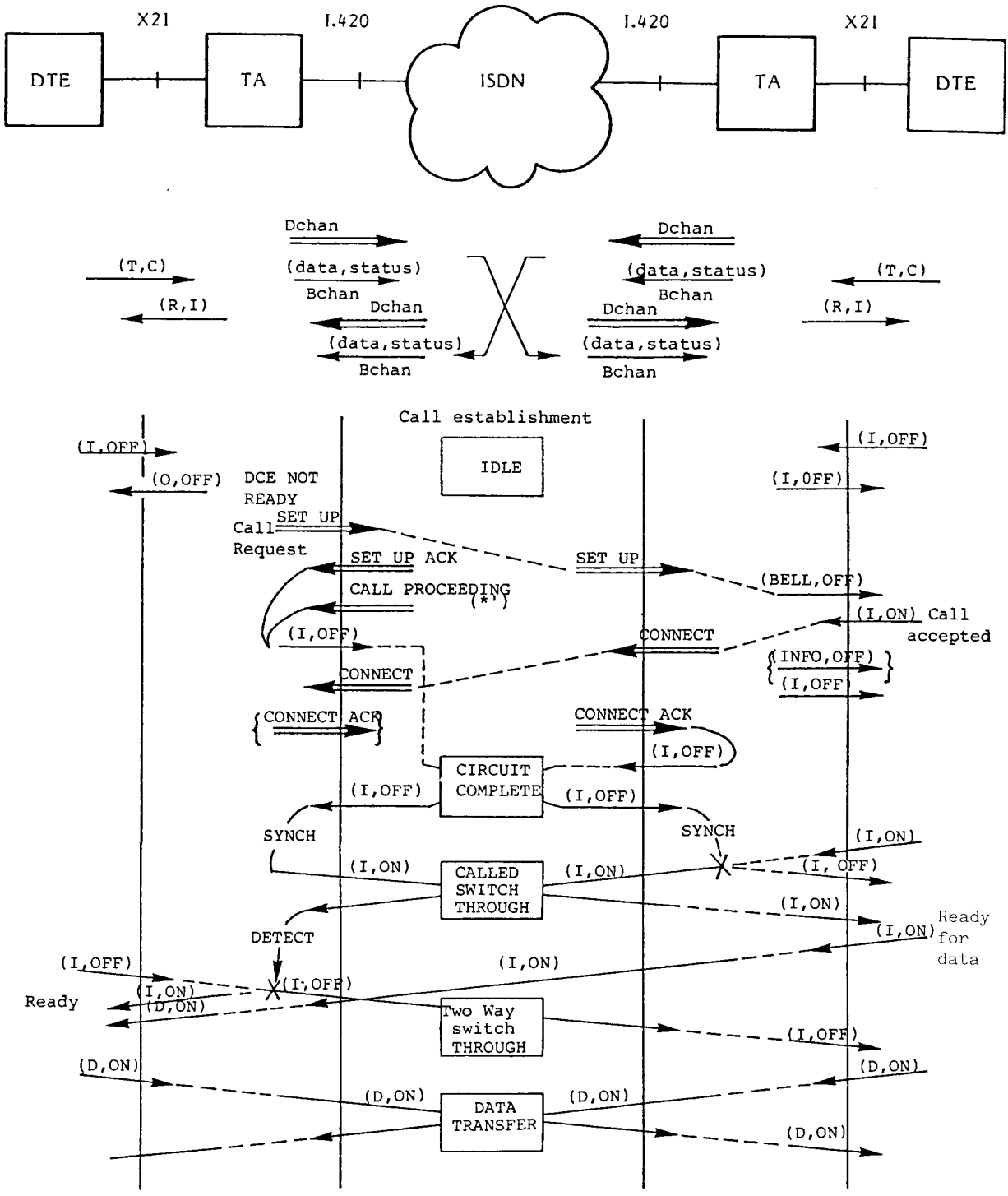
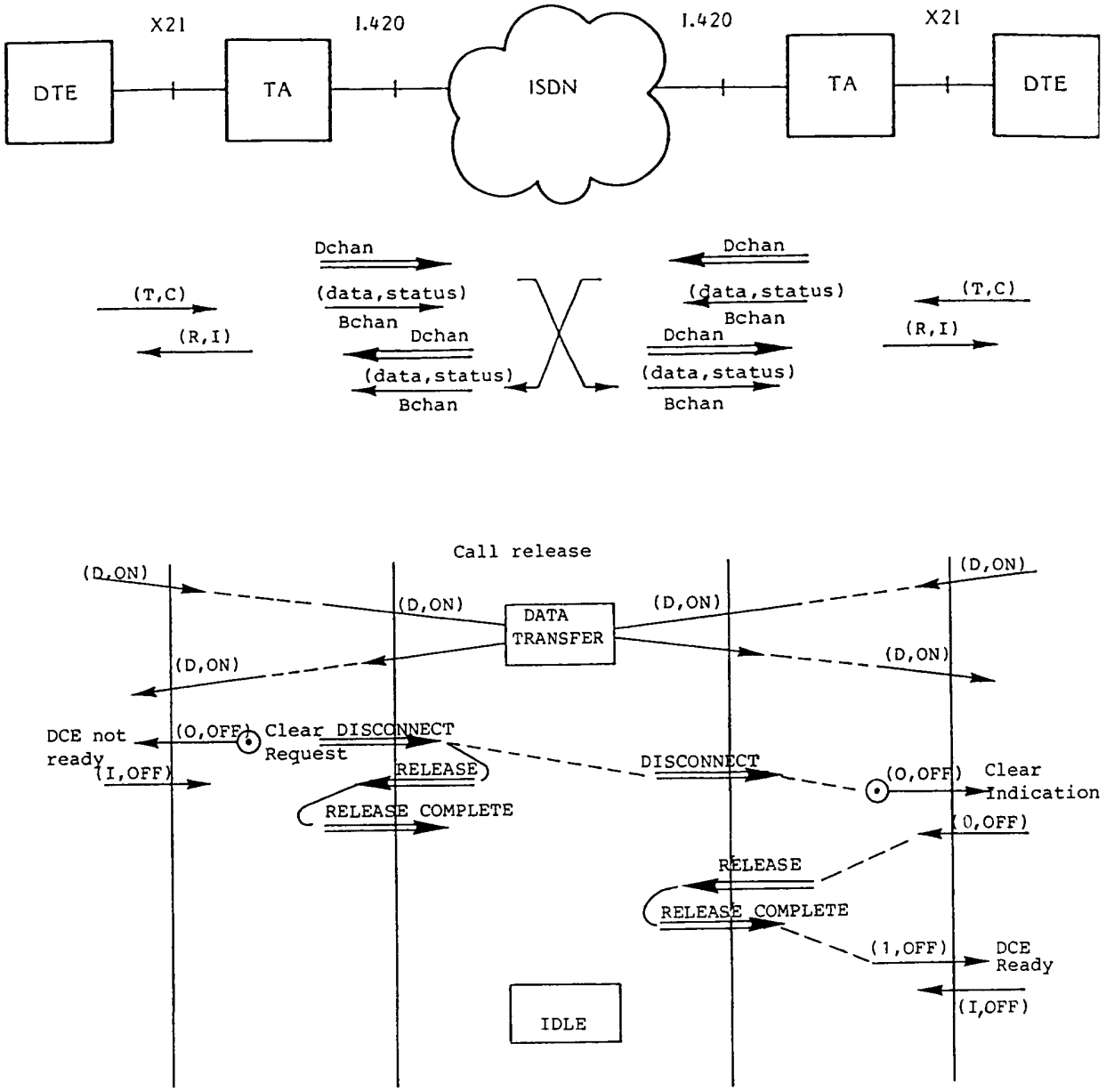


Figure B-7: X.21 leased - X.21 switched call establishment
(Status information conveyed across the network)



NOTE: The figure depicts the case of call clearing initiated by a manual intervention at the calling TA. Call clearing may also be initiated by the called DTE.

Figure B-8: X.21 leased - X.21 switched call clearing (Status information conveyed across the network)

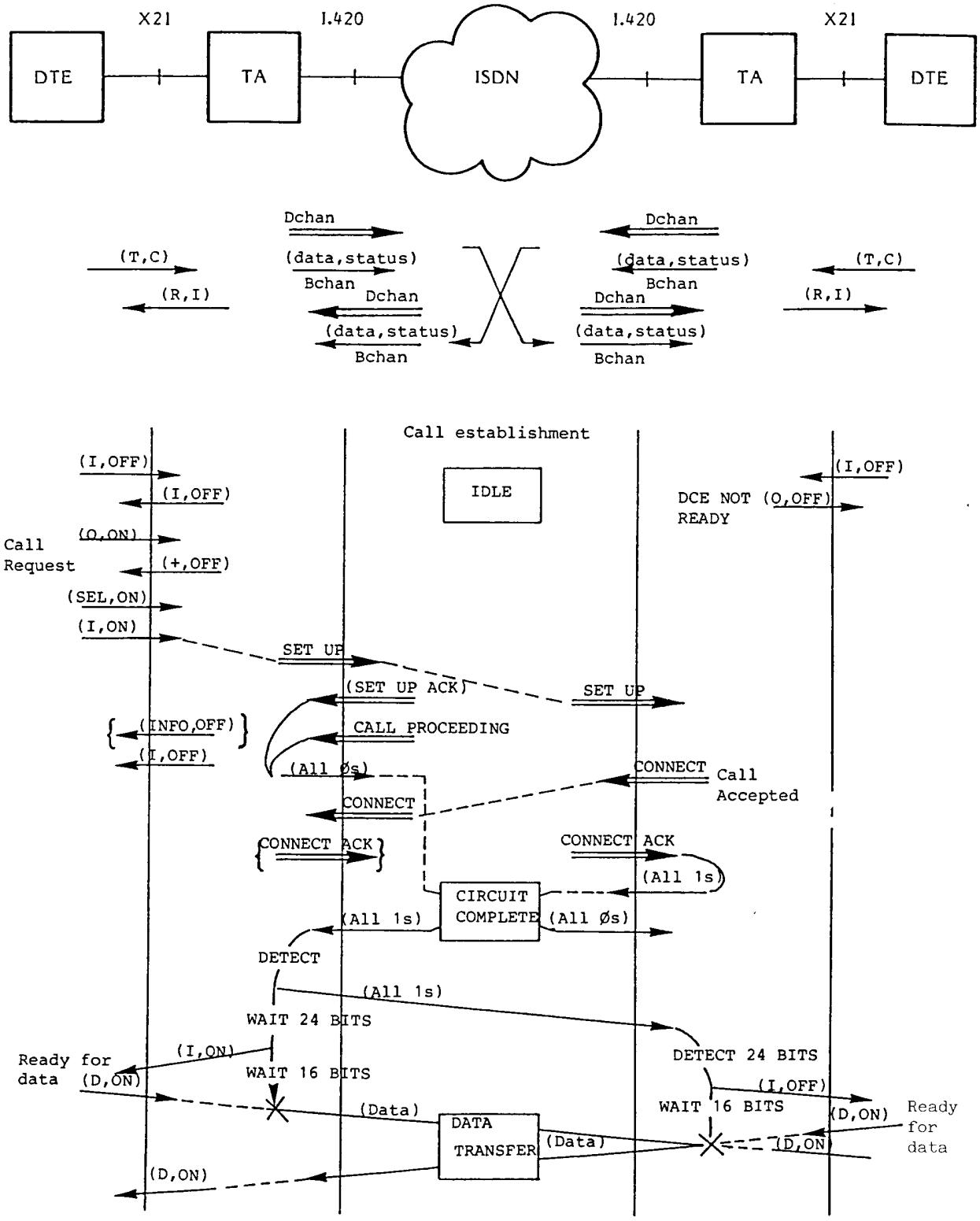


Figure B-9: X.21 switched - X.21 leased call establishment (Status information not conveyed across the network)

