THE INTERNATIONAL TELEGRAPH AND TELEPHONE CONSULTATIVE COMMITTEE

CCITT

SIXTH PLENARY ASSEMBLY

GENEVA, 27 SEPTEMBER - 8 OCTOBER 1976

ORANGE BOOK

VOLUME VIII.2

PUBLIC DATA NETWORKS

Published by the
INTERNATIONAL TELECOMMUNICATION UNION
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ISBN 92-61-00461-X

CONTENTS OF THE CCITT BOOK
APPLICABLE AFTER THE SIXTH PLENARY ASSEMBLY (1976)

ORANGE BOOK

Each volume also contains, for its field and where appropriate:

— definitions of specific terms used;
— supplements for information and documentary purposes.

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Part I – Supplement to definitions in Series 52 and 53

Part II – Series X Recommendations

Data transmission over public data networks

* This Recommendation has been subject to revision by Study Group VII in April, 1977 and application of the accelerated approval procedure (Resolution No. 2, VIth Plenary Assembly, Geneva, 1976) has been requested. If approved by Member Administrations, an updated version of the Recommendation will be published under separate cover.

Part III – Questions on public data networks entrusted to Study Group VII for the period 1977-1980

PRELIMINARY NOTES

1. For principles governing the collaboration between the International Telecommunication Union and other international organizations in the study of data transmission, reference should be made to Recommendation A.20, Volume I.

2. In this Volume, the expression "Administration" is used for shortness to indicate both a telecommunication Administration and a recognized private operating agency.

PART I

SUPPLEMENT TO DEFINITIONS IN SERIES 52 AND 53

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SUPPLEMENT TO DEFINITIONS IN SERIES 52 AND 53

Note 1. – This Supplement contains only new and amended definitions of terms in Series 52 and 53 which were elaborated by Study Group VII during the period 1973-1976 and approved by the VIth Plenary Assembly of the CCITT.

The *Green Book,* Volume VIII should be referred to for the definitions unchanged during the period 1973-1976.

Note 2. – The amended definitions bear the same number as the existing ones published in the *Green Book,* Volume VIII and are identified by the number symbol (#).

All other definitions published in this supplement are those newly added after the VIth Plenary Assembly.

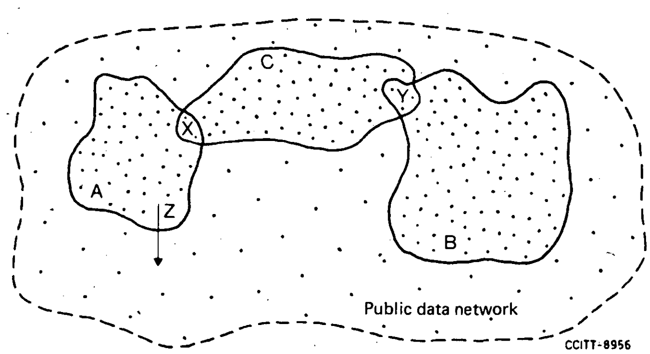
Note 3. – The existing Definitions 52.45 "Circuit-switched connection" and 52.46 "Packet-mode operation/Packet switching" are of special concern in data transmission and they are therefore listed in Series 53, as well as in Series 52, as 53.515 (52.45) and 53.52 (52.46) respectively.

SERIES 52. DEFINITIONS INVOLVING BOTH TELEGRAPHY AND DATA TRANSMISSION

No.	Terms
# 52.34	**Error correcting system** A system employing an error detecting code and so arranged that some or all of the signals detected as being in error are automatically corrected at the receiving terminal before delivery to the data sink or to the telegraph receiver. *Note.* – In a packet switched data service the error correcting system might result in the retransmission of at least one or more complete packets should an error be detected.
# 52.41	**Selection signals** The sequence of characters which indicates all the information to establish a call. The selection signals consist of two elements: the facility request and the address. The facility request always precedes the address. In some cases one of the two elements may be omitted. There may be several facility requests and several addresses in the selection signals.
# 52.43	**address** The part of the selection signals which indicates the destination of a call.
52.431	**address separator** The character which separates the different addresses in the selection signals.
52.432	**facility request** The part of the selection signals which indicates the required facility.
52.433	**facility request separator** The character which separates the different facility requests in the selection signals.
52.434	**end of selection** The character which indicates the end of the selection signals.
# 52.44	**user service or facility** A user service or facility available on demand to a user and provided as part of a public data network transmission service. Some facilities may be available on a per call basis and, others may be assigned for an agreed period at the request of the user. On certain assigned facilities per call options may also be available.
52.461 53.525	**packet-mode terminal** A data terminal equipment which can control and format packets and transmit and receive packets.
52.462 (53.53)	**packet disassembly** A user facility which enables packets destined for delivery to a non-packet mode terminal to be delivered in the appropriate form (for example) in character form at the applicable rate.

No.	Terms
# 52.47	**user class of service** A category of data transmission service provided in a public data network in which the data signalling rate, the terminal operating mode and the code structure (if any) are standardized.
52.471	**interworking between user classes of services** The means whereby a data terminal equipment belonging to one user class of service may communicate with a data terminal equipment belonging to a different user class of service.
# 52.48	**closed user group** A facility assigned to specified users of a public data network transmission service(s), which permits such users to communicate with each other but precludes communication with all other users of the service or services. *Note 1.* – A user (DTE) may belong to more than one closed user group. *Note 2.* – See the following diagram.
52.481	**closed user group with outgoing access** A facility assigned to a user in a closed user group to enable that user to communicate with other users of a public data network transmission service where appropriate and/or to users having a data terminal equipment connected to any other public switched network to which interworking facilities are available. *Note.* – See the following diagram.

Diagram associated with the definitions of closed user group (Definition 52.48) and closed user group with outgoing access (Definition 52.481)



Notes

1. A, B and C are closed user groups
2. Terminal X belongs to closed user groups A and C
3. Terminal Y belongs to closed user groups B and C
4. Terminal Z in closed user group A has outgoing access

No.	Terms

52.49 **direct call**

A facility which avoids the use of address selection signals. The network interprets the call request signal as an instruction to establish a connection with a single destination address previously designated by the user.

Note. – This facility may permit faster call set-up than usual. No special priority is implied over other users of the network in establishing a connection. The designated address is assigned for an agreed period.

52.605 **time out**

A network parameter related to an enforced event designed to occur at the conclusion of a predetermined elapsed time.

Note. – A time out condition can be cancelled by the receipt of an appropriate time out cancellation signal.

52.69 **power off conditon**

A condition in which power is not available within a unit of equipment.

52.695 **manual calling**

A facility which permits the entry of selection signals from a calling terminal installation at an undefined character rate. The characters may be generated at the DTE or the DCE.

52.70 **automatic calling**

A facility by which selection signals must be entered contiguously at the full character rate. The address characters will be generated in the DTE.

Note. – A limit may be imposed by the Administration to prevent more than a permitted number of ineffective call attempts to the same address within a specified period.

52.705 **manual answering**

A facility by which a call is established only if the called user signals his readiness to receive it by means of a manual operation.

52.71 **automatic answering**

A facility by which the called DTE automatically responds to the calling signal and the call may be established whether or not the called DTE is attended.

52.715 **information security**

The protection of information against unauthorized disclosure, transfer, modifications, or destruction, whether accidental or intentional.

52.72 **data security**

The protection of data against unauthorized disclosure, transfer, modifications, or destruction, whether accidental or intentional.

52.725 **telecommunication security**

The protection of telecommunication signals so that their information content can be extracted only by those authorized and equipped to do so.

No.	Terms
52.73	**exposure**
	The vulnerability multiplied by the probability of occurrence within a given time.
52.735	**grade of service**
	The grade of service is a measure of the traffic handling capability of the network from the point of view of sufficiency of equipment and trunking throughout a multiplicity of nodes.
	Note 1. – The criteria for specifying grade of service for circuit switched systems are described in the Series E.500 Recommendations.
	Note 2. – The criteria for specifying grade of service for packet switching networks remains to be defined and is the subject of further study under Question 5/VII.
52.74	**lost call**
	A request for a connection which is rejected due to network congestion.

SERIES 53. DEFINITIONS OF SPECIAL CONCERN IN DATA TRANSMISSION

No.	Terms
53.014	**octet** A group of eight binary digits operated upon as an entity.
53.015	**octet alignment** The process of alignment to an 8-bit sequence.
53.016	**octet timing signal** A signal that identifies the first bit in each octet in a contiguous sequence of serially transmitted octets.
53.017	**permanently locked envelope** Used when envelopes are always separated by a number of bits corresponding to an integer number of envelopes.
53.103	**homogeneous multiplex** A multiplex structure in which all the information bearer channels are at the same data signalling rate.
53.104	**heterogeneous multiplex** A multiplex structure in which all the information bearer channels are not at the same data signalling rate.
53.105	**adaptive channel allocation** A method of multiplexing where the information capacities of channels are not predetermined but are assigned on demand.
53.175	**status channel** A channel indicating whether a group of bits is for data or control use.
53.231	**framing bit** A binary digit which is used for frame synchronization.
53.232	**synchronization bit** A binary digit which is used for character synchronization.
53.362	**data signalling rate transparency** A network parameter which enables the transfer of data between one user and another without placing any restriction, within certain limits, on the data signalling rate used.

No. Terms

53.365 **multiplex aggregate bit rate**

That bit rate in a time division multiplexer which is equal to the sum of the input channel data signalling rates available to the user plus the rate of the overhead bits required. That is:

$$\text{Aggregate bit rate} = \left(\sum_{i}^{m} n_i + H\right) R$$

where: n_i = the number of bits per multiplex frame associated with the i^{th} input channel.

m = the maximum number of input channels to the multiplexer (including non-working and/or equipped channels)

H = the number of overhead bits per multiplex frame of the output channel.

R = the repetition rate of the frame of the output channel.

Note. – The number of bits in the multiplex frame is assumed to be constant.

53.46 **data switching exchange**

The set of equipments installed at a single location to switch data traffic.

Note. – data switching exchange may provide only circuit switching, only packet switching or both.

53.48 **public data network**

A network established and operated by an Administration for the specific purpose of providing data transmission services to the public.

53.485 **public data transmission service**

A data transmission service established and operated by an Administration and provided by means of a public data network. Circuit switched, packet switched and leased circuit data transmission services are feasible.

53.49 **circuit switched data transmission service**

A service requiring the establishment of a circuit switched data connection before data can be transferred between data terminal equipments.

53.495 **packet switched data transmission service**

A service involving the transmission and, if necessary, the assembly and disassembly of data in the form of packets.

53.50 **leased circuit data transmission service**

A service whereby a circuit (or circuits) of the public data network is (are) made available to a user or group of users for his (or their) exclusive use.

Note. – Where only two data circuit-terminating equipments are involved it is known as a point-to-point facility and where more than two are involved it is known as a multipoint facility.

No.	Terms
53.505	**data circuit** **data channel (Am)** A means of two-way data transmission between two points comprising associated "transmit" and "receive" channels. *Note 1.* – Between data switching exchanges, the data circuit may or may not include data circuit-terminating equipment depending on the type of interface used at the data switching exchange. *Note 2.* – Between the data terminal installation and a data switching exchange and/or concentrator, the data circuit includes the data circuit-terminating equipment at the data terminal installation end and may also include equipment similar to a data circuit-terminating equipment at the data exchange or concentrator location. *Note 3.* – Either physical or virtual data circuits may be established.
53.51	**data connection** The interconnection of a number of data circuits on a tandem basis by means of switching equipment to enable data transmission to take place between data terminal equipments. *Note 1.* – Where one or more of the data circuits which are interconnected is a virtual data circuit the overall connection is known as a virtual data connection. *Note 2.* – The overall connection includes the data circuit terminating equipment at the respective data terminal installation locations.
53.515 (52.45)	**circuit-switched connection** As defined under 52.45 in Volume VIII of the *Green Book*.
53.52 (52.46)	**packet-mode operation** **packet switching** As defined under Definition 52.46 in Volume VIII of the *Green Book*.
53.525 (52.461)	**packet-mode terminal** As defined above under Definition 52.461 in the supplement to Series 52 definitions.
53.53 (52.462)	**packet disassembly** As defined above under Definition 52.462 in the supplement to Series 52 definitions.
53.535	**synchronous data networks** A data network which uses a method of synchronization between data circuit-terminating equipment (DCE) and the data switching exchange (DSE) and between DSEs, the data signalling rates being controlled by timing equipment within the network.
53.54	**virtual call** A user facility in which a call set-up procedure and a call clearing procedure will determine a period of communication between two DTEs in which user's data will be transferred in the network in the packet mode of operation. All the user's data is delivered from the network in the same order in which it is received by the network. *Note 1.* – This facility requires end-to-end transfer control of packets within the network.

No. Terms

Note 2. – Data may be delivered to the network before the call set-up has been completed but it will not be delivered to the destination address if the call set-up attempt is unsuccessful.

Note 3. – Multi-access DTEs may have several virtual calls in operation at the same time.

53.545 **permanent virtual circuit**

A user facility in which a permanent association exists between two DTEs which is identical to the data transfer phase of a virtual call. No call set-up or clearing procedure is possible or necessary.

53.55 **packet format**

A set of rules governing the structure of data control information in a packet. The packet format defines the size and content of the various fields which make up a packet.

53.555 **packet length selection**

A user facility where a DTE may select a certain maximum user data field length out of a defined set.

53.56 **delivery confirmation**

A user facility which will provide information to the sending DTE that a given packet has been delivered to the nominated address(es).

53.565 **data phase**

That phase of a data call during which data signals may be transferred between DTEs which are interconnected via the network.

53.57 **network control phase**

That phase of a data call during which network control signals are exchanged between a DTE and the network for the purpose of call establishment, call disconnection or for control signalling during the data phase.

53.575 **call control procedure**

The entire set of interactive signals necessary to establish, maintain and release a data call.

53.58 **call control character**

A character of an alphabet, or a part of it, which is used for call control. It may be used in conjunction with defined signal conditions on other interchange circuits.

53.585 **proceed-to-select**

An event in the call establishment phase of a data call which confirms the reception of a "call request" signal and advises the calling DTE to proceed with the transmission of the "selection signals".

53.59 **automatic sequential connection**

A facility provided by a public data service to automatically connect in a predetermined sequence, the DTEs at each of a set of specified addresses to a single DTE at a specified address.

No.	Terms

53.595 **multiple lines at the same address**

The facility of permitting a user to receive calls to a single address on more than one access circuit.

53.60 **redirection of calls**

A facility which permits a called user to request the network to transfer a call to another nominated address. This may be for:

i) all calls following the request;

ii) individual calls.

53.605 **priority facility**

A facility which gives a user preference over the other users. Priority may be given for instance to handling of the call, packet transfers, and other services provided by the network.

53.61 **information (inquiry) facility**

A facility whereby a user, by sending a predetermined address from the terminal installation, may gain access to general information regarding data communication services.

Note. – Access may be provided, for example, for directory inquiry, charging inquiry, fault reporting.

53.615 **call-back when busy terminal installation becomes free (automatic recall)**

A facility which enables the originator of a call attempt to a busy terminal installation to request the network to establish the call when the busy terminal installation becomes free.

53.62 **called line identification facility**

A facility provided by the network which enables a calling terminal to be notified by the network of the address to which the call has been connected.

53.625 **calling line identification facility**

A facility provided by the network which enables a called terminal to be notified by the network of the address from which the call has originated.

53.63 **flow control**

The procedure for controlling the rate of transfer of packets between two nominated points in a data network for example between a DTE and a data switching exchange.

53.635 **transmit flow control**

A transmission procedure which controls the rate at which data may be transmitted from one terminal point so that it is equal to the rate at which it can be received by the remote terminal point.

Note 1. – This procedure may apply between a DTE and the adjacent data switching exchange or between two DTEs. In the latter case the transmission rate may be controlled due to network or remote DTE requirements.

Note 2. – This procedure would operate independently in the two directions of data transfer thus permitting different data transfer rates in both directions of transmission.

No.	Terms

53.64 **data collection**

A facility for gathering small quantities of data from a nominated group of addresses, assembling them within the network into a single message for delivery to another nominated address.

