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DATA COMMUNICATION NETWORK: INTERFACES

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT AND DATA CIRCUIT-TERMINATING EQUIPMENT FOR SYNCHRONOUS OPERATION ON PUBLIC DATA NETWORKS

Recommendation X.21

FOREWORD

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

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

Recommendation X.21 was revised by Study Group VII and was approved under the Resolution No. 2 procedure on the 10th of September 1992.

CCITT NOTES

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

2) A list of abbreviations used in this Recommendation can be found in Annex J.

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Recommendation X.21

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT AND DATA CIRCUIT-TERMINATING EQUIPMENT FOR SYNCHRONOUS OPERATION ON PUBLIC DATA NETWORKS

(Geneva, 1972; amended at Geneva, 1976 and 1980, Malaga-Torremolinos, 1984 and Melbourne, 1988, revised in 1992)

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Preface

The CCITT,

considering

(a) that Recommendations X.1 and X.2 define the services and facilities to be provided by a public data network;

(b) that Recommendation X.92 defines the hypothetical reference connections for synchronous public data networks;

(c) that Recommendation X.96 defines *call progress* signals;

(d) that the necessary elements for an interface Recommendation should be defined in architectural levels;

(e) that it is desirable for characteristics of the interface between the data terminal equipment (DTE) and data circuit-terminating equipment (DCE) of a public data network to be standardized,

unanimously declares the view

that the interface between the DTE and DCE in public data networks for user classes of service employing synchronous transmission should be as defined in this Recommendation.

1 Scope

1.1 This Recommendation defines the physical characteristics and call control procedures for a general purpose interface between DTE and DCE for user classes of service, as defined in Recommendation X.1, employing synchronous transmission.

1.2 The formats and procedures for *selection*, *call progress* and *DCE-provided information* are included in this Recommendation.

1.3 The provision for duplex operation is covered.

1.4 The operation of the interface for half duplex operation when the data circuit interconnects with Recommendation X.21 *bis* DTEs is described in Annex E. Half duplex operation between X.21 DTEs is for further study when such new facilities are identified.

2 DTE/DCE physical interface elements

2.1 *Electrical characteristics*

2.1.1 *Data signalling rates of 9600 bit/s and below*

The electrical characteristics of the interchange circuits at the DCE side of the interface will comply with Recommendation X.27 without cable termination in the load. The electrical characteristics at the DTE side of the interface may be applied according to either Recommendation X.27 either with or without cable termination in the load, or Recommendation X.26. The B′ leads of receivers in an X.26 DTE must be brought out to the interface individually and not connected together (see § 2.2).

Note – In certain instances where X.27 circuits are implemented on both sides of the interface, it may be necessary to add either serial impedance matching resistors or parallel cable terminating resistors as specified in X.27 to assure proper operation of the interchange circuits.

2.1.2 *Data signalling rates above 9600 bit/s*

The electrical characteristics of the interchange circuits at both the DCE side and the DTE side of the interface will comply with Recommendation X.27 with or without implementation of the cable termination in the load.

2.2 *Mechanical characteristics*

Refer to ISO 4903 (15-pole DTE/DCE interface connector and contact number assignments) for mechanical arrangements.

2.3 *Functional characteristics of interchange circuits*

Definitions of the interchange circuits concerned (see Table 1/X.21) are given in Recommendation X.24.

In this Recommendation, signal conditions on interchange circuits T, C, R and I are designated by t, c, r and i, respectively.

Signal conditions on circuit C (*control*) and I (*indication*) refer to continuous ON (significant level binary 0) and continuous OFF (significant level binary 1) conditions.

TABLE 1/X.21

Interchange circuit	Name	Direction		Remarks
		to DCE	from DCE	
G	Signal ground or common return			See Note 1
G_a	DTE common return	X		
T	Transmit	X		
R	Receive		X	
C	Control	X		
I	Indication		X	
S	Signal element timing		X	See Note 2
B	Byte timing		X	See Note 3
X	DTE signal element timing	X		See Note 4

Note 1 – This conductor may be used to reduce environmental signal interference at the interface. In the case of shielded interconnecting cable, the additional connection considerations are part of Recommendation X.24 and ISO 4903.

Note 2 – Timing for continuous isochronous data transmission will be provided.

Note 3 – May be provided as an optional additional facility (see § 3.1.1).

Note 4 – The use and the termination of this circuit by the DCE is a national matter.

2.4 *Physical link control conditions*

The DTE and DCE shall be prepared to send steady binary conditions 0 and 1 on circuit R or T, together with associated conditions on circuit C or I, for a period of at least 24 bit intervals. Detection of steady binary 0 or 1 on circuit R or T for 16 contiguous bit intervals with the associated condition on circuit I or C may be interpreted by the DTE or DCE as a steady state condition.

If the DTE (or DCE) recognizes that the device on the other side of the interface is signalling recognition of the current state, then the DTE (or DCE) may begin signalling the next valid state. If the DTE (or DCE) is not ready to begin signalling the next valid state, it is obliged to continue signalling the current state until it is so ready.

Note – As for state 12, § 5.1 has precedence over this § 2.4.

2.5 *Quiescent phase*

During the quiescent phase, the DTE and the DCE signal their ability to enter operational phases such as the call control phase or the data transfer phase as defined for the appropriate service. The basic quiescent signals of the DTE and the DCE can appear at the interface in various combinations which result in different interface states as defined below and shown in Figure A-1/X.21.

2.5.1 *DTE quiescent signals*

2.5.1.1 *DTE ready*

The DTE indicates its readiness to enter operational phases, according to the appropriate service, by signalling t = 1, c = OFF.

2.5.1.2 *DTE uncontrolled not ready*

The DTE indicates that it is unable to enter operational phases, according to the appropriate service, generally because of abnormal operating conditions, by signalling t = 0, c = OFF.

For leased circuit service point-to-point when the DTE enters *DTE uncontrolled not ready*, the remote interface may signal r = 0, i = OFF. Additional actions to be taken by the DCE are for further study.

For leased circuit-centralized multipoint when a DTE enters *DTE uncontrolled not ready*, no indication of this signal will be given at the other connected DTE/DCE interfaces.

2.5.1.3 *DTE controlled not ready*

DTE controlled not ready indicates that, although the DTE is operational, it is temporarily unable to accept incoming calls for circuit switched service.

This signal is indicated by t = 01 . . . (alternate bits are binary 0 and binary 1), c = OFF. This signal shall persist for a minimum of 24 bit intervals.

Note – DTE controlled not ready is normally entered from the *ready* state, as defined in § 2.5.3.1. In some networks, the DCE may not recognize the *DTE controlled not ready* signal if the DTE does not first signal *DTE ready* at the same time the DCE signals *DCE ready*.

2.5.2 *DCE quiescent signals*

2.5.2.1 *DCE ready*

The DCE indicates its readiness to enter operational phases, according to the appropriate service, by signalling r = 1, i = OFF.

2.5.2.2 *DCE not ready*

DCE not ready indicates that no service is available and will be signalled whenever possible during network fault conditions and when test loops are activated. This signal is indicated by r = 0, i = OFF.

2.5.2.3 *DCE controlled not ready*

DCE controlled not ready indicates that, although the DCE is operational, it is temporarily unable to render service.

This signal is indicatd by r = 01 . . . (alternate bits are binary 0 and binary 1), i = OFF. This signal shall persist for a minimum of 24 bit intervals.

Note 1 – DCE controlled not ready may be entered from any state.

Note 2 – DCE controlled not ready may be provided as an optional facility.

2.5.3 *Quiescent states*

See Figure A-1/X.21.

2.5.3.1 *Ready (state 1)*

Ready is entered when the DTE and the DCE simultaneously signal *DTE ready* and *DCE ready*, respectively.

2.5.3.2 *State 14*

State 14 is entered when the DTE and the DCE simultaneously signal *DTE controlled not ready* and *DCE ready*, respectively.

2.5.3.3 *State 18*

State 18 is entered when the DTE and the DCE simultaneously signal *DTE ready* and *DCE not ready*, respectively.

2.5.3.4 *State 22*

State 22 is entered when the DTE and the DCE simultaneously signal *DTE uncontrolled not ready* and *DCE not ready*, respectively.

2.5.3.5 *State 23*

State 23 is entered when the DTE and the DCE simultaneously signal *DTE controlled not ready* and *DCE not ready*, respectively.

2.5.3.6 *State 24*

State 24 is entered when the DTE and the DCE simultaneously signal *DTE uncontrolled not ready* and *DCE ready*, respectively.

2.6 *Failure detection*

2.6.1 *Fault conditions of interchange circuits*[1)]

The DTE should interpret a fault condition on circuit R as r = 0, using failure detection type 2, a fault condition on circuit I as i = OFF, using failure detection type 1, and a fault condition on both circuits R and I as r = 0, i = OFF, *DCE not ready*. Alternatively, a fault condition on one of these circuits, R or I, may be interpreted by the DTE as *DCE not ready*, r = 0, i = OFF using failure detection type 3.

The DCE will interpret a fault condition on circuit T as t = 0, using failure detection type 2, a fault condition on circuit C as c = OFF, using failure detection type 1, and a fault condition on both circuits T and C as t = 0, c = OFF, *DTE uncontrolled not ready*. Alternatively, a fault condition on one of these circuits, T or C, may be interpreted by the DCE as *DTE uncontrolled not ready*, t = 0, c = OFF using failure detection type 3.

2.6.2 *DCE fault conditions*

If the DCE is unable to provide service (e.g., loss of alignment or loss of incoming line signal) after a period longer than a fixed duration, it will indicate *DCE not ready* by signalling r = 0, i = OFF (see § 2.5.2.2). The value of that duration is network dependent. Prior to this *DCE not ready* signal, the DTE should be prepared to receive garbled signals or contiguous binary 1 on circuit R with i = ON.

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1) For the association of the receiver circuit-failure detection to particular interchange circuits in accordance with the type of failure detection, see Recommendation X.26, § 11 and Recommendation X.27, § 9.

2.6.3 *Signal element timing provision*

The signal element timing signal is delivered to the DTE on circuit S whenever possible, even when the DCE loses alignment or the incoming line signal. The signal element timing rate should in no case deviate from the nominal value by more than ± 1%.

3 Alignment of call control characters and error checking

All characters for call control purposes are selected from International Alphabet No. 5 (IA5) according to Recommendation T.50.

3.1 *Character alignment*

For the interchange of information between the DTE and the DCE for call control purposes, it is necessary to establish correct alignment of characters. Each sequence of call control characters to and from the DCE shall be preceded by two or more contiguous 1/6 (SYN) characters.

3.1.1 Certain Administrations will require the DTE to align call control characters transmitted from the DTE to either SYN characters delivered to the DTE or to signals on the byte timing interchange circuit.

Administrations who require this alignment shall provide the byte timing interchange circuit, but its use and termination by the DTE shall not be mandatory.

3.1.2 Certain Administrations will permit call control characters to be transmitted from the DTE independently of the SYN characters delivered to the DTE.

3.1.3 Additionally, for an intermediate period (see Note), Administrations will provide connection to the public data network of DTEs operating as described in § 3.1.2 above.

Note – The intermediate period would be determined by customer demand and other relevant factors as interpreted by individual Administrations.

3.2 *Error checking*

Odd parity according to Recommendation X.4 applies for IA5 characters interchanged for call control purposes.

4 Elements of the call control phase for circuit switched service

The state diagram provided in Figure A-2/X.21, shows the relationship between the various *call control* phase states as defined below, together with the recognized transactions between these states under normal operating conditions. Illustrated examples of the time sequence relationships between these states and associated time-out operation are provided in Figures B-1/X.21 and B-2/X.21.

States which are indicated by an IA5 character on circuits T and R shall be entered and exited on a character boundary. At this time, in some networks, the transition from state 6 to state 11, or state 6 to state 12 may not be on a character boundary.

Once character alignment has been established by the DCE in response to an outgoing call request, or for presentation of an incoming call, the alignment will be maintained until entering *connection in progress*, state 11 or *ready for data* if state 11 is by-passed. This implies that all IA5 character sequences transmitted on circuit R, such as 2/11 ("+"), *call progress* signals, *DCE-provided information*, etc., appear on the same character boundary even if they are separated by two or more SYN characters.

The call control phase can be terminated by either the DTE or the DCE by *clearing* as defined in § 6.

4.1 *Events of the call control procedures*

See Figure A-2/X.21.

4.1.1 *Call request (state 2)*

The calling DTE shall indicate a request for a call by signalling steady binary condition t = 0, c = ON, provided that it was previously signalling *DTE ready*.

The change of state from *ready* (t = 1, c = OFF) to *call request* (t = 0, c = ON) shall be such that the transition to t = 0 occurs within a maximum of 7 bit intervals of the transition to c = ON. Either transition may occur first.

Note – When optimizing the use of the byte timing circuit B, the transition to t = 0 shall occur within the same bit interval as the transition to c = ON. This might become a requirement for use with special user facilities which might arise from further study.

If the DTE signals *call request* (state 2) and the DCE simultaneously signals r = 0, i = OFF, the DCE will be assumed to be in state 19 *(DCE clear indication)*.

4.1.2 *Proceed to select (state 3)*

When the network is prepared to receive selection information the DCE will transmit continuously character 2/11 ("+") preceded by 2 or more contiguous characters 1/6 ("SYN") on the R circuit with i = OFF.

Proceed-to-select is maintained until receipt of the *end-of-selection* signal, or in the case of *direct call*, receipt of *DTE waiting*.

The *proceed-to-select* signal will start within 3 seconds of the *call request* being sent.

4.1.3 *Selection signal sequence (state 4)*

The selection signal sequence shall be transmitted by the DTE on the T circuit with c = ON and shall be preceded by two or more contiguous 1/6 ("SYN") characters with c = ON.

The format of the *selection* signal sequence is defined in § 4.6.1.

The information content and coding of the *selection* signal sequence is contained in Annex G and Recommendation X.121.

The *selection* signal sequence shall start within 6 seconds of *proceed-to-select* being received and shall be completed within 36 seconds.

The maximum permissible interval between individual selection characters is 6 seconds.

The period, if any, between individual selection characters shall be filled by character 1/6 ("SYN") with c = ON.

4.1.4 *DTE waiting (state 5)*

During *DTE waiting*, the DTE signals steady binary condition t = 1, c = ON. (See also § 4.4 for *direct call* conditions.)

4.1.5 *Incoming call (state 8)*

The DCE will indicate an incoming call by continuous transmission of character 0/7 ("BEL") preceded by two or more contiguous 1/6 ("SYN") characters on the R circuit with i = OFF.

If the DCE signals *incoming call* and the DTE simultaneously signals t = 0, c = OFF, the DTE will be assumed to be in state 16 *(clear request)*.

The connection of incoming calls will be inhibited when the DTE signals either *DTE uncontrolled not ready* or *DTE controlled not ready*.

4.1.6 *Call accepted (state 9)*

4.1.6.1 *General case*

The DTE shall accept the incoming call as soon as possible by signalling the steady state binary condition t = 1, c = ON.

1) The DCE will return to *DCE ready* if the incoming call is not accepted within 500 milliseconds,

   or, where manual answering is permitted,

2) the DCE will return to *DCE ready* if the incoming call is not accepted within 60 seconds.

4.1.6.2 *Sub-addressing*

Sub-addressing is an optional procedure.

Two procedures for sub-addressing at the called end are defined: the simple sub-addressing procedure and the enhanced sub-addressing procedure. Choice of the provision of these procedures is a national matter.

4.1.6.2.1 *Simple sub-addressing procedure*

See Figure A-6/X.21.

The procedure is as follows:

a) *Call accept:* see § 4.1.6.1.

b) *DCE waiting:* see § 4.1.7.

c) *DCE-provided information:* when provided, sub-addressing information will be transmitted by the DCE to the called DTE after *call accepted* has been sent by the DTE, and prior to any other *DCE-provided information* if any.

   The format of sub-addressing information is defined in § 4.6.3.

   The information content of sub-addressing information is defined in Annex H.

d) *Connection in progress:* see § 4.1.10.

e) *Ready for data:* see § 4.1.11.

4.1.6.2.2 *Enhanced sub-addressing procedure*

See Figures A-5/X.21 and B-3/X.21.

4.1.6.2.2.1 *Proceed with call information (state 9B)*

Note – State 9B is only entered in the case of a DTE with sub-addressing.

The DTE shall accept the incoming call as soon as possible by transmitting continuously character 2/10 (“*”) preceded by 2 or more contiguous characters 1/6 (“SYN”) on the T circuit with c = OFF.