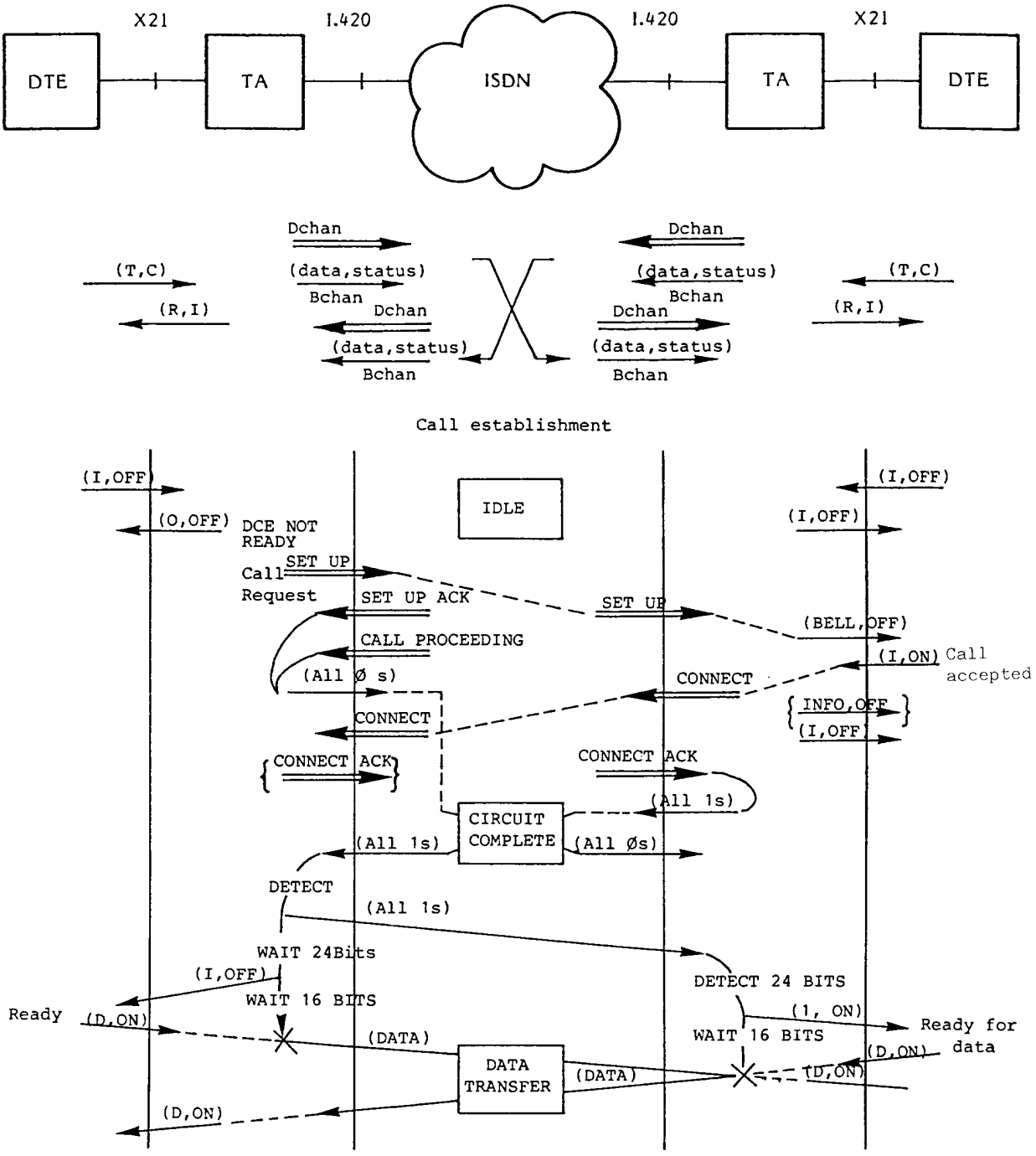


Figure B-10: X.21 leased - X.21 switched call establishment
(Status information not conveyed across the network)

Annex C (normative): Message functional definitions and contents, applicable at the interface at the coincident S and T reference point

Each message definition includes:

a) a brief description of the message direction and use, including whether the message has:

1) local significance, i.e. relevant only in the originating or terminating access;

2) access significance, i.e. relevant in the originating and terminating access, but not in the network;

3) global significance, i.e. relevant in either originating or terminating access, and in the network.

b) a table listing the information elements contained in the message. For each information element, the table indicates:

1) the reference of section of ETS 300 102-1 describing the coding of the information element,

2) the direction in which it may be sent; i.e. user to network (u -> n), network to user (n -> u), or both,

NOTE: the user-network terminology in this Annex refers to the TA - ET, TA - NT2 interface structures.

3) whether inclusion is mandatory ("M") or optional ("O");

In each case of "O", a corresponding note summarises the circumstances under which the information element shall be included.

4) the length(s), in octets. "?" means the maximum length is undefined.

The information elements are listed in order of appearance in the message. The relative order of information elements is the same for all message types.

c) further explanatory notes, as necessary.

Further procedural description relating to these messages are contained in ETS 300 102-1, Section 5.

1 Alerting

This message may be sent by the called TA to the network, and by the network to the calling TA to indicate that called user alerting has been initiated (see table C.1). Only manual answering TAs need to send this message to the network.

This message has global significance.

Table C.1: ALERTING message content

Message type: ALERTING
Direction: both

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2
Message type	4.4	both	M	1
Channel Identification	4.5	both NOTE 1	0	3
Progress indicator	4.5	n --> u NOTE 2	0	4
Display	4.5	n --> u NOTE 3	0	2-34

NOTE 1: The channel identification information element is mandatory if this message is the first message in response to SETUP, unless the user accepts the B-channel indicated in the SETUP message.

NOTE 2: Included in the event of interworking.

NOTE 3: Included if the network provides information that can be presented to the user.

2 Call proceeding

This message is sent by called user to the network on by the network to the calling user to indicate that requested call establishment has been initiated, and no more call establishment information will be accepted (see table C.2).

This message has local significance.

Table C.2: CALL PROCEEDING message content

Message type: CALL PROCEEDING
Direction: both (see NOTE 3)

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2
Message type	4.4	both	M	1
Channel Identification	4.5	both	0 NOTE 1	3
Progress indicator	4.5	n --> u	0 NOTE 2	4
Display	4.5	n --> u	0 NOTE 4	2-34

NOTE 1: The Channel identification information element is mandatory in the network-to-user direction if this message is the first message in response to SETUP. In the user-to-network direction the information element is mandatory if this message is the first message in response to SETUP, unless the user accepts the channel indicated in the SETUP message.

NOTE 2: Included in the event of interworking.

NOTE 3: In principle the called TA does not need to send this message to the network prior to the ALERTING or the CONNECT message.

NOTE 4: Included if the network provides information that can be presented to the user.

3 Connect

This message is sent by the called TA to the network, and by the network to the calling TA to indicate call acceptance by the called user (see table C.3).

This message has global significance.

Table C.3: CONNECT message content

Message type: CONNECT
Direction: both

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2
Message type	4.4	both	M	1
Channel Identification	4.5	both	0 NOTE 1	3
Progress indicator	4.5	n --> u	0 NOTE 2	4
Display	4.5	n --> u	0 NOTE 3	2-34
Date/time	4.5	n --> u	0 NOTE 5	2-7
Low layer compatibility	4.5	both	0 NOTE 4	2-16

NOTE 1: The Channel identification information element is mandatory if this message is the first message in response to SETUP, unless the user accepts the B-channel indicated in the SETUP message.

NOTE 2: Included in the event of interworking.

NOTE 3: Included if the network provides information that can be presented to the user.

NOTE 4: Included in the user-to-network direction when the answering user wants to return low layer compatibility information to the calling user. Included in the network-to-user direction if the user awarded the call included a Low layer compatibility information element in the CONNECT message. Optionally included for low layer compatibility negotiation, but some networks may not transport this information element to the calling user (see Annex M of ETS 300 102-1).

NOTE 5: Included by the network e.g. dependent on the Telecommunication service requested by the user or as a subscription option or as a network provider default option.

4 Connect acknowledge

This message is sent by the network to the called TA to indicate the user has been awarded the call, and may be sent by the calling TA to the network to promote symmetrical call control procedures (see table C.4).

This message has local significance.

Table C.4: CONNECT ACKNOWLEDGE message content

Message type: CONNECT ACKNOWLEDGE
Direction: Network to user

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	n --> u	M	1
Call reference	4.3	n --> u	M	2
Message type	4.4	n --> u	M	1
Display	4.5	n --> u	0 NOTE 1	2-34
NOTE 1: Included if the network provides information that can be presented to the user.				

5 Disconnect

This message is sent by either the TA or the network as an invitation to release the channel (if any) and the call reference. The equipment sending this message shall disconnect from the channel. The channel (if any) and call reference are not available for re-use at this time (see table C.5).

This message has global significance.