53.645 **calls barred**

A facility which permits a terminal installation to make outgoing or to receive incoming calls only (but not both).

53.65 **ready**

A steady-state condition at the DTE/DCE interface which denotes that the DCE is ready to accept a call request signal or that the DTE is ready to accept an incoming call, respectively.

53.655 **not ready**

A steady-state condition at the DTE/DCE interface which denotes that the DCE is not ready to accept a call request signal or that the DTE is not ready to accept an incoming call, respectively.

Note. – The DTE may be controlled not ready or uncontrolled not ready.

53.66 **DTE waiting**

A call control signal condition at the DCE/DTE interface which indicates that the DTE is waiting for a call control signal from the DCE.

53.665 **DCE waiting**

A call control signal at the DCE/DTE interface which indicates that the DCE is waiting for another event in the call establishment procedure.

53.67 **call accepted**

A call control signal sent by the called DTE to indicate that it accepts the incoming call.

53.675 **call not accepted**

A call control signal sent by the called DTE to indicate that it does not accept the incoming call.

53.68 **call progress signal**

A call control signal transmitted by the DCE to the calling DTE to inform it about the progression of a call (positive call progress signal) or the reason why the connection could not be established (negative call progress signal).

53.685 **calling line identification signal**

A sequence of characters transmitted to the called DTE to permit identification of the calling line.

53.69 **called line identification signal**

A sequence of characters transmitted to the calling DTE to permit identification of the called line.

No.	Terms
53.695	**connection in progress** A call control signal at the DCE/DTE interface which indicates to the DTE that the establishment of the data connection is in progress and that the ready for data signal will follow.
53.70	**ready for data** A call control signal transmitted by the DCE to the DTE to indicate that the data connection is available for data transfer between both DTEs.
53.705	**clearing** A sequence of events to disconnect a call and return to the ready state.
53.71	**unsuccessful call** A call attempt which does not result in the establishment of a data connection.
53.715	**request data transfer** A call control signal sent by the DTE to the DCE to request the establishment of the data connection in leased circuit service.
53.72	**data transfer requested** A call control signal transmitted by the DCE to the DTE in leased circuit service to indicate that the distant DTE is wishing to exchange data.
53.725	**DTE clear request** A call control signal sent by the DTE to initiate clearing.
53.73	**DCE clear indication** A call control signal transmitted by the DCE to indicate that it is clearing the call.
53.735	**clear confirmation** A call control signal to acknowledge reception of the DTE clear request by the DCE or the reception of the DCE clear indication by the DTE.
53.74	**housekeeping information** Signals which are added to a digital signal to enable the equipment associated with that digital signal to function correctly, and possibly to provide ancillary facilities.
53.745	**transmission code violation** Digits which are not in the transmission code and which, when used in small quantities, can give some more information without significantly affecting the spectrum of signal.
53.75	**stuffing character** A character used on isochronous transmission links to take account of differences in clock frequencies.

No.	Terms

53.755 **idle character**

A control character that is sent when there is no information to be sent.

53.76 **reception congestion**

A network congestion condition occurring at a switching centre.

53.765 **symmetrical channel**

A network parameter used to indicate that the send and receive directions of transmission have the same data signalling rate.

53.77 **aligner**

A device used to align the elements of one data structure to particular elements of another structure and, in some cases, also to change between the two structures.

53.775 **reframing time** (frame alignment recovery time)

(Same as Definition No. 4005 – *frame alignment recovery time*, in Recommendation G.702.)

The time that elapses between a valid frame alignment signal being available at the receive terminal equipment and frame alignment being established.

Note. – The frame alignment recovery time includes the time required for replicated verification of the validity of the frame alignment signal.

53.78 **frame** (multiplex structure)

A set of consecutive digit time slots in which the position of each digit time slot can be identified by reference to a frame alignment signal.

The frame alignment signal does not necessarily occur, in whole or in part, in each frame.

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PART II

Series X Recommendations

DATA TRANSMISSION OVER PUBLIC DATA NETWORKS

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SECTION 1

SERVICES AND FACILITIES

Recommendation X.1

INTERNATIONAL USER CLASSES OF SERVICE IN PUBLIC DATA NETWORKS

(Geneva, 1972, amended at Geneva, 1976)

The establishment in various countries of public networks for data transmission creates a need to standardize user data signalling rates, terminal operating modes, address selection and call progress signals to facilitate international interworking.

Recommendations in Series V already standardize data signalling rates for synchronous data transmission in the general telephone network and modulation rates for modems. These rates are, however, not necessarily the most suitable for public networks devoted entirely to data transmission and this leads to the requirement for an additional Recommendation.

The CCITT,

bearing in mind,

a) the desirability of providing sufficient data signalling rates to meet users' needs;

b) the requirement to optimize terminal, transmission and switching costs to provide an overall economic service to the user;

c) the particular operating modes of users' data terminals;

d) the users' need to transfer information consisting of any bit sequence and of any number of bits up to a certain amount;

e) the interaction between users' requirements, technical limitations and tariff structure,

unanimously declares the view

that users' data transmission requirements via public data networks may best be served by defined user classes of service.

These user classes of service are shown in Table 1/X.1; they cater for three particular types of users' data terminals, namely for:

- terminals operating in the start-stop mode (as typified by teleprinters used for message transfer in classes 1 and 2,
- terminals operating in a synchronous mode in classes 3 to 7,
- terminals operating in the packet mode in classes 8 to 11.

TABLE 1/X.1 – **User classes of service for public data networks**

a) Terminal operating mode – start-stop (See Notes 1-7)

User class of service	Data signalling rate and code structure	Address selection and call progress signals
1	300 bit/s, 11* units/character, start-stop	300 bit/s, International Alphabet No. 5 (11 units/character)
2	50-200 bit/s, 7.5-11* units/character, start-stop	200 bit/s, International Alphabet No. 5 (11 units/character)

* Usage in accordance with Recommendation X.4.

b) Terminal operating mode – synchronous (See Note 7)

User class of service	Data signalling rate	Address selection and call progress signals
3	600 bit/s	600 bit/s, International Alphabet No. 5
4	2400 bit/s	2400 bit/s, International Alphabet No. 5
5	4800 bit/s	4800 bit/s, International Alphabet No. 5
6	9600 bit/s	9600 bit/s, International Alphabet No. 5
7	48000 bit/s	48000 bit/s, International Alphabet No. 5

c) Terminal operating mode – packet (See Note 7)

User class of service	Data signalling rate	Address selection and call progress signals
8	2400 bit/s	2400 bit/s } See Recommendation X.25 for user packet format
9	4800 bit/s	4800 bit/s
10	9600 bit/s	9600 bit/s
11	48000 bit/s	48000 bit/s

Note 1. – There is no user class of service for the data signalling rate of 50 bit/s, the transmission mode of 7.5 units/character start-stop and address selection and call progress signals at 50 bit/s, International Telegraph Alphabet No. 2. However, several Administrations have indicated that their telex service (50-baud, International Telegraph Alphabet No. 2) will be provided as one of the many services carried by their public data network.

Note 2. – Although it is recognized that start-stop data terminals operating on a character-by-character basis will continue to exist for a long time, it is expected that their long-range development direction is towards the use of synchronous mode of transmission at the DCE/DTE interface.

Note 3. – Taking account of the existence of data terminal equipments operating in the start-stop mode at a data signalling rate of 300 bit/s and with a 10 unit/character code structure, some Administrations have indicated that their public data networks will accommodate such terminals. Other Administrations, however, have indicated that they cannot guarantee acceptable transmission if such terminals are connected to their networks. The implications of admitting such terminals in class 1 is for further study.

Note 4. – Class 2 will provide, in the data transfer phase, for operation at the following data signalling rates and code structures:

50	bit/s	(7.5 units/character)
100	bit/s	(7.5 units/character)
110	bit/s	(11 units/character)
134.5	bit/s	(9 units/character)
200	bit/s	(11 units/character)

Address selection and call progress signals would be at 200 bit/s, International Alphabet No. 5 (11 units/character) as indicated in Table 1a)/X.1.

Note 5. – Some Administrations have indicated that for certain of the data signalling rates listed in Note 4 above they will permit users in class 2 to operate the same signalling rate and code structure for both data transfer and address selection and to receive call progress signals at these signalling rates and code structures. Where International Alphabet No. 5 is used for the address selection and call progress signals the appropriate parts of Recommendation X.20 or X.20 *bis* shall apply. Procedures to be used with other alphabets is a matter for the discretion of individual Administrations.

Note 6. – For data terminals in user class of service 2, it should be noted that some public data networks may not be able to prevent two terminals working at different data signalling rates and code structures from being connected together by means of a circuit switched connection.

Note 7. – In a packet switched data transmission service it should be noted that terminals in different user classes of service may be connected together by means of a packet switched connection.

Recommendation X.2

INTERNATIONAL USER FACILITIES IN PUBLIC DATA NETWORKS

(Geneva, 1972, amended at Geneva, 1976)

The CCITT,

bearing in mind,

a) the international user classes of service indicated in Recommendation X.1;

b) the need to standardize user facilities in public data networks which should be made available on an international basis;

c) the need to standardize additional user facilities which may be provided by Administrations and which may be available on an international basis;

d) the impact which these user facilities could have on tariff structures.

unanimously declares the view that,

1. the user facilities should be standardized for each of the user classes of service indicated in Recommendation X.1 for each of the following:

i) circuit switched data transmission services;

ii) packet switched data transmission services;

iii) leased circuit data transmission services.

2. the user facilities to be available on an international basis are as indicated in Table 1/X.2. Some of the user facilities are available on a per call basis and others may be assigned for an agreed contractual period. In all cases the user has the option of requesting a given user facility.

TABLE 1/X.2 – **International user facilities in public data networks**

a) Circuit switched service (See Notes 1 and 2)

User facility	User classes of service		Definition reference
	1-2	3-7	
Optional user facilities assigned for an agreed contractual period			52.44
Direct call	E	E	52.49
Closed user group	E	E	52.48
Closed user group with outgoing access	A	A	52.481
Calling line identification	A	A	53.625
Called line identification	A	A	53.62
Optional user facilities per call			52.44
Abbreviated address calling	A	A	52.50
Multi-address calling	A	A	52.51

b) Packet switched service (See Notes 1-4)

User facility	User classes of service				Definition reference
	1-7	8-11			
	See Note 3	DG	VC	PVC	
Optional user facilities assigned for an agreed contractual period					52.44
Permanent virtual circuit (PVC)	E	–	–	E	53.545
Closed user group	E	A	E	–	52.48
Closed user group with outgoing access	A	A	A	–	52.481
Packet assembly and/or disassembly	E	–	–	–	52.462
Optional user facilities per call					52.44
Abbreviated address calling	A	See Note 4		–	52.50
Datagram (DG)	See Note 4	A	–	–	
Virtual call (VC)	E	–	E	–	53.54

c) Leased circuit service (See Note 1)

User facility	User classes of service		Definition reference
	1-2	3-7	
Point-to-point	E	E	37.17

E = an essential user facility to be made available internationally.
A = an additional user facility which may be available in certain public data networks and may also be available internationally.
DG = applicable when the datagram facility is being used.
VC = applicable when the virtual call facility is being used.
PVC = applicable when the permanent virtual circuit is being used for certain user classes of service.
– = not applicable.

Note 1. – It is assumed that terminals have an interface to only one of the three data transmission services identified.

Note 2. – The subject of interworking between data terminals having interfaces to different data transmission services is for further study.

Note 3. – The interface signalling scheme for terminals in these user classes of service having an interface to the packet switched data transmission service is for further study.

Note 4. – For further study.

Recommendation X.4

GENERAL STRUCTURE OF SIGNALS OF INTERNATIONAL ALPHABET No. 5 CODE FOR DATA TRANSMISSION OVER PUBLIC DATA NETWORKS [1)]

(Geneva, 1976)

The CCITT,

I. *considering, firstly,*

the agreement between the International Organization for Standardization (ISO) and the CCITT on the main characteristics of a seven-unit alphabet (International Alphabet No. 5) to be used for data transmission and for telecommunications requirements that cannot be met by the existing five-unit International Telegraph Alphabet No. 2;

the interest, both to the users and to the telecommunication services, of an agreement concerning the chronological order of transmission of bits in serial working,

declares the view

that the agreed rank number of the unit in the alphabetical table of combinations should correspond to the chronological order of transmission in serial working on telecommunication circuits;

that, when this rank in the combination represents the order of the bit in binary numbering, the bits should be transmitted in serial working with the low order bit first;

that the numerical meaning corresponding to each information unit considered in isolation is that of the digit:

0 for a unit corresponding to condition A (travail = space), and

1 for a unit corresponding to condition Z (repos = mark),

in accordance with the definitions of these conditions for a two-condition transmission system;

II. *considering, moreover,*

that it is often desirable, in data and messages transmission, to add an extra "parity" unit to allow for the detection of errors in received signals;

the possibility offered by this addition for the detection of faults in terminal equipment;

the need to reserve the possibility of making this addition during the transmission itself, after the seven information units proper have been sent,

1) See Recommendation V.4 for data transmission over public telephone networks.

declares the view

that signals of International Alphabet No. 5 code for data and messages transmission should in general include an additional "parity" unit;

that the rank of this unit and, hence, the chronological order of the transmission in serial working should be the eighth of the combination thus completed;

III. *considering*

that, in start-stop systems working with electromechanical equipment, the margin of such equipment and the reliability of the connection are considerably increased by the use of a stop element corresponding to the duration of two-unit intervals of the modulation;

that for start-stop systems using International Alphabet No. 5 at modulation rates of 200 and 300 bauds, Recommendations X.1 and X.31 specify that transmit devices should use a stop element lasting at least two units;

that the previously expressed preference for a two-unit stop element arises from a transmission point of view where anisochronous public data networks are concerned,

declares the view

that in start-stop systems using combinations of International Alphabet No. 5 normally followed by a parity unit, the first information unit of the transmitted combination should be preceded by a start element corresponding to condition A (space);

that the duration of this start element should be one-unit interval for the modulation rate under consideration, at transmitter output;

that the combination of seven information units, normally completed by its parity unit, should be followed by a stop element corresponding to condition Z (mark);

that for public anisochronous data networks, data terminal equipment using International Alphabet No. 5 should comply with Recommendations X.1 and X.31 and use a stop element lasting at least two units;

that the start-stop receivers should be capable of correctly receiving start-stop signals from a source which appears to have a nominal cycle of 10 units (i.e., with a nominal one-unit stop element). However, for certain electromechanical equipment the receivers may only be capable of correctly receiving signals when the stop element is not reduced below one unit (even in the presence of distortion);

IV. *considering, finally,*

that the direction of the parity unit can only be that of the even parity on the perforated tapes, particularly owing to the possibility of deletion (combination 7/15 of the alphabet) which causes a hole to appear in all tracks;

that, on the other hand, the odd parity is considered essential in the equipment which depends on transitions in the signals to maintain synchronism [in cases where combination 1/6 (SYNC) of the alphabet does not permit of an economical solution],

declares the view

that the parity unit of the signal should correspond to the even parity in links or connections operated on the principle of the start-stop system.

that this parity should be odd on links or connections using end-to-end synchronous operation,

that arrangements should be made when necessary to reverse the direction of the parity unit at the input and output of the synchronous equipment connected either to apparatus working on the start-stop principle or receiving characters on perforated tape.

SECTION 2

DATA TERMINAL EQUIPMENT AND INTERFACES

Recommendation X.20

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR START-STOP TRANSMISSION SERVICES ON PUBLIC DATA NETWORKS

(Geneva, 1972, amended at Geneva, 1976)

CONTENTS

1. *Scope*

1.1 This Recommendation applies to the interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for start-stop transmission services on public data network. In particular it is applicable to:

a) circuit-switched service,

b) lease circuit service, either point-to-point or multipoint connections.

The application in packet-switched service is for further study.

This Recommendation refers to other Recommendations which define the electrical and functional characteristics of the interchange circuits.

1.2 In the case of switched data network service it additionally defines the procedural characteristics of the interface in terms of a call control procedure for start-stop transmission in user classes of service 1 and 2 of Recommendation X.1.

1.3 The DCE of these user classes of service provides all conversions required between the DTE/DCE interface and the line. It also serves for the provision of the essential and optional user facilities according to Recommendation X.2. Nationally assigned user facilities may also be included.