Proceed with call information is maintained until receipt of *end of call information* signal. The *proceed with call information* signal will start within 500 ms of the *incoming call* signal being received.

4.1.6.2.2.2 *Call information signal sequence (state 10C)*

Note – State 10C is only entered in the case of a DTE with sub-addressing.

The *call information signal* sequence will be transmitted by the DCE on the R circuit with i = OFF and will appear on the same boundary as it was entered in state 8.

The call information signal may be preceded by two or more contiguous 1/6 (“SYN”) characters.

The *call information* is also a *DCE-provided information* (see also § 4.1.9).

The information content and coding of the *call information signal* sequence is contained in Annex H and Recommendation X.121.

The *call information signal* sequence will start and will be completed within 2 seconds after the *proceed with call information* being sent.

The maximum period, if any, between individual call information characters will be filled by character 1/6 ("SYN") with i = OFF.

The format of *call information* is the same as the format of *DCE-provided information* and is defined in § 4.6.3.

4.1.6.2.2.3 *DCE waiting (states 6D and 6C)*

During *DCE waiting*, the DCE will signal 2 or more contiguous 1/6 ("SYN") characters with i = OFF.

4.1.6.2.2.4 *DTE-provided information (state 25)*

The *DTE-provided information* shall be transmitted by the DTE with sub-addressing on circuit T with c = OFF.

A *DTE-provided information* shall consist of 1 or more *DTE-provided information* blocks. *Each DTE-provided information* block shall be limited to a maximum length of 128 characters.

Note – The figure of 128 characters maximum length is provisional and may be changed to another value in the future.

The format of the *DTE-provided information* is defined in § 4.6.4.

The coding of *DTE-provided information* should be in line with Annex F and Recommendation X.96.

The *DTE-provided information* shall be sent on the same character boundary as it was entered in state 9B. *DTE-provided information* blocks within a *DTE-provided information* may be preceded and separated by 1/6 ("SYN") characters.

A *DTE-provided information* (state 25) shall be sent to the DCE within 20 seconds after the *end of call information* signal, character 2/11 ("+") being received.

After reception of a *DTE-provided information* block, the DCE will reset and restart time-out T14C.

4.1.7 *DCE waiting (state 6A and state 6B)*

During *DCE waiting*, the DCE will signal two or more contiguous 1/6 ("SYN") characters on the R circuit with i = OFF. In the state diagram, Figure A-2/X.21, state 6A applies to calling procedures and state 6B applies to called procedures.

4.1.8 *Call progress signal (state 7)*

The *call progress* signal will be transmitted by the DCE to the calling DTE on the R circuit with i = OFF when an appropriate condition is encountered by the network.

A *call progress* signal will consist of 1 or more *call progress* signal blocks. A *call progress* signal block will consist of 1 or more *call progress* signals.

The format of the *call progress* signal sequence is defined in § 4.6.2.

The coding of *call progress* signals is provided in Annex F.

The description of *call progress* signals is provided in Recommendation X.96.

A *call progress* signal will be preceded by two or more contiguous 1/6 ("SYN") characters sent during state 6A. The period between these blocks will also be filled by *DCE waiting* (state 6A).

A *call progress* signal will be transmitted by the DCE within 20 seconds of: (1) the *end-of-selection* signal or (2) in the case of *direct call*, the *DTE waiting* signal being sent by the DTE. The *call progress* signal, however, will not be sent by the DCE before the reception of the *end-of-selection* signal or *DTE waiting* signal is sent by the DTE, except in the case of expiration of time-out T11, T12, or T13 where there may be a *call progress* signal followed by *clear indication*.

Note – When an error is detected in a received *call progress* signal sequence, the DTE may choose to either ignore the signal or attempt a new call after clearing.

4.1.9 *DCE-provided information (states 10A and 10B)*

The *DCE-provided information* will be transmitted by a DCE to the calling DTE (state 10A) or a called DTE (state 10B) on circuit R with i = OFF.

A *DCE-provided information* will consist of 1 or more *DCE-provided information* blocks. Each *DCE-provided information* block will be limited to a maximum length of 128 characters.

The format of the *DCE-provided information* is defined in § 4.6.3.

The information content of *DCE-provided information* is provided in Annex H.

The *DCE-provided information* will be preceded by two or more contiguous 1/6 ("SYN") characters. *DCE-provided information* blocks within a *DCE-provided information* will be separated by 1/6 ("SYN") characters (the time between blocks to be filled by two or more SYN characters is for further study). In the case of a calling DTE (state 10A), the preceding and separating SYN characters will be from *DCE waiting* (state 6A). In the case of a called DTE (state 10B), the preceding SYN characters and the separating SYN characters will be from *DCE waiting* (state 6B).

In certain circumstances, SYN characters may be inserted between characters within a *DCE-provided information* block. Each insertion shall contain at least 2 SYN characters, and the inserted SYN characters will be counted as part of the maximum limit of 128 characters per block. In any case, the insertion of SYN characters should be rare and minimized.

A *DCE-provided information* (state 10B) will be sent to the called DTE within 6 seconds of the *call accepted* signal being sent. After reception of a *DCE-provided information* block, the called DTE should reset time-limit T4B.

4.1.9.1 *Line identification*

Calling and *called line identification* is an optional additional facility.

The information content of *calling* and *called line identification* is provided in Annex H.

Calling and *called line identification* will be transmitted by the DCE on the R circuit with i = OFF during states 10B or 10A, respectively.

When provided, called line identification (state 10A) will be transmitted by the DCE to the calling DTE after all *call progress* signals, if any.

When provided, calling line identification (state 10B) will be transmitted by the DCE to the called DTE after *call accepted* has been sent by the DTE.

In the case where the *calling line identification* facility is not provided by the originating network, or the *called line identification* facility is not provided by the destination network, a *dummy line identification* shall be provided by the DCE to the DTE. In some networks, when the *calling line identification* is not provided by the originating network, the data network identification code (DNIC) will be provided by the DCE to the DTE in place of the *dummy line identification*.

4.1.9.2 *Charging information*

Charging information is an optional additional facility provided during state 10B.

Upon completion of clearing the call for which *charging information* has been requested, the DCE will, within 200 ms after entering *ready* (state 1), establish an incoming call to the DTE for the purpose of giving *charging information*.

Note – The DTE is advised not to signal *call request* or *not ready* during the above 200 ms period. If the DTE does, the *charging information* will not be transmitted to the DTE.

Charging information will be transmitted by the DCE on R circuit with i = OFF.

The DCE will send *clear indication* (state 19) upon sending the last *charging information* block. The DTE should send *clear request* (state 16) when it has correctly received the *charging information* signal, if the DCE has not previously signalled *clear indication*.

The format of *charging information* is defined in § 4.6.3.

4.1.10 *Connection in progress (state 11)*

While the connection process is in progress, the DCE will indicate *connection in progress* (state 11) by signalling r = 1, i = OFF.

In some circumstances, *connection in progress* (state 11) may be bypassed.

4.1.11 *Ready for data (state 12)*

When the connection is available for data transfer between both DTEs, the DCE will indicate *ready for data* (state 12) by signalling r = 1, i = ON.

1) *Ready for data* will be indicated by the DCE to the calling DTE within 6 seconds of the last *call progress* signal or *DCE-provided information* signals being received by the DTE or within 20 seconds of the *end-of-selection* signal being signalled by the DTE,

   or, when manual answering is permitted at the called DTE.

2) *Ready for data* will be indicated by the DCE to the calling DTE within 60 seconds of the appropriate *call progress* signal being received or within 20 seconds of the *end-of-selection* signal being received.

   It will be indicated to the called DTE within 6 seconds of *call accepted* being signalled by the DTE or receipt of *DCE-provided information* signal.

   Subsequent procedures are described in § 5, *data transfer* phase.

4.1.12 *Events of the call control procedure for centralized multipoint circuit-switched service*

4.1.12.1 *Call request (state 2)*

See § 4.1.1.

4.1.12.2 *Proceed to select request (state 3)*

See § 4.1.2.

4.1.12.3 *Selection signal sequence (state 4)*

See § 4.1.3.

A *facility request* signal is used to indicate the category of point-to-multipoint service which is required.

The coding is defined in Annex G.

4.1.12.4 *DTE waiting (state 5)*

See § 4.1.4.

4.1.12.5 *Incoming call (state 8)*

See § 4.1.5.

4.1.12.6 *Call accepted (state 9)*

See § 4.1.6.1.

4.1.12.7 *DCE waiting (state 6A and state 6B)*

See § 4.1.7.

4.1.12.8 *Call progress signal sequence (state 7)*

See § 4.1.8.

In a point-to-multipoint call the *call progress* signals related to each of the called DTEs are transmitted and then in the same order, the *called line identification* signals of the different called DTEs.

When no specific call progress signals are necessary for a given called DTE, then the call progress signal "00" is used for this DTE so that the order can be kept.

4.1.12.9 *DCE-provided information sequence (states 10A and 10B)*

The *DCE-provided information* sequences will be transmitted by a DCE to the calling DTE (state 10A) or a called DTE (state 10B) on circuit R with i = OFF.

A *DCE-provided information* sequence will consist of one or more *DCE-provided information* blocks. Each *DCE-provided information* block will be limited to a maximum length of 128 characters, except for called line identification in case of point-to-multipoint calls where the maximum length is 512 characters.

The format of the *DCE-provided information* sequence is defined in § 4.6.3.

The information content of *DCE-provided information* is provided in Annex H.

The *DCE-provided information* sequence will be preceded by two or more contiguous 1/6 ("SYN") characters. *DCE-provided information* blocks within a *DCE-provided information* sequence will be separated by 1/6 ("SYN") characters (the time between blocks to be filled by two or more SYN characters is for further study). In the case of a calling DTE (state 10A), the preceding and separating SYN characters will be from *DCE waiting* (state 6A). In the case of a called DTE (state 10B), the preceding SYN characters and the separating SYN characters will be from *DCE waiting* (state 6B).

In certain circumstances, SYN characters may be inserted between characters within a *DCE-provided information* block. Each insertion shall contain at least 2 SYN characters, and the inserted SYN characters will be counted as part of the maximum limit of 128 characters per block. In any case, the insertion of SYN characters should be rare and minimized.

A *DCE-provided information* sequence (state 10B) will be sent to the called DTE within 6 seconds of the *call accepted* signal being sent. After reception of a *DCE-provided information* block, the called DTE should reset time-limit T4.

4.1.12.9.1 *Line identification*

The *called line identification* related to the different called DTEs is provided in sequence.

See § 4.1.9.1.

4.1.12.9.2 *Charging information*

See § 4.1.9.2.

4.1.12.10 *Connection in progress (state 11)*

See § 4.1.10.

4.1.12.11 *Ready for data (state 12)*

See § 4.1.11.

4.2 *Unsuccessful call*

If the required connection cannot be established, the DCE will indicate this and the reason to the calling DTE by means of a *call progress* signal. Afterwards the DCE will signal *DCE clear indication* (state 19).

4.3 *Call collision (state 15)*

A *call collision* is detected by a DTE when it receives *incoming call* in response to *call request*. The DTE shall not deliberately cause a *call collision* by responding to *incoming call* with *call request*.

A *call collision* is detected by a DCE when it receives *call request* in response to *incoming call*.

When a *call collision* is detected by the DCE, the DCE will indicate *proceed-to-select* (state 3) and cancel the incoming call.

4.4 *Direct call*

For a *direct call* facility, the entering of *DTE waiting* (state 5) directly upon receipt of *proceed-to-select* (state 3) indicates the request for the direct call. When the *direct call* facility is provided on a per-call basis, the DTE may choose either an addressed call by presenting *selection* signal (state 4) or a direct call by presenting *DTE waiting* (state 5). When the *direct call* facility only is provided on a subscription basis, *selection* signals (state 4) are always bypassed.

4.5 *Facility registration/cancellation procedure*

Registration/cancellation of optional user facilities shall be accomplished by a DTE using normal call establishment procedures using the *selection* sequence which is defined in § 4.6.1.

The format of the *facility registration/cancellation* signal is defined in § 4.6.1.3.

The *facility registration/cancellation* procedure shall not be combined with establishment of a normally addressed call, but shall be taken as an independent procedure.

In response to acceptance or rejection of the *facility registration/cancellation* actions, the network will provide the appropriate *call progress* signal followed by *clear indication*.

4.6 *Selection, call progress and DCE provided information formats*

(See also Annex D for a syntactic description of the formats.)

4.6.1 *Format of selection sequence*

A *selection* sequence shall consist of a *facility request* block, or an *address* block, or a *facility request* block followed by an *address* block, or a *facility registration/cancellation* block.

4.6.1.1 *Facility request block*

A *facility request* block shall consist of one or more *facility request* signals.

Multiple *facility request* signals shall be separated by character 2/12 (" , ").

A *facility request* signal shall consist of a *facility request* code and may contain one or more *facility* parameters. The *facility request* code, *facility* parameter and subsequent *facility* parameters shall be separated by character 2/15 (" / "). For an interim period the 2/15 (" / ") separator will not be used in some networks.

The end of a *facility request* block shall be indicated by character 2/13 ("–").

4.6.1.2 *Address block*

An *address* block shall consist of one or more *address* signals.

An *address* signal shall consist of either a *full address* signal or an *abbreviated address* signal.

Start of an *abbreviated address* signal shall be indicated by a prefix character 2/14 (" . ").

Multiple *address* signals shall be separated by character 2/12 (" , ").

4.6.1.3 *Facility registration/cancellation block*

A *facility registration/cancellation* block shall consist of one or more *facility registration/cancellation* signals.

A *facility registration/cancellation* signal shall consist of up to four elements in order: *facility request* code, *indicator*, *registration* parameter, *address* signal.

The elements of a *facility registration/cancellation* signal shall be separated by character 2/15 (" / ").

If a *facility registration/cancellation* signal contains less than four of the elements, the elements should be eliminated in reverse order (e.g., a two-element *facility registration/cancellation* signal will contain the *facility request* code " / " *indicator*). If any element to be sent within the sequence is not required, a 3/0 ("0") character should be inserted in the position of each missing element (e.g., *facility request* code /0/0/ *address* signal).

Multiple *facility registration/cancellation* signals shall be separated by character 2/12 (" , ").

The end of a *facility registration/cancellation* block shall be indicated by character 2/13 (" – ") and shall be followed by an end of selection.

4.6.1.4 *End of selection*

The end of *selection* shall be indicated by character 2/11 ("+").

4.6.2 *Format of a call progress block*

A *call progress* block shall consist of one or more *call progress* signals.

A call progress signal shall consist of a call progress code and may contain an indicator.

The call progress code and the indicator shall be separated by character 2/13 ("–").

Each *call progress* signal need not be repeated.

Multiple *call progress* signals shall be separated by character 2/12 (" , ").

The end of a *call progress* block shall be indicated by character 2/11 ("+").

4.6.3 *Formats of DCE-provided information*

The following formats are specified for *DCE-provided information* signals which have been identified.

The *DCE-provided information* shall, except for *calling* and *called line identification*, be started by the IA5 character 2/15 (" / "). To distinguish between different types of *DCE-provided information* the prefix should be followed by one or more numerical characters, followed by the character 2/15 (" / ") before the actual information is presented. The end of a *DCE-provided information* block shall be indicated by character 2/11 ("+"). The order in which the *DCE-provided information* blocks are presented to the DTE is variable.

Multiple *DCE-provided information* signals shall be separated by character 2/12 (",").

A dummy *DCE-provided information* block may be sent in the case of sub-addressing and will be indicated by the prefix as described above (" / ", "4", " / ") followed by 2/11 ("+").

The dummy sub-address should be sent if the network supports sub-addressing but no sub-address has been sent by the calling DTE.

4.6.3.1 *Format of called and calling line identification*

Calling line identification block and *called line identification* block shall be preceded by character 2/10 (" * ").

When a *calling* or *called line identification* block contains data network identification codes (DNIC) or data country codes (DCC), the block shall instead of one character 2/10 (" * ") be preceded by 2 characters 2/10 (" ** ").

A *called line identification* block shall consist of one or more *called line identification* signals.

Multiple *called line identification* signals shall be separated by character 2/12 (" , ").

End of *calling line identification* block and *called line identification* block shall be indicated by character 2/11 ("+").

The *dummy line identification* block shall be indicated by character 2/10 (" * ") followed by 2/11 ("+").

4.6.3.2 *Format of charging information*

The *charging information* block will be preceded by character 2/15 (" / ") followed by a second IA5 numerical character, followed by character 2/15 (" / "). The end of *charging information* block shall be indicated by character 2/11 ("+").

4.6.4 *Format of DTE-provided information*

A *DTE-provided information* block shall consist of 1 or more *DTE-provided information* signals.