Table C.5: DISCONNECT message content

Message type: DISCONNECT
Direction: both

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2
Message type	4.4	both	M	1
Cause	4.5	both	M	4-32
Display	4.5	n --> u	0 NOTE 1	2-34
NOTE 1: Included if the network provides information that can be presented to the user.				

6 Information

This message is sent from the network to the TA to provide additional information. It may be used to provide miscellaneous call-related information (see table C.6).

This message has local significance (but may carry information of global significance).

Table C.6: INFORMATION message content

Message type: INFORMATION
Direction: Network to user

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	n --> u	M	1
Call reference	4.3	n --> u	M	2
Message type	4.4	n --> u	M	1
Cause	4.5	n --> u	0 NOTE 1	2-32
Display	4.5	n --> u	0 NOTE 2	2-34

NOTE 1: As a network option, may be used for stimulus operation of supplementary services (see section 7 of ETS 300 102-1).

NOTE 2: Included if the network provides information that can be presented to the user.

7 Notify

This message is sent from the network to the TA to indicate information pertaining to a call, such as user suspended (see table C.7).

This message has access significance.

NOTE: On receipt of a NOTIFY message the TA makes no response and remains in the same call state.

Table C.7: NOTIFY message content

Message type: NOTIFY
Direction: Network to user

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	n --> u	M	1
Call reference	4.3	n --> u	M	2
Message type	4.4	n --> u	M	1
Notify indicator	4.5	n --> u	M	3
Display	4.5	n --> u	0	2-34 NOTE 1

NOTE 1: Included if the network provides information that can be presented to the user.

8 Progress

This message is sent from the network to the TA to indicate the progress of call in the event of interworking (see table C.8).

This message has global significance.

Table C.8: PROGRESS message content

Message type: PROGRESS
Direction: Network to user

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	n --> u	M	1
Call reference	4.3	n --> u	M	2
Message type	4.4	n --> u	M	1
Progress indicator	4.5	n --> u	M	4
Display	4.5	n --> u	0 NOTE 1	2-34
NOTE 1: Included if the network provides information that can be presented to the user.				

9 Release

This message is sent, from either the TA or the network, to indicate that the equipment sending the message has disconnected the channel and intends to release the call reference, and that the receiving equipment should release the channel and prepare to release the call reference after sending RELEASE COMPLETE (see table C.9).

This message has local significance; however it has global significance when sent as the first clearing message.

Table C.9: RELEASE message content

Message type: RELEASE
Direction: both

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2
Message type	4.4	both	M	1
Cause	4.5	both	0 NOTE 1	2-32
Display	4.5	n --> u	0 NOTE 2	2-34

NOTE 1: Mandatory if the message is the first clearing message or if the RELEASE message is sent as a result of timer T305 or T306 expiry.

NOTE 2: Included if the network provides information that can be presented to the user.

10 Release complete

This message is sent, from either the TA or the network to indicate that the equipment sending the message has released the channel (if any) and the call reference (if any); the receiving equipment shall release the call reference. (see table C.10).

This message has local significance; however it has global significance when sent as the first clearing message.

Table C.10: RELEASE COMPLETE message content

Message type: RELEASE COMPLETE
Direction: both

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2
Message type	4.4	both	M	1
Cause	4.5	both	0 NOTE 1	2-32
Display	4.5	n --> u	0 NOTE 2	2-34

NOTE 1: Mandatory if the message is the first call clearing message, included when the RELEASE COMPLETE message is sent as a result of an error handling condition.

NOTE 2: Included if the network provides information that can be presented to the user.

11 SETUP

This message is sent from either the TA or the network, to initiate call establishment (see table C.11).

This message has global significance.

Table C.11: SETUP message content

Message type: SETUP
Direction: both

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2
Message type	4.4	both	M	1
Sending complete	4.5	both	0 NOTE 10	1
Bearer capability	4.5	both	M NOTE 1	4-10
Channel identification	4.5	both	0 NOTE 2	3
Progress indicator	4.5	n --> u	0 NOTE 3	4
Display	4.5	n --> u	0 NOTE 9	2-34
Calling party number	4.5	both	0 NOTE 4	2-24
Calling party subaddress	4.5	both	0 NOTE 4	2-8
Called party number	4.5	both	0 NOTE 5	2-23
Called party subaddress	4.5	both	0 NOTE 6	2-8
Low layer compatibility	4.5	both	0 NOTE 7	4-10
High layer compatibility	4.5	both	0 NOTE 8	4

Notes to table C.11.

NOTE 1: The bearer capability and compatibility information elements may be used to describe a CCITT telecommunication service, if appropriate.

NOTE 2: This information element is mandatory in the network-to-user direction. Included in the user-to-network direction when the user wishes to indicate a channel ; when not included, this is interpreted as "any channel acceptable". It is recommended that the TA does not include this information element.

NOTE 3: Mandatory if the call is not end-to-end ISDN.

NOTE 4: May be included by a calling TA and provided to the called TA in accordance with rules defined e.g. in conjunction with certain supplementary services (e.g. calling line identification).

NOTE 5: May be included to transport called party number information to the network or to the user.

NOTE 6: Included in the user-to-network direction if the calling TA desires to indicate a called subaddress. Included in the network-to-user direction if the calling TA included a called party subaddress.

NOTE 7: Included in the user-to-network direction if the calling TA wishes to provide low layer compatibility information to the called TA. Included in the network-to-user direction if the calling user had included it in the SETUP message.

NOTE 8: Included in the user-to-network direction if the calling TA wishes to provide high layer compatibility information to the called TA or indicate to the network a request for a certain network provided teleservice. Included in the network-to-user direction if the calling TA had included it in the SETUP message.

NOTE 9: Included if the network provides information that can be presented to the user.

NOTE 10: Included if the user or the network optionally indicates that all information necessary for call establishment is included in the SETUP message.

12 SETUP ACKNOWLEDGE

NOTE: the SETUP ACKNOWLEDGE message is not applicable when the Sending complete information element is included in the SETUP message (see section 2.1.2.1.1).

This message is sent by the network to the calling TA, to indicate call establishment has been initiated but additional information may be required. (see table C.12).

This message has local significance.

Table C.12: SETUP ACKNOWLEDGE message content

Message type: SETUP ACKNOWLEDGE
Direction: Network to user

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	n --> u	M	1
Call reference	4.3	n --> u	M	2
Message type	4.4	n --> u	M	1
Channel identification	4.5	n --> u	M	3
Progress indicator	4.5	n --> u	0 NOTE 1	4
Display	4.5	n --> u	0 NOTE 2	2-34

NOTE 1: Included in the event of interworking or in connection with the provision of in-band information/pattern.

NOTE 2: Included if the network provides information that can be presented to the user.

13 STATUS

This message is sent from either the TA or the network at any time during a call to report an error condition as specified in section 5.9 of ETS 300 102-1.

This message has local significance.

Table C.13: STATUS message content

Message type: STATUS
Direction: both

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	both	M	1
Call reference	4.3	both	M	2
Message type	4.4	both	M	1
Cause	4.5	both	M	4-32
Call state	4.5	both	M	3
Display	4.5	n -- > u	0 NOTE 1	2-34
NOTE 1: Included if the network provides information that can be presented to the user.				

Annex D: Asynchronous DTE TA operating sequences

1 TA duplex operation

When using the TA to provide data transmission services within ISDN, the call is established over a 64 kbit/s circuit switched connection using the procedures applicable to the particular network and/or terminal configuration.

The internal arrangement of the TA functional parts and the DTE (with a V-series type interface) is not within the scope of this standard. It is assumed that means are provided to control the entry to and the exit from the data transfer mode. For example, it is assumed that the means are provided to control circuits 108/1 (Connect data set to line) or 108/2 (Data terminal ready) internally, that is within the station at the customer premises. However, for the purpose of this standard, circuit 108/2, as defined in CCITT Recommendation V.24, is assumed.

1.1 IDLE (or Ready) state

1.1.1 During the idle (or ready) state the TA (DCE) will be receiving the following from the DTE:

Circuit 103 = continuous binary 1
Circuit 105 = (see note)
Circuit 108/1 = OFF
Circuit 108/2 = ON

NOTE: In many duplex DTEs circuit 105 is either permanently in an ON condition or is not present. If not present, the function must be set in an ON condition in the TA. See section 1.2.4 below for the case where a duplex DTE can operate circuit 105.

1.1.2 During the idle (or ready) state the TA will transmit the continuous binary 1's into the B- and D-channels (i.e. all of figure 4 of section 2.1.1.2.1 of this ETS = binary 1).

1.1.3 During the idle (or ready) state the TA (DCE) will transmit the following towards the DTE:

Circuit 104 = continuous binary 1
Circuit 107 = OFF
Circuit 106 = OFF
Circuit 109 = OFF

1.2 Connect TA to line state

1.2.1 When the TA is to be switched to the data mode, circuit 108 must be ON.

Switching to the data mode causes the TA to transmit the following towards the ISDN (refer to figure 4 of this ETS):

a) frame synchronization pattern, as follows:

- octet 0 of the odd frames = all binary 0's
- bit number one of all other octets = binary 1

b) data bits = binary 1

c) status bits S = OFF and X = OFF (ON = binary 0 ; OFF = binary 1)

NOTE 1: At this time circuit 103 is not connected to the data channel (e.g. the binary 1 condition of the data bits is generated within the TA).

NOTE 2: In the following description only the inter-operation between TE2/TA (DTE/DCE) interface and the intermediate rate frames and the 64 kbit/s frame are described. The second step of rate of adaption encoding and decoding and the multiplexing and demultiplexing of the ISDN basic user/network interface are defined in CCITT Recommendation I.460 and I.430, respectively.

1.2.2 At this time (i.e. switching to data mode) the receiver in the TA will begin to search for the frame synchronization pattern in the received bit stream.

At this time, a timer T1 (set to 10 seconds) shall be started.

1.2.3 When the receiver recognizes the frame synchronization pattern, it causes the S and X bits in the transmitted frames to be turned ON (provided that circuit 108 is ON).

1.2.4 When the receiver recognizes that the status of bits S and X are in the ON condition it will perform the following functions:

a) Turn ON circuit 107 toward the DTE and stop timer T1.

NOTE: A duplex DTE that implements and is able to operate circuit 105 may be expected to turn this circuit ON at any time. However, if not previously turned ON, it must be turned ON in response to the ON condition on circuit 107.

b) Then, circuit 103 may be connected to the data bits in the frame; however the DTE must maintain a binary 1 condition until circuit 106 is turned ON in the next portion of the sequence.

c) Turn ON circuit 109 and connect the data bits to circuit 104.