1.4 The information content of the specified selection signal format and the call progress signal format is not included in this Recommendation. It is the subject of other Recommendations.

2. *Physical characteristics*

2.1 *Interchange circuits*

A list of the interchange circuits concerned is presented in Table 1/X.20. Definitions of these interchange circuits are given in Recommendation X.24.

TABLE 1/X.20

Interchange circuit	Interchange circuit name	Direction	
		to DCE	from DCE
G (see Note)	Signal ground or common return		
Ga	DTE common return	X	
Gb	DCE common return		X
T	Transmit	X	
R	Receive		X

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

2.2 *Electrical characteristics*

The electrical characteristics of the interchange circuits at the DCE side of the interface will comply with Recommendation X.26.

The electrical characteristics at the DTE side of the interface may be applied according to Recommendations X.26, X.27 (without cable termination in the load), or Recommendation V.28.

2.3 *Mechanical characteristics*

Refer to ISO DIS 4903 *(15-pin DTE/DCE interface connector and pin assignment)* for mechanical arrangements.

3. *Call control procedures*

Figure 1/X.20 – Sequence of signals at the interface, shows the procedures at the interface during call establishment, the data transfer phase, and the clearing of a call including unsuccessful calls. Figure 2/X.20 shows the state diagrams, which define the logical relationships of events at the interface. (Annex 1 defines the symbols used for the state diagrams.)

3.1 *Call establishment*

3.1.1 *Ready* (state 1)

Circuits T and R show binary 0.

3.1.2 *Call request* (state 2)

Circuit T is changed to binary 1.

3.1.3 *Proceed to select* (state 3)

Circuit R is changed to binary 1.

3.1.4 *Selection signals* (state 4)

The selection characters are transmitted on circuit T. In the case of direct calls, no *Selection signals* are transmitted.

3.1.5 *Incoming call* (state 5)

Circuit R is changed to binary 1.

3.1.6 *Call accepted* (state 6)

Circuit T is changed to binary 1 not later than 600 ms after the incoming call is recognized. 10-100 ms thereafter, the DTE transmits the call control character ACK.

3.1.7 *Called and Calling line identification* (states 7A and 7B)

When provided, the *Called line identification* (state 7A) will be transmitted by the DCE to the calling DTE after all *Call progress* signals, if any.

When provided, the *Calling line identification* (state 7B) will be transmitted by the DCE to the called DTE after *Call accepted* has been sent by the DTE.

3.1.8 *Connected* (state 8)

The call control character ACK is transferred on circuit R. The event *Connected* begins nominally at the middle of the first stop unit of the call control character.

3.1.9 *Ready for data* (state 9)

After receipt of *Connected* the DTE shall be ready for the reception of data.

Twenty milliseconds after the beginning of *Connected*, the DTE may commence with the transmission of data.

3.2 *Data transfer* (state 10)

The events during *Data transfer* are in the responsibility of the DTE.

3.3 *Clearing*

3.3.1 *DTE Clear request* (state 11)

Circuit T is changed to binary 0 for more than 210 ms and shall not be reversed to binary 1 before *DCE Ready.*

3.3.2 *DCE Clear confirmation* (state 12)

Within 6 seconds after the beginning of *DTE Clear request* circuit R is changed to binary 0 for more than 210 ms and will not be reversed to binary 1 before *DCE Ready.*

3.3.3 *DCE Clearing* (state 13)

Circuit R is changed to binary 0 for more than 210 ms and will not be reversed to binary 1 before *DCE Ready.*

3.3.4 *DTE Clear confirmation* (state 14)

Within 210-490 ms after the beginning of *DCE Clearing,* circuit T is changed to binary 0 for more than 210 ms and shall not be reversed to binary 1 before *DCE Ready.*

3.3.5 *DTE Ready* (state 15)

Within 210-490 ms after the beginning of *DCE Clear confirmation* or < 490 ms after the beginning of *DTE Clear confirmation*, respectively, the DTE shall be ready to accept an *Incoming call.*

3.3.6 *DCE Ready* (state 1)

490 ms after the beginning of DCE or DTE *Clear confirmation,* respectively, the DCE is ready to accept a new *Call request.*

3.3.7 *Clear collision*

In case *DTE Clear request* and *DCE Clearing* occur at the same instant or during an overlapping time of 210 ms, the DTE shall proceed in its clearing procedure.

3.4 *Unsuccessful call*

3.4.1 *Unsuccessful call request*

If a *Call request* is not successful, the DCE may indicate the reasons by means of call progress signals. In any case, *DCE Clearing* will be performed.

3.4.2 *Call not accepted* (state 17)

If an *Incoming call* cannot be accepted, circuit T has to be changed to binary 1 not later than 600 ms after the beginning of *Incoming call.* 10-100 ms thereafter the DCE shall transmit the call control character NAK and then *DTE Clear request.*

3.5 *Fault conditions*

3.5.1 *No Proceed to select*

If the *Proceed to select* signal has not been received on circuit R within 6 seconds after the beginning of *Call request*, the DTE shall perform *DTE Clear request.*

3.5.2 *No Selection signal*

If no *Selection signal* is transmitted within 6 seconds from the beginning of *Proceed to select* or the preceding *Selection signal, DCE Clearing* will be performed.

3.5.3 *No Connected signal*

If the call control character for *Connected* has not been received on circuit R within 60 seconds after

a) the end of the selection signal sequence, or

b) the end of the call control character for *Call accepted*

the DTE shall perform *DTE Clear request.*

Note. – It should be noted that the setting up time for connections may vary. The value of 60 seconds is a maximum time-out which, if it expires, should lead to the call attempt being abandoned by the calling DTE.

3.5.4 *Circuit T in circuit failure state*

If circuit T is in a power-off or an open circuit condition, the DCE interprets this condition as binary 0.

3.5.5 *Circuit R in circuit failure state*

If circuit R is in a power-off or an open circuit condition, the DTE interprets this condition as binary 0.

3.6 *Call collision* (state 18)

A *Call collision* is detected by the DCE when it receives *Call request* in response to an *Incoming call.* The DCE may either accept the *Call request* or may perform *DCE Clearing.*

4. *Call control formats*

4.1 *Format of selection sequence* (see Annex 2)

A selection sequence shall consist of facility request block or address block, or both.

4.1.1 *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 (",").

End of a *Facility request* block shall be indicated by character 2/13 ("–").

4.1.2 *Address*

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

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

Start of *Abbreviated address signals* shall be indicated by a prefix character 2/14 (".").

4.1.3 *End of selection sequence*

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

4.2 *Format of a Call progress block*

A *Call progress block* shall consist of one or more *Call progress* signals. Each *Call progress signal* need not be repeated.

Each *Call progress signal* is preceded by characters 0/13 (CR = carriage return) and 0/10 (LF = line feed).

End of *Call progress block* will be indicated by character 2/11 ("+").

4.3 *Format of called and calling line identification*

A *Calling line identification signal* and a *Called line identification block* shall be preceded by characters 0/13 (CR = carriage return), 0/10 (LF = line feed) and 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 characters 0/13 (CR) and 0/10 (LF).

The end of a *Calling line identification signal* and a *Called line identification block* shall be indicated by character 2/11 ("+").

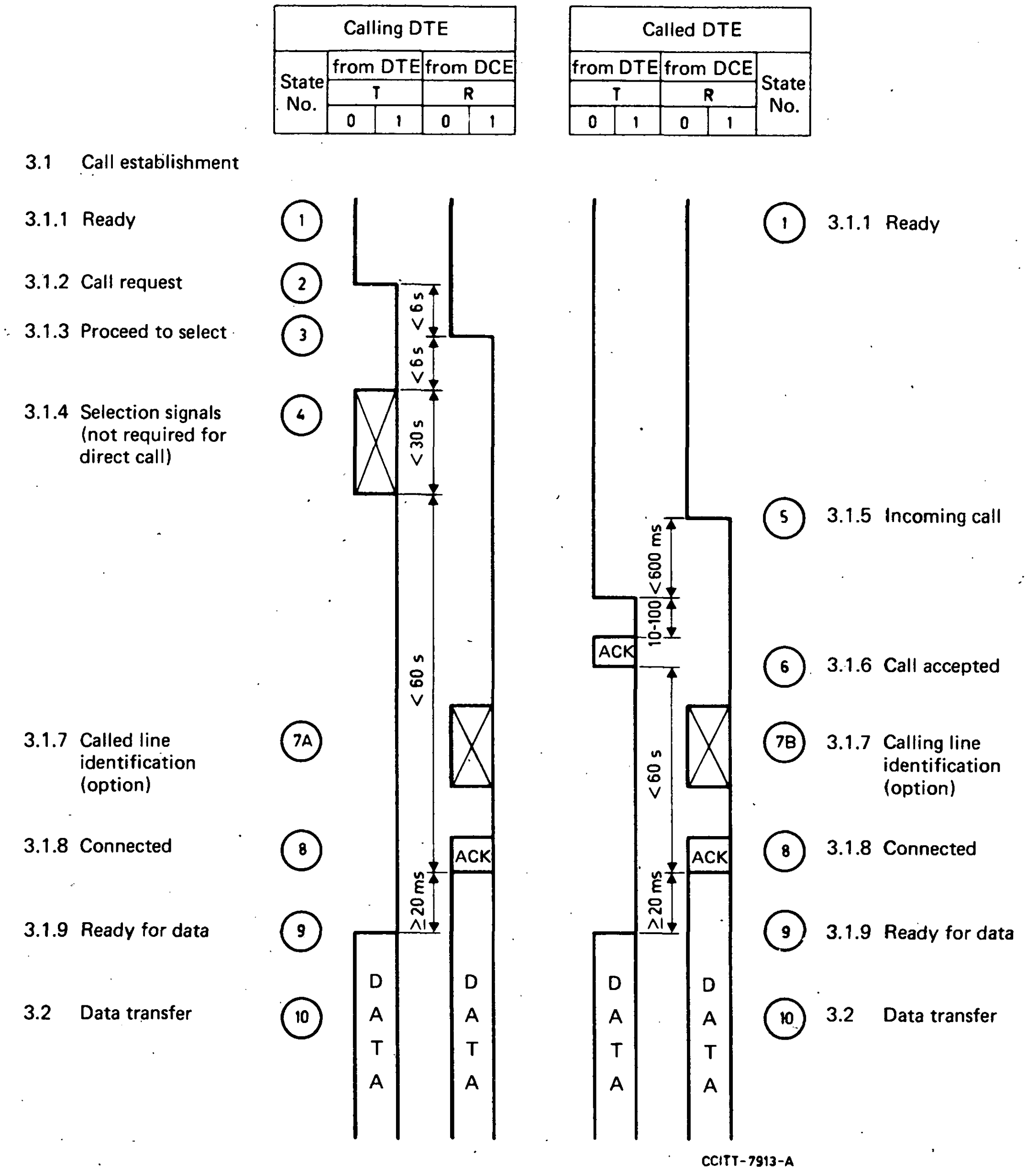
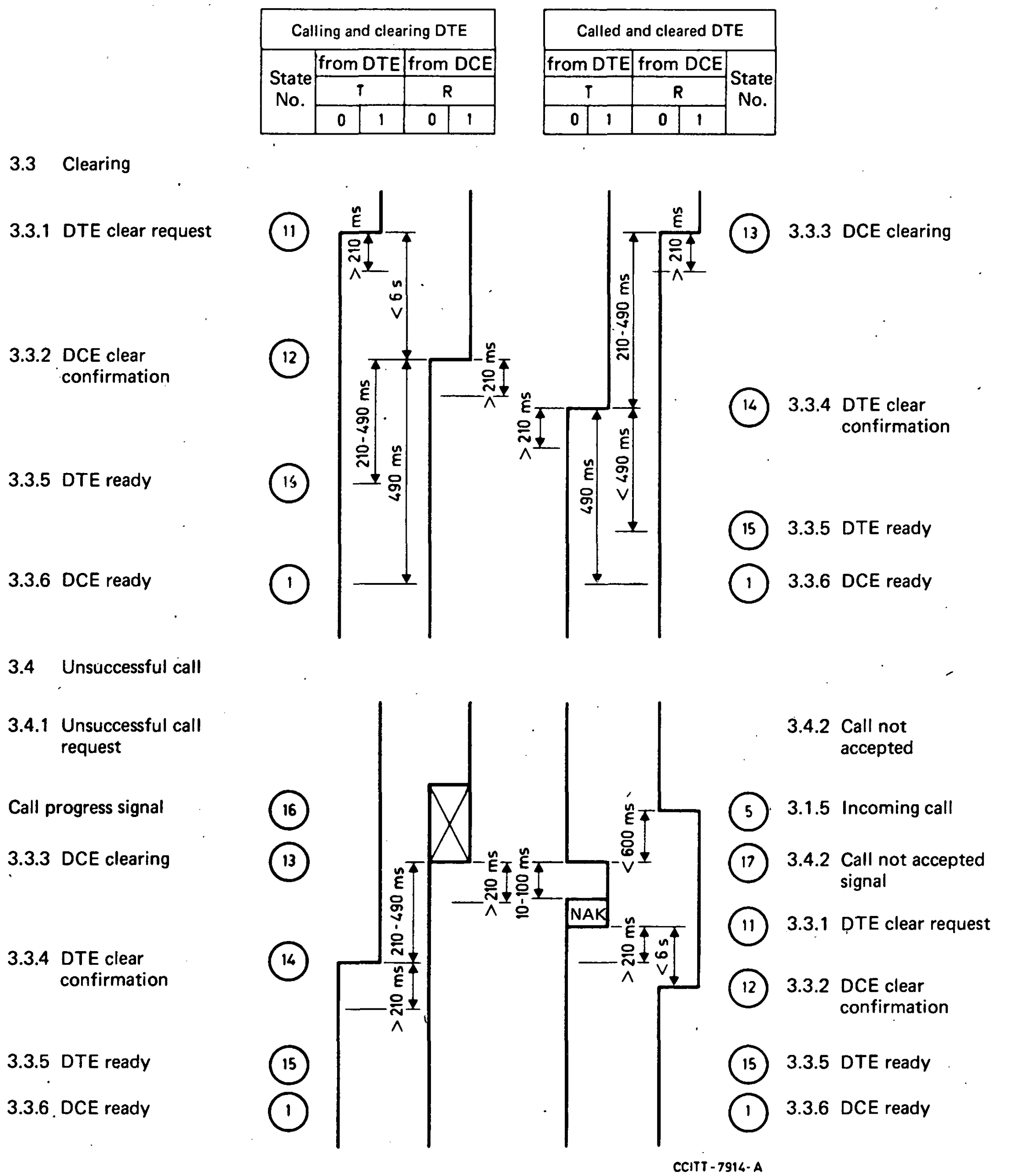


FIGURE 1a/X.20 – **Sequence of signals at the interface** (call establishment/data transfer)



Note. – The numbering refers to 3. *Call control procedures* in the text.