Each *DTE-provided information* signal need not be repeated.

Multiple *DTE-provided information* signals shall be separated by character 2/12 (" , ").

End of *DTE-provided information* block shall be indicated by character 2/11 ("+").

5 Data transfer phase

During the data transfer phase, any bit sequence may be sent by either DTE.

For the interchange of information between one DTE and another DTE during the *data transfer phase*, the DTEs will be responsible for establishing their own alignment.

The byte timing interchange circuit, when implemented, may be utilized by the DTEs for mutual character alignment.

Data link control procedures and any other DTE-to-DTE protocols are not the subject of this Recommendation.

5.1 *Circuit-switched service*

All bits sent by a DTE after indication of *ready for data* for 16-bit intervals (see § 2.4) and before sending *DTE clear request* will be delivered to the corresponding DTE after that corresponding DTE has received *ready for data* and before it has received *DCE clear indication* (provided that the corresponding DTE does not take the initiative of clearing).

All bits received by a DTE, after indication of *ready for data* for 16-bit intervals (see § 2.4) and before receiving *DCE clear indication* or receiving *DCE clear confirmation*, were sent by the corresponding DTE. Some of those bits may have originated as *DTE waiting* before that corresponding DTE has received *ready for data*; those bits are binary 1.

During *data transfer* (state 13), c = ON, i = ON and data are transferred on circuits T and R.

Data transfer may be terminated by *clearing*, as defined in § 6, by either:

i) the DCE, or

ii) any connected DTE.

The action to be taken when circuit C is turned OFF during *data transfer* (state 13), except when the DTE is signalling *DTE clear request* (state 16) by t = 0, c = OFF, is for further study except for the procedures for half-duplex operation between DTEs conforming to Recommendations X.21 and X.21 *bis* as described in Annex E.

5.2 *Leased circuit service – Point-to-point* (see Figure A-3/X.21) *and packet-switched service* (Recommendation X.25, level 1)

In this section, for the case of packet-switched service, one of the DTEs must be understood as being the packet network data switching exchange (DSE).

Data transmitted by the DTE on circuit T with c = ON are delivered to the remote DTE on circuit R with i = ON.

Both DTEs may employ duplex operation for the exchange of data.

Any bit sequence may be sent by either DTE during the ON-condition of its circuit C.

Note – The entering of the DTE/DCE-interface of *DTE uncontrolled not ready* (state 22) will be signalled on the remote end as *DCE not ready* (state 18).

In Figure A-3/X.21 a state diagram indicating a possible data connection is shown. Apart from state 13, two additional states, 13S and 13R, can be identified.

5.2.1 *Send data (state 13S)*

Data transmitted by the DTE on circuit T with c = ON are delivered to the remote DTE on circuit R with i = ON.

5.2.2 *Receive data (state 13R)*

Data transmitted by a distant DTE with c = ON are received on circuit R with i = ON.

5.2.3 *Data transfer (state 13)*

When c = ON, i = ON, data are transferred on circuits T and R.

5.2.4 *Termination of data transfer*

The DTE signals the termination of *data transfer* by signalling t = 1, c = OFF. The DCE indicates termination of *data transfer* by signalling r = 1, i = OFF.

Note – The action taken by the DCE when the DTE signals c = OFF and t does not equal 1, is for further study except for the *DTE uncontrolled not ready* procedures described in § 2.5.1.2.

5.3 *Leased circuit service – Centralized multipoint*

See Figure A-3/X.21.

5.3.1 *Central DTE data transfer*

5.3.1.1 *Send data (state 13S)*

Data transmitted by the central DTE on circuit T with c = ON are delivered to all remote DTEs on circuit R with i = ON.

5.3.1.2 *Receive data (state 13R)*

Data transmitted by any remote DTE with c = ON (one at a time as determined by the data link protocol) during state 13S are delivered to the central DTE on circuit R with i = ON.

5.3.2 *Remote DTE data transfer*

Data transmitted by a remote DTE are not delivered to other remote DTEs.

Note – Transmission of data by two or more remote DTEs at the same time may result in unsatisfactory conditions.

5.3.2.1 *Send data (state 13S)*

Data transmitted by remote DTEs with c = ON (one at a time as determined by the data link protocol) are delivered to the central DTE on circuit R with i = ON.

5.3.2.2 *Receive data (state 13R)*

Data transmitted by the central DTE with c = ON are delivered to the remote DTE on circuit R with i = ON.

5.3.3 *Data transfer (state 13)*

When c = ON, i = ON data transmitted by the central DTE are delivered to all remote DTEs, and data transmitted by a remote DTE (one at a time as determined by data link protocol) are delivered to the central DTE. A remote DTE may send (one at a time as determined by the data link protocol) while the central DTE is sending to all remote DTEs.

5.4 *Circuit-switched service – Point-to-multipoint service*

The different configurations of point-to-multipoint are defined in Recommendation X.2.

5.4.1 *Centralized multipoint*

All bits sent by the central DTE after indication of *ready for data* for 16-bit intervals (see § 2.4) and before clearing procedure has been started by the central DTE or by the network, will be delivered to all remote DTEs after they have received *ready for data* and before they have received *DCE clear indication* (provided that the remote DTEs do not take the initiative of clearing).

All bits received by a remote DTE, after indication of *ready for data* for 16-bit intervals (see § 2.4) and before clearing procedure has been started by the central DTE, by the network or the remote DTE, were sent by the central DTE. Some of those may have originated as *DTE waiting* before the central DTE has received *ready for data*; those bits are binary 1.

All bits sent by a remote DTE, after indication of *ready for data* for 16-bit intervals (see § 2.4) and before clearing procedure has been started by the central DTE, by the network or by the remote DTE, will be delivered to the central DTE after that central DTE has received *ready for data* and before it has received *DCE clear confirmation* or *DCE clear indication*, provided that the the other remote DTEs are transmitting binary 1.

All bits received by the central DTE, after receiving *ready for data* for 16-bit intervals (see § 2.4) and before receiving *DCE clear indication* or *DCE clear confirmation*, were sent by one of the remote DTEs. Some of these may have originated as *DTE waiting* before the remote DTEs have received *ready for data*; those bits are binary 1.

During *data transfer* (state 13), c = ON, i = ON and data are transferred on circuits T and R.

Data transfer may be terminated by clearing, as defined in § 6 below, by either:

i) the central DTE or,

ii) all the remote DTEs or,

iii) the DCEs.

6 Clearing phase

See Figure A-4/X.21.

In centralized multipoint calls:

– clearing by the central DTE imply clearing of the call;

– clearing by a remote DTE clears the call for this DTE, and has no effect on the calls which remain established for the other remote DTEs;

– clearing by the last remote DTE still in the call leads to the clearing of the call.

6.1 *Clearing by the DTE (states 16, 17, 21)*

The DTE should indicate clearing by signalling the steady binary condition t = 0, c = OFF, *DTE clear request* (state 16).

The DCE will respond by signalling the steady state condition r = 0, i = OFF, *DCE clear confirmation* (state 17), followed by the steady binary condition r = 1, i = OFF, *DCE ready* (state 21). The *DCE ready* signal will be sent within 2 seconds after the receipt of the *DTE clear request* signal.

The DTE shall recognize *DCE clear confirmation* and, except as noted below, shall then respond to *DCE ready*, when presented, within 100 millisecondes by signalling t = 1, c = OFF, *ready* (state 1).

In the case where *DCE clear confirmation* is either not presented by the DCE or not recognized by the DTE, the DTE shall remain in the *DTE clear request* state for a minimum of 2 seconds and then go to *DTE ready*. In this case, the DTE may not respond to *DCE ready* within the 100 milliseconds stipulated above and may be considered by the DCE to be *uncontrolled not ready* (state 24) for a finite period of time (until it goes to *DTE ready*).

6.2 *Clearing by the DCE (states 19, 20, 21)*

The DCE will indicate clearing to the DTE by signalling the steady binary condition r = 0, i = OFF, *DCE clear indication* (state 19).

The DTE should signify *DTE clear confirmation* (state 20) by signalling the steady binary condition t = 0, c = OFF, within 500 milliseconds. The DCE will signal r = 1, i = OFF, *DCE ready* (state 21) within 2 seconds of receiving *DTE clear confirmation*.

The DTE should respond to *DCE ready* within 100 milliseconds by signalling t = 1, c = OFF, *ready* (state 1).

In the case where *DTE clear confirmation* is either not presented by the DTE or not recognized by the DCE, the DCE shall remain in the *DCE clear indication* state for a minimum of 500 milliseconds (until the time T15 has expired) and then signal *DCE ready*.

7 Test loops

The definitions of the test loops and the principles of maintenance testing using the test loops are provided in Recommendation X.150.

7.1 *DTE test loop – Type 1 loop*

This loop is used as a basic test of the operation of the DTE, by looping back the transmitted signals inside the DTE for checking. The loop should be set up inside the DTE as close as possible to the DTE/DCE interface.

While the DTE is in the loop 1 test condition:

– circuit T is connected to circuit R inside of the DTE;

– circuit C is connected to circuit I inside of the DTE;

– the DCE continues to present signal element timing on circuit S and, if implemented, byte timing on circuit B. The DTE need not make use of the timing information.

Loop 1 may be established from either the *data transfer* or *ready* state.

In some networks, for short routine tests during the *data transfer* state, the DTE should either maintain the same status on the interchange circuits as before the test or send the *controlled not ready* signal. If the loop is established from the *data transfer* state, the DCE may continue to deliver data to the DTE during the test as though the DTE were in normal operation. It will be the responsibility of the DTEs to recover from any errors that might occur while the test loop is activated.

If the loop is established from the *ready* state, the DTE should signal one of the *not ready* states.

7.2 *Local test loop – Type 3 loop*

Local test loops (type 3 loops) are used to test the operation of the DTE, the interconnecting cable and either all or parts of the local DCE, as discussed below.

Loop 3 may be established from any state.

For testing on leased circuits and for short duration testing on circuit-switched connections the DCE should either continue to present toward the line the conditions that existed before the test (e.g. either *data transfer* or *ready* state) or send the *controlled not ready* state to the remote DTE. Where this is not practical (e.g. in some cases for loop 3a) or desirable (e.g. for long duration testing in circuit-switched applications) the DCE should terminate an existing call and, if possible, signal toward the subscriber-line one of the *not ready* states.

Manual and/or automatic control should be provided on the DCE for activation of the test loop.

The precise implementation of the test loop within the DCE is a national option. At least one of the following local loops should be implemented:

7.2.1 *Loop 3d*

This loop is used to test the operation of the DTE, including the interconnecting cable, by returning transmitted signals to the DTE for checking. The loop is set up inside the local DCE and does not include interchange circuit generators and loads.

While the DCE is in the loop 3d test condition:

– circuit T is connected to circuit R inside of the DCE;

– circuit C is connected to circuit I inside of the DCE;

– the DCE continues to present signal element timing on circuit S and, if implemented, byte timing on circuit B. The DTE must make use of the timing information.

Note – While test loop 3d is operated, the effective length of the interface cable is doubled. Therefore, to insure proper operation of loop 3d, the maximum DTE/DCE interface cable length should be one-half the length normally appropriate for the data signalling rate in use.

7.2.2 *Loop 3c*

This loop is used to test the operation of the DTE, including the interconnecting cable and DCE interchange circuit generators and loads.

The configuration is identical to that given for loop 3d in § 7.2.1 with the exception that the looping of circuit T to circuit R and the looping of circuit C to circuit I includes the interchange circuit generators and loads. The note concerning restriction of interface cable length is not applicable.

7.2.3 *Loop 3b*

This loop is used as a test of the operation of the DTE and the line coding and control logic and circuitry of the DCE. It includes all the circuitry of the DCE with the exclusion of the line signal conditioning circuitry (e.g. impedance matching transformers, amplifiers, equalizers, etc.). The delay between transmitted and received test data is a few octets (see Note).

The configuration is identical to that given for loop 3c in § 7.2.2 except for the location of the point of loopback.

Note – In some DCEs, the setting of loop 3b will result in momentary loss of envelope alignment causing random signals to appear on the receiving interchange circuit for a period of time. This may impact upon the DTE test procedure. In some networks the setting of loop 3b will cause clearing of existing connections.

7.2.4 *Loop 3a*

This loop is used to test the operation of the DTE and the DCE. The loop should include the maximum amount of circuitry used in DCE working including, in particular, the line signal conditioning circuitry. It is recognized that, in some cases, the inclusion of devices (e.g. attenuators, equalizers or test loop translators) may be necessary in the loopback path. The subscriber line is suitably terminated during a loop 3a test condition. The delay between transmitted and received test data is a few octets (see Note).

The configuration is identical to that given for test loop 3b in § 7.2.3 except for the location of the point of loopback.

Note – In some DCEs, the setting of loop 3a will result in momentary loss of envelope alignment causing random signals to appear on the receiving interchange circuit for a period of time. This may impact upon the DTE test procedure. In some networks the setting of loop 3a will cause clearing of existing connections.

7.2.5 *Automatic operation of test loop 3*

See Figure A-9/X.21.

The procedure provides for transparent loop testing and may be entered from any state.

7.2.5.1 *Send loop 3 command (state L31)*

The testing DTE shall indicate a request for a local loop 3 by signalling t = 00001111 (alternate bit quadruples are binary 0 and binary 1), c = OFF. The loop command shall persist until the DCE signals r = 00001111..., i = OFF, but not longer than 6 s. Some networks may require the loop command to be preceded by 2 or more contiguous 1/6 ("SYN") characters and to appear on a character boundary 00001111. Some networks will not require the preceding SYN-characters to be sent, i.e. they will treat the loop command as a bit pattern which, therefore, does not need to appear on a character boundary. However, this would impose no restrictions on DTEs sending the loop command on a character boundary with preceding SYN-characters.

7.2.5.2 *Loop 3 confirmation (state L32)*

The DCE indicates that the local loop 3 is established by signalling r = 00001111, i = OFF.

Note – This bit pattern received on circuit R is the loop command reflected by the local loop 3.

7.2.5.3 *Test data (state L33)*

The DTE enters the transparent *test data* state by turning c = ON. During the test any bit sequence may be sent by the DTE. The looped back data are received on circuit R with i = ON.

7.2.5.4 *Loop 3 clear request (state L34A)*

The DTE signals the termination of the test data by turning c = OFF.

7.2.5.5 *Loop 3 clear request (state L34B)*

In cases where the DTE does not wish to enter state L33 it may leave state L32 by signalling t ≠ 00001111, c = OFF for a minimum time of 24 bits.

7.2.5.6 *Loop 3 clear confirmation (state L35)*

Release of the loop is confirmed by the DCE signalling r ≠ 00001111, i = OFF.

7.3 *Network test loop – Type 2 loop*

Network test loops (type 2 loops) are used by the Administration's test centre to test the operation of the leased line or subscriber line and either all or part of the DCE, as discussed below.

7.3.1 *General*

Loop 2 may be controlled manually on the DCE or automatically from the network or where allowed by national testing principles automatically from the remote DTE.

In case of a collision between call request and the activation of the loop, the loop activation command will have priority.

When the test is in progress, the DCE will signal r = 0, i = OFF or r = 0101, i = OFF. The choice as to which of these signals is sent is a national matter.

7.3.2 *Automatic operation of test loop 2*

See Figures A-7/X.21 and A-8/X.21.

The procedure provides for transparent loop testing and is entered from the *data transfer* phase, state 13 in circuit switched service point-to-point. It may also be entered from any state in leased circuit service.

7.3.2.1 *Send loop 2 command (state L21)*

The testing DTE shall indicate a request for a remote loop 2 by signalling t = 00110011 (alternate bit pairs are binary 0 and binary 1), c = OFF. The loop command shall persist until the DCE signals r = 00110011 . . . , i = OFF, but not longer than 2 s. Some networks may require the loop command to be preceded by 2 or more contiguous 1/6 ("SYN") characters and to appear on a character boundary 00110011. Some networks will not require the preceding SYN-characters to be sent, i.e. they will treat the loop command as a bit pattern which, therefore, does not need to appear on a character boundary. However, this would impose no restrictions on DTEs sending the loop command on a character boundary with preceding SYN-characters.

7.3.2.2 *Loop 2 confirmation (state L22)*

The DCE indicates that the remote loop 2 is established by signalling r = 001100 . . . , i = OFF.

Note – This bit pattern received on circuit R is the loop command reflected by the remote loop 2.

7.3.2.3 *Test data (state L23)*

The DTE enters the transparent *test data* state by turning c = ON.