NOTE: Binary 1 is being received on circuit 104, at this time.

d) After an N bit interval, it will turn ON circuit 106. The proposed value for N is 24.

e) Circuit 106 transitioning from OFF to ON will cause the transmitted data to transition from binary 1 to the data mode.

If circuit 107 has not been turned ON, after expiry of timer T1 the TA shall be disconnected according to procedures given in section 1.4 below.

1.3 Data transfer state

1.3.1 While in the data transfer state the following circuit conditions exist:

a) circuit 105 (when implemented), 106, 107, 108/1 or 108/2 and 109 are in the ON condition;

b) data is being transmitted on circuit 103 and received on circuit 104.

1.4 Disconnect mode

1.4.1 At the completion of the data transfer phase, the local DTE will indicate a disconnect request by turning OFF circuit 108. This will cause the following to occur:

a) the status bits S in the frame towards ISDN will turn OFF, status bits X are kept ON;

b) circuit 106 will be turned OFF;

c) the data bits in the frame will be set to binary 0.

1.4.2 If circuit 108 is still ON at the remote TA, this TA will recognize the transition of the status bits from ON to OFF and the data bits from data to binary 0 as a disconnected signal and it will turn OFF circuits 107 and 109. This DTE should respond by turning OFF circuit l08 and transferring to the disconnected mode. The disconnection will be signalled via the ISDN D-channel signalling protocol. At this time, the DTE/DCE interface should be placed in the idle (or ready) state.

1.4.3 The TA at the station that originated the disconnect request will recognize reception of S = OFF or the loss of framing signals as a disconnect acknowledgement and turn OFF circuits 107 and 109 and transfer to the disconnected mode. The disconnection will be signalled via the ISDN D-channel signalling protocol. At this time, he DTE/DCE interface should be placed in the idle (or ready) state.

1.5 Loss of frame synchronization

1.5.1 In the event of loss of frame synchronisation, the TA should attempt to resynchronise as follows :

a) Place circuit 104 in binary 1 condition (passes from the data mode).

b) Turn OFF status bit X in the transmitted frame.

c) The remote TA upon recognition of status bit X = OFF will turn OFF circuit 106 which will cause the remote DTE to place circuit 103 in a binary 1 condition.

d) The local TA should attempt to resynchronise on the incoming signal.

e) If after an interval of three seconds the local TA cannot attain synchronization, it should send a disconnect request by turning OFF all of the status bits for several (at least three) frames with data bits set to binary 0 and then disconnect by turning OFF circuit 107 and transferring to the disconnected mode as discussed in section 1.4.2 above.

NOTE: The values of three seconds and three frames are provisional and should be confirmed or amended after further study.

f) If resynchronisation is achieved, the TA should turn ON status bit X towards the distant terminal.

g) If resynchronisation is achieved, the TA (which has turned OFF circuit 106) should, after an N bit interval, turn ON circuit 106. This will cause circuit 103 to change from binary 1 to the data mode.

NOTE 1: The proposed value of N is 24.

NOTE 2: During a resynchronisation attempt circuits 107 and l09 should remain ON.

2 TA half-duplex operation

The data call establishment for the interworking of half-duplex DTEs equipped with V-series type interfaces is the same as discussed in section 1 above. The only difference between half-duplex operation is in the control of the circuits 105, 106 and 109 as follows:

NOTE: This is a unique application : therefore, TA arranged for half-duplex operation will not be able to interwork with either a V-series or an X-series duplex DTE (TE2).

2.1 In a TA arranged to accommodate half-duplex DTEs, circuit 109 will be under the control of the status bits SP in the incoming frame, as follows:

NOTE: Status bits SP as specified in figure 4 of this standard are equivalent to Status bits SB defined in Table 3 of Recommendation V.110).

a) If at the local interface circuit 109 is OFF and circuit 104 is in the binary 1 state, the DTE may "request to send" by turning ON circuit 105.

b) The TA will then turn ON status bits SB in the transmitted frame which will turn ON circuit 109 in the remote interface and connect circuit 104 to the data bit stream of the incoming frame.

c) After an N bit interval the local TA will turn ON circuit 106, which will allow the local DTE to transmit data on circuit 103.

NOTE: the proposed value of N is 24.

d) Upon completion of the transmission the local DTE will turn OFF circuit 105. This will in turn:

- turn OFF circuit 106 in the local interface and circuit 103 will revert to the binary 1 state.

- turn OFF status bits SB which will in turn at the remote TA turn OFF circuit 109 and place circuit 104 in a binary 1 condition.

e) At this time the remote DTE is able to reverse the sequence by turning ON circuit 105.

3 Automatic calling

The mapping of V.25 and/or V.25bis automatic calling and/or automatic answering procedures to the ISDN D-channel signalling protocols requires further study.

Annex E (normative): Timer values

Two timers T1 and T2 are involved in the Ready for Data alignment procedure for entering the data transfer phase between two terminals (see section 2.3.4 and Annex B of this standard).

The default values are:

T1 = 1 sec.

T2 = 2 sec. (It should be possible to adjust easily this timer in the range 1 to 20 seconds to cope with possible operational difficulties that may be encountered).

NOTE: These timers must take into account the information transfer delay between the calling and the called TA's; the default values allow up to 3 satellite hops in the connection.

Annex F (normative): SDL diagrams for the protocol mapping of X.21 TA's

1 General

In order to provide a clear and unambiguous understanding of the protocol mapping in the TA (X.21 procedures of the R-interface to ISDN signalling procedures at the S-interface) a formal description method is used. This annex presents a formal description using the Specification and Description Language (SDL) recommended by CCITT Recommendations Z.101 - Z.103.

This SDL description supplements the procedures given in section 2.1.2.1 (and illustrated by figures 8 and 9) of this ETS.

2 The formal description

a) Because of fundamental differences in the formal description techniques used in CCITT Recommendation X.21 (Annex A) and the one used to describe X.21 TA it was not possible to realize a one-to-one translation of the states as described in CCITT Recommendation X.21 into the states as described in the X.21 TA. However, corresponding states from CCITT Recommendation X.21 are indicated as a comment in the X.21 TA description.

b) Only the regular call control phases of the X.21 TA are described. Note that X.21 sub-addressing procedures (simple or enhanced) are not described. No timers, etc. are shown.

c) The following functions are not shown in detail in the SDL diagrams:

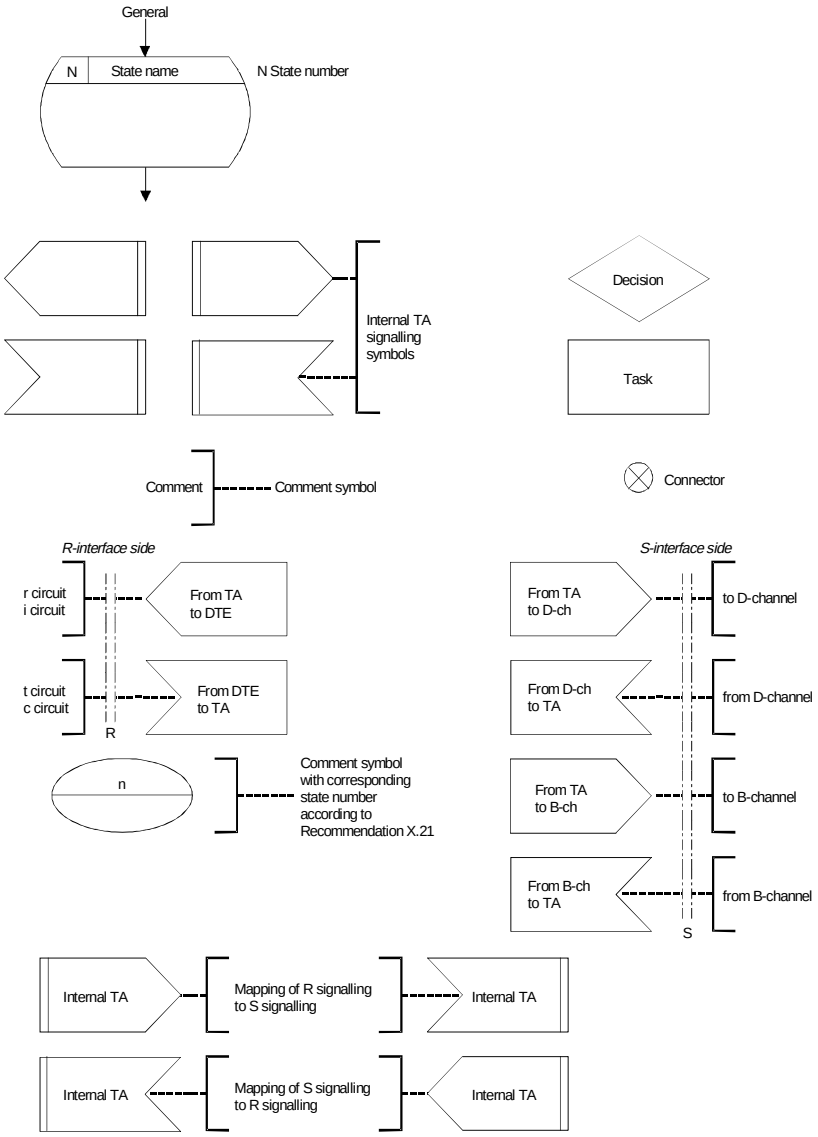
- switch-through at the R-interface (on the R-interface data is internally mapped to the B-channel handler);
- end-to-end synchronization;
- the rate adaption and frame/envelope assembly/disassembly processes.

d) In order to describe it, the TA is divided into three functional parts which can act simultaneously, namely:

- the R-interface;
- the D-channel handler on the S-interface side;
- the B-channel handler on the S-interface side.