FIGURE 1b/X.20 – **Sequence of signals at the interface (clearing/unsuccessful call)**

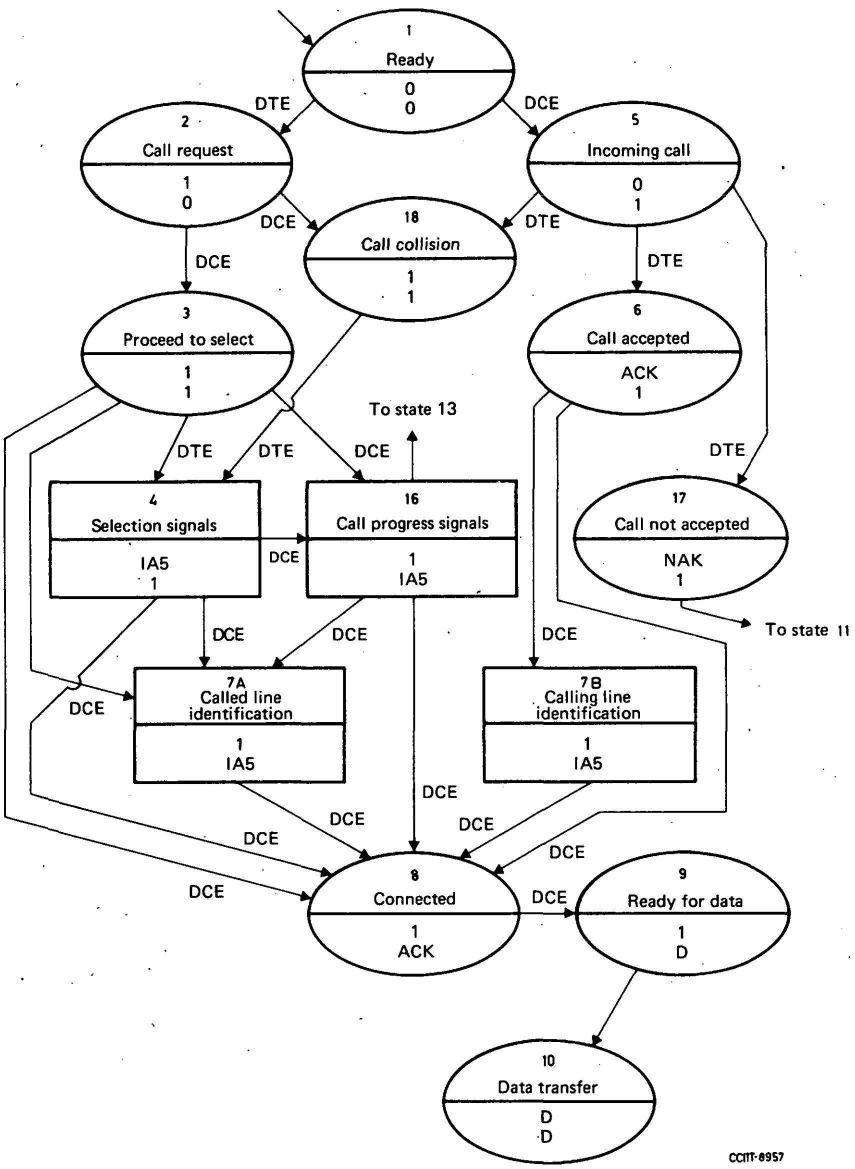


FIGURE 2a/X.20 – **State diagram** (call establishment phase)

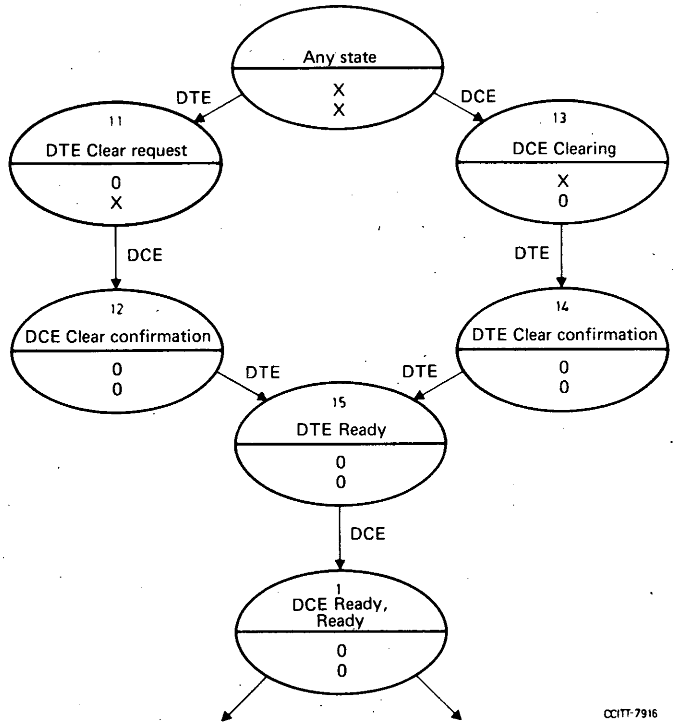


FIGURE 2b/X.20 – **State diagram** (clearing phase)

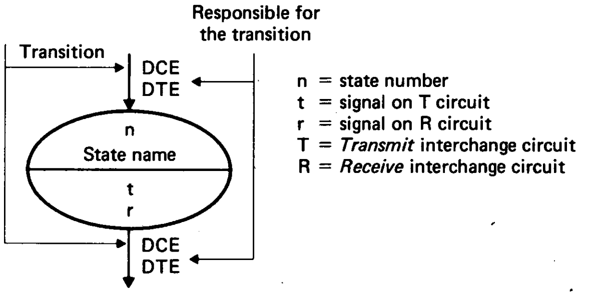
ANNEX 1

(to Recommendation X.20)

Definition of symbols used in the state diagrams

Each state is represented by an ellipse wherein the state name and number is indicated, together with the signals on the interchange circuits which represent that state.

Each state transition is represented by an arrow and the equipment responsible for the transition (DTE or DCE) is indicated beside that arrow. A rectangle represents a sequence of states and transitions.



D = DTE to DTE data signals
0 and 1 = refer to steady binary conditions
X = any value
IA5 = International Alphabet No. 5 (Recommendation V.3 and X.4)
Any state = includes all states during call establishment and data transfer

ANNEX 2

(to Recommendation X.20)

Formats of selection, call progress and line identification signals

The following description uses Backus Normal Form as the formalism for syntactic description, for example, as in ISO Recommendation R 1538 [1]. A vertical line " | " separates alternatives.

<*Selection Sequence*> : : = <Facility Request Block> < – > <Address Block> < + > |
<Facility Request Block> < – > < + > | <Address Block> < + >

<Facility Request Block> : : = <Facility Request Signal>
<Facility Request Block> < , >
<Facility Request Signal>

<Address Block> : : = <Address Signal> | <Address Block> < , > <Address Signal>

<Address> : : = <Full Address Signal> | < . > <Abbreviated Address Signal>

<*Call Progress Block*> : : = <CR> <LF> <Call Progress Signal> < + > | <Call Progress Signal>
<Call Progress Block>

<*Calling Line Identification*> : : = <CR> <LF> <*> <Calling Line Identification Signal> < + >

<*Called Line Identification*> : : = <CR> <LF> <*> <Called Line Identification Block> < + >

<Called Line Identification Block> : : = <Called Line Identification Signal > | <Called Line Identification Block> <CR> <LF> <Called Line Identification Signal>

<CR> : : = IA 5 character 0/13

<LF> : : = IA 5 character 0/10

<*> : : = 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

<Facility Request Signal>
<Full Address Signal>
<Abbreviated Address Signal>
<Call Progress Signal>
<Calling Line Identification Signal>
<Called Line Identification Signal>

Subject of another Recommendation (not yet available)

[1] ISO Recommendation R 1538: Programming Language "ALGOL", March 1972.

Recommendation X.20 *bis*

V.21-COMPATIBLE INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR START-STOP TRANSMISSION SERVICES ON PUBLIC DATA NETWORKS

(Geneva, 1976)

Introduction

Many DTEs are in use which are equipped with interfaces recommended for DCEs on telephone-type networks. For an interim period public data networks should also provide such interfaces in order to enable the connection of existing DTEs to these networks.

1. *Scope*

This Recommendation applies to the interface between DTE designed for interfacing to modems according to Recommendation V.21 and DCE on public data networks.

The operation is limited to start-stop transmission at data signalling rates and character structures specified in user classes of service 1 and 2 of Recommendation X.1.

The application comprises:

a) circuit switched service,

b) leased circuit service.

The application in packet switched service is for further study.

2. *Interchange circuits*

2.1 *Functional characteristics*

The functional characteristics of the interchange circuits concerned (see Table 1/X.20 *bis*) comply with Recommendation V.24.

TABLE 1/X.20 *bis*

Interchange circuit	
Number	Designation
102	Signal ground or common return
103	Transmitted data
104	Received data
106	Ready for sending
107	Data set ready
108/1 [a]	Connect data set to line
108/2 [b]	Data terminal ready
109	Data channel received line signal detector
125 [c]	Calling indicator

[a] Used in case of automatic control of the direct call facility.
[b] Used in case of switched data network service.
[c] Not provided in leased circuit service.

2.2 *Electrical characteristics*

The electrical characteristics of the interchange circuits comply with Recommendation V.28, using the 25-pin interface connector and pin assignments in ISO DIS 2110.2.

3. *Operational requirements*

3.1 *Operation of interchange circuit 107*

The DCE switches circuit 107 to ON after establishment of the data circuit.

The circuit 107 is switched to OFF only as a response to the OFF condition of the circuit 108.

3.2 *Operation of interchange circuits 109 and 106*

The DCE switches circuit 109 to ON together with circuit 107. Circuit 106 is put to ON 20 to 40 ms after the appearance of the ON condition on circuit 107.

The circuits 109 and 106 are switched to OFF either when circuit 108 is switched to OFF or when circuit 108 is ON and the DCE indicates a *Clear request* from the network (DCE Clearing).

3.3 *Operation of interchange circuit 125*

Circuit 125 will be switched OFF when circuit 107 comes ON.

3.4 *Unaccepted call*

If the ON condition of circuit 125 is not answered by an ON condition on circuit 108 within 450 ms, the incoming call will be rejected by the DCE.

3.5 *Multipoint operation*

As the circuits 106 and 109 are always in the ON condition, the transmission disciplines must be determined by end-to-end control procedures of the DTEs.

3.6 *Direct call facility*

Manual control: The direct call is initiated when the direct call button at the DCE is pressed and circuit 108/2 is ON.

Automatic control: The direct call is initiated when the DTE switches the circuit 108/1 to ON.

Recommendation X.21

GENERAL PURPOSE INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR SYNCHRONOUS OPERATION ON PUBLIC DATA NETWORKS

(Geneva, 1972, amended at Geneva, 1976)

CONTENTS

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 it is desirable for the characteristics of the interface between the DTE and DCE in 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 mode of transmission should be as defined in this Recommendation.

1. *Scope*

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

1.2 The information content of *Selection*, *Call progress* and *Line identification* signals is not included in this Recommendation. It is the subject of other Recommendations.

1.3 The operation of the interface when the data circuit interconnects with Recommendation X.21 *bis* DTEs is described in Annex 6.

2. *Interchange circuits*

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

TABLE 1/X.21

Interchange circuit	Name	Direction		Remarks
		to DCE	from DCE	
G	Signal ground or common return			see Note 1
Ga	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

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.

Note 2. – Continuous isochronous transmission will be provided.

Note 3. – May be provided as an optional additional facility (see 4. below).

3. *Physical characteristics*

3.1 *Electrical characteristics*

3.1.1 *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 Recommendation X.27 (without cable termination in the load), or Recommendation X.26. The B-leads of circuits R, I, S and B, if provided, must be connected to the individual differential inputs and not connected together. (See ISO DIS 4903.)

3.1.2 *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 implementation of the cable termination in the load).

3.2 *Mechanical characteristics*

Refer to ISO DIS 4903 *(15-pin DTE/DCE interface connector and pin assignment)* for mechanical arrangements.

4. *Character alignment*

4.1 *Call establishment and other call control phases*

For the interchange of information [2] 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.

4.1.1 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.

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

4.1.3 Additionally, for an intermediate period (see Note) Administrations will provide connection to the public data network of DTEs operating as described in 4.1.2 above.

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

4.2 *Data phase*

For the interchange of information between one DTE and another DTE after the call has been established, 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.)

5. *Interface procedures and timing of events*

Annex 1 shows the state diagrams which give the definition of logical relationships of events at the interface. (Annex 4 defines the symbols used for the state diagrams).

Annex 2 shows examples of timing diagrams of the signals at the interface. Those diagrams show only the most frequent sequences of signals. All timing diagrams are derived from the state diagrams.

Annex 3 provides the tables of DTE time limits and DCE time-outs which define the timing relationships of events at the interface.

All call control characters are selected from International Alphabet No. 5 according to Recommendations V.3 and X.4 and have odd parity.

Steady binary conditions 0 and 1 on circuit T or R together with the associated condition on circuit C or I persist for at least 15 bits.

ON and OFF conditions for circuit C *(Control)* and I *(Indication)* respectively refer to continuous ON (binary 0) and continuous OFF (binary 1) conditions.

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

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[2] See Definition 53.029 *Information, Green Book*, Volume VIII, page 33.

5.1 *Quiescent states for circuit switched service* (see Annex 1, Figure 2/X.21)

5.1.1 *Ready* (state 1)

Both DTE and DCE shall signify their readiness for a new call by sending *Ready* signals, that is, t = 1, c = OFF, r = 1, i = OFF.

5.1.2 *DTE Uncontrolled not ready* (state 21)

DTE Uncontrolled not ready indicates that the DTE is unable to accept incoming calls, generally because of abnormal operating conditions, and will inhibit the connection of incoming calls. This state is signalled by t = 0, c = OFF.

5.1.3 *DTE Controlled not ready* (state 14)

DTE Controlled not ready indicates that, although the DTE is operational, it is temporarily unable to accept incoming calls.

The state is signalled by t = 01 . . . . (alternate bits are binary 0 and binary 1), c = OFF.

In some networks no action will be taken when DTE *Controlled not ready* is signalled from the DTE. The consequences of this for the caller should be studied further.

Note 1. – The *Controlled not ready* state is normally entered from the *Ready* state. Other states from which *Controlled not ready* may be entered are left for further study.

Note 2. – Possible use and specification of a family of *Controlled not ready* signals is left for further study.

5.1.4 *DCE not ready* (state 18)

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 state is signalled by steady binary condition r = 0, i = OFF.

5.2 *Call establishment and clearing for circuit switched service* (see Annex 1, Figures 1/X.21 and 2/X.21)

5.2.1 *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 the same bit interval as the transition to c = ON.

5.2.2 *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 end of selection signal or *DTE Waiting* is received.

The *Proceed to select* signal shall start within 3 seconds of the *Call request* being sent.

5.2.3 *Selection signals* (state 4)

The *Selection signals* 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 *Selection signals* is defined in 6.1 below.

The information content of *Selection signals* is the subject of another Recommendation.

Selection 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.

5.2.4 *DTE Waiting* (state 5)

The period following transmission of the end of selection signal during which no information is transmitted from the DTE will be signalled by steady binary condition t = 1, c = ON. (See also 5.2.16 below.)

5.2.5 *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.

5.2.6 *Call accepted* (state 9)

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 the *Ready* state if the incoming call is not accepted within 500 milliseconds. (See Note below.)

   or, where manual answering is permitted,

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

Note. – This time-out limit is subject to further study with the objective to reduce the maximum response time in the future to 100 milliseconds.

5.2.7 *DCE Waiting* (state 6)

The period following receipt of the end of selection signal or receipt of *Call accepted* by the DCE and during which no information is transmitted from the DCE shall be filled by the transmission of two or more contiguous 1/6 ("SYN") characters on the R circuit with i = OFF.

The transition from this state to state 11 or 12 need not be on a SYN character boundary.

5.2.8 *Call progress signals* (state 7) (Refer to Annex 5)

The format of *Call progress signals* is defined in 6.2 below.

The *Call progress signals* will be transmitted by the DCE to the calling DTE on the R circuit with i = OFF.

In some cases there may be no *Call progress signals.*

In some cases there may be several *Call progress blocks,* in that case the period between these blocks will be filled by *DCE Waiting* (state 6B). A *Call progress block* will be preceded by 2 or more contiguous 1/6 ("SYN") characters.

Call progress signals will be transmitted by the DCE within 20 seconds of the end of selection signal being sent by the DTE.

The information content of *Call progress signals* is the subject of another Recommendation.

5.2.9 *Line identification* (states 10 and 10 *bis*) (Refer to Annex 5)

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

Calling and *Called line identification* will be transmitted by the DCE on the R circuit with i = OFF.

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

When provided the *Calling line identification* (state 10 *bis*) will be transmitted by the DCE to the called DTE after *Call accepted* has been sent by the DTE.

The period after Calling or *Called line identification* during which no information is transmitted from the DCE will be filled by the DCE Waiting condition (state 6 C).

The format of *Calling* and *Called line identification* is defined in 6.3 below.

The information content of *Calling* and *Called identification* is the subject of another Recommendation.

5.2.10 *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.

5.2.11 *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 2 seconds of the last *Call progress 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 80 seconds of the end of selection signal being received.

   It will be indicated to the called DTE within 2 seconds of *Call accepted* being signalled by the DTE.