During the test any bit sequence may be sent by the DTE. The looped back data are received on circuit R with i = ON.

Note – Allowance must be made for propagation delay in the network.

7.3.2.4 *Loop 2 clear request (state L24A)*

The DTE signals the termination of the *test data* state by turning c = OFF.

In the case where the DTE wishes to clear the connection it signals t = 0, c = OFF (state 16).

In the case where the DTE wishes to re-enter the *data transfer* phase it signals t ≠ 0 ≠ 0011, c = OFF until the DCE signals state L25 *loop 2 clear confirmation*, r ≠ 0 ≠ 0011, i = OFF. After that, the DTE re-enters the *data transfer* phase by signalling t = D, c = ON.

7.3.2.5 *Loop 2 clear request (state L24B)*

In cases where the DTE does not wish to enter state L23 it may leave state L22 by signalling t ≠ 0011, c = OFF for a minimum time of 24 bits.

In the case where the DTE wishes to clear the connection it signals t = 0, c = OFF (state 16).

In the case where the DTE wishes to re-enter the data transfer phase it signals t ≠ 0 ≠ 0011, c = OFF until the DCE signals state L25 loop 2 clear confirmation, r ≠ 0 ≠ 0011, i = OFF. After that, the DTE re-enters the data transfer phase by signalling t = D, c = ON.

7.3.2.6 *Loop 2 clear confirmation (state L25)*

Release of the loop is confirmed by the DCE signalling r ≠ 0011 . . . , i = OFF.

Note – The DCE signalling of r = 0, i = OFF must be interpreted by the DTE as *loop clear confirmation* and *DCE clear indication* (state 19).

7.3.2.7 *Receive loop 2 command (state L26)*

The DCE will indicate the receipt of a *loop command* by transmission of 0011 . . . on circuit R with i = OFF.

Note – In some networks state L26 will be bypassed if the loop 2 is operated from the Administration's test centre.

7.3.2.8 *Loop 2 consent (state L26A)*

The DTE of the tested station will indicate its readiness for a loop test by signalling t = X, c = OFF.

Note – Some networks may require this state for additional security against malicious test loop operation.

7.3.2.9 *DCE controlled not ready (state L27)*

When the DCE has closed the loop 2 it transmits 0101 . . . on circuit R and i = OFF to the DTE.

This DTE should not interpret this state as a *clear* indication, if it was in the *data transfer* phase before the test procedure began.

7.3.2.10 *Loop 2 released (state L28)*

When the DCE stops transmitting 0101 . . . for more than 24 bits on circuit R, the DTE is informed that it may continue with the state it had left at the beginnng of state L27.

7.3.2.11 *DCE not ready (state L29)*

In the case when the DCE is not able to send *DCE controlled not ready*, it will signal *DCE not ready* (state L29). This state will persist until the loop is released.

Note – It is not possible to re-enter the *data transfer* phase in this case.

7.3.3 *Implementation of type 2 loops*

The precise implementation of the test loop within the DCE is a national option. At least one of the following network test loops should be implemented:

7.3.3.1 *Loop 2b*

This loop is used by either the Administration's test centre(s) and/or the remote DTE to test the operation of the subscriber line and all the circuitry of the DCE with the exception of interchange circuit generators and loads.

While the DCE is in the loop 2b test condition:

– circuit R is connected to circuit T inside of the DCE,

– circuit I is connected to circuit C inside of the DCE,

– at the interface, the DCE signals r = 0, i = OFF, or where provided r = 0101 . . . , i = OFF,

– the DCE provides timing information on circuits S and, if implemented, on circuit B.

7.3.3.2 *Loop 2a*

This loop is used by either the Administration's test centre(s) or the remote DTE to test the operation of the subscriber line and the entire DCE.

The configuration is identical to that given for loop 2b in § 7.3.3.1 except for the location of the point of loop back. Alternatively, the DCE may present an open circuit or power off condition on circuits R and I.

7.4 *Subscriber-line test loop – Type 4 loop*

Subscriber-line test loops (type 4 loops) are provided for the maintenance of lines by the Administrations.

Note – In the case of loops 4 and 2 (see § 7.3) the DCE may signal the local DTE in such a manner that the DTE can distinguish a test mode from a network failure. This is for further study.

7.4.1 *Loop 4a*

This loop is only provided in the case of 4-wire subscriber lines. Loop 4a is for the maintenance of lines by Administrations. When receiving and transmitting pairs are connected together, the resulting circuit cannot be considered normal. Loop 4a may be established inside the DCE or in a separate device.

While the DCE is in the loop 4a test condition:

– the DCE signals to the local DTE r = 0, i = OFF, or where provided r = 0101 . . . , i = OFF.

– the DCE provides timing information on circuit S and, if implemented, circuit B.

7.4.2 *Loop 4b*

This loop is used by Administrations to test the operation of the subscriber line including the line signal conditioning circuitry in the DCE. When the receiving and transmitting circuits are connected at this point, loop 4b provides a connection that can be considered as normal; however, some impairment of the performance is expected since the DCE does not perform a complete signal regeneration.

The configuration is identical to that given for loop 4a in § 7.4.1 except for the location of the point of the loopback.

7.5 *Signal element timing provision*

The provision of signal element timing to the DTE is maintained when any of the loops, described above, are activated.

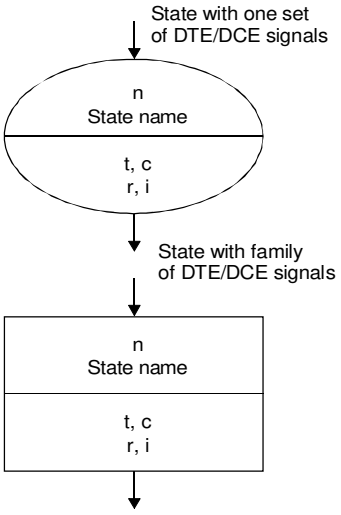
When test loops are activated, the signal element timing should in no case deviate from the nominal value by more than ± 1%.

ANNEX A

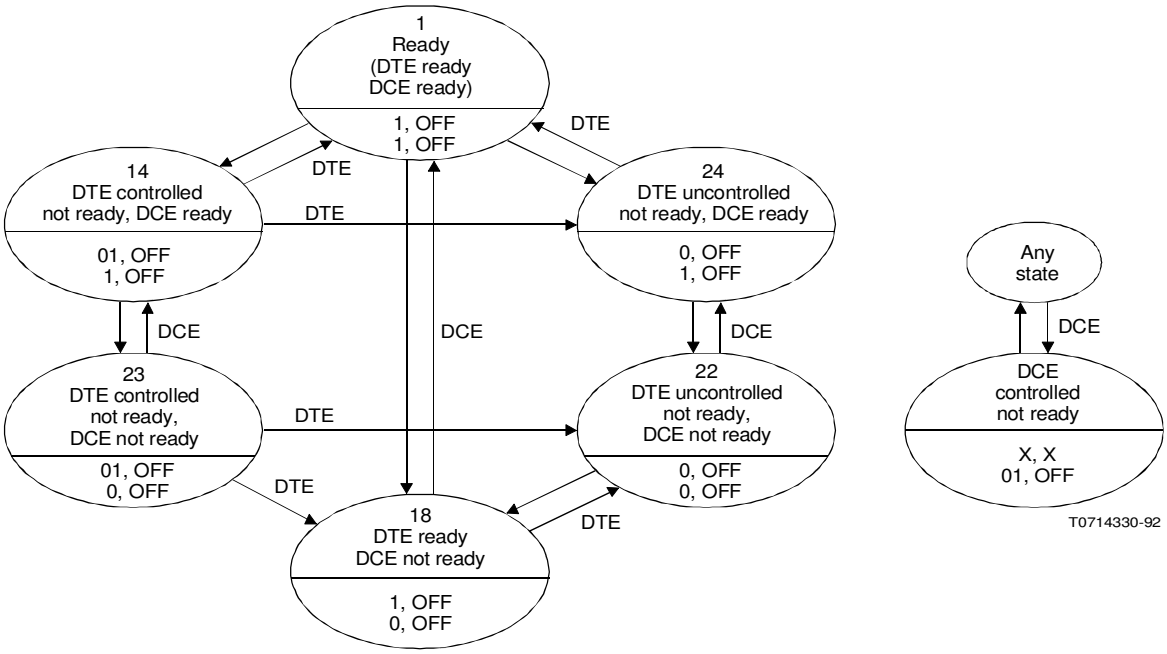
(to Recommendation X.21)

Interface signalling state diagrams

Definition of symbols used in the state diagrams



n	State number
t	Signal on T circuit
c	Signal on C circuit
r	Signal on R circuit
i	Signal on I circuit
T	Transmit interchange circuit
C	Control interchange circuit
R	Receive interchange circuit
I	Indication interchange circuit
D	DTE or DCE data signals
0 and 1	Steady binary conditions
01	Alternate binary 0 and binary 1
X	Any value
OFF	Continuous OFF (binary 1)
ON	Continuous ON (binary 0)
IA5	Characters from International Alphabet No. 5 (Recommendations V.3 and X.4)
+	IA5 character 2/11
BEL	IA5 character 0/7
SYN	IA5 character 1/6
↓	Transition with indication of whether DTE or DCE is responsible for transition

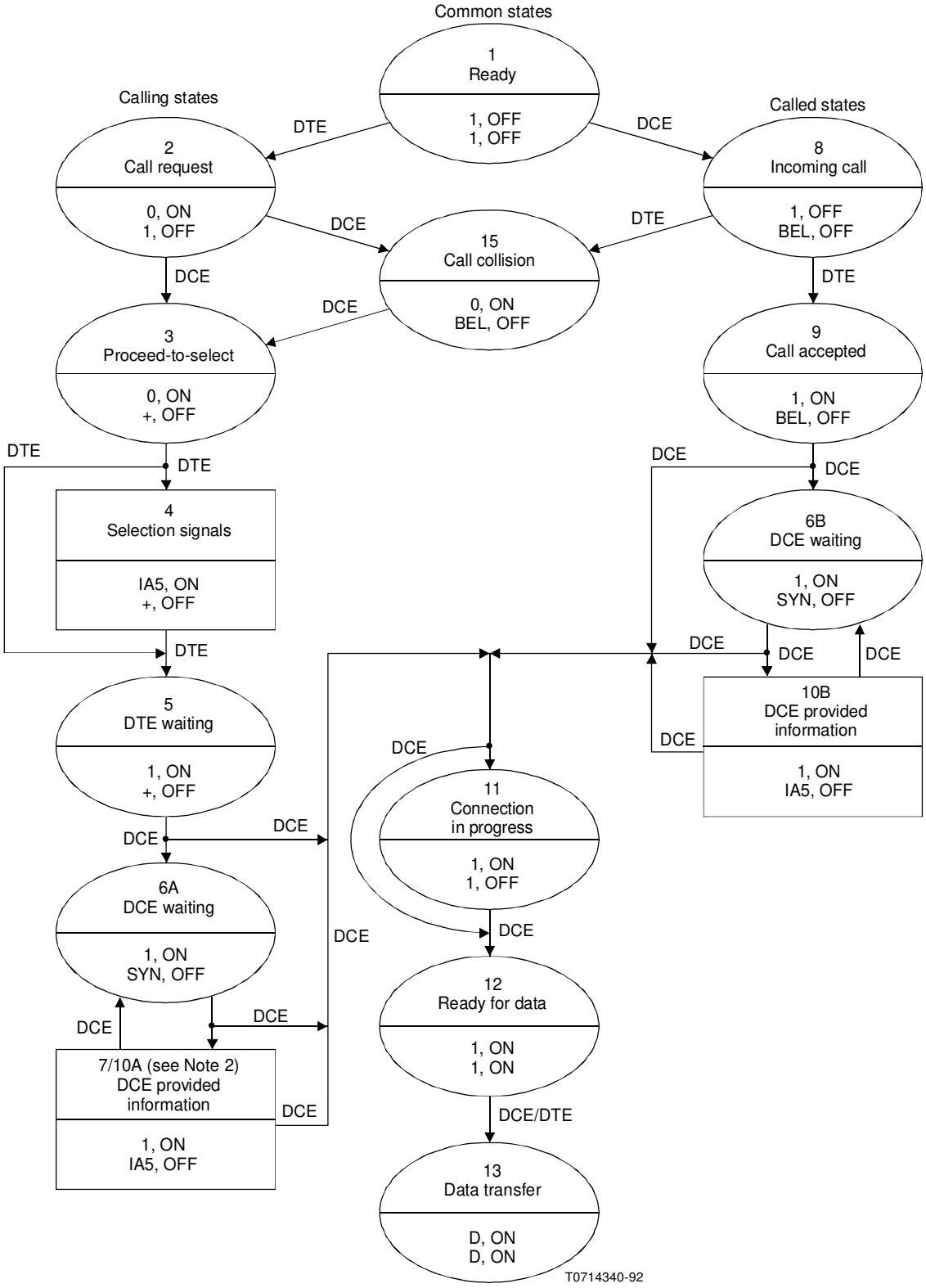


Note 1 – This state diagram shows transitions that will be allowed by all Administrations. Other transitions are possible and may be allowed by some Administrations.

Note 2 – *DCE controlled not ready appearing* during the call establishment phase should be interpreted as a *DCE clear indication.*

FIGURE A-1/X.21

Quiescent states.

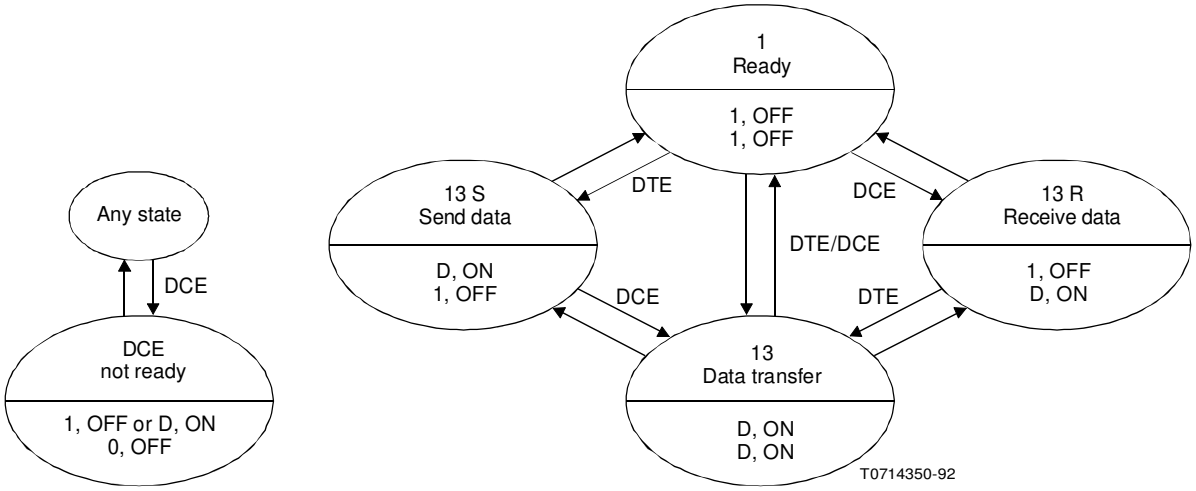


Note 1 – As indicated in Figure A-4/X.21, the DCE may enter state 19 from any state and the DTE may enter state 16 from any state except *ready*.