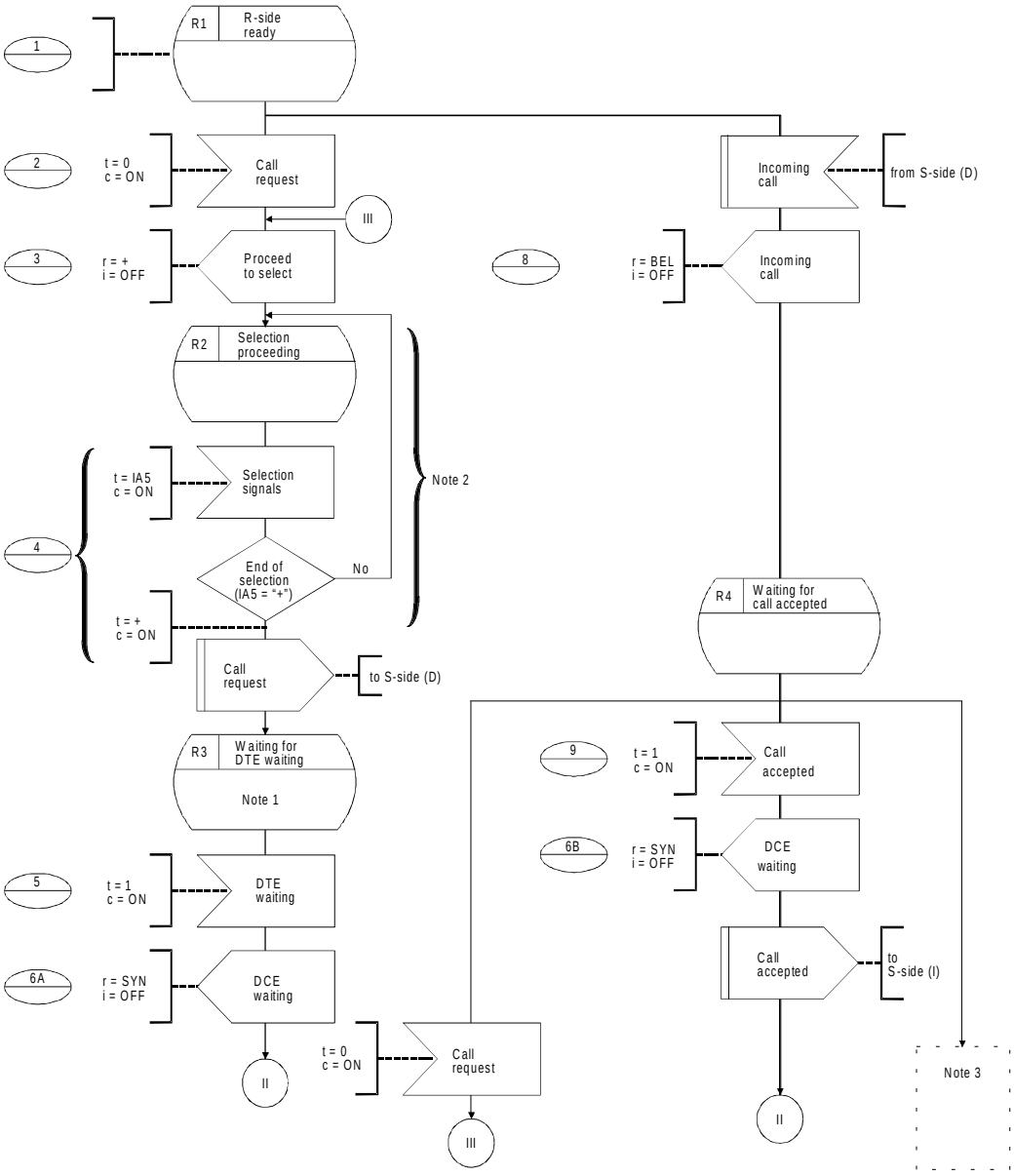
The (ordering of the) interacting signals between R- and S-interfaces represent the actual mapping of the R-interface procedures to the S-interface procedures.

Figure F-1 shows the symbols used in the SDL diagrams and figures F-2 to F-6 describe the protocol mapping of the X.21 TA.



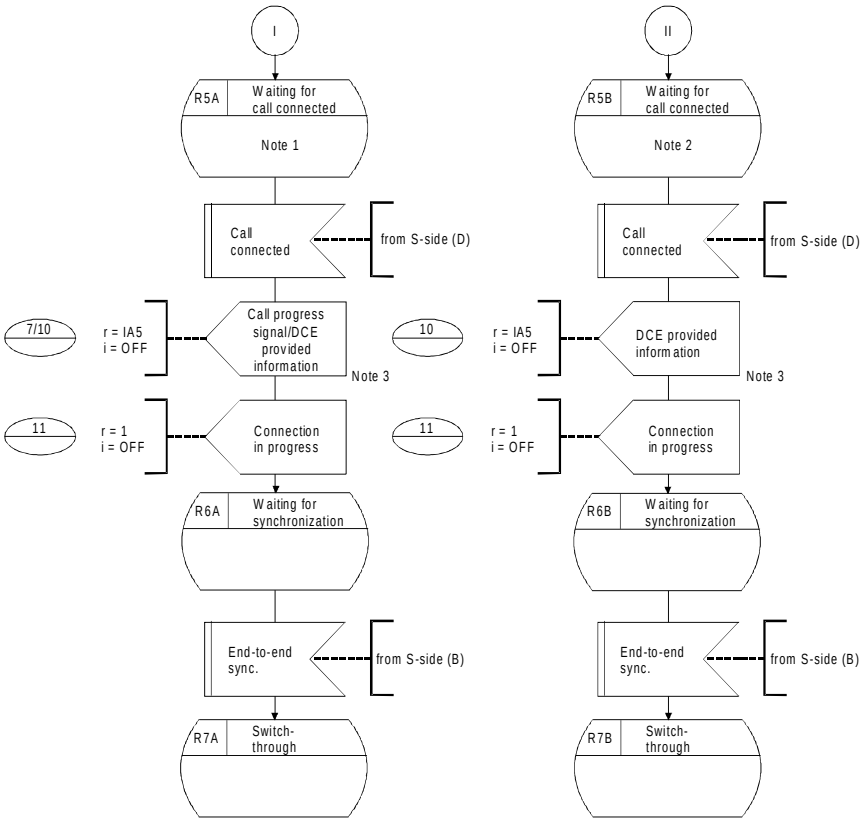
NOTE – Two-process representation at R-interface side and S-interface side employed in the following figures does not imply two-process implementation.

Figure F-1: Use of symbols in SDL diagrams for X.21 terminal adapter (TA) signalling



Note 1 - Manual answering terminals are not considered in this figure.
Note 2 - If an internal

Figure F-2 (sheet 1 of 2): R-interface side of the X.21 TA; call control phase



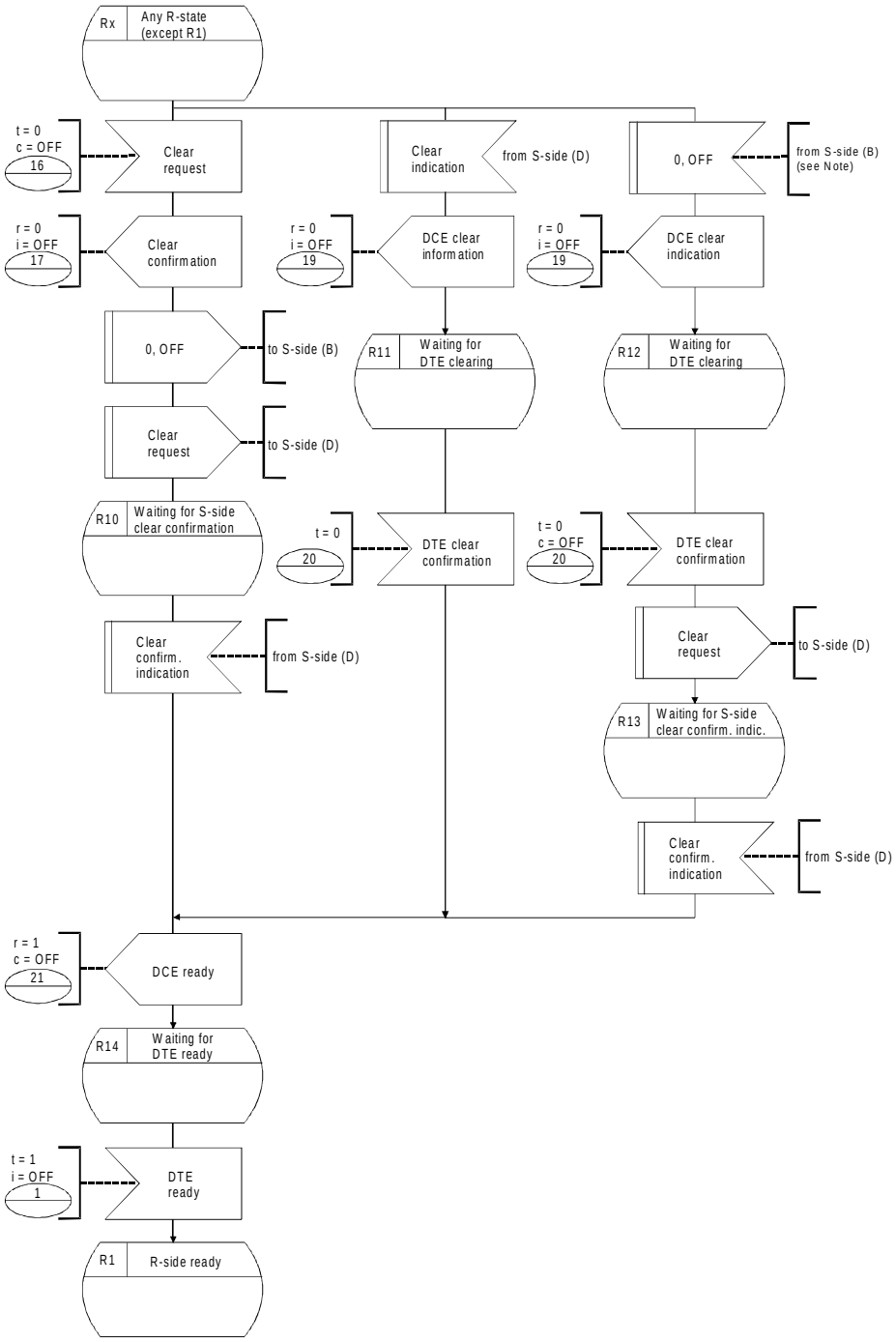
Note 1 - If an internal *incoming call* signal is received while in this state, it should be ignored by the R-side.

Note 2 - X.21 extended address procedure is left for further study.

Note 3 - DCE waiting states (6A or 6B; see Recommendation X.21, Figure A.2/X.21) may be bypassed.