   Subsequent procedures are described in 5.4 below, *Data transfer*.

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

Either a calling or a called DTE may clear a call at any time. The DTE should indicate clearing by signalling the steady binary condition t = 0, c = OFF, *DTE Clear request* (state 16).

Within 2 seconds the DCE will signal the steady binary condition r = 0, i = OFF, *DCE Clear confirmation* (state 17), followed by the steady binary condition r = 1, i = OFF, *DCE ready* (state 21). In some networks where the coding r = 1, i = OFF, is used only for the indication of the *DCE Ready* the *DCE Clear confirmation* state may be bypassed.

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

5.2.13 *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 *Clear confirmation* (state 20) by signalling the steady binary condition t = 0, c = OFF, within 100 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).

5.2.14 *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).

5.2.15 *Call collision* (state 15)

A *Call collision* is detected by a DTE when it receives *Incoming Call* in response to *Call request.*

It 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.*

5.2.16 *Direct call*

For the direct call facility *Selection Signals* (state 4) are bypassed; *Proceed to select* (state 3) is followed by *DTE Waiting* (state 5) within 6 seconds.

5.3 *Procedures for leased circuit services*

5.3.1 *Leased circuit data transmission service point-to-point operation*

5.3.1.1 *DCE Not ready*

As in 5.1.4 above.

5.3.1.2 *Operation of interchange circuits*

When c = ON:

1) i = ON at the distant interface,

2) data transmitted on circuit T are delivered at the distant interface on circuit R.

When c = OFF, the DTE must signal t = 1:

1) i = OFF at the distant interface,

2) r = 1 at the distant interface.

5.3.2 *Demand leased circuit service – point-to-point operation*

A demand leased circuit service is not yet defined as an international service, and consequently does not appear in Recommendation X.2. However, in view of possible national provision of such a service and its study for introduction internationally the following information is provided for guidance.

A possible procedure is described for the establishment of data transfer phase for a demand leased circuit service. However, *DCE Not ready* should always be as indicated below. (See Annex 1, Figure 3/X.21 and Annex 2, Figure 5/X.21.)

5.3.2.1 *Ready* (state 1)

Both DTE and DCE shall signify their readiness to establish the data transfer phase by signalling t = 1, c = OFF, r = 1, i = OFF respectively.

5.3.2.2 *DTE Uncontrolled not ready*

The DTE shall indicate it is unable to enter data transfer phase by signalling t = 0, c = OFF.

5.3.2.3 *DCE Not ready*

As in 5.1.4 above.

5.3.2.4 *Request data transfer* (state 11A)

The originating DTE signals t = 1, c = ON.

5.3.2.5 *Data transfer requested* (state 11B)

The DCE indicates data transfer requested by signalling r = 1, i = ON.

5.3.2.6 *Ready for data* (state 12)

The DTE responds to the data transfer requested signal by signalling t = 1, c = ON. The DCE indicates to the originating DTE that it is ready for data by signalling, r = 1, c = ON. Subsequent procedures are described in 5.4 below, Data Transfer.

5.3.2.7 The procedures for the termination of the data transfer phase require further study.

5.3.3 *Leased circuit services – multipoint operation*

For further study.

5.4 *Data transfer* (state 13)

Transmission of *Ready for data* (state 12) indicates to the DTE that data transmission and reception can commence.

DTE Clear request or *DCE Clear indication* (state 16 or 19) indicates the end of *Data transfer* (state 13).

All bits sent by a DTE after receiving *Ready for data* 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 receiving *Ready for data* and before receiving *DCE Clear indication* or receiving *DCE Clear confirmation* have been sent by the corresponding DTE. Some of them may have been sent before that corresponding DTE has received *Ready for data*; those bits are steady 1.

During *Data transfer* (state 13) any bit sequence may be sent by either DTE.

The action to be taken when circuit C is turned OFF during *Data transfer* (state 13), while the DTE does not signal t = 0, is a subject of further study.

6. *Selection, Call progress and Line identification formats* (also see Annex 5)

6.1 *Format of selection sequence*

Selection sequence shall consist of a *Facility request block* or *Address block* or both.

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 (",").

End of a *Facility request block* shall be indicated by character 2/13 ("-").

6.1.2 *Address*

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

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

Start of *Abbreviated address signals* shall be indicated by a prefix character 2/14 (".").

6.1.3 *End of selection sequence*

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

6.2 *Format of a Call progress block*

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

Each *Call progress signal* need not be repeated.

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

End of *Call progress block* shall be indicated by character 2/11 ("+").

6.3 *Format of called and calling line identification*

Calling line identification signal and *Called line identification block* shall be preceded by character 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 signal* and *Called line identification block* shall be indicated by character 2/11 ("+").

7. *Failure detection and isolation*

7.1 *Indeterminate condition of interchange circuits*

If the DTE is unable to determine the binary state of the R, I, or, if provided, B circuit it should interpret r = 0, i = OFF, b = OFF respectively.

If the DCE is unable to determine the binary state of the T or C circuit it will interpret t = 0, c = OFF respectively.

7.2 *DCE fault conditions*

If the DCE is unable to provide service (e.g. loss of alignment or of incoming line signal) for a period longer than a fixed duration it will indicate *DCE Not ready* by signalling r = 0, i = OFF. (see 5.1.4 above.) The value of that duration has to be defined after further study. Prior to this *DCE Not ready* signal, garbled signals may be delivered to the DTE.

7.3 *Test loops*

7.3.1 *Test of the DTE*

In order to assist the test of the DTE, and specifically of the interconnecting cable, a loop is provided in the DCE which causes signals on the T circuit to be presented on the R circuit and signals on the C circuit to be presented on the I circuit.

The loop should be near the DCE/DTE interface. The DCE drivers and terminators may be included in the loop. The precise implementation of the loop within the DCE is a national option.

Manual control should be provided on the DCE for activation of the loop.

Consideration of automatic control is an item for further study.

7.3.2 *Network maintenance*

For network maintenance purposes a loop is implemented in the DCE.

That loop may be controlled manually on the DCE or automatically from the network. That is a national option, as is the method used for the automatic control of the loop when implemented.

In circuit switched service, the loop may be activated without the knowledge and agreement by the customer for periods which do not exceed one second. The loop should not be activated when the DTE is engaged in a call.

In the leased circuit service, the loop should not be activated before the customer has been informed of it. Some Administrations may activate the loop when an abnormal condition is detected in the network without first informing the customer.

When the test is in progress the DCE will signal r = 0, i = OFF.

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

Garbled signals may be delivered to the DTE on the R and I circuits prior to the closing of the loop.

7.4 *Tolerance of the signal element timing signal under fault condition and when test loop is closed*

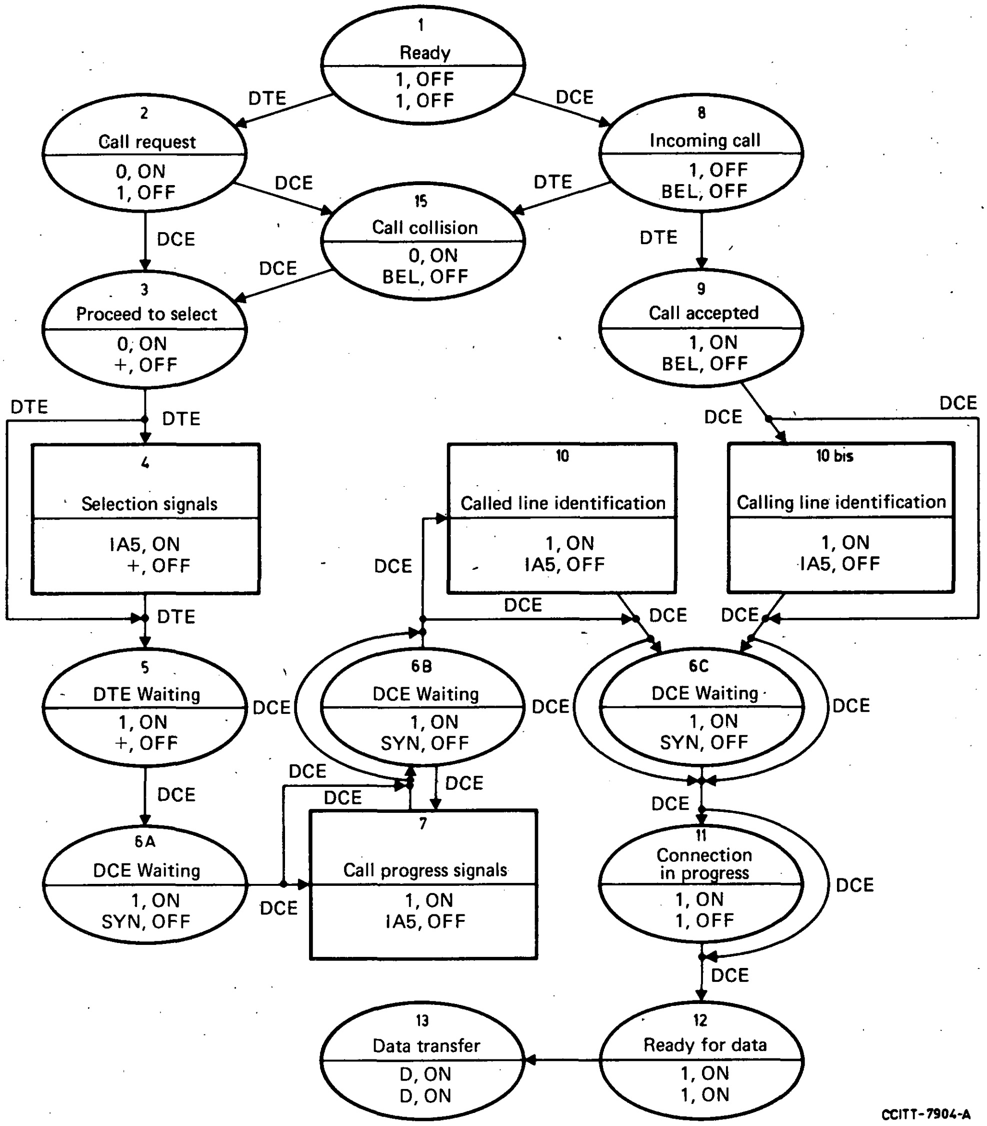
The signal element timing signal is delivered to the DTE on the S circuit whenever possible.

In particular it is delivered to the DTE when one of the loops described in 7.3 above is activated or when the DCE loses alignment or incoming line signal.

The tolerance of the signal element timing will be ± 1%.

ANNEX 1
(to Recommendation X.21)

Interface signalling state diagrams

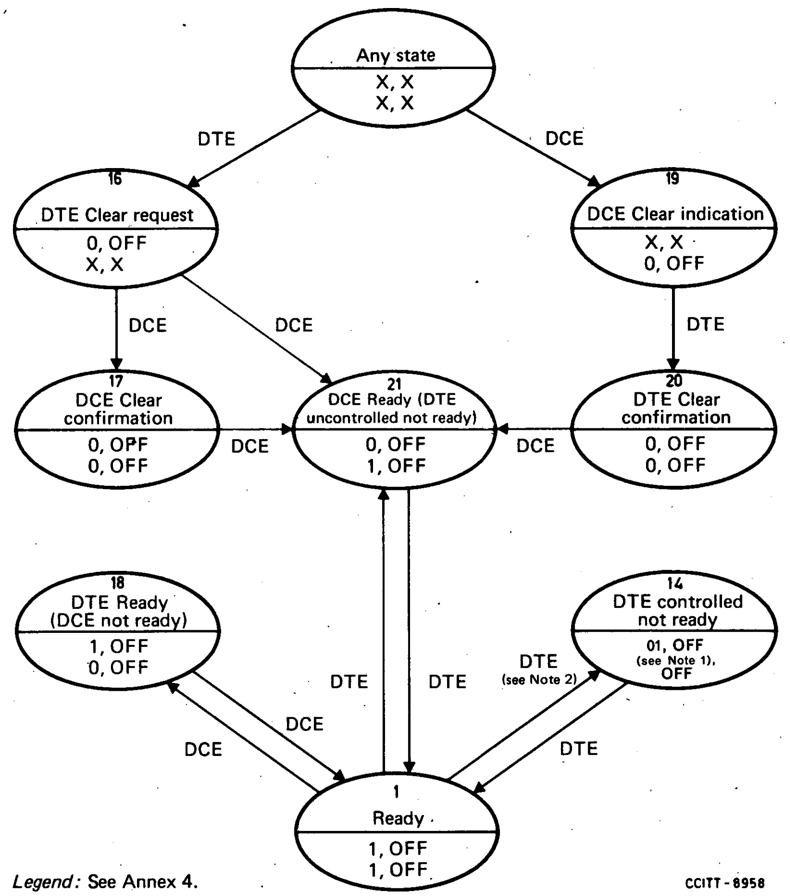


Legend: See Annex 4.

Note 1. – As indicated in Figure 2/X.21 the DCE may enter state 19 from any state and the DTE may enter state 16 from any state.

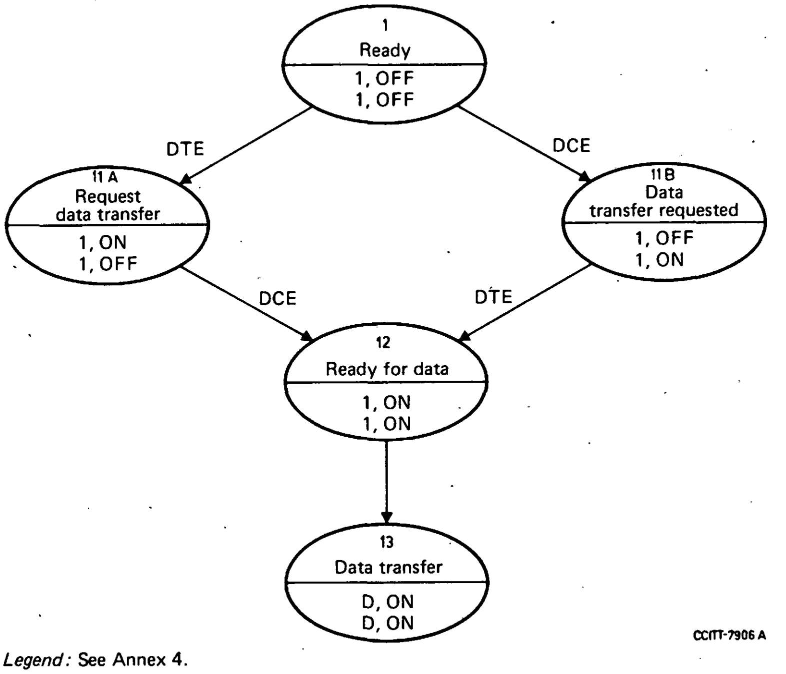
Note 2. – States 6A, 6B and 6C are presented in Figure 1/X.21 for convenience. They are all functionally equivalent and are referred to in the text as state 6.

FIGURE 1/X.21 – **Call establishment phase for circuit switched service**



Note 1. – The condition of the R circuit is for further study.
Note 2. – The DTE may be able to enter the *controlled not ready* state from states other than *ready*, this is for further study.

FIGURE 2/X.21 – **Clearing phase and quiescent states for circuit switched service**



Legend: See Annex 4.

Note. – The procedures for termination of the *Data transfer* phase require further study.