Note 2 – For simplification of the state diagram, state 7 (*call progress* signals) is merged with state 10A *(DCE provided information).*

FIGURE A-2/X.21

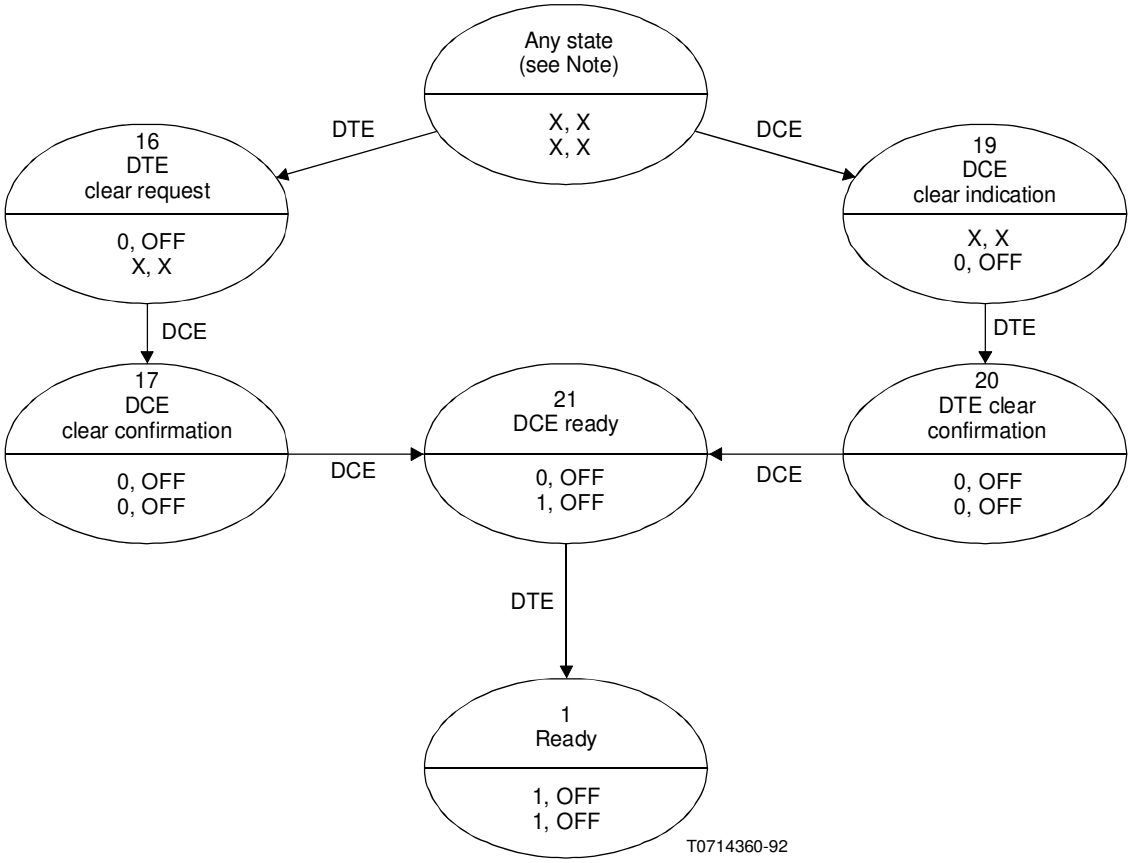
Call control phase for Circuit-switched service



Note – States 13S, 13R and 13 may be entered from any of the quiescent states shown in Figure A-1/X.21.

FIGURE A-3/X.21

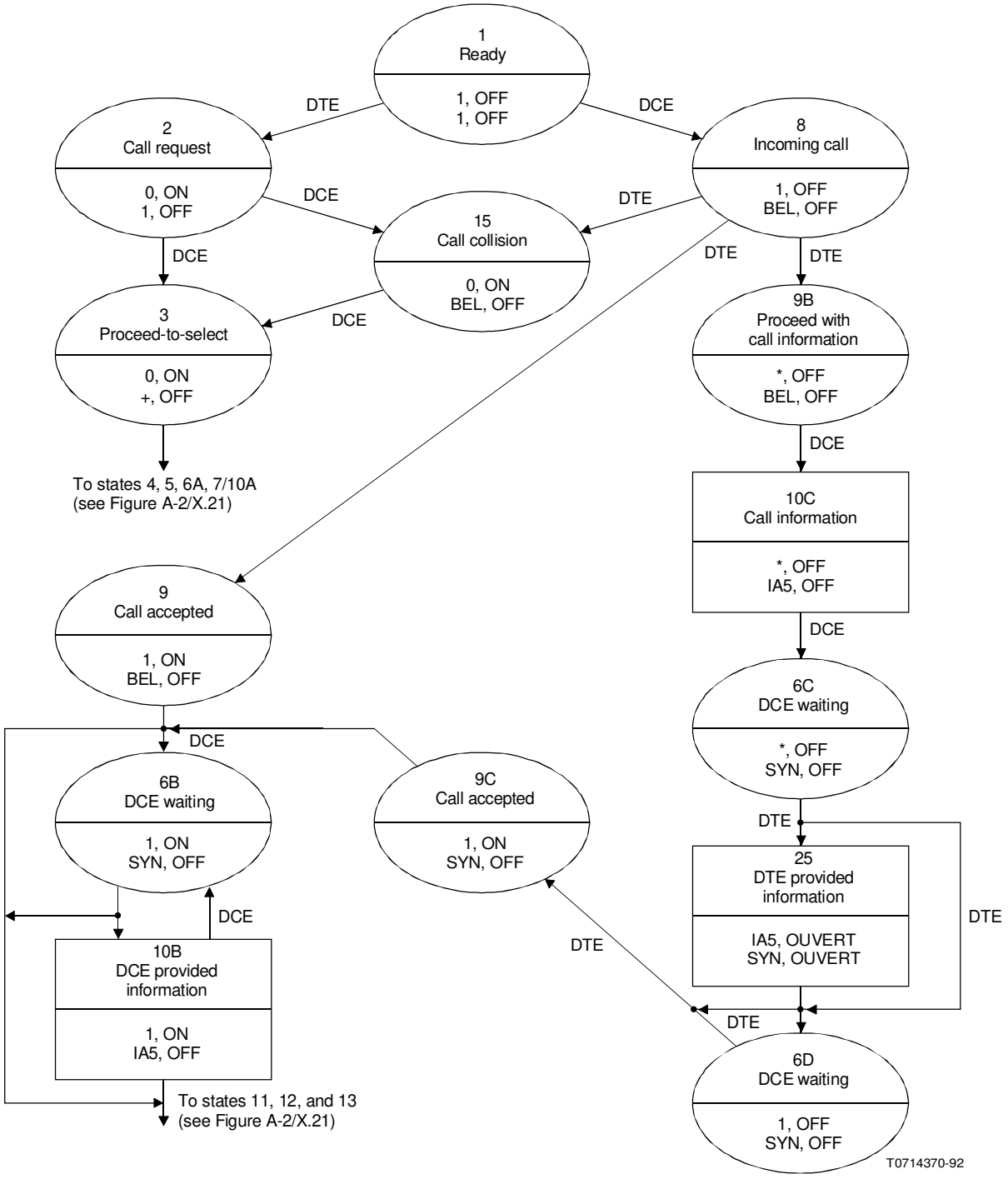
Leased circuit service – Point-to-point and packet-switched service



Note – Any state in Figure A-2/X.21 except *ready*.

FIGURE A-4/X.21

Clearing phase



Note 1 – States 2, 3 and 15 are drawn for clarification only.

Note 2 – Transition from state 8 to state 9 only in the case of the DTE being unable to accept *call information*.

FIGURE A-5/X.21

Call control phase for DTEs with enhanced sub-addressing for Circuit-switched service

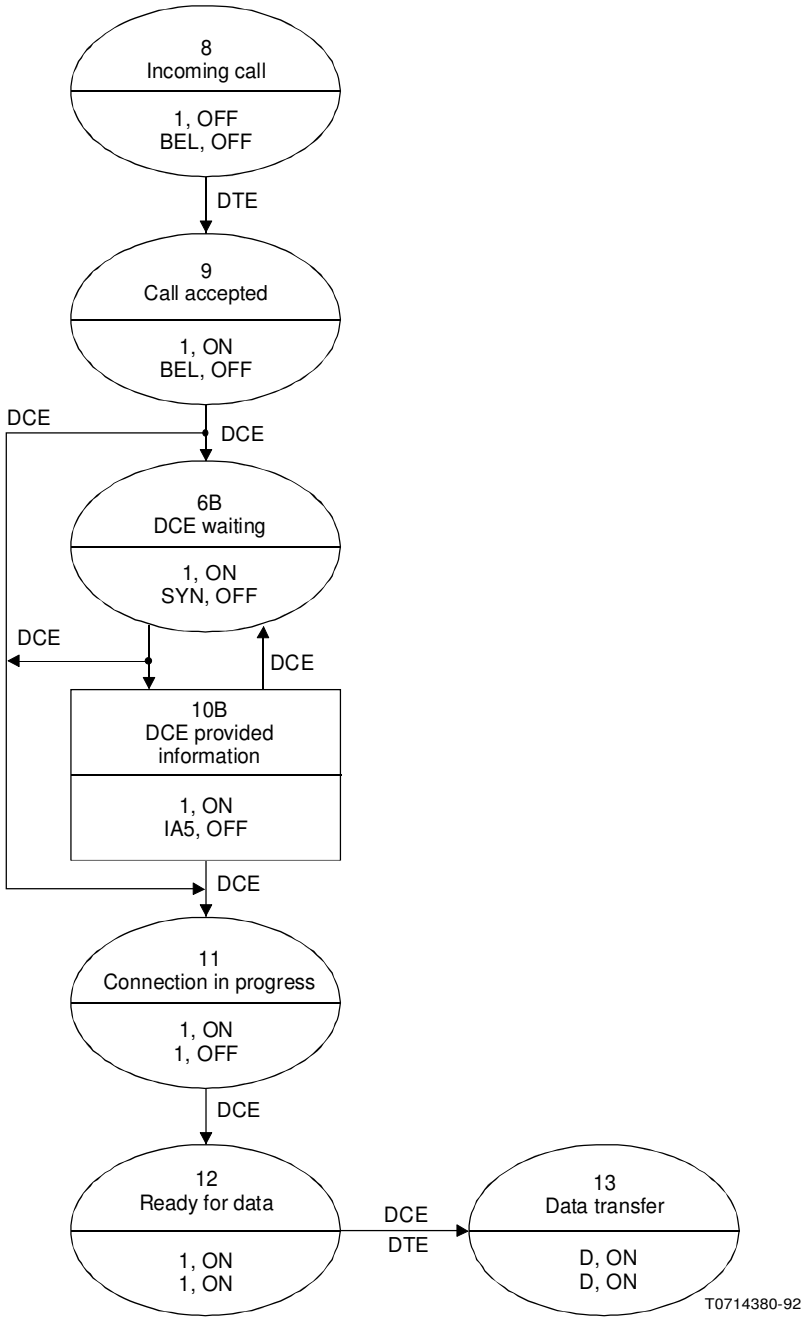
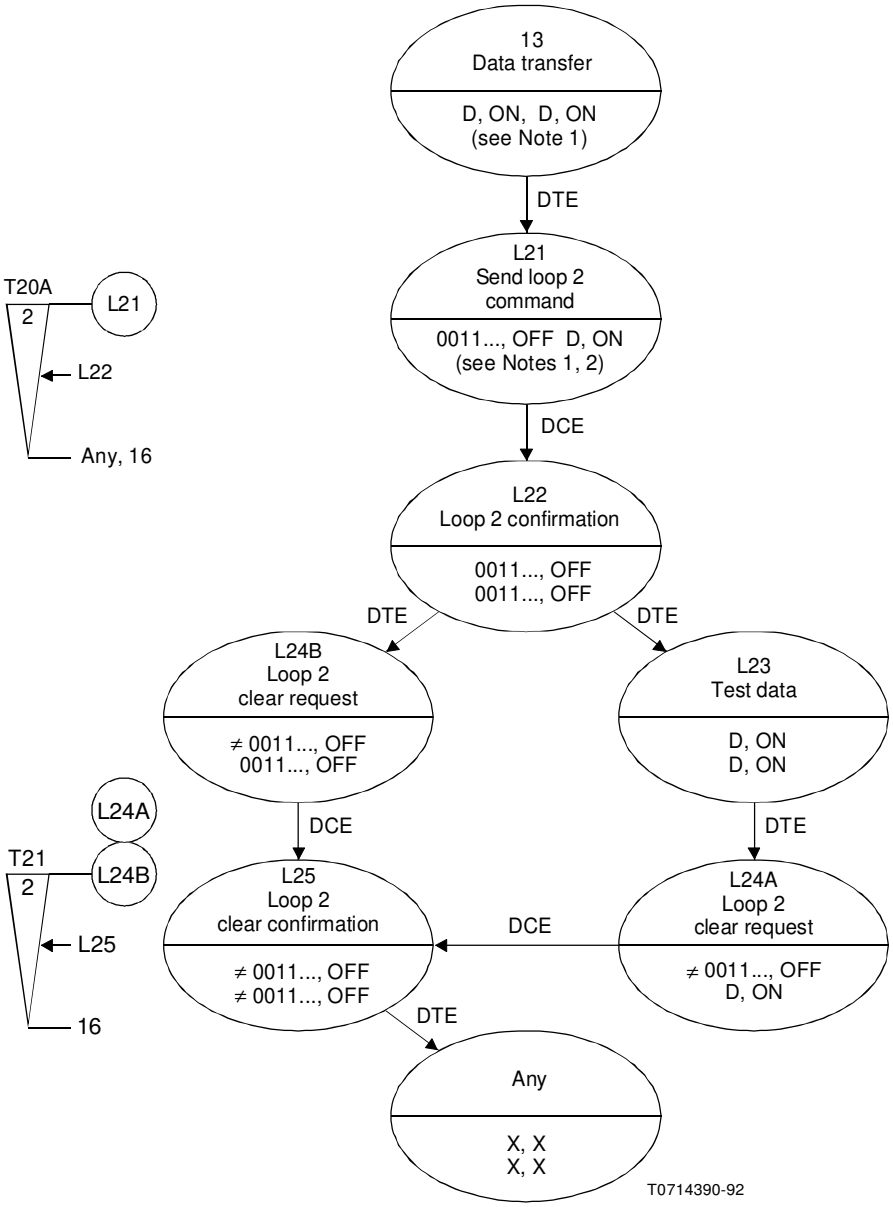


FIGURE A-6/X.21

Call control phase for called DTE with simple sub-addressing for the Circuit-switched service

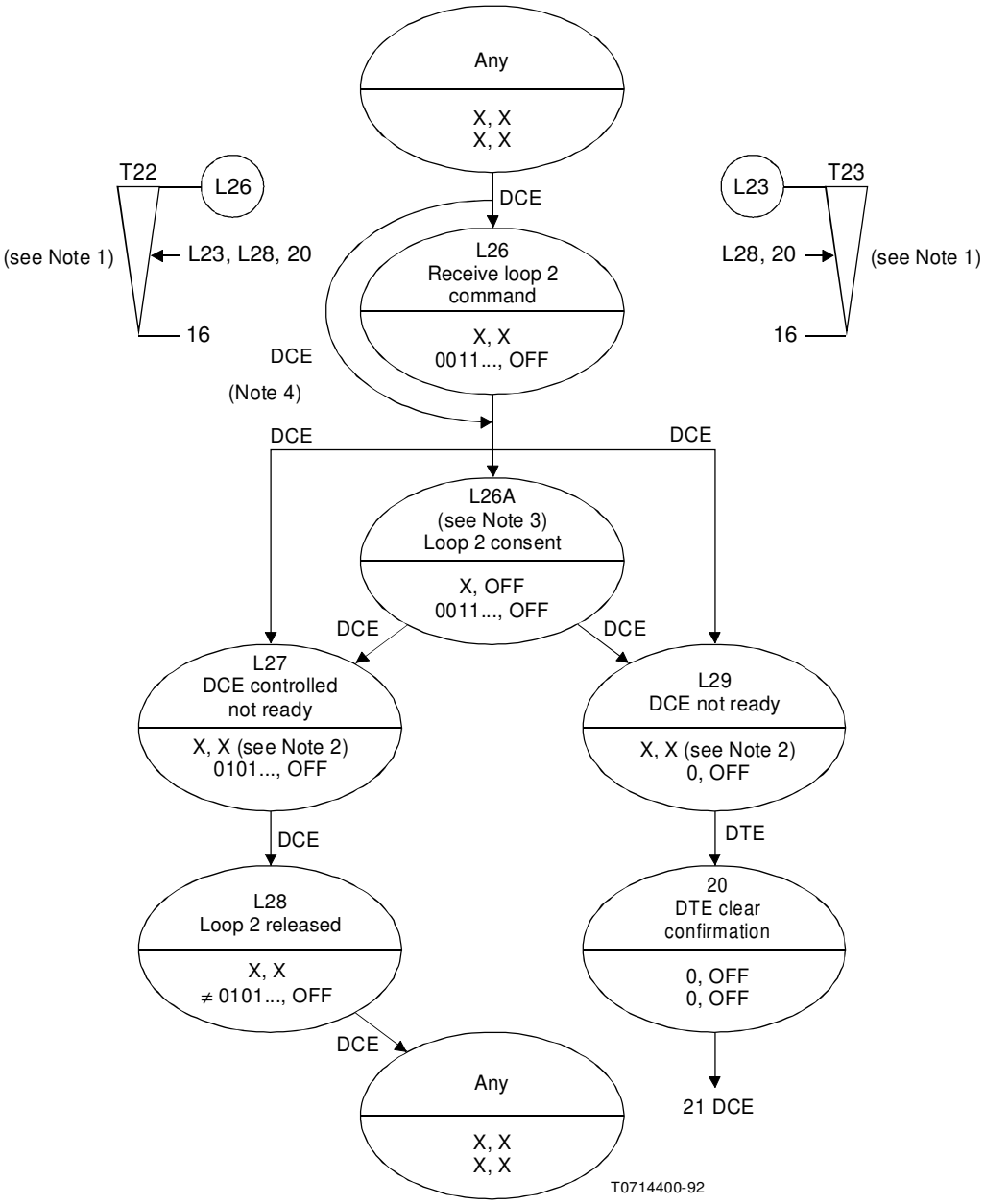


Note 1 – In leased circuit service any state.