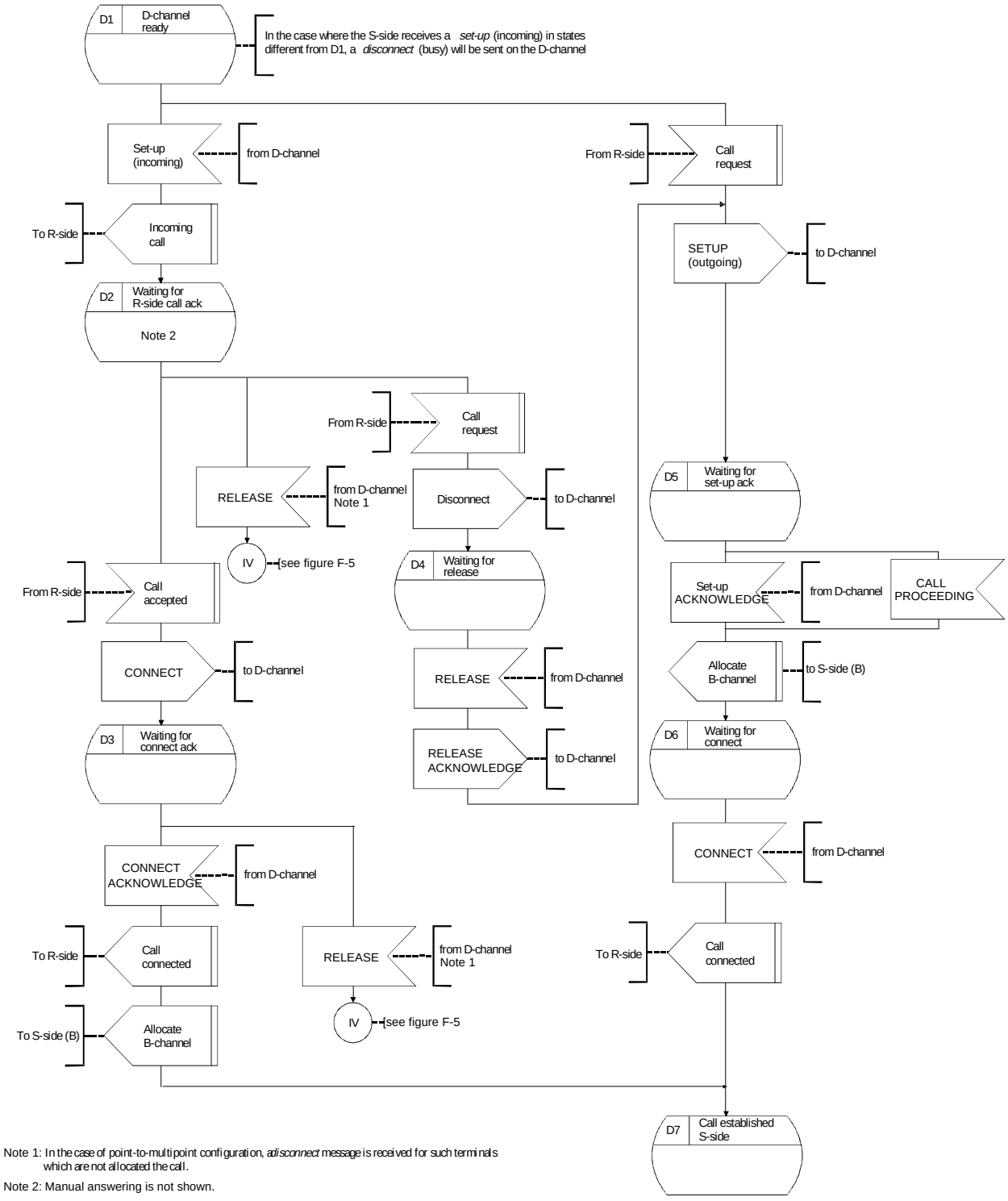
Note 4 - The X.21 states *controlled* and *uncontrolled not ready* are not shown in these diagrams. However, if an internal incoming call is received from the S-side during these states, the R-side will respond with an internal *clear request* to the S-side with the appropriate reason.

Figure F-2 (sheet 2 of 2): R-interface side of the X.21 TA; call control phase



NOTE – In the case of 64 kbit/s, the 0, OFF signal is not defined on the B-channel.

Figure F-3: R-interface side of the X.21 TA; clearing phase



Note 1: In the case of point-to-multipoint configuration, *adisconnect* message is received for such terminals which are not allocated the call.

Note 2: Manual answering is not shown.

Figure F-4: S-interface of the X.21 TA; call control phase of the D-channel handler

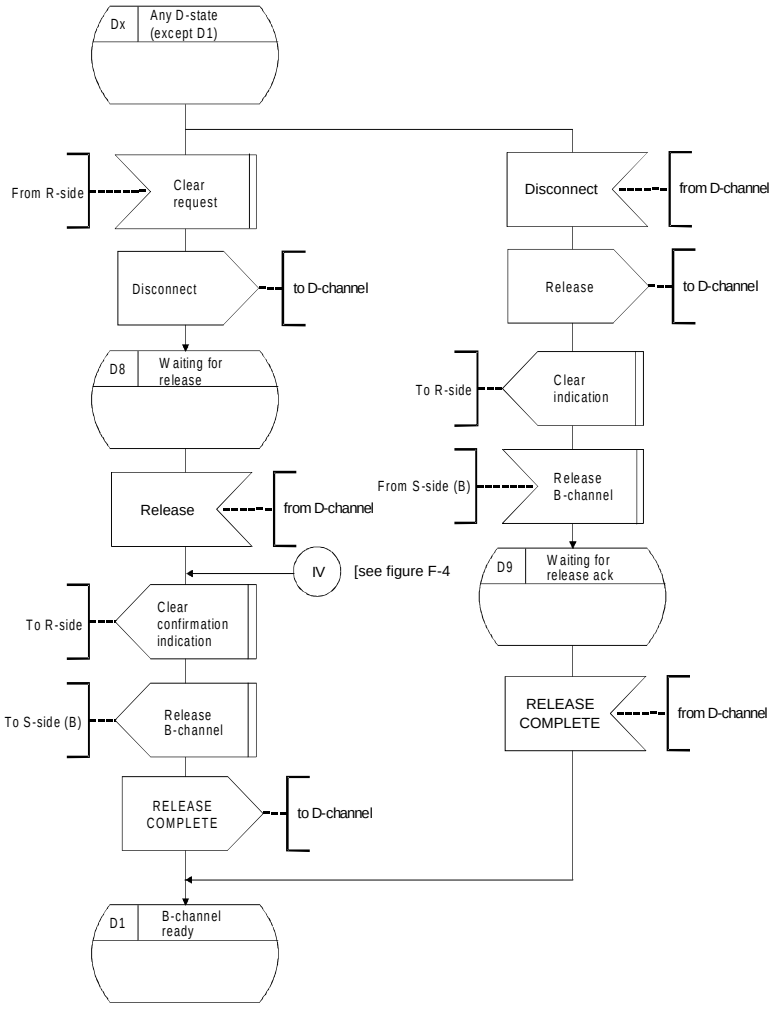
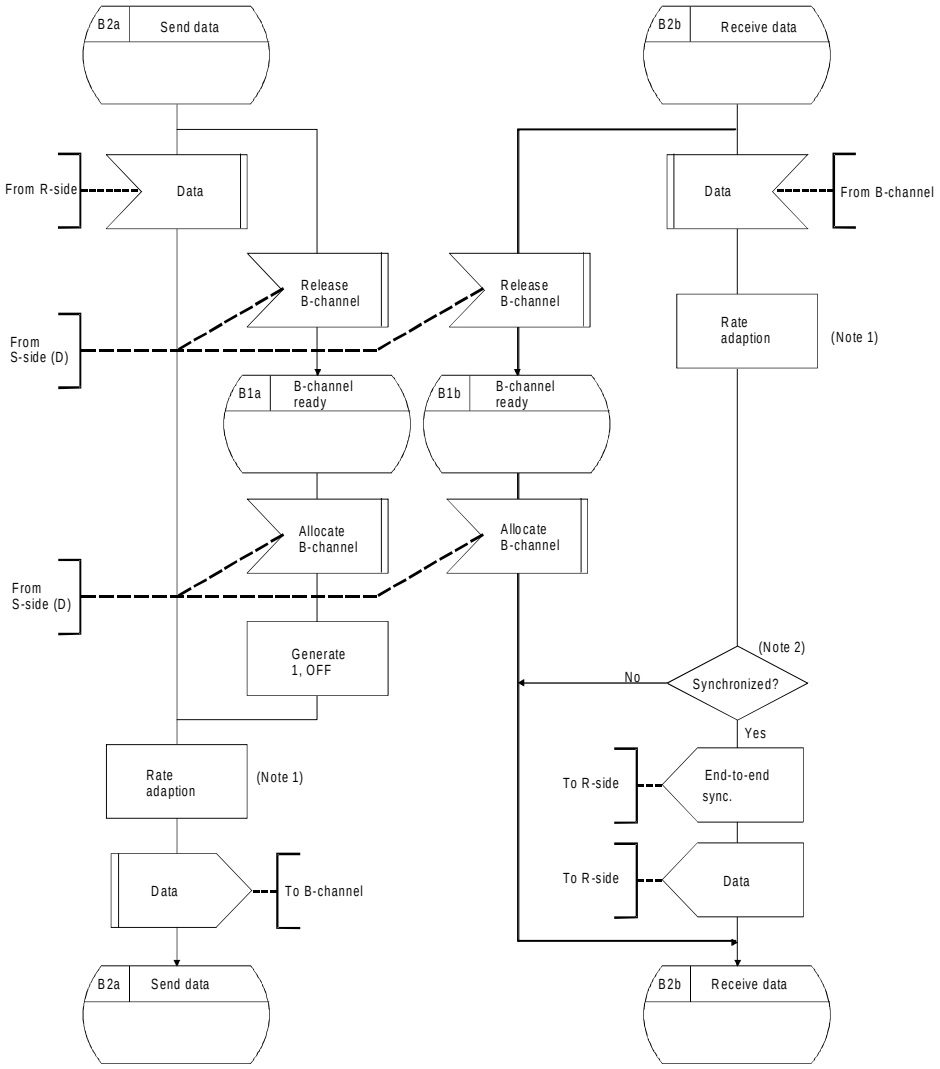


Figure F-5: S-interface side of the X.21 TA; clearing phase of the D-channel handler



NOTES
1 Only required for user classes 3 to 7.
2 See 2.1.4, 2.2.4 and 2.3.4.