FIGURE 3/X.21 – **Establishment of Data transfer phase for demand leased circuit service, point-to-point operation**

ANNEX 2

(to Recommendation X.21)

Interface signalling sequence diagrams

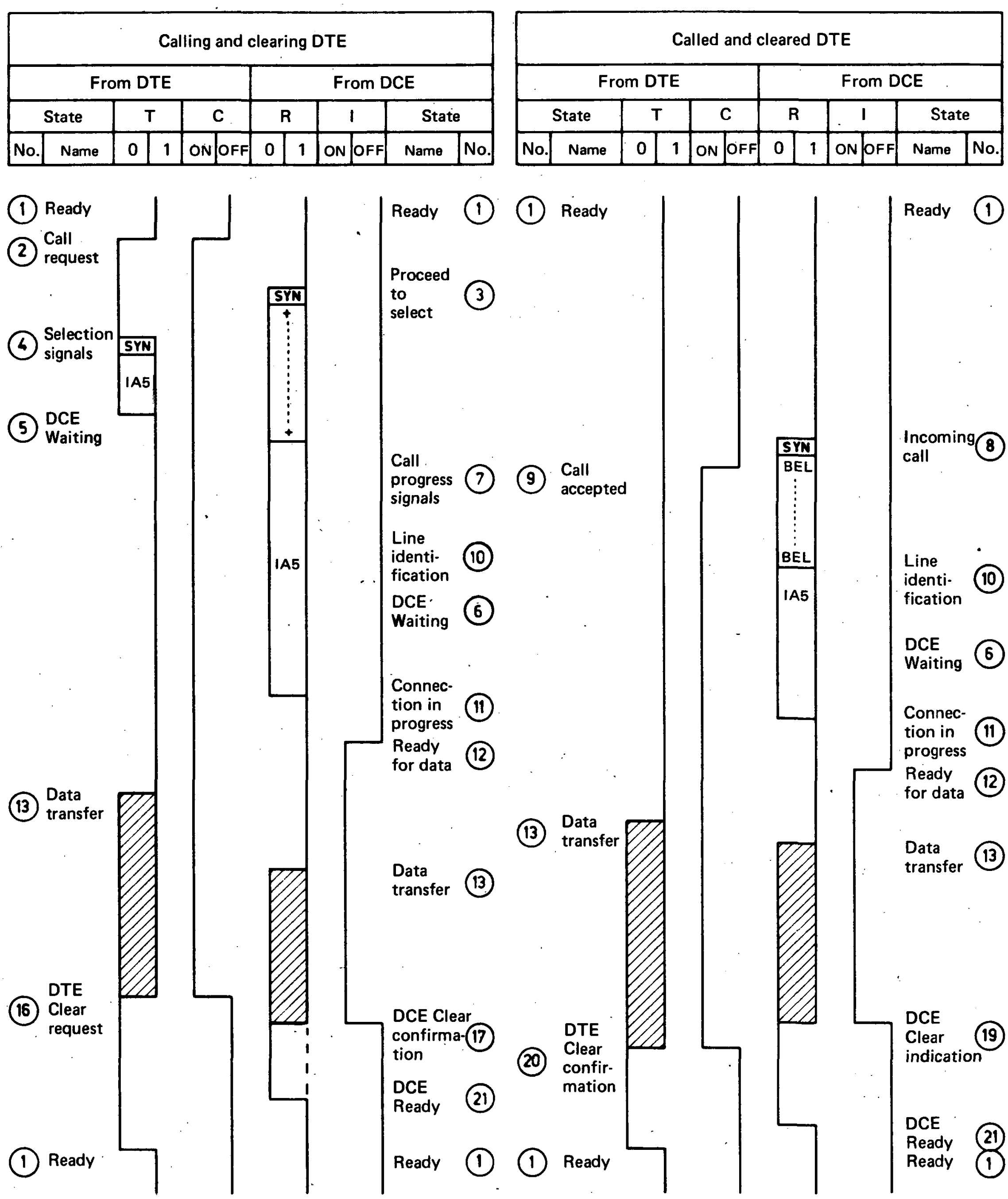


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FIGURE 4/X.21 – **Successful call and clear for circuit switched service**
(Example of sequence of events at the interface)

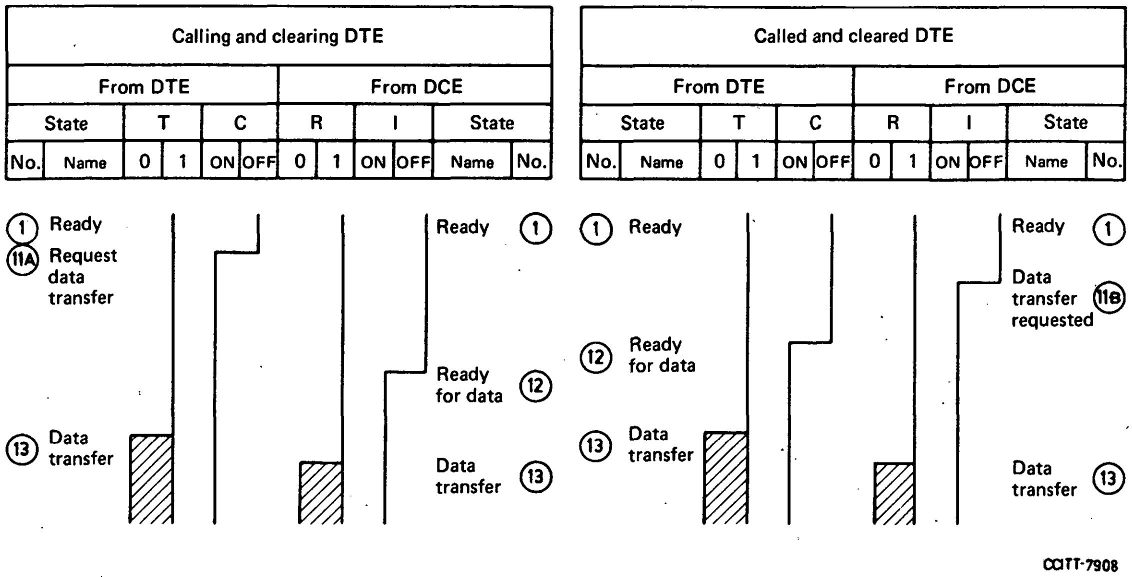


FIGURE 5/X.21 – **Call establishment for demand leased circuit service**

ANNEX 3

(to Recommendation X.21)

DTE time-limits and DCE time-outs

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 abandon the call. To maximize efficiency, the DTE should incorporate time-limit to send the appropriate signal under the defined circumstances summarized in Table 2/X.21. The time limits given in the first column are the maximum times allowed for the DCE to response and are consequently the lower limits of times a DTE must allow for proper network operation. A time-out longer than the minimum time shown may optionally be used in the DTE; for example, all DTE time-outs 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 will result in reduced efficiency of network utilization.

TABLE 2/X.21 – **DTE Time limits**

Time limit	Time-limit number	Started by	Normally terminated by	Preferred action to be taken when time expires
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 of end of selection or *DTE Waiting* (direct call) (state 4 or 5)	Reception of *Call progress signals* or *Ready for data* (states 7, 10, 11, 12)	DTE signals *DTE Clear request* (state 16)
2 s	T3A	Reception of *Call progress signals* (state 7)	Reception of *Ready for data* or *DCE Clear indication* (state 12 or 19)	DTE signals *DTE Clear request* (state 16)
60 s	T3B (see Note)	Reception of applicable *Call progress signals* (state 7)	Reception of *Ready for data* or *DCE Clear indication* (state 12 or 19)	DTE signals *DTE Clear request* (state 16)
2 s	T4	Change of state to *DTE Call accepted* (state 9)	Reception of *Ready for data* or *DCE Clear indication* (state 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 *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)	DTE regards the DCE as *Not ready* and signals *Ready* (state 18)

Note. – 60 s (T3B) applies for manual answering DTEs.

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 3/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.

TABLE 3/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 (See Note 1)	DCE signalling of *Proceed to select* (state 3)	DCE reception of end of selection signal (state 5)	DCE will signal *DCE Clear indication* (state 19) or transmit appropriate call progress signal followed by *DCE Clear indication*
6 s	T12	DCE signalling of *Proceed to select* (state 3)	DCE reception of first selection character (state 4) or *DTE Waiting* (state 5)	
6 s	T13 (See Note 1)	DCE reception of nth selection character (state 4)	DCE reception of (n+1)th selection character or end of selection signal (state 4)	
500 ms (See Note 2)	T14A	DCE signalling of incoming call (state 8)	Change of state to *Call accepted* (state 9)	The DTE is noted as not answering. The DCE will signal *Ready* (state 1)
60 s (See Note 3)	T14B			
100 ms	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 21)
100 ms	T16	Change of state to *DCE Ready* (state 21)	Change of state to *Ready* (state 1)	DCE will mark the DTE as *Uncontrolled not ready* (state 21)

Note 1. – T11 and T13 does not apply in case of a direct call.
Note 2. – This time-out value is a subject for further study with the objective of reducing it in the future to 100 ms.
Note 3. – T14B will be provided when manual answering DTEs are allowed.

ANNEX 4

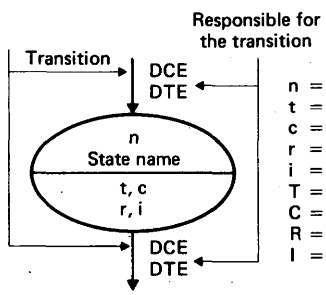
(to Recommendation X.21)

Definition of symbols used in the state diagrams

Each state is represented by an ellipse wherein the state name and number is indicated, together with the signals on the four interchange circuits which represent that state.

Each state transition is represented by an arrow and the equipment responsible for the transition (DTE or DCE) is indicated beside that arrow.

A rectangle represents a sequence of states and transitions.



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

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D	= DTE to DTE data signals
0 and 1	= refer to steady binary conditions
01	= refers to alternate binary 0 and binary 1 conditions
X	= any value
OFF and ON	= respectively refer to continuous OFF (binary 1) and ON (binary 0) conditions
IA5	= International Alphabet No. 5 (Recomendations V.3 and X.4)
Any state	= includes all states during call establishment and data transfer

ANNEX 5

(to Recommendation X.21)

Formats of Selection, Call progress, and line identification signals

The following description uses Backus Normal Form as the formalism for syntactic description, for example as in ISO Recommendation R 1538 [3]. A vertical line " | " separates alternatives.

<*Selection Sequence*> : : = <Facility Request Block> < – > <Address Block> < + > |
<Facility Request Block> < – > < + > | <Address Block> < + >

<Facility Request Block> : : = <Facility Request Signal> | <Facility Request Block>
< , > <Facility Request Signal>

<Address Block> : : = <Address Signal> | <Address Block> < , > <Address Signal>

<Address> : : = <Full Address Signal> | < . > <Abbreviated Address Signal>

[3] ISO Recommendation R 1538: Programming Language "ALGOL", March 1972.

<*Call Progress Block*> : : = <Call Progress Signal> < + > | <Call Progress Signal> < , > <Call Progress Block>

<*Calling Line Identification*> : : = <*> <Calling Line Identification Signal> < + >

<*Called Line Identification*> : : = <*> <Called Line Identification Block> < + >

<Called Line Identification Block> : : = <Called Line Identification Signal> | <Called Line Identification Block> < , > <Called Line Identification Signal>

<*> : : = 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

<Facility Request Signal> <Full Address Signal> <Abbreviated Address Signal> <Call Progress Signal> <Calling Line Identification Signal> <Called Line Identification Signal>	Subject of another Recommendation (not yet available)

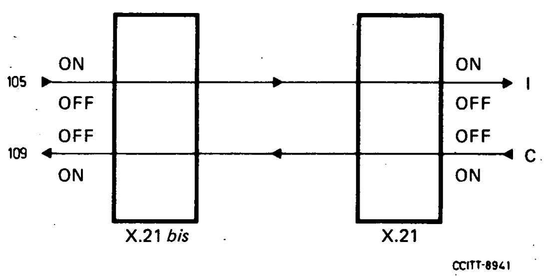
ANNEX 6

(to Recommendation X.21)

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

Interworking between V-Series DTEs connected to a public data network according to Recommendation X.21 *bis* at one end and Recommendation X.21 DTEs at the other end should always be possible for DTEs not requiring half-duplex transmission at the Recommendation X.21 *bis* interface, i.e. V-Series DTEs which do not require circuit 109 to be OFF before transmission can commence.

In addition to this, certain Administrations may also provide facilities allowing DTEs to use half-duplex transmission according to the figure below.



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.

Recommendation X.21 *bis*

USE ON PUBLIC DATA NETWORKS OF DATA TERMINAL EQUIPMENTS (DTEs) WHICH ARE DESIGNED FOR INTERFACING TO SYNCHRONOUS V-SERIES MODEMS

(Geneva, 1976)

CONTENTS

Preface

The CCITT

considering that

a) the interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for synchronous operation on public data networks is specified in Recommendation X.21;

b) several Administrations are also planning to provide as an interim measure the connection to public data networks of synchronous DTEs which are designed for interfacing to synchronous V-Series modems;

c) the international standardization of the implementation of such connection, if provided, is of great importance, *unanimously declares the following view:*

1. The connection of DTEs with V-Series-type interface to public data network may allow for:

i) leased circuit service,

ii) direct call facility,

iii) address call facility.

2. This Recommendation defines operational modes and optional features. It is left to the discretion of each Administration to decide which optional features to implement. When implemented they should be in accordance with this Recommendation.

The Recommendation specifies the operation at the interface when the data circuit interconnects V-Series DTEs. Interworking between V-Series DTEs and X.21 DTEs is described in Annex 1.

1. *The use of V-series DTEs for leased circuit service*

1.1 *General*

V-Series DTEs utilizing the leased circuit service in public data networks is discussed in the following.

The data signalling rates are those defined in Recommendation X.1 for user classes of service employing synchronous mode of transmission across the interface.

1.2 *Use of interchange circuits*

The electrical characteristics of the interchange circuits at the DCE side of the interface comply with Recommendation V.28 using the 25-pin connector and pin allocation standardized by ISO (DIS 2110.2).

The electrical characteristics of the interchange circuits at the DTE side of the interface may be applied according to Recommendation V.28 or Recommendation X.26 as specified in the ISO standard for the assignments of the 37-pin interface connector (ISO DIS 4902).

For applications of the data signalling rate of 48 kbit/s, indications concerning the connector and electrical characteristics at both the DCE side and the DTE side of the interface are given in the ISO standard for the assignment of the 34-pin interface connector (ISO IS 2593) and in Recommendation V.35 respectively.

Table 1/X.21 *bis* shows the use of interchange circuits for the leased circuit service.

TABLE 1/X.21 *bis*

V.24 interchange circuit No.	Designation
102	Signal ground or common return
103	Transmitted data
104	Received data
105	Request to send
106	Ready for sending
107	Data set ready (See Note 1)
108.1	Connect data set to line (See Notes 2 and 3)
109	Data channel received line signal detector
114	Transmitter signal element timing (DCE) (See Note 4)
115	Receiver signal element timing (DCE) (See Note 4)
142	Test indicator (DCE) (See Note 5)

All these circuit functions are in accordance with Recommendation V.24 and the appropriate modem Recommendations (see also 1.2.1 below).

Note 1. – Circuit 107 shall go OFF only in cases of DCE power-off (normally the indeterminate state is interpreted as OFF), loss of service (see paragraph 3.2 below) or when circuit 108.1, when implemented, is turned OFF.

Note 2. – Not required for V.35 compatible interface.

Note 3. – The DCE interprets the ON condition on circuit 108.1, when implemented, as an indication that the DTE is operational. If circuit 108.1 is not provided the DCE will consider the lack of circuit 108.1 as ON condition. The DCE turns circuit 107 ON while circuit 108.1, if present, is ON and the circuit connection is available.

Note 4. – The DCE shall provide the DTE with transmitter and receiver signal element timings, this is done by feeding circuits 114 and 115 with the same timing signal from the DCE.

Note 5. – This circuit is used to indicate to the DTE the test mode status of the DCE. The ON condition indicates that the DCE is in a test mode, precluding transmission of data to a remote DTE. The OFF condition indicates that the DCE is in the non-test mode with no test in progress.

1.2.1 *Operational requirements*

i) *Half-duplex facility*

When the half-duplex facility is provided for the DTE, in order to take care of those DTEs which do require circuit 109 to be OFF before circuit 105 can be turned ON, circuit 105 shall be able to control circuit 109 at the other end, so that circuit 109 OFF can be used as an indication to the DTE that it can turn circuit 105 ON.