Note 2 – Networks which implement state L26A *loop 2 consent* will require the remote DTE to be signalling c = OFF.

FIGURE A-7/X.21

Loop 2 activation/deactivation – Testing station



Note 1 – T22 and T23 are a national matter.

Note 2 – Networks which implement state L26A *loop 2 consent* will require the remote DTE to be signalling c = OFF.

Note 3 – Some networks may require this state for additional security against malicious test loop operation.

Note 4 – In some networks state L26 will be bypassed if loop 2 is operated from the Administration's test centre or the sequence is less than 24 bits.

FIGURE A-8/X.21

Loop 2 activation/deactivation – Tested station

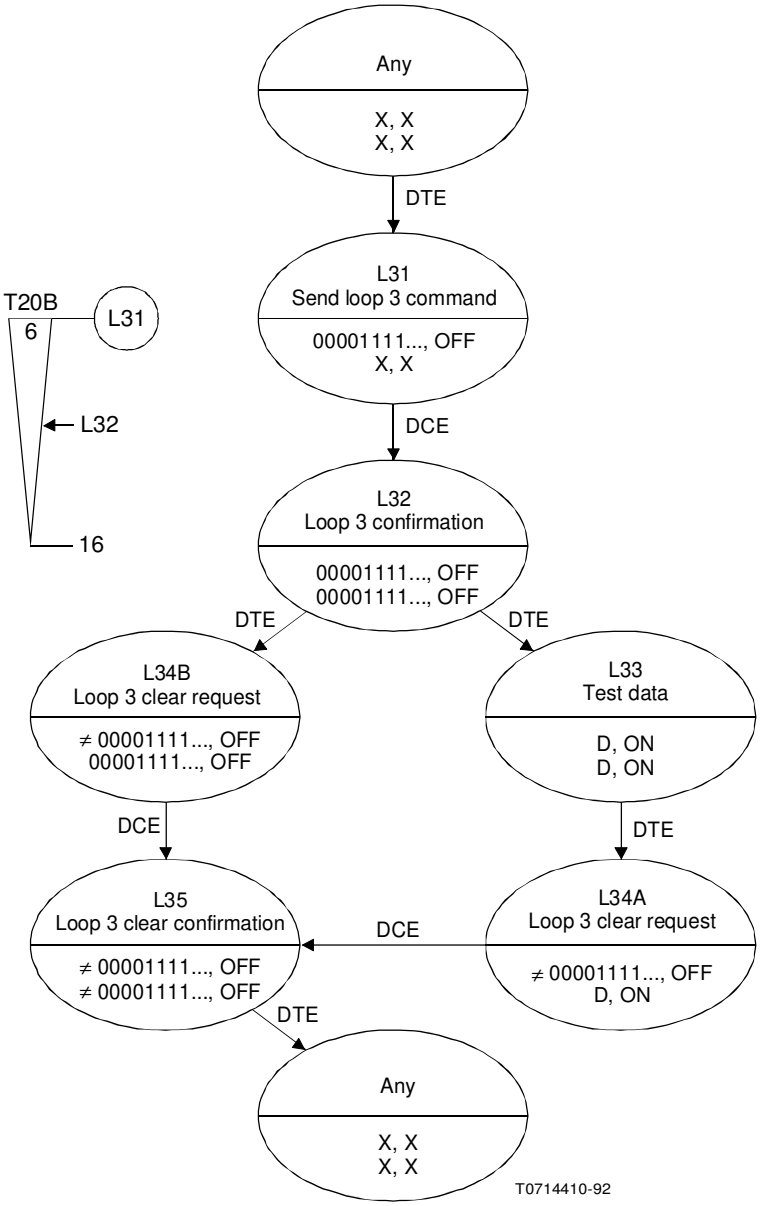


FIGURE A-9/X.21

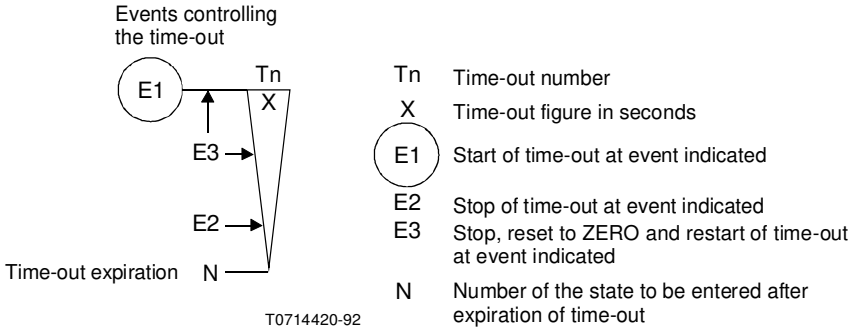
Loop 3 activation/deactivation

ANNEX B

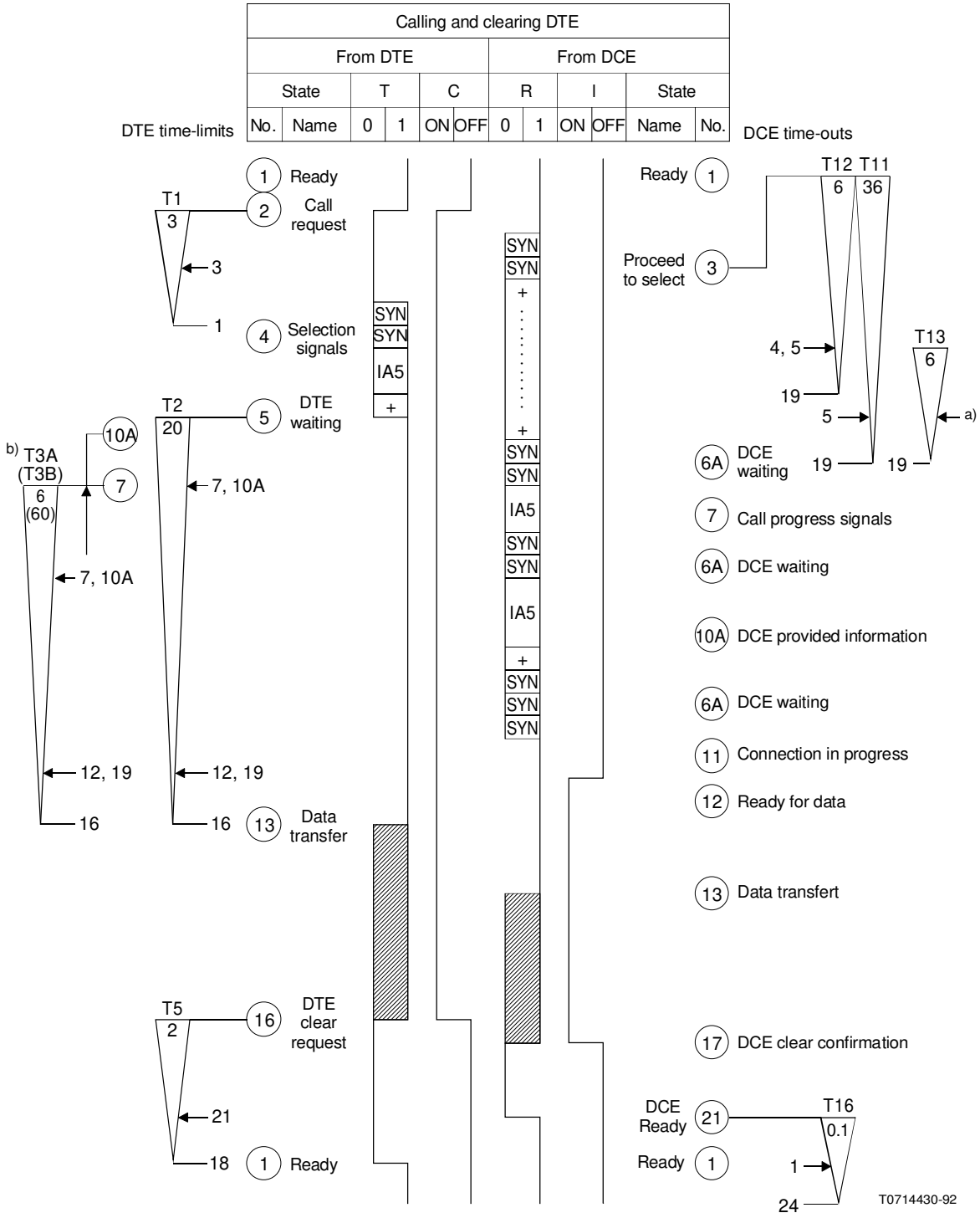
(to Recommendation X.21)

Interface signalling sequence diagrams and time-out operations

Definition of symbol used to illustrate time-out operation
in the signalling sequence diagrams:



Note – For additional alternative assignments of DTE time-limits or DCE time-outs not shown together with the signalling sequence diagrams, see Table C-2/X.21.



[a] For additional alternative assignments of DTE time-limits or DCE time-outs not shown together with the signalling sequence diagrams, see Table C-2/X.21.

[b] For full details, see Table C-1/X.21.

FIGURE B-1/X.21

Example of sequence of events: successful call and clear for Circuit-switched service (calling and clearing DTE)

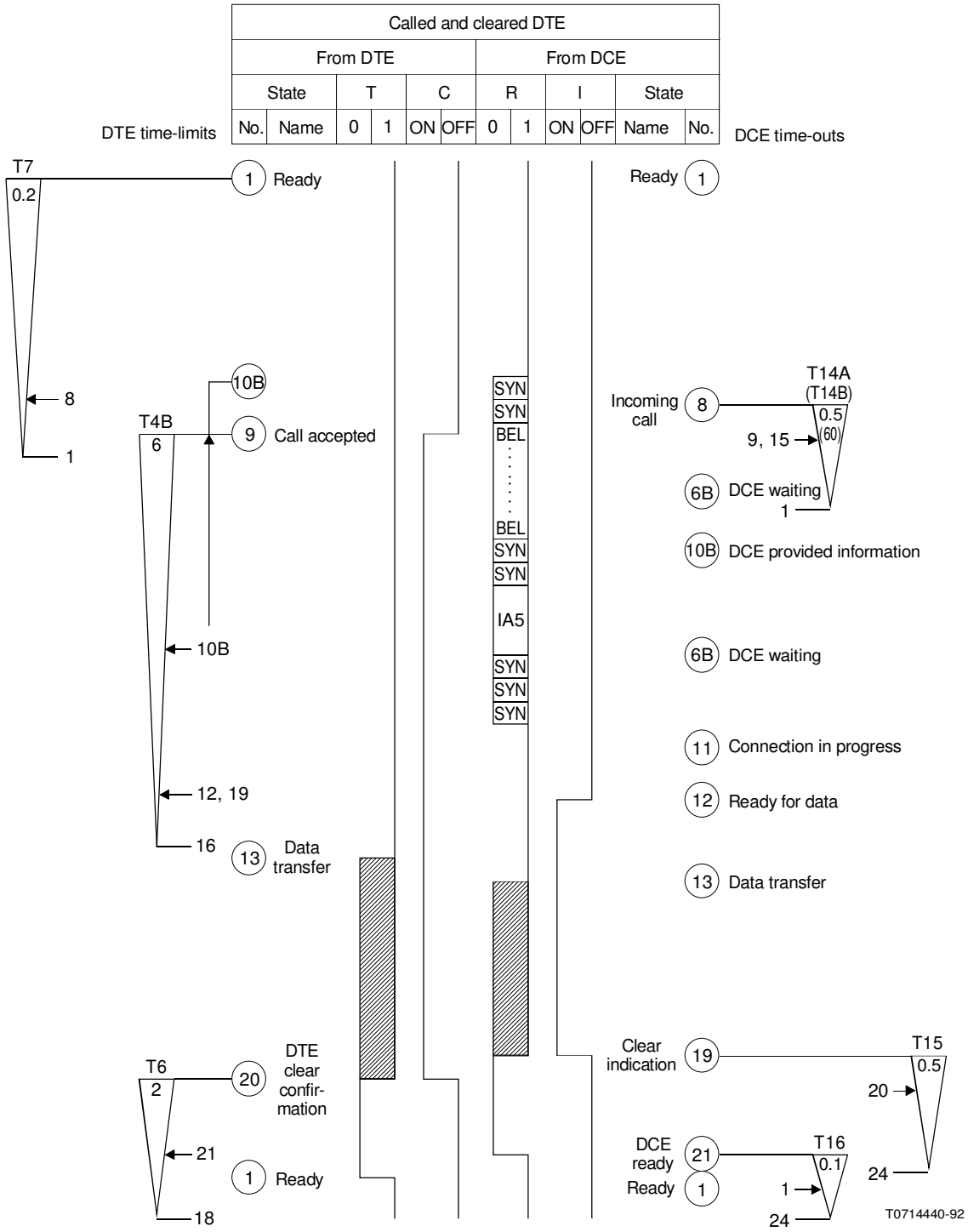


FIGURE B-2/X.21

Example of sequences of events: successful call and clear for Circuit-switched service (called and cleared DTE)

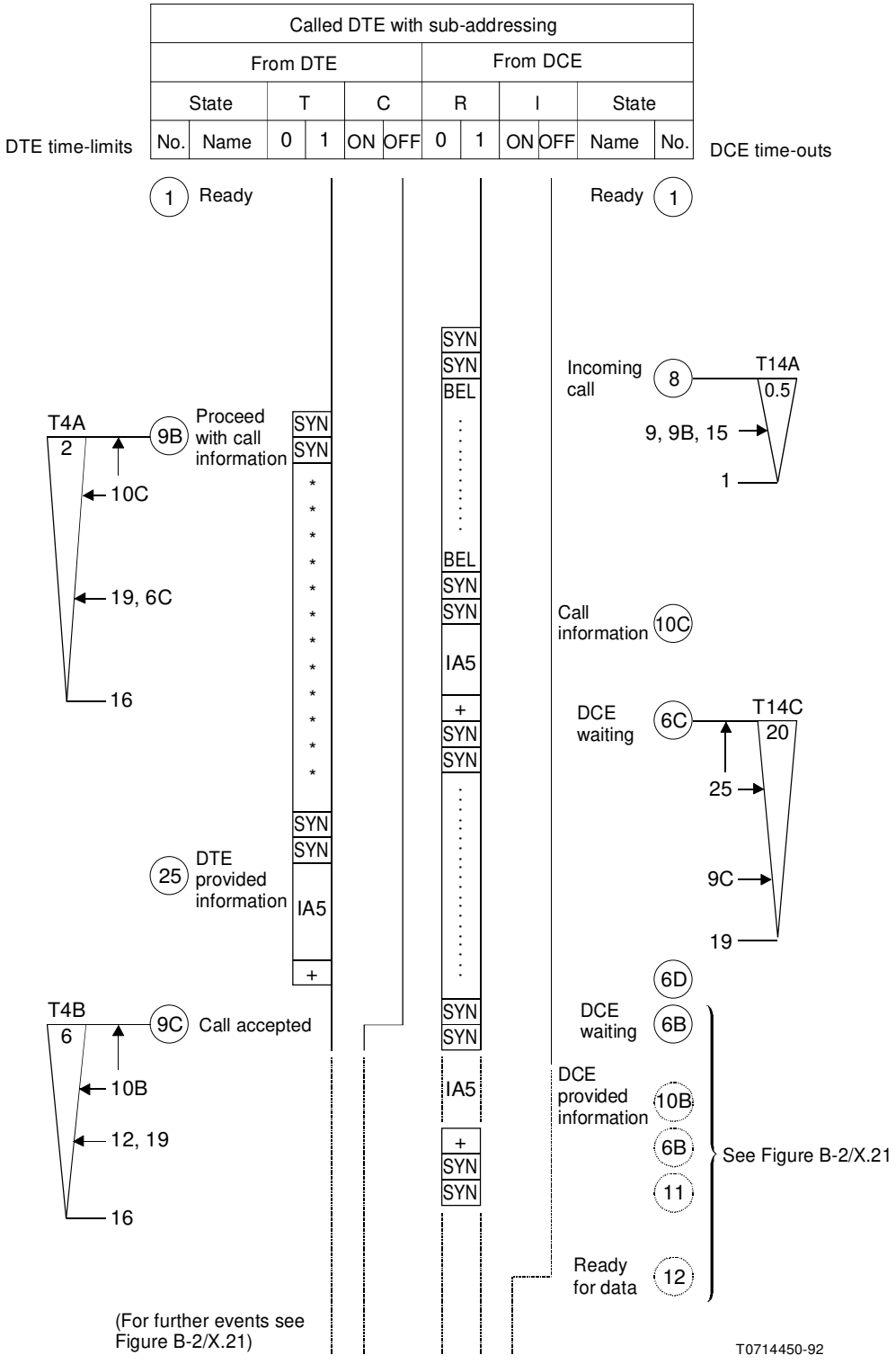


FIGURE B-3/X.21

Example of sequences of events: successful call of a DTE with enhanced sub-addressing for Circuit-switched service

ANNEX C

(to Recommendation X.21)

DTE time-limits and DCE time-outs

C.1 *DTE time-limits*

Under certain circumstances this Recommendation requires the DCE to respond to a signal from the DTE within a stated maximum time. If any of these maximum times is exceeded, the DTE should initiate the action indicated in Table C-1/X.21. To maximize efficiency, the DTE should incorporate time-limits to send the appropriate signal under the defined circumstances summarized in Table C-1/X.21. The time-limits given in the first column are the maximum times allowed for the DCE to respond and are consequently the lower limits of the times a DTE must allow for proper network operation. A time-limit longer than the time shown may be optionally used in the DTE; for example, all DTE time-limits could have one single value equal to or greater than the longest time-limit shown in this table. However, the use of a longer time-limit will result in reduced efficiency of network utilization. The actual DCE response time should be as short as is consistent with the implementing technology and in normal operation should be well within the specified time-limit. The rare situation where a time-limit is exceeded should only occur when there is a failure in DCE operation.