Figure F-6: S-interface side of the X.21 TA; B-channel handler

Annex G (informative): Flow control option for Asynchronous DTE TA's

A flow control option, for use with TAs supporting asynchronous DTEs, is described in this Appendix. Flow control allows the connection of asynchronous DTEs operating at different user data rates by reducing the character output of the faster to that of the slower. Support of flow control will require the use of the end-to-end (TA-to-TA) protocol defined in section 2 below and an incoming line (from network) buffer in addition to a selected Local protocol (see section 1 below). Depending upon the Local Flow Control protocol employed, there will also be a requirement for character buffering from the DTE interface. The size of this buffer is not defined in this standard because it is implementation dependent.

Local flow control of the DTE interface is required where the DTE operates at a rate higher than the synchronous rate established between the TAs. End-to-end flow control is required where the synchronous rate established between TAs is consistent with the operating rate of one DTE (or interworking function unit) and higher than the synchronous rate consistent with the operating rate of the other DTE (or interworking function unit). Both local and end-to-end flow control could be required in some applications.

1 Local flow control: TA to DTE

Connection may be made between TAs connected to asynchronous DTEs operating at two different speeds. It is the responsibility of the TA connected to the faster DTE to execute a Local Flow Control protocol to reduce the character rate to that of the slower DTE. This operation will require some buffer storage in the TA. A TA may support several different Local Flow Control protocols, although only one will be selected at anyone time. There are a number of such protocols in use, some of which are detailed in the following text.

1.1 105/106 operation

This is an out-of-band Flow Control mechanism, utilizing two of the interchange Circuits specified in V.24. If a DTE requires to transmit a character, it turns ON Circuit 105 (request to send). The DTE can only begin transmission when it receives in return Circuit 106 ON (ready for sending). If, during transmission of a block of characters Circuit l06 goes OFF, the DTE must cease transmission (after completing the transmission of any character of which transmission has started) until Circuit l06 turns ON again.

1.2 X ON/X OFF operation

This is an in-band Flow Control mechanism using two characters of the IA5 set for X ON and X OFF operation. If a DTE receives an X OFF character, it must cease transmission. When it receives an X ON character, it may resume transmission. The characters typically used for X ON and X OFF are DC1 and DC3 (bit combination 1/1 and 1/3 in recommendation T.50) respectively, although alternative bit combinations can be used.

1.3 Other methods

Alternative and non-standard methods of asynchronous flow control are in use, and these may be mapped onto the TA flow control protocol.

2 End-to-end flow control: TA to TA

Matching (by reduction) of the transmitted character rate of the DTE to the rate of the TA is not sufficient in all cases to guarantee correct operation, and end-to-end flow control may be required.

The X-bit is used to carry Flow Control information. A TA will buffer incoming characters. When the number of buffered characters exceeds a threshold TH1, depending upon implementation, the TA will set the X-bit of its outgoing frames to OFF.

Upon receipt of a frame containing an X-bit set to OFF, a TA will execute its selected Local Flow Control procedure indicating that the attached DTE must stop sending characters, and cease the transmission of data after completion of the characters in progress by setting the data bits in the outgoing frames to ONE.

When the buffer contents of a TA which has initiated an end-to-end Flow Control drops below threshold TH2, the TA will reset the outgoing X bit to ON.

When the far-end TA receives a frame with the X bit set to ON, it will recommence data transmission, and, by use of the Local Flow Control procedure, indicate to the attached DTE that it may continue.

NOTE: There may be a delay between initiation of the end-to-end Flow Control Protocol and termination of the incoming character stream. The characters arriving during this time must be buffered, and the total buffer size will depend upon the character rate, round trip delay and the buffer threshold.

3 Use of channel capacity

Upon accepting a call from a TA supporting Flow Control and operating at a different user rate and/or intermediate rate, the called TA will adopt the identical intermediate rate and bit repetition factor. This will override the parameters normally selected. In such cases, the TA Connected to the faster DTE will execute a Local Flow Control procedure to reduce the character rate to that of the slower DTE.

Thus, if a faster DTE calls a slower DTE, the faster intermediate channel rate and bit repetition factor will be adopted by the TAs at both ends. To reduce the character rate received by the slower DTE, its TA will exercise End-to-end Flow Control and cause the TA on the calling side to utilise Local Flow Control.

If a slower DTE calls a faster DTE, the slower intermediate channel rate and bit repetition factor will be adopted by the TAs on both ends. To reduce the character rate transmitted by the faster DTE its TA will exercise Local Flow Control.

If the called TA does not implement the intermediate rate and bit repetition factor used by the calling TA, the call shall be rejected.

4 Requirements for a TA supporting flow control

The following are general requirements for a TA supporting Flow Control:

i) A TA supporting Flow Control shall be capable of operating with an intermediate rate and bit repetition factor that is independent of the asynchronous speed used at its DTE interface.

ii) A TA supporting Flow Control shall be capable of recognizing the intermediate rate and bit repetition factor required for an incoming call, and adopting it. User rate information will be obtained from signalling.

iii) A TA supporting Flow Control shall be capable of executing a Local Flow Control protocol to reduce the character rate to that of the far-end DTE.

iv) A TA supporting Flow Control will support the use of end-to-end (TA to TA) Flow Control using the X bit, and will contain a character buffer.

NOTE 1: The request for flow control operation may be indicated by the calling TA to the called TA in the Bearer capability or in the Low Layer compatibility information element contained in the SETUP message (refer to ETS 300 102-1 and Annex I of this standard for the detailed coding of these information elements).

NOTE 2: The adaption functions relevant to bit rate adaption for steps RA1 and RA2 and the Ready for Data alignment remain as described in section 2.1.4 of the main body of this ETS.

Annex H (informative): Network independent clocking

1 General

In cases where synchronous data signals at user rates up to and including 19.2 kbit/s are received from outside the ISDN (e.g. through an interworking unit from a DTE/modem on the PSTN), the data may not be synchronized to the ISDN. The following method shall be used to enable transfer of those data signals and the corresponding bit timing information via the 80-bit frame to the receiving TA. Such a situation would exist where the signals are received through an interworking unit from voice-band data modems on the analogue PSTN where the transmitted data from the remote modem is synchronized to the modem clock (normal case for such applications). The frequency tolerance of such modems is 100 ppm.

2 Measurement of phase differences

The phase difference between the following two frequencies will be measured:

i) - R1 = 0.6 x the nominal intermediate rate (except where filling bits are used; see NOTE), synchronized with the ISDN ;

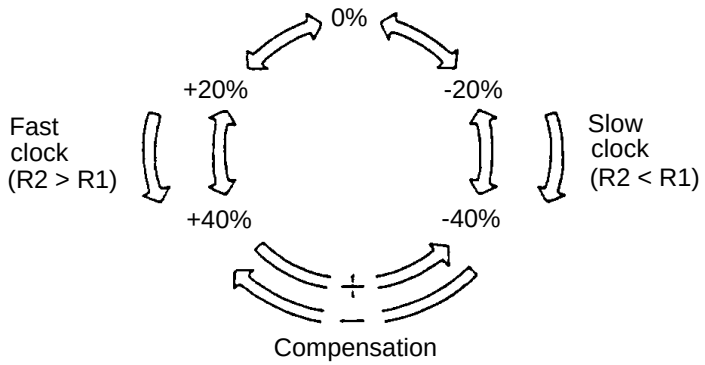
ii) - R2 = 0.6 x the nominal intermediate rate (except where filling bits are used, see NOTE), derived from and synchronized with the bit timing received from the remote synchronous source, e.g. a modem.

NOTE: Clocks R1 and R2 are nominally either 4800, 9600 or 19200 Hz at 8 kbit/s, 16 kbit/s and 32 kbit/s intermediate rate, respectively.

Where filling bits are used, in the cases of 7200 and 14400 bit/s, R1 and R2 will have the same nominal rate as the user bit rate.

Compensation will affect one, one-half, one-quarter or one-eighth of a user data bit, depending upon the bit repetition factor.

A state diagram for the transmitting TA showing the phase of R2 relative to R1 appears in figure H.1 below. Table H.1 shows the related bit coding.



NOTE 1: Phase measurements are given relative to R1 by the formula:

Phase = phase (R2) - phase (R1)

NOTE 2: Receipt of a bit combination requiring an illegal move of more than one state will cause a legal move of one state in the appropriate direction.

NOTE 3: The initial state for both the receiving and transmitting sides of the TA will be 0%.

Figure H.1: Network-independent clocking state diagram

Comparison of R1 and R2 will give a phase difference relative to R1 which will be encoded as shown in table H.1 below. The resultant 3-bit code will be transmitted in bit positions E4, E5 and E6 of the 80-bit multiframe (see figure 4 of this ETS), and used for clock control at the receiving TA.

To avoid continuous jitter between neighbouring displacement positions, hysteresis shall be applied, as follows :

The displacement code shall be changed only when the measured phase difference between R1 and R2 is 15% (of the R1 clock period) more or less than the difference indicated by the existing displacement code.

Example: Bit combination 000 indicates a phase difference of nominally 20%. This bit combination will be changed into 001 when the measured difference is 35% or more, and into 111 when the measured phase difference is 5% or less.

3 Positive/negative compensation

On transition from the +40% state to the -40% state, an extra user D bit has to be transmitted in the 80-bit frame, using bit E6 (positive compensation). At the receiving TA, this extra bit will be inserted between bits R8 and P1 as shown in figure 4 of this ETS, immediately following the E- bits.

On transition from the -40% state to the +40% state, a bit combination is transmitted in the 80-bit frame (E4, E5 and E6 = 1, 1, 0, respectively), indicating to the receiving TA that bit P1 of the even frame of the 80-bit frame, being set to ONE, does not contain user data and should be removed (negative compensation).

4 Encoding

The encoding of the measured phase difference for clock control and the positive/negative compensation control overrides and replaces the clock control coding.

Table H.1: Coding of E bits for network-independent clocking

Displacement (in % of nominal R1 clock period at n x 4800 bit/s, n = 1, 2 or 4)		**Coding in the 80-bit frame**		
		E4	**E5**	**E6**
nominally	0	1	1	1
	+ 20	0	0	0
	+ 40	0	0	1
	- 40	0	1	0
	- 20	0	1	1
Compensation control				
Positive compensation of a One		1	0	1
Positive compensation of a Zero		1	0	0
Negative compensation		1	1	0

Annex I (informative): BC, HLC and LLC information element coding examples applicable to user specific applications

This Annex gives coding examples of BC, LLC and HLC information elements for specific applications of the circuit mode 64 kbit/s unrestricted 8 kHz structured bearer capability.