Note. – Attention is drawn to the fact that, although circuit 105 can control circuit 109 at the other end, in case of the half-duplex facility, the detection of a line signal should be replaced by some other control mechanism.

ii) *Response times*

The response time of the OFF to ON transition of circuit 106 as a response to circuit 105 OFF to ON should provisionally be between 30 and 50 ms for the 600 bit/s user rate, and 10 to 20 ms for the higher user rate.

iii) *Clamping*

The following conditions apply:

- In the event of line failure (e.g. channel out of service, loss of alignment) the DCE shall clamp circuit 104 to steady binary 1 condition and circuit 109 to OFF condition.
- In all applications the DCE shall hold circuit 104 in binary 1 condition, when circuit 109 is in the OFF condition.
- In addition, when the half-duplex facility is provided, the DCE shall hold circuit 104 in the binary 1 condition and circuit 109 in the OFF condition when circuit 105 is in the ON condition.

iv) *Timing arrangements*

Timing signals on circuits 114 and 115 should always be maintained when the DCE is capable of generating them, disregarding the conditions of the other circuits. Circuit 114 and 115 should be held by the DCE in the OFF condition when the DCE is unable to generate the timing information.

2. *The use of V-Series DTEs for direct call and address call facilities*

2.1 *General*

V-Series DTEs utilizing the direct call or the address facility in public data networks is discussed in the following.

The data signalling rates are those defined in Recommendation X.1 for user classes of service employing synchronous mode of transmission across the interface.

2.2 *Use of interchange circuits*

The electrical characteristics of the interchange circuits at the DCE side of the interface comply with Recommendation V.28 using the 25-pin connector and pin allocation standardized by ISO (DIS 2110.2). The electrical characteristics of the interchange circuits at the DTE side of the interface may be applied according to Recommendation V.28 or Recommendation X.26 as specified in the ISO standard for the assignments of the 37-pin interface connector (ISO DIS 4902).

For applications of the data signalling rate of 48 kbit/s, indications concerning the connector and electrical characteristics at both the DCE side and the DTE side of the interface are given in the ISO standard for the assignment of the 34-pin interface connector (ISO IS 2593) and in Recommendation V.35 respectively.

For further definitions of the interchange circuits than outlined below, refer to Recommendation V.24 and the appropriate V-Series modem Recommendations.

2.2.1 *Call establishment and disconnection phases*

The following interchange circuits should be used for control signalling in the call establishment and disconnection phases:

Circuit 102 – Signal ground or common return

Circuit 107 – Data set ready

This circuit is used to indicate the following operational functions.

Condition of circuit 107	Function in the network
ON	Ready for data
OFF	DCE Clear indication (See 2.2.1.1)
OFF	DCE Clear confirmation

Circuit 108.1 Connect data set to line

This circuit is used alternatively to circuit 108.2. The following operational functions should be indicated.

Condition of circuit 108.1	Function in the network
ON	Call request
ON	Call accepted
OFF	DTE Clear request
OFF	DTE Clear confirmation (See 2.2.1.1)

A DTE receiving an incoming call should turn circuit 108.1 ON to indicate *Call accepted* within 500 ms, otherwise the call will be cleared.

Circuit 108.2 Data terminal ready

This circuit is used alternatively to circuit 108.1. The following operational functions should be indicated.

Condition of circuit 108.2	Function in the network
ON	Call accepted
OFF	DTE Clear request
OFF	DTE Clear confirmation (See 2.2.1.1)

When a DTE with circuit 108.2 OFF receives an incoming call the DTE should turn circuit 108.2 from OFF to ON within 500 ms to indicate *Call accepted*, otherwise the call will be cleared.

Optionally where a DTE does not provide circuit 108.1 or 108.2, normally the *Call accepted* signal would be generated within the DCE as an answer to incoming call received from the network. However it is possible to signal to the network *DTE Controlled not ready* by a manual action on the DCE.

It is not mandatory for the DTE to turn circuit 108.2 OFF to give clear confirmation. Optionally in the case of DTEs not providing circuit 108 or unable to use circuit 108.2 for disconnection the *Clear confirmation* signal would be generated within the DCE as an answer to *Clear indication* received from the network.

Circuit 114 – Transmitter signal element timing (DCE)

Circuit 115 – Receiver signal element timing (DCE)

The DCE shall provide the DTE with transmitter and receiver element timings. This is done by feeding circuits 114 and 115 with the same timing signal from the DCE.

Circuit 125 – Calling indicator

The ON condition indicates Incoming Call. The circuit will be turned OFF in conjunction with circuit 107 turned ON or when DCE *Clear indication* is received.

Circuit 142 – Test indicator

Direction: from DCE

This circuit is used to indicate to the DTE the test-mode status of the DCE.

2.2.1.1 *Operational requirements*

i) *DCE Clear indication*

DCE Clear indication to the DTE, when implemented, is signalled to the DTE by turning circuit 107 OFF. *DTE Clear confirmation* should be given by the DTE within 50 ms after *DCE Clear indication* is received on circuit 107.

However, not all DTEs allow circuit 107 to be turned OFF if circuit 108 has not been turned OFF previously. In this case the Administration will not insist that the DCE will turn 107 OFF to indicate to the DTE that the connection has been cleared down, unless circuit 108 has been turned OFF. The implications of the latter case are for further study.

ii) *Line identification*

Calling and *Called line identification* signals cannot be handled by V-Series DTEs.

iii) *Call progress signals*

Call progress signals cannot be handled by V-Series DTEs. If automatic address calling is provided in accordance with Recommendation V.25 the reception of negative *Call progress signals* will be indicated to the DTE on circuit 205.

2.2.2 *Data transfer phase*

The interchange circuits shown in Table 2/X.21 *bis* should be used in the data transfer phase.

TABLE 2/X.21 *bis*

V.24 Interchange circuit No.	Designation
102	Signal ground or common return
103	Transmitted data
104	Received data
105	Request to send
106	Ready for sending
109	Data channel received line signal detector
114	Transmitter signal element timing (DCE) (See Note 1)
115	Receiver signal element timing (DCE) (See Note 1)

All the circuit functions are in accordance with Recommendation V.24 and the appropriate modem Recommendations.

Note 1. – The DCE shall provide the DTE with transmitter and receiver element timings. This is done by feeding circuits 114 and 115 with the same timing signal from the DCE.

2.2.2.1 *Operational requirement*

i) *Half-duplex facility*

When the half-duplex facility is provided for the DTE, circuit 105 shall be able to control circuit 109 at the other end, so that circuit 109 OFF can be used as an indication to the DTE that it can turn circuit 105 ON.

ii) *Response times*

The response time of the OFF to ON transition of circuit 106 as a response to circuit 105 OFF to ON should provisionally be between 30 and 50 ms for the 600 bit/s user rate, and 10 to 20 ms for the higher user rate.

iii) *Clamping*

The following conditions shall apply:

- In the event of line failure (e.g. channel out of service, loss of alignment) the DCE shall clamp circuit 104 to steady binary 1 condition and circuit 109 to OFF condition.
- In all applications the DCE shall hold circuit 104 in binary 1 condition, when circuit 109 is in the OFF condition.
- In addition, when the half-duplex facility is provided, the DCE shall hold circuit 104 in the binary 1 condition and circuit 109 in the OFF condition when circuit 105 is in the ON condition.

iv) *Timing arrangements*

Timing signals on circuits 114 and 115 should always be maintained when the DCE is capable of generating them, disregarding the conditions of the other circuits. Circuit 114 and 115 should be held by the DCE in the OFF condition when the DCE is unable to generate the timing information.

Continuous isochronous operation should be used.

2.3 *Operational modes*

2.3.1 *Direct call facility*

The following operational modes may be provided for:

i) Automatic direct call and automatic disconnection from DTE. Circuit 108.1 should be used.

ii) Manual direct call from DCE and automatic disconnection from DTE. Circuit 108.2 should be used.

iii) Manual direct call and manual disconnection from DCE. For DTEs not providing circuit 108 or unable to use circuit 108.2 for disconnection.

Only automatic call answering controlled by circuit 108.1 or 108.2 when provided, or automatically within the DCE itself should be implemented. However in the last case it is possible to signal to the network *DTE Controlled not ready* by a manual action on the DCE.

Note. – Consideration of manual answering and the implications of manual *DTE Clear confirmation* are for further study.

2.3.2 *Address call facility*

The following operational modes may be provided for:

i) Manual address calling from DCE and automatic disconnection from DTE. Circuit 108.2 should be used.

ii) Manual address calling and manual disconnection from DCE. For DTEs not providing circuit 108.1 or 108.2 or unable to use circuit 108.2 for disconnection.

Only automatic answering controlled by circuit 108.2 when provided, or automatically within the DCE itself should be implemented. However in the last case it is possible to signal to the network *DTE Controlled not ready* by a manual action on the DCE.

iii) Automatic address calling and automatic disconnection from DTE if provided, should use the 200 series interchange circuits and the V.25 relevant procedures. The spare control characters on the digit signal circuits 206-209 may be used for special purposes (e.g. start of prefix, prefix separator, start of address) during the selection sequence.

3. *Failure detection and isolation*

3.1 *Indeterminate conditions on interchange circuits*

If the DTE or DCE is unable to determine the condition of circuits 105, 107, 108.1 or 108.2 and possibly circuits 103 and 104 as specified in the relevant electrical interfaces specifications it shall interpret this as OFF condition or binary 1 (circuits 103 and 104).

3.2 *DCE fault conditions*

If the DCE is unable to provide service (e.g. loss of alignment or of incoming line signal) for a period longer than a fixed duration it will turn circuit 107 to the OFF condition. The value of this duration has to be defined after further study.

Moreover, as soon as the DCE detects this condition it turns circuit 109 in the OFF condition and circuit 104 in the binary 1 condition.

3.3 *Test loops*

3.3.1 *Test of the DTE*

In order to assist the test of the DTE, and specifically of the interconnecting cable, a loop is provided in the DCE where the signals transmitted on circuits 103 and 105 are presented on circuits 104 and 109 respectively. Circuit 106 should follow circuit 105 with or without the usual delay. Circuit 107 should be ON. Additionally, circuit 142 should be ON whilst the loop is activated.

In circuit switched service, as described in 2. above, any existing connection with a remote station should be cleared by the DCE when the loop is activated.

The loop should be near the DCE/DTE interface. The DCE drivers and terminators may be included in the loop. The precise implementation of the loop within the DCE is a national option. Manual control should be provided on the DCE for activation of the loop.

3.3.2 *Network maintenance*

For network maintenance purposes a loop is implemented in the DCE: signals incoming from the network towards circuits 104 and 109 are diverted from these circuits and looped back to the network in place of signals from circuits 103 and 105 respectively.

The loop may be controlled manually on the DCE or automatically by the network. The control of the loop and the method used for the automatic control, when implemented, is a national option.

In the circuit switched service the loop should not be activated when the DTE is engaged in a call. The loop may be activated by the network without the knowledge and agreement of the DTE for periods which do not exceed one second.

In the leased circuit service the loop should not be activated before the customer has been informed of it. Some Administrations may activate the loop when abnormal conditions are detected in the network without first informing the customer.

When the test is in progress the DCE will turn circuits 107 and 109 in the OFF condition, circuit 104 in the binary 1 condition and circuit 142 in the ON condition.

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

3.4 *Tolerance of the signal element timing signal under fault conditions*

The signal element timing signal is delivered to the DTE on circuits 114 and 115 whenever possible.

In particular, it is delivered to the DTE when one of the loops described in 3.3 above is activated or when the DCE loses alignment or incoming line signal. The tolerance of the signal element timing will be ± 1%.

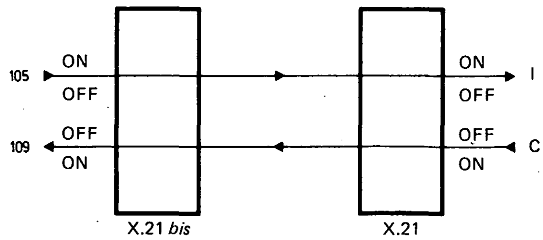
ANNEX

(to Recommendation X.21 *bis*)

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

Interworking between V-Series DTEs connected to a public data network according to Recommendation X.21 *bis* at one end and X.21 DTEs at the other end should always be possible for DTEs not requiring half-duplex transmission at the X.21 *bis* interface, i.e. V-Series DTEs which do not require circuit 109 to be OFF before transmission can commence.

In addition to this, certain Administrations may also provide facilities allowing DTEs to use half-duplex transmission according to the figure below.



Those Administrations not providing this facility shall cause the X.21 DCE to signal r = 1, i = ON when the 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.

Recommendation X.24

LIST OF DEFINITIONS FOR INTERCHANGE CIRCUITS BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) ON PUBLIC DATA NETWORKS

(Geneva, 1976)

CONTENTS

Introduction

The CCITT

considering that

a) the interface between DTE and DCE on public data neworks requires, in addition to the electrical and functional characteristics of the interchange circuits, the definition of procedural characteristics for call control functions and selection of the facilities according to Recommendation X.2;

b) the functions of the circuits defined in Recommendation V.24 are based on the requirements of data transmission over the general telephone network and are not appropriate for use at DTE/DCE interfaces in public data networks;

expresses the view that

a new Recommendation to include the list of definitions of interchange circuits for use in public data networks is required.

1. *Scope*

1.1 This Recommendation applies to the functions of the interchange circuits provided at the interface between DTE and DCE of data networks for the transfer of binary data, call control signals and timing signals.

For any type of practical equipment, a selection will be made from the range of interchange circuits defined in this Recommendation, as appropriate. The actual interchange circuits to be used in a particular DCE for a user class of service according to Recommendation X.1 and defined user facilities according to Recommendation X.2, are those indicated in the relevant Recommendation for the procedural characteristics of the interface, e.g., Recommendation X.20 or X.21.

To enable a standard DTE to be developed, the use and termination by the DTE of certain circuits even when implemented in the DCE are not mandatory. This is covered by the individual interface Recommendations.

The interchange circuits defined for the transfer of binary data are also used for the exchange of call control signals.

The electrical characteristics of the interchange circuits are detailed in the appropriate Recommendation for electrical characteristics of interchange circuits. The application of those characteristics for a particular DCE is specified in the Recommendation for the procedural characteristics of the interface.

1.2 The range of interchange circuits defined in this Recommendation is applicable to the range of services which could be offered on a public data network, e.g., circuit switching services (synchronous and start/stop), telex service, packet switching services, message registration and retransmission service and facsimile service.

2. *Line of demarcation*

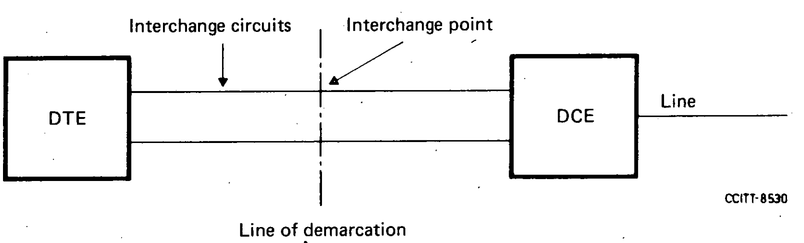


FIGURE 1/X.24 – **General illustration of interface equipment layout**

The interface between DTE and DCE is located at a connector which is the interchange point between these two classes of equipment shown in Figure 1/X.24.

2.1 The connector will not necessarily be physically attached to the DCE and may be mounted in a fixed position near the DTE. The female part of the connector belongs to the DCE.

2.2 An interconnecting cable will normally be provided together with the DTE. The cable length is limited by electrical parameters specified in the appropriate Recommendations for the electrical characteristics of the interchange circuits.

3. *Definition of interchange circuits*

A list of the data network series interchange circuits is presented in tabular form in Table 1/X.24.

Circuit G – Signal ground or common return

This conductor establishes the signal common reference potential for unbalanced double-current interchange circuits with electrical characteristics according to Recommendation V.28. In case of interchange circuits according to Recommendations X.26 and X.27, it interconnects the zero volt reference points of a generator and a receiver to reduce environmental signal interference, if required.

TABLE 1/X.24 – **Data network interchange circuits**

Interchange circuit designation	Interchange circuit name	Data		Control		Timing	
		From DCE	To DCE	From DCE	To DCE	From DCE	To DCE
G	Signal ground or common return						
Ga	DTE common return				X		
Gb	DCE common return			X			
T	Transmit		X		X		
R	Receive	X		X			
C	Control				X		
I	Indication			X			
S	Signal element timing					X	
B	Byte timing					X	

Within the DCE, this conductor shall be brought to one point, protective ground or earth, by means of a metallic strap within the equipment. This metallic strap can be connected or removed at installation, as may be required to minimize the introduction of noise into electronic circuitry or to meet applicable regulations.