The time-limits and actions for loop testing are given in Table C-3/X.21.

C.2 *DCE Time-outs*

Under certain circumstances this Recommendation requires the DTE to respond to a signal from the DCE within a stated maximum time. If any of these maximum times is exceeded, a time-out in the DCE will initiate the actions summarized in Table C-2/X.21. These constraints must be taken into account in the DTE design. The time-outs given in the first column of the table are the minimum time-out values used in the DCE for the appropriate DTE response and are consequently the maximum times available to the DTE for response to the indicated DCE action. The actual DTE response time should be as short as is consistent with the implementing technology and in normal operation should be within the specified time-out. The rare situation where a time-out is exceeded should only occur when there is a failure in the DTE operation.

The time-outs and actions for loop testing are given in Table C-4/X.21.

TABLE C-1/X.21

DTE time-limits

Time-limit	Time-limit number	Started by	Normally terminated by	Preferred action to be taken when time-limit exceeded
3 s	T1	Signalling of *call request* (state 2)	Reception of *proceed-to-select* (state 3)	DTE signals *DTE ready* (state 1)
20 s	T2	Signalling *end-of-selection* or *DTE waiting* (direct call) (state 5)	Reception of *call progress* signals, *DCE provided information, ready for data* or *DCE clear indication* (states 7, 10A, 12 or 19)	DTE signals *DTE clear request* (state 16)
6 s	T3A	Reception of *call progress signals* or *DCE-provided information* (states 7 or 10A). Restarted by additional *call progress signals* or *DCE-provided information* (states 7 or 10A) (see Note 2)	Reception of *ready for data* or *DCE clear indication* (states 12 or 19)	DTE signals *DTE clear request* (state 16)
60 s	T3B (see Note 1)	Reception of applicable *call progress signals* (state 7). Restarted by additional *call progress signals* or *DCE provided information* (states 7 or 10A) (see Note 2)	Reception of *ready for data* or *DCE clear indication* (states 12 or 19)	DTE signals *DTE clear request* (state 16)
2 s	T4A	Signalling of *proceed with call information* (state 9B). Restarted by reception of *call information* (state 10C) (see Note 2)	Reception of *end of call information character* or *DCE clear indication* (state 19) or *DCE waiting* (state 6C)	DTE signals *DTE clear request* (state 16)
6 s	T4B	Signalling of *call accepted* (states 9 and 9C). Restarted by reception of *DCE-provided information* (state 10B) (see Note 2)	Reception of *ready for data* or *DCE clear indication* (states 12 or 19)	DTE signals *DTE clear request* (state 16)
2 s	T5	Change of state to *DTE clear request* (state 16)	Change of state to *DCE ready* (state 21)	DTE regards the DCE as *DCE not ready* and signals *DTE ready* (state 18)
2 s	T6	Change of state to *DTE clear confirmation* (state 20)	Reception of *DCE ready* (state 21)	
0.2 s	T7	Change of state to *ready* (state 1) when *charge information* (state 10B) has been requested	Reception of *incoming call* (state 8)	DTE returns to normal operation and may note absence of *charge information* (state 10B)

Note 1 — T3B shall be used when receiving call progress signal (CPS) 01 and may also be used when receiving other CPS in code group 0.

Note 2 — Restart means time-out set to ZERO and restarted.

TABLE C-2/X.21

DCE time-outs

Time-out	Time-out number	Started by	Normally terminated by	Action to be taken when time-out expires
36 s	T11	DCE signalling of *proceed-to-select* (state 3)	DCE reception of *end-of-selection* signal or in the case of direct call, *DTE waiting* (state 5)	DCE will signal *DCE clear indication* (state 19) or transmit appropriate *call progress* signals (state 7) followed by *DCE clear indication* (state 19)
6 s	T12	DCE signalling of *proceed-to-select* (state 3)	DCE reception of first selection character or in the case of direct call, *DTE waiting* (state 5)	
6 s	T13	DCE reception of *n*th selection character (state 4)	DCE reception of (*n* + 1)th selection character or *end-of-selection* signal	
0.5 s	T14A	DCE signalling of *incoming call* (state 8)	Signalling of *proceed with call information* (state 9B) or *call accepted* (state 9) or *call collision* (state 15)	The DTE is noted as not answering. The DCE will signal *ready* (state 1)
60 s	T14B (see Note 1)			
20 s	T14C (see Note 2)	DCE transmitting *end of call information character.* Restarted by state 25 *DTE-provided information* (see Note 3)	Change of state to *call accepted* (state 9C)	DCE will signal *DCE clear indication* (state 19) or transmit appropriate *call progress* signals followed by *DCE clear indication* (state 19)
0.5 s	T15	Change of state to *DCE clear indication* (state 19)	Change of state to *DTE clear confirmation* (state 20)	DCE will signal *DCE ready* and mark *DTE uncontrolled not ready* (state 24)
100 ms	T16	Change of state to *DCE ready* (state 21)	Change of state to *ready* (state 1)	DCE will mark *DTE uncontrolled not ready* (state 24)

Note 1 — T14B will be provided when manual answering DTEs are allowed. It is not envisaged that manual answering DTEs will use the enhanced sub-addressing procedure (see § 4.1.6.2.2).

Note 2 — T14C applies only to enhanced sub-addressing.

Note 3 — Restart means time-out set to ZERO and restarted.

TABLE C-3/X.21

DTE time-limits for loop testing

Time-limit	Time-limit number	Started by	Normally terminated by	Preferred action to be taken when time-limit expires
2 s	T20A	DTE sending the *loop command* (state L21)	CE signalling *loop confirmation* (state L22)	DTE stops sending *loop command* and enters any state or signals *DTE clear request* (state 16)
6 s	T20B	DTE sending the *loop command* (state L31)	DCE signalling *loop confirmation* (state L32)	
2 s	T21	TE sending *loop 2 clear request* (state L24A or L24B)	DCE signalling *loop 2 clear confirmation* (state L25)	DTE signals *DTE clear request* (state 16)

TABLE C-4/X.21

DCE time-outs for loop testing

Time-out	Time-out number	Started by	Normally terminated by	Action to be taken when time-out expires
Duration is a national option	T22	DCE signalling *receive loop 2 command* (state L26)	DCE reception of *loop released* (state L28) or *test data* (state L23) or *DTE clear confirmation* (state 20)	DCE at the tested side causes the connection to be cleared
Duration is a national option	T23	*Test data* (state L23) being received by the tested DCE	*Loop released* (state L28) or *DTE clear confirmation* (state 20) being received by the tested DCE	DCE at the tested side causes the connection to be cleared

ANNEX D

(to Recommendation X.21)

Formats of selection, call progress, and DCE-provided information signals

The following description uses Backus Naur form as the formalism for syntactic description. A vertical line "|" separates alternatives.

<*> : : = IA 5 character 2/10

<+> : : = IA 5 character 2/11

< , > : : = IA 5 character 2/12

<—> : : = IA 5 character 2/13

< . > : : = IA 5 character 2/14

< / > : : = IA 5 character 2/15

<η> : : = IA 5 characters 3/0-3/9

< : > : : = IA 5 character 3/10

<Facility parameter> : : = See Annex G

<Facility request signal> : : = See Annex G

<Full address signal> : : = See Recommendation X.121

<Abbreviated address signal> : : = National option

<Calling line identification signal> : : = See Annex H

<Called line identification signal> : : = See Annex H

<Indicator> : : = See Annexes F and G

<Facility request code> : : = See Annex G

<Registration parameter> : : = See Annex G

<Call progress signal> : : = See Annex F

<DCE-provided information signal>: : = See Annex H

<DTE provided information signal>: : = See Annex F

The above signals are combined as follows:

<Address signal> : : = <Full address signal> | < . > <Abbreviated address signal>

<Address block> : : = <Address signal> | <Address block> < , > <Address signal>

<Facility registration/cancellation signal> : : = <Facility request code> < / > <Indicator> < / > <Registration parameter> < / > <Address signal>

<Facility registration/cancellation block> : : = <Facility registration/cancellation signal> | <Facility registration/cancellation block> < , > <Facility registration/cancellation signal>

<Facility request signal> : : =	<Facility request code> | <Facility request signal> < / > <Facility parameter>
<Facility request block> : : =	<Facility request signal> | <Facility request block> < , > <Facility request signal>
<Selection sequence> : : =	<Facility request block> <—> <Address block> <+> | <Facility request block> <—> <+> | <Address block> <+> | <Facility registration/cancellation block> <—> <+>
<Call progress signal> : : =	<Call progress code> | <Call progress code> <—> <indicator>
<Call progress block> : : =	<Call progress signal> <+> | <Call progress signal> < , > <Call progress block>
<Calling line identification> : : =	<*> <Calling line identification signal> <+>
<Calling line identification (with DNIC or DCC)> : : =	<**> <Calling line identification signal> <+>
<Called line identification block> : : =	<Called line identification signal> | <Called line identification block> < , > <Called line identification signal>
<Called line identification> : : =	<*> <Called line identification block> <+>
<Called line identification (with DNIC or DCC)> : : =	<**> <Called line identification block> <+>
<Dummy line identification> : : =	<*> <+>
<DCE-provided information block> : : =	<DCE-provided information signal> <+> | <DCE-provided information signal> < , > <DCE-provided information block> (Note)
<DTE-provided information block> : : =	<DTE-provided information signal> <+> | <DTE-provided information signal> < , > <DTE-provided information block>

Note — For *DCE-provided information* signals and blocks other than *calling* or *called line identification* signals and blocks.

ANNEX E

(to Recommendation X.21)

Interworking between DTEs conforming to Recommendations X.21 and X.21 *bis*

It is recognized that interworking between V-Series DTEs connected to a public data network according to Recommendation X.21 *bis* at one end and Recommendation X.21 at the other end should always be possible for DTEs not using half-duplex operation.

Certain Administrations may provide facilities allowing interworking between DTEs operating in accordance with Recommendations X.21 and X.21 *bis* using half-duplex operation by switching circuit C, I and circuit 109, 105 during the data transfer phase in accordance with Figure E-1/X.21.

Those Administrations not providing this facility shall cause the Recommendation X.21 DCE to signal r = 1, i = ON when the Recommendation X.21 *bis* DTE signals circuit 105 OFF. This will permit half-duplex operation for those DTEs that do not require circuit 109 to be OFF before signalling circuit 105 ON.

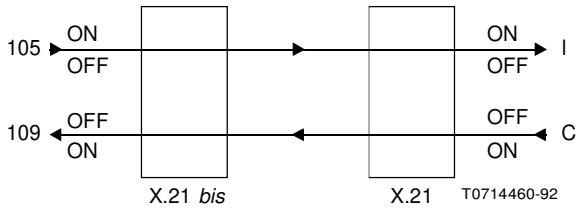


FIGURE E-1/X.21

ANNEX F

(to Recommendation X.21)

Coding of call progress signals and DTE provided information

TABLE F-1/X.21

Code group (see Note 1)	Code	Indicator	Significance	Category
0	00	–	Note 2	Without clearing
	01	–	Terminal called	
	02	–	Redirected call	
	03	–	Connect when free	
	04	–	Private network reached (see Note 3)	
	05	–	Public network reached (see Note 4)	

TABLE F-1/X.21 *(cont.)*

Code group (see Note 1)	Code	Indicator	Significance	Category
2	20 21 22 23	— — — —	No connection Number busy Selection signals procedure error Selection signals transmission error	With clearing due to short-term conditions
3				Unassigned
4 and 5	41 42 43 44 45 45 46 47 48 49 51 52	— — — — — YY-MM-DDhh:mm — — — — — —	Access barred Changed number Not obtainable Out of order Controlled not ready DTE inactive until . . . . Uncontrolled not ready DCE power off Invalid facility request Network fault in local loop Call the information service Incompatible user class of service	With clearing due to long-term conditions
6	61	—	Network congestion	With clearing due to network short-term conditions
7	71 72	— —	Long-term network congestion RPOA out of order	With clearing due to network long-term conditions
8	81 82 83	— — —	Registration/cancellation confirmed Redirection activated Redirection deactivated	With clearing due to network procedure
9	Reserved for national purposes			

Note 1 — From the DTE point of view group 0 means "wait", groups 2 and 6 mean "try again, next try may result in a call set-up", groups 4 and 5, and 7 mean "there is no reason for the DTE to try again because the answer will be the same for a longer period of time". Since group 8 results from a procedure between the DTE and the network, no special action is expected to be taken by the DTE.

Some Administrations may specify by regulation both the delay between and the maximum number of call re-attempts permitted by a DTE in these circumstances (see Recommendation X.96).

Note 2 – Reserved for use in case of point-to-multipoint calls. This coding is used for a remote DTE to indicate that the call can be established with this one (i.e. no clearing due to the remote DTE or to the network), so that the same order of sequence of *call progress* signals and *called lines identification* can be kept.

Note 3 – In the case of sub-addressing, the DTE may see *call progress* signals which have originated in the public network and/or the private network. In such cases the call progress signal *private network* reached shall be used to discriminate between the different origins.

Note 4 – In the case of a DTE being connected to a private network which also provides for access to a public network, the DTE may see *call progress* signals which have originated in the private network and/or the public network. In such cases the call progress signal *public network reached* should be used by the private network in order to discriminate between the different origins.

ANNEX G

(to Recommendation X.21)

Facility request, indicator and parameter coding

(for use as appropriate in *facility request* signals and *facility registration/cancellation* signals)

TABLE G-1/X.21

(see Annex D for formats and Note 1 below)

Facility request code	Facility parameter	Indicator	Registration parameter	Address signal	Facility
0	—	—	—	—	Reserved for future use (may be combined with second character)
1	XX (see Note 2)	—	—	—	Closed user group (other than preferential)
2	—	—	—	—	Unassigned
3	—	—	—	—	Unassigned
45	—	1	YY-MM-DD-hh:mm	—	DTE inactive registration
45	—	2	—	—	DTE inactive cancellation
50	—	—	—	—	Reserved
51	—	—	—	—	Reserved
53	—	—	—	—	Reserved
60	0, 1, 2, 3, 4, 5	—	—	—	Multiple address calling
61	—	—	—	—	Charging information
62	—	—	—	—	Called line identification
63	—	1	—	—	Redirection of call activation
63	—	2	—	—	Redirection of call cancellation
63	—	3	—	—	Redirection of call status
64	—	—	—	—	Reverse charging
65	—	1	—	AS	Direct call registration
65	—	2	—	—	Direct call cancellation
66	—	1	AAS	AS	Abbreviated address registration
66	—	2	AAS	—	Abbreviated address cancellation
68	—	—	—	—	Reserved
7	—	—	—	—	Reserved
8	—	—	—	—	Reserved
9	Reserved for national purposes				

AAS Abbreviated address signal.

AS Address signal.