The examples shown are typical applications but are not exhaustive. Further applications are possible. Furthermore, it is assumed that a pure ISDN environment exists and no network provided interworking function is selected by the calling user. Therefore, the particular user rate as well as the rate adaption technique applied are specified in the Low layer compatibility information element provided in the SETUP message, thus permitting compatibility decision only by the destination terminal.

1 Support of Terminal Adaptors V.110/X.30

1.1 Synchronous mode of operation

1.1.1 Request by a calling terminal equipment

a) BC Information Element Coding:

Octet	Information element field	Field value
3	Coding standard	CCITT standardized coding
	Information transfer capability	unrestricted digital information
4	Transfer mode	circuit mode
	Information transfer rate	64 kbit/s
5	User information layer 1 protocol	———
6	User information layer 2 protocol	———
7	User information layer 3 protocol	———

b) HLC Information Element Coding: (Note)

Octet	Information element field	Field value
3	Coding standard	CCITT standardized coding
	Interpretation	first high layer characteristics identification to be used in the call
	Presentation method of protocol profile	High layer protocol profile
4	High layer characteristics identification	according to the teleservice supported by the terminal
4a	Extended high layer characteristics identification	———

Note: The HLC information element shall only be included if a terminal supporting a teleservice is connected to the TA (e.g. a teletex terminal).

Calling side (continued)

c) LLC Information Element Coding:

Octet	Information element field		Field value
3	Coding standard		CCITT standardized coding
	Information transfer capability		unrestricted digital information
3a	Negotiation indicator		(set according to the capability of the TA)
4	Transfer mode		circuit mode
	Information transfer rate		64 kbit/s
4a	Structure, configuration, establishment		———
4b	Symmetry, information transfer rate (destination → origination)		———
	Layer 1		
5		User information layer 1 protocol	(CCITT standardized rate adaption V.110/X.30)
5a		Synchron/asynchron	synchronous
		Negotiation	(set according to the capability of the TA)
		User rate	user rate at reference point R
5b		Intermediate rate	(set according to the user rate)
		NIC on Tx	(set by the user according to the capability of the TA)
		NIC on Rx	
		Flow control on Tx	(irrelevant, set to 0)
		Flow control on Rx	
		Rate adaption header	———
		Multiple frame support	
		Mode of operation	
		Logical link identifier negotiation	
		Assignor/assignee	
		In-band/outband negotiation	
5c		Number of stop bits	———
		Number of data bits	
		Parity	
5d		Duplex mode	note 2
		Modem type	(irrelevant)
6	User information layer 2 protocol		(according to user layer 2 protocol)
6a	Optional layer 2 protocol information		———
7	User information layer 3 protocol		(according to user layer 3 protocol)
7a	Optional layer 3 protocol information		———

Legend: Field values in brackets () may or may not be included.

NOTE 1: Terminal adapters X.30 supporting user class of service 19 (64 kbit/s) will not include octet 5b.

NOTE 2: Where a TA wishes to indicate the mode of operation (half or full duplex), then octet 5d will be present with the modem type being not relevant. In this case, octet 5c needs to be present but is irrelevant.

1.1.2 Compatibility at the called terminal equipment

a) BC Information Element Coding:

Octet	Information element field	Field value
3	Coding standard	CCITT standardized coding
	Information transfer capability	unrestricted digital information
4	Transfer mode	circuit mode
	Information transfer rate	64 kbit/s
5	User information layer 1 protocol	———
6	User information layer 2 protocol	———
7	User information layer 3 protocol	———

b) HLC Information Element Coding: (Note)

Octet	Information element field	Field value
3	Coding standard	CCITT standardized coding
	Interpretation	first high layer characteristics identification to be used in the call
	Presentation method of protocol profile	high layer protocol profile
4	High layer characteristics identification	check according to the teleservice supported by the terminal
4a	Extended videotelephony characteristics identification	———

Note: Depending on the type of terminal connected to the calling TA, the HLC information element may be present (e.g. a teletex terminal).

c) LLC Information Element Coding:

Octet	Information element field		Field value
3	Coding standard		CCITT standardized coding
	Information transfer capability		unrestricted digital information
3a	Negotiation indicator		(check according to the capability of the TA)
4	Transfer mode		circuit mode
	Information transfer rate		64 kbit/s
4a	Structure, configuration, establishment		———
4b	Symmetry, information transfer rate (destination → origination)		———
	Layer 1		
5		User information layer 1 protocol	(CCITT standardized rate adaption V.110/X.30
5a		Synchron/asynchron	synchronous
		Negotiation	(check according to the capability of the TA)
		User rate	check this value according the user rate at reference point R
5b		Intermediate rate	(check according to the capability of the TA)
		NIC on Tx	(check according to the capability of the TA)
		NIC on Rx	
		Flow control on Tx	ignore
		Flow control on Rx	
		Rate adaption header	———
		Multiple frame support	
		Mode of operation	
		Logical link identifier negotiation	
		Assignor/assignee	
		In-band/outband negotiation	
5c		Number of stop bits	———
		Number of data bits	
		Parity	
5d		Duplex mode	(check according to the capability of the TE2 supported)
		Modem type	ignore
6	User information layer 2 protocol		(check according to user layer 2 protocol supported by the terminal)
6a	Optional layer 2 protocol information		———
7	User information layer 3 protocol		(check according to user layer 3 protocol supported by the terminal)
7a	Optional layer 3 protocol information		———

Note: In the case of TAs according to ITU-T Recommendation X.30 supporting user class of service 19 (64 kbit/s), octet 5b will not be present. The field values in brackets may or may not be checked by the receiving TA.

1.2 Asynchronous mode of operation

1.2.1 Request by a calling terminal equipment

a) BC Information Element Coding:

Octet	Information element field	Field value
3	Coding standard	CCITT standardized coding
	Information transfer capability	unrestricted digital information
4	Transfer mode	circuit mode
	Information transfer rate	64 kbit/s
5	User information layer 1 protocol	———
6	User information layer 2 protocol	———
7	User information layer 3 protocol	———

b) HLC Information Element Coding: (Note)

Octet	Information element field	Field value
3	Coding standard	CCITT standardized coding
	Interpretation	first high layer characteristics identification to be used in the call
	Presentation method of protocol profile	high layer protocol profile
4	High layer characteristics identification	according to the teleservice supported by the terminal
4a	Extended high layer characteristics identification	———

Note: The HLC information element shall only be included if a terminal supporting a high layer application is connected to the TA (e.g. a teletex terminal).

c) LLC Information Element Coding:

Octet	Information element field		Field value
3	Coding standard		CCITT standardized coding
	Information transfer capability		unrestricted digital information
3a	Negotiation indicator		(set according to the capability of the TA)
4	Transfer mode		circuit mode
	Information transfer rate		64 kbit/s
4a	Structure, configuration, establishment		———
4b	Symmetry, information transfer rate (destination → origination)		———
	Layer 1		
5		User information layer 1 protocol	CCITT standardized rate adaption V.110/X.30
5a		Synchron/asynchron	asynchronous
		Negotiation	(set according to the capability of the TA)
		User rate	user rate at reference point R
5b		Intermediate rate	(set according to the user rate)
		NIC on Tx	irrelevant, set to "0"
		NIC on Rx	irrelevant, set to "0"
		Flow control on Tx	(set according to the capability of the TA)
		Flow control on Rx	
		Rate adaption header	———
		Multiple frame support	
		Mode of operation	
		Logical link identifier negotiation	
		Assignor/assignee	
		In-band/outband negotiation	
5c		Number of stop bits	(set according to the capability of the TA)
		Number of data bits	
		Parity	
5d		Duplex mode	(set according to user's requirements)
		Modem type	irrelevant
6	User information layer 2 protocol		(according to user layer 2 protocol)
6a	Optional layer 2 protocol information		———
7	User information layer 3 protocol		(according to user layer 3 protocol)
7a	Optional layer 3 protocol information		———

Field values in brackets () may or may not be included.

1.2.2 Compatibility at the called terminal equipment

a) BC Information Element Coding:

Octet	Information element field	Field value
3	Coding standard	CCITT standardized coding
	Information transfer capability	unrestricted digital information
4	Transfer mode	circuit mode
	Information transfer rate	64 kbit/s
5	User information layer 1 protocol	———
6	User information layer 2 protocol	———
7	User information layer 3 protocol	———

b) HLC Information Element Coding: (Note)

Octet	Information element field	Field value
3	Coding standard	CCITT standardized coding
	Interpretation	first high layer characteristics identification to be used in the call
	Presentation method of protocol profile	high layer protocol profile
4	High layer characteristics identification	check according to the high layer application supported by the terminal
4a	Extended high layer characteristics identification	———

Note: Depending on the type of terminal connected to the calling TA, the HLC information element may be present (e.g. a teletex terminal).

c) LLC Information Element Coding:

Octet	Information element field		Field value
3	Coding standard		CCITT standardized coding
	Information transfer capability		unrestricted digital information
3a	Negotiation indicator		(check according to the capability of the TA)
4	Transfer mode		circuit mode
	Information transfer rate		64 kbit/s
4a	Structure, configuration, establishment		———
4b	Symmetry, information transfer rate (destination → origination)		———
	Layer 1		
5		User information layer 1 protocol	CCITT standardized rate adaption V.110/X.30
5a		Synchron/asynchron	asynchronous
		Negotiation	(check according to the capability of the TA) (note)
		User rate	check according to the user rate at reference point R (note)
5b		Intermediate rate	(check according to the capability of the TA) (note)
		NIC on Tx	ignore
		NIC on Rx	
		Flow control on Tx	(check according to the capability of the TA) (note)
		Flow control on Rx	
		Rate adaption header	———
		Multiple frame support	
		Mode of operation	
		Logical link identifier negotiation	
		Assignor/assignee	
		In-band/outband negotiation	
5c		Number of stop bits	(check according to the capability of the TA)
		Number of data bits	
		Parity	
5d		Duplex mode	(check according to the capability of the TE2 supported)
		Modem type	ignore
6	User information layer 2 protocol		(check according to user layer 2 protocol)
6a	Optional layer 2 protocol information		———
7	User information layer 3 protocol		(check according to user layer 3 protocol)
7a	Optional layer 3 protocol information		———

Note: The following cases may occur:

(1) if there is a match of the fields "user rate", intermediate rate" and "flow control" then there will be no in-band parameter exchange required;

(2) if these field values do not match, then call acceptability is dependent on in-band negotiation results according to CCITT Recommendation V.110.

The field values in brackets may or may not be checked by the receiving TA.

History

Document history	
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