Note 1 — For an interim period, the 2/15 "/" separator in the formats will not be used in some networks.

Note 2 — XX is an index number, i.e., a key code for closed user group other than the preferential group. The index number shall be used to distinguish between parts or groups within one facility. The index number shall furthermore be chosen from IA5, column 3, positions 3/0-3/9, giving a range of possible numbers from 00 to 99.

G.1 *Multiple address calling*

This facility provides the calling DTE with the capability to request a category of point to multipoint service.

The coding is as follows:

<60> < / > <η> <—> <Address block> <+>

where

η is a numerical character with the following significance:

0 Reserved

1 Reserved

2 Reserved

3 Centralized multipoint

4 Reserved

5 Reserved.

G.2 *Charging information*

This facility enables the calling DTE to request at the *call establishment phase* that charging information for the call be provided at the end of the call.

<61> <—> <address> <+>

G.3 *Redirection of call*

This facility enables the DTE to request the network to route its incoming calls towards another address. The use of this facility is assigned for an agreed contractual period.

Activation of redirection of call — The activation of this facility is coded as follows:

<63> < / > <1> <—> <+>

Cancellation of redirection of call — The cancellation of this facility is coded as follows:

<63> < / > <2> <—> <+>

Status of redirection of call — The DTE has the capability to ask the network for the status of its redirection. The coding is as follows:

<63> < / > <3> <—> <+>

G.4 *Reverse charging*

This facility enables the calling DTE to request that reverse charging be applied for the call.

The coding is as follows:

<64> <—> <address> <+>

G.5 *Direct call on a per call basis*

This facility enables the DTE to designate the address to which all calls will be established when the *selection signals* phase (state 4) is bypassed during call establishment.

Registration — The coding of this registration of the address is as follows:

<65> < / > <1> < / > <0> < / > <Address> <—> <+>

where

<Address> is the designated address.

The DTE is able to amend the designated address by performing a cancellation procedure followed by the registration procedure.

The coding of the cancellation procedure is as follows:

<65> < / > <2> <—> <+>

G.6 *Abbreviated address calling*

This facility enables the DTE to define a full address by an abbreviated address.

The registration coding of an abbreviated address is as follows:

<66> < / > <1> < / > <xy> < / > <Address> <—> <+>

where

<xy> = abbreviated address corresponding to the full address,

<address> = full address.

Cancellation — The coding of the cancellation of an abbreviated address is as follows:

<66> < / > <2> < / > <xy> <—> <+>

where

<xy> is the abbreviated address.

G.7 *Closed user group selection*

This facility provides the calling DTE with the possibility to communicate within more than one closed user group.

The coding is as follows:

<1> < / > <xx> <—> <Address block> <+>

where

<xx> is the closed user group index number, i.e. the key code for the closed user group other than the preferential group. The index number shall be used to distinguish between parts or groups within one facility. The index numbers are numerical characters chosen from column 3 of IA5.

G.8 *DTE inactive registration/cancellation*

This facility enables the DTE to inform the network about a period of time during which the DTE is unable to accept incoming calls for circuit-switched service.

DTE inactive registration — The activation of this facility is as follows:

<45> < / > <1> < / > <YY-MM-DD-hh:mm> <—> <+>

where

YY: Year, MM: Month, DD: Day, hh: Hour, mm: Minute

IA5 characters are used for “YY”, “MM”, “DD”, “hh”, “mm”, “—”, and “:”.

DTE inactive cancellation is as follows:

<45> < / > <2> <—> <+>

ANNEX H

(to Recommendation X.21)

Information content of DCE-provided information

H.0 *General*

Except for the *calling* and *called line identification*, the general format for *DCE-provided information*, as defined in § 4.6.3 should apply.

The coding of numerical character used to distinguish between different types of *DCE-provided information* is indicated in Table H-1/X.21.

H.1 *Information content of calling and called line identification*

Two formats are defined:

i) *Calling* and *called line identification* consist of the international data number as defined in Recommendation X.121 preceded by *two* prefixes 2/10 (" ** "). In the case where the originating network does not provide *calling line identification*, only the data network identification code (DNIC) part of the International Data Number preceeded by two prefixes 2/10 (" ** ") may be sent in place of the *dummy line identification*.

ii) *Calling* and *called line identification* consist of the national number (NN) or network terminal number (NTN) preceded by the prefix 2/10 (" * ").

H.2 *General coding of the DCE-provided information*

TABLE H-1/X.21

Coding of DCE provided information

Identifier	Meaning	Remarks
0	Reserved	
1 2 3	Charging information Charging information Charging information	See details in § H.3
4	Sub-addressing	See details in § H.4
5	Date and time indication	See details in § H.5
6	Characteristics of the call	See details in § H.6
7	Type of call indication	See details in § H.7
81	Closed user group indication	See details in § H.8
82	Closed user group outgoing access indication	See details in § H.8.1
9	Reserved	

H.3 *Information content of charging information*

The *charging information* will inform the subscriber of either the monetary charges for a call, the duration of the call, or the number of units used during the call.

When *charging information* is given in monetary charges for the call, n = 1 and the information shall consist of x number of integer digits optionally followed by a colon and two digits representing the fraction. The format applied is as follows:

< / > <1> < / > <X...>

< / > <1> < / > <X...> <:> <yy>

When the *charging information* is presented as the duration of a call, n = 2 and the information shall consist of x number of integer digits representing seconds, the format applied is as follows:

< / > <2> < / > <X...>

When the *charging information* is presented as the number of units used, n = 3, and the information shall consist of x number of integer digits representing the units, the format applied is as follows:

< / > <3> < / > <X...>

H.4 *Sub-addressing information*

The *sub-addressing information* will inform the called DTE of the sub-address sent by the calling DTE.

The format of the sub-addressing information is as follows:

< / > <4> < / > <X...>

The format of the dummy information is as follows:

< / > <4> < / >

H.5 *Date and time indication*

The *date and time indication* will inform the subscriber of the date and time the call is established. The format for the *date and time indication* is as follows:

< / > <5> < / > <YY-MM-DD-hh:mm>

where

YY: Year, MM: Month, DD: day, hh: hour and mm: minute

IA5 characters are used for “YY”, “MM”, “DD”, “hh”, “mm”, “—” and “:”.

H.6 *Characteristics of the call*

The *characteristics of the call* will inform the called DTE of the different facilities that have been requested by the calling DTE.

The format of the characteristic of the call is as follows:

< / > <6> < / > <XY>

where

X and Y are two numerical characters.

Table H-2/X.21 indicates the allocation of values of these two characters to facilities.

TABLE H-2/X.21

00	Reserved
01	Reverse charging
02	Reserved
02	Reserved

H.7 *Type of call indication*

The *type of call indication* will inform the called DTE of the configuration of the incoming call.

The format of the *type of call indication* is as follows:

< / > <7> < / > <XY>

where

X and Y are two numerical characters.

Table H-3/X.21 indicates the allocation of values of those two characters to different configurations of calls.

TABLE H-3/X.21

00	Reserved
01	Reserved
02	Reserved
03	Centralized multipoint
04	Reserved

H.8 *Closed user group indication*

The *closed user group indication* will inform the called DTE to which closed user group the incoming call belongs.

The format of the *closed user group indication* is as follows:

< / > <81> < / > <xxxx...x>

where

<x> : closed user group index number.

H.8.1 *Closed user group outgoing access indication*

The *closed user group outgoing access indication* will inform the called DTE from a DTE belonging to a closed user group with outgoing access facility. If the called DTE belongs to the same closed user group, the local closed user group index number will be indicated. In other cases, no indication will be given.

The format of the *closed user group outgoing access indication* is as follows:

< / > <82> < / > <xx . . . x>

where

<x> is the closed user group index number.

ANNEX I

(of Recommendation X.21)

Reference and transition tables

TABLE I-1/X.21

Cross reference of interchange circuit signals, states and reference section

T,	C	R,	I	State No.	Reference in the Recommendation (§)
1,	OFF	1,	OFF	1	2.5.3.1
1,	OFF	0,	OFF	18	2.5.3.3
0,	OFF	1,	OFF	21, 24	2.5.3.6
0,	OFF	0,	OFF	17, 20, 22	2.5.3.4
1,	OFF	BEL,	OFF	8	4.1.5
01,	OFF	1,	OFF	14	2.5.3.2
01,	OFF	0,	OFF	23	2.5.3.5
X,	X	01,	OFF	L27	7.3.2.8
0011,	OFF	D,	ON	L21	7.3.2.1
011,	OFF	0011,	OFF	L22	7.3.2.2
*,	OFF	BEL,	OFF	9B	4.1.6.2.2.1
*,	OFF	IA5,	OFF	10C	4.1.6.2.2.2
IA5,	OFF	SYN,	OFF	25	4.1.6.2.2.4
*,	OFF	SYN,	OFF	6C	4.1.6.2.2.3
1,	OFF	D,	ON	13R	5.2.2, 5.3.1.2, 5.3.2.2
0,	OFF	1,	ON	16	6.1
0,	OFF	0,	ON	16	6.1
0,	FF	D,	ON	16	6.1
1,	ON	1,	OFF	11	4.1.10
1,	ON	0,	OFF	19	6.2
0,	ON	1,	OFF	2	4.1.1
0,	ON	0,	OFF	19	6.2
1,	ON	BEL,	OFF	9	4.1.6
1,	ON	+,	OFF	5	4.1.4
1,	ON	SYN,	OFF	6A, 6B, 9C	4.1.7
1,	ON	IA5, [a]	OFF	7, 10A, 10B	4.1.8, 4.1.9
0,	ON	BEL,	OFF	15	4.3
0,	ON	+,	OFF	3	4.1.2
IA5,	ON	+,	OFF	4	4.1.3
D,	ON	1,	OFF	13S	5.2.1, 5.3.1.1, 5.3.2.1
D,	ON	0,	OFF	19	6.2, Fig. A-3/X.21
1,	ON	1,	ON	12	4.1.1.1
D,	ON	D,	ON	13	5.1, 5.2.3, 5.3.3

a) An IA5 character other than BEL.

TABLE I-2/X.21

Recognized transitions between states

(other transitions are not considered valid)

State No.	Name	T,	C	R,	I	DTE transition to state No.	DCE transition to state No.	Time-out transition		
								To state No.	Time-out No.	Terminated by state No.
1	Ready	1,	OFF	1,	OFF	2, 13S, 14, 24	8, 13R, 18	1	T7	8
2	Call request	0,	ON	1,	OFF	—	3, 15	1	T1	3
3	Proceed-to-select	0,	ON	+,	OFF	4, 5	—	19	T11, T12	4, 5
4	Selection signal	IA5,	ON	+,	OFF	5	—	19	T13	(EOS)
5	DTE waiting	1,	ON	+,	OFF	—	6A, 11, 12	6	T2	7, 10A, 12, 19
6A	DCE waiting	1,	ON	SYN,	OFF	—	7, 10A, 11, 12	—	—	—
6B	DCE waiting	1,	ON	SYN,	OFF	—	10B, 11, 12	—	—	—
6C	DCE waiting	*,	OFF	SYN,	OFF	6D, 9C, 25	—	19	T14C	9C, 25
6D	DCE waiting	1,	OFF	SYN,	OFF	9C	—	—	—	—
7	Call progress signal	1,	ON	IA5,	OFF	—	6A, 10A, 11, 12	16	T3A, T3B	7, 10A, 12, 19
8	Incoming call	1,	OFF	BEL,	OFF	15, 9, 9B	—	1	T14A, T14B	9, 15
9	Call accepted	1,	ON	BEL,	OFF	—	6B, 11, 12	16	T4B	10B, 12, 19
9B	Proceed with call information	*,	OFF	BEL,	OFF	—	10C	16	T4A	10B, 10C, 19
9C	Call accepted	1,	ON	SYN,	OFF	—	6B, 11, 12	16	T4A	10B, 12, 19
10A	DCE-provided information	1,	ON	IA5,	OFF	—	6A, 11, 12	—	—	—
10B	DCE-provided information	1,	ON	IA5,	OFF	—	6B, 11, 12	—	—	—
10C	Call information	*,	OFF	IA5,	OFF	—	6C	19	T4A	9C, 25
11	Connection in progress	1,	ON	1,	OFF	—	12	—	—	—
12	Ready for data	1,	ON	1,	ON	13	13	—	—	—
13	Data transfer	D,	ON	D,	ON	13R	13S, DCE not ready	—	—	—
13R	Receive data	1,	OFF	D,	ON	13	1	—	—	—
13S	Send data	D,	ON	1,	OFF	1	13	—	—	—

EOS End of selection

TABLE I-2/X.21 *(cont.)*

State No.	Name	T,	C	R,	I	DTE transition to state No.	DCE transition to state No.	Time-out transition		
								To state No.	Time-out No.	Terminated by state No.
14	DTE controlled not ready, DCE ready	01,	OFF	1,	OFF	1, 24	23	—	—	—
15	Call collision	0,	ON	BEL,	OFF	—	3	—	—	—
16	DTE clear request	0, (see Note)	OFF	X,	X	—	17	18	T5	21
17	DCE clear confirmation	0,	OFF	0,	OFF	—	21	—	—	—
18	DTE ready, DCE not ready	1,	OFF	0,	OFF	22	1	—	—	—
—	DCE not ready	D,	ON	0,	OFF	—	1, 13, 13S	—	—	—
19	DCE clear indication	X (see Note)	X	0,	OFF	20	—	24	T15	20
20	DTE clear confirmation	0,	OFF	0,	OFF	—	21	18	T6	21
21	DCE ready	0,	OFF	1,	OFF	1	—	24	T16	1
22	DTE uncontrolled not ready, DCE not ready	0,	OFF	0,	OFF	18	24	—	—	—
23	DTE controlled not ready, DCE not ready	01,	OFF	0,	OFF	18, 22	14	—	—	—
24	DTE uncontrolled not ready, DCE ready	0,	OFF	1,	OFF	1	22	—	—	—
—	DCE controlled not ready	X,	X	01,	OFF	—	—	—	—	—
L21	Send loop 2 command	0011,	OFF	D,	ON	—	L22	Any, 16	T20A	L22
L22	Loop 2 confirmation	0011,	OFF	0011,	OFF	L23, L24B	—	—	—	—

TABLE I-2/X.21 *(end)*

State No.	Name	T,	C	R,	I	DTE transition to state No.	DCE transition to state No.	Time-out transition		
								To state No.	Time-out No.	Terminated by state No.
L23	Test data	D,	ON	D,	ON	L24A	—	16	T23	L28
L24A	Loop 2 clear request	≠ 0011,	OFF	D,	ON	—	L25	16	T21	L25
L24B	Loop 2 clear request	≠ 0011,	OFF	0011,	OFF	—	L25	16	T21	L25
L25	Loop 2 clear confirmation	≠ 0011,	OFF	≠ 0011,	OFF	Any	—	—	—	—
L26	Receive loop 2 command	X	X	0011,	OFF	L26A	L27, L29	16	T22	L23, L28, 20
L26A	Loop 2 consent	X	OFF	0011,	OFF	—	L27, L29	—	—	—
L27	DCE controlled not ready	X,	X	0101,	OFF	—	L28	—	—	—
L28	Loop 2 released	X,	X	≠ 0101,	OFF	—	Any	—	—	—
L29	DCE not ready	X,	X	0,	OFF	20	—	—	—	—
L31	Send loop 3 command	00001111,	OFF	X,	X	—	L32	Any	T20B	L32
L32	Loop 3 confirmation	00001111,	OFF	00001111,	OFF	L33, L34B	—	—	—	—
L33	Test data	D,	ON	D,	ON	L34A	—	—	—	—
L34A	Loop 3 clear request	≠ 00001111,	OFF	D,	ON	—	L35	—	—	—
L34B	Loop 3 clear request	≠ 00001111,	OFF	00001111,	OFF	—	L35	—	—	—
L35	Loop 3 clear confirmation	≠ 00001111,	OFF	≠ 00001111,	OFF	Any	—	—	—	—
Any state (see Note)		X,	X	X,	X	16	19	—	—	—

Note — DCE clear indication (state 19) or *DTE clear request* (state 16) may be entered from any state except *ready* (state 1).

ANNEX J

(to Recommendation X.21)

Alphabetical list of abbreviations used in this Recommendation

AAS	Abbreviated address signal
AS	Address signal
CPS	Call progress signal
DCC	Data country code
DCE	Data circuit-terminating equipment
DNIC	Data network identification code
DSE	Data switching exchange
DTE	Data terminal equipment
EOS	End of selection
IA5	International Alphabet No. 5
NN	Nationall number
NTN	Network terminal number