Note. – Where a shielded interconnecting cable is used at the interface, the shield may be connected either to circuit G, or to protective ground in accordance with national regulations. Protective ground may be further connected to external grounds as required by applicable electrical safety regulations.

For unbalanced interchange circuits with electrical characteristics in accordance with Recommendation X.26, two common-return conductors are required, one for each direction of signalling, each conductor being connected to ground only on the generator side of the interface. Where used, these shall be designated circuits Ga and Gb, and they are defined as follows:

Circuit Ga – DTE common return

This conductor is connected to the DTE circuit common and is used as the reference potential for the unbalanced X.26 type interchange circuit receivers within the DCE.

Circuit Gb – DCE common return

This conductor is connected to the DCE circuit common and is used as the reference potential for the unbalanced X.26 type interchange circuit receivers within the DTE.

Circuit T – Transmit

Direction: To DCE

The binary signals originated by the DTE to be transmitted during the data transfer phase via the data circuit to one or more remote DTEs are transferred on this circuit to the DCE.

This circuit also transfers the call control signals originated by the DTE, to be transmitted to the DCE in the call establishment and other call control phases as specified by the relevant Recommendations for the procedural characteristic of the interface.

The DCE monitors this circuit for detection of electrical circuit fault conditions, according to the specifications of the electrical characteristics of the interface. A circuit fault is to be interpreted by the DCE as defined in the Recommendation for the procedural characteristics of the interface.

Circuit R – Receive

Direction: From DCE

The binary signals sent by the DCE as received during the data transfer phase from a remote DTE, are transferred on this circuit to the DTE.

This circuit also transfers the call control signals sent by the DCE as received during the call establishment and other call control phases as specified by the relevant Recommendations for the procedural characteristics of the interface.

The DTE monitors this circuit for detection of electrical circuit fault conditions, according to the specifications of the electrical characteristics of the interface. A circuit fault is to be interpreted by the DTE as defined in the Recommendation for the procedural characteristics of the interface.

Circuit C – Control

Direction: To DCE

Signals on this circuit control the DCE for a particular signalling process.

Representation of a control signal requires additional coding of circuit T-*Transmit* as specified in the relevant Recommendation for the procedural characteristics of the interface. During the data phase, this circuit shall remain ON. During the call control phases, the condition of this circuit shall be as specified in the relevant Recommendation for the procedural characteristics of the interface.

Note. – After appropriate selection of special user facilities (not yet defined), it might be required to change the ON condition after entering the data phase in accordance with the regulations for the use of these facilities. This subject is for further study.

The DCE monitors this circuit for detection of electrical circuit fault conditions, according to the specifications of the electrical characteristics of the interface. A circuit fault is to be interpreted by the DCE as defined in the Recommendation for the procedural characteristics of the interface.

Circuit I – Indication

Direction: From DCE

Signals on this circuit indicate to the DTE the state of the call control process.

Representation of a control signal requires additional coding of circuit R-*Receive*, as specified in the relevant Recommendation for the procedural characteristics of the interface. The ON condition of this circuit signifies that signals on circuit R contain information from the distant DTE. The OFF condition signifies a control signalling condition which is defined by the bit sequence on circuit R as specified by the procedural characteristics of the interface.

The DTE monitors this circuit for detection of electrical circuit fault conditions, according to the specifications of the electrical characteristics of the interface. A circuit fault is to be interpreted by the DTE as defined in the Recommendation for the procedural characteristics of the interface.

Note. – For use with special user facilities (not yet defined) it might be required to use the OFF condition after entering the data transfer phase in accordance with the regulations for the use of these facilities. This subject is for further study.

Circuit S – Signal element timing

Direction: From DCE

Signals on this circuit provide the DTE with signal element timing information. The condition of this circuit shall be ON and OFF for nominally equal periods of time. However, for burst isochronous operations, longer periods of OFF condition may be permitted equal to an integer odd number of the nominal period of the ON condition as specified by the relevant procedural characteristics of the interface.

The DTE shall present a binary signal on circuit T-*Transmit* and a condition on circuit C-*Control*, in which the transitions nominally occur at the time of the transitions from OFF to ON condition of this circuit.

The DCE presents a binary signal on circuit R-*Receive* and a condition on circuit I-*Indication* in which the transitions nominally occur at the time of the transitions from OFF to ON condition of this circuit.

The DCE shall transfer signal element timing information on this circuit across the interface at all times that the timing source is capable of generating this information.

Circuit B – Byte timing (see Note 2)

Direction: From DCE

Signals on this circuit provide the DTE with 8-bit byte timing information. The condition of this circuit shall be OFF for nominally the period of the ON condition of circuit S-*Signal element timing* which indicates the last bit of an 8-bit byte and shall be ON at all other times within the period of the 8-bit byte.

During the call control phases, the call control characters and steady state conditions used for all information transfers between the DCE and the DTE, in either direction, shall be correctly aligned to the signals of circuit B.

The DTE shall present the beginning of the first bit of each call control character on circuit T-*Transmit* nominally at the time of the OFF to ON transition of circuit S which follows the OFF to ON transition of circuit B.

A change of condition of circuit C-*Control* may occur at any OFF to ON transition of circuit S, but it will be sampled in the DCE at the time of the OFF to ON transition of circuit B, i.e., for evaluation of the following call control character on circuit T.

The centre of the last bit of each call control character will be presented by the DCE on circuit R-*Receive* nominally at the time of the OFF to ON transition of circuit B.

A change of condition of circuit I-*Indication* will occur nominally at the OFF to ON transition of circuit S which follows the OFF to ON transition of circuit B.

The DCE shall transfer byte timing information on this circuit across the interface at all times that the timing source is capable of generating this information.

Note 1. – During the data transfer phase, DTEs communicating by means of an 8-bit code may utilize the byte timing information for mutual character alignment.

It is a prerequisite for the provision of this feature that character alignment is preserved after the call has entered the data transfer phase and that the alignment obtained at one interface is synchronized to the alignment at the other interface. (This is only possible on some connections.)

Furthermore, where this feature is available, a change of condition on circuit C as defined above may result in an equivalent change in the relative alignment on circuit I at the distant interface.

Note 2. – In some Recommendations for the procedural characteristics of the interface (e.g., X.21), the use and termination of this circuit by the DTE is not mandatory even when implemented in the DCE.

Recommendation X.25

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR TERMINALS OPERATING IN THE PACKET MODE ON PUBLIC DATA NETWORKS *

(Geneva, 1976)

The establishment in various countries of public data networks providing packet-switched data transmission services creates a need to produce standards to facilitate international interworking.

The CCITT,

considering

a) that Recommendation X.1 includes specific user classes of service for data terminal equipments operating in the packet mode, Recommendation X.2 defines user facilities, Recommendations X.21 and X.21 *bis* define DTE/DCE interface characteristics, Recommendation X.95 defines network parameters, and Recommendation X.96 defines call progress signals;

b) that the logical control links for packet-switched data transmission services are defined in Recommendation X.92;

c) the need for defining an international recommendation for the exchange between DTE and DCE of control information for the use of packet-switched data transmission services;

d) that data terminal equipments operating in the packet mode will send and receive network call control information and user information in the form of packets;

e) that the necessary elements for an interface recommendation should be defined independently as:

Level 1 – The physical, electrical, functional and procedural characteristics to establish, maintain and disconnect the physical link between the DTE and the DCE.

Level 2 – The link access procedure for data interchange across the link between the DTE and the DCE.

Level 3 – The packet format and control procedures for the exchange of packets containing control information and user data between the DTE and the DCE.

f) that certain data terminal equipments operating in the packet mode will use a packet interleaved, synchronous data circuit;

g) the desirability of being able to use a single data circuit to a DSE for all user facilities;

unanimously declares the view

that for data terminal equipments operating in the packet mode:

1. The physical, electrical, functional and procedural characteristics to establish, maintain and disconnect the physical link between the DTE and the DCE should be as specified in 1. below *Level 1 DTE/DCE interface characteristics*, see below.

* This Recommendation has been subject to revision by Study Group VII in April, 1977 and application of the accelerated approval procedure (Resolution No. 2, VIth Plenary Assembly, Geneva, 1976) has been requested. If approved by Member Administrations, an updated version of the Recommendation will be published under separate cover.

2. The link access procedure for data interchange across the link between the DTE and the DCE should be as specified in 2. below *Link access procedure across the DTE/DCE interface (level 2)*, see below.

3. The packet level control procedures for the exchange of call control information and user data at the DTE/DCE interface should be as specified in 3. below *Description of the packet level DTE/DCE interface for virtual call and permanent virtual circuit facilities (level 3)*, see below.

4. The format for packets exchanged between the DTE and the DCE should be as specified in 4. below *Packet formats for virtual call and permanent virtual circuit facilities*, see below.

5. Procedures and formats for optional user facilities should be as specified in 5. below *Procedures and formats for optional user facilities to be studied for virtual call and permanent virtual circuit facilities*, see below.

Note. – It is for further study whether alternative procedures for levels 2 and 3 of Recommendation X.25 would be advantageously introduced for cases where packet-switched facilities are accessed through circuit-switched connections.

INDEX TO RECOMMENDATION X.25

1. LEVEL 1 DTE/DCE INTERFACE CHARACTERISTICS

The DTE/DCE interface characteristics defined as the level 1 element shall be in accordance with Recommendation X.21 for user classes of service 8 to 11. For an interim period, some Administrations may offer a DTE/DCE interface at this level in accordance with Recommendation X.21 *bis*, for user classes of service 8 to 11.

Note. – The level 1 DTE/DCE interface also includes the failure detection and isolation procedures as defined in Recommendation X.21 or X.21 *bis*.

2. LINK ACCESS PROCEDURE ACROSS THE DTE/DCE INTERFACE (LEVEL 2)

2.1 *Scope and field of application*

2.1.1 The Link Access Procedure (LAP) described hereunder is used for data interchange between a DCE and a DTE operating in user classes of service 8 to 11 as indicated in Recommendation X.1.

2.1.2 The procedure uses the principle and terminology of the High Level Data Link Control (HDLC) procedure specified by the International Organization for Standardization (ISO).

Note. – Reference ISO documents DIS 3309.2 and DIS 4335. When the study on the part of HDLC applicable to LAP is completed and agreed by ISO in cooperation with the CCITT, the LAP specification for level 2 will be appropriately completed with the objective of achieving general compatibility with ISO HDLC.

2.1.3 The transmission facility is full duplex.

2.1.4 The application is defined as two-way simultaneous Asynchronous Response Mode (ARM).

Both the DTE and DCE contain a primary and secondary function.

Note 1. – Other possible applications are for further study, e.g.

– two-way alternate asynchronous response mode,

– two-way simultaneous, normal response mode,

– two-way alternate, normal response mode.

Note 2. – Allocation of primary and secondary functions other than as specified above is a subject for further study.

2.2 *Frame structure*

2.2.1 All transmissions are in frames conforming to one of the formats of Table 1/X.25. The flag preceding the address field is defined as the opening flag.

TABLE 1/X.25 – Frame formats

Bit order of transmission	12345678	12345678	12345678	16 to 1	12345678
	Flag	Address	Control	FCS	Flag
	F 01111110	A 8-bits	C 8-bits	FCS 16-bits	F 01111110

FCS = Frame Checking Sequence

Bit order of transmission	12345678	12345678	12345678		16 to 1	12345678
	Flag	Address	Control	Information	FCS	Flag
	F 01111110	A 8-bits	C 8-bits	I N-bits	FCS 16-bits	F 01111110

FCS = Frame Checking Sequence

2.2.2 *Flag sequence*

All frames shall start and end with the flag sequence consisting of one 0 followed by six contiguous 1s and one 0. A single flag may be used as both the closing flag for one frame and the opening flag for the next frame.

2.2.3 *Address field*

The address field shall consist of one octet. The coding of the address field is described in 2.4.1 below.

2.2.4 *Control field*

The control field shall consist of one octet. The content of this field is described in 2.3.2 below.

Note. – The use of the extended control field is a subject for further study.

2.2.5 *Information field*

The information field of a frame is unrestricted with respect to code or grouping of bits.

See 2.3.4.8 and 2.4.7.3 below with regard to the maximum information field length.

2.2.6 *Transparency*

The DTE or DCE, when transmitting, shall examine the frame content between the two flag sequences including the address, control and FCS sequences and shall insert a 0 bit after all sequences of 5 contiguous 1 bits (including the last 5 bits of the FCS) to ensure that a flag sequence is not simulated. The DTE or DCE, when receiving, shall examine the frame content and shall discard any 0 bit which directly follows 5 contiguous 1 bits.

2.2.7 *Frame checking sequence (FCS)*

The FCS shall be a 16-bit sequence. It shall be the ones complement of the sum (modulo 2) of:

1. the remainder of $x^k(x^{15} + x^{14} + x^{13} + \ldots + x^2 + x + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency, and

2. the remainder after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the content of the frame, existing between but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

As a typical implementation, at the transmitter, the initial remainder of the division is preset to all ones and is then modified by division by the generator polynomial (as described above) on the address, control and information fields; the ones complement of the resulting remainder is transmitted as the 16-bit FCS sequence.

At the receiver, the initial remainder is preset to all ones, and the serial incoming protected bits and the FCS when divided by the generator polynomial will result in a remainder of 0001110100001111 (x^{15} through x^0, respectively) in the absence of transmission errors.

2.2.8 *Order of bit transmission*

Addresses, commands, responses and sequence numbers shall be transmitted with the low order bit first (for example the first bit of the sequence number that is transmitted shall have the weight 2^0).

The order of transmitting bits within the information field is not specified under 2. of this Recommendation. The FCS shall be transmitted to the line commencing with the coefficient of the highest term.

Note. – The low order bit is defined as bit 1, as depicted in Tables 2/X.25, 3/X.25 and 4/X.25.

2.2.9 *Invalid frames*

A frame not properly bounded by two flags, or having fewer than 32 bits between flags, is an invalid frame.

2.2.10 *Frame abortion*

Aborting a frame is performed by transmitting at least seven contiguous one bits (with no inserted zeros).

2.2.11 *Interframe time fill*

Interframe time fill is accomplished by transmitting contiguous flags between frames.

2.2.12 *Link channel states*

2.2.12.1 *Active channel state*

A channel is in an active condition when the DTE or DCE is actively transmitting a frame, an abortion sequence or interframe time fill.

2.2.12.2 *Idle channel state*

A channel is defined to be in an idle condition when a contiguous ones state is detected that persists for at least 15 bit times.

The action to be taken upon detection of the idle channel state is subject for further study.

Note. — A link channel as defined here is the means of transmission for one direction.

2.3 *Elements of procedure*

2.3.1 The elements of procedure are defined in terms of actions that occur on receipt of commands at a secondary.

The elements of procedures specified hereunder contain a selection of commands and responses relevant to the link and system configuration described in 2.1 above.

A procedure is derived from these elements of procedure and is described in 2.4 below. Together 2.2 and 2.3 form the general requirements for the proper management of the access link.

2.3.2 *Control field formats and state variables*

2.3.2.1 *Control field formats*

The control field contains a command or a response, and sequence numbers where applicable.

Three types of control field formats (see Table 2/X.25) are used to perform numbered information transfer (I Frames), numbered supervisory functions (S Frames) and unnumbered control functions (U Frames).

Information transfer format — I

The I format is used to perform an information transfer. The functions of N(S), N(R) and P/F are independent; i.e. each I Frame has an N(S) sequence number, an N(R) sequence number which may or may not acknowledge additional frames received by the DTE or DCE, and a P/F bit.

Supervisory format — S

The S format is used to perform link supervisory control functions such as acknowledge information frames, request retransmission of information frames, and to request a temporary suspension of transmission of information frames.

TABLE 2/X.25 – **Control field formats**

Control field bits	1	2	3	4	5	6	7	8
I Frame	0		N(S)		P/F		N(R)	
S Frame	1	0	S		P/F		N(R)	
U Frame	1	1	M		P/F		M	

N(S) = transmitter send sequence count (Bit 2 = Low order bit)
N(R) = transmitter receive sequence count (Bit 6 = Low order bit)
S = supervisory function bits
M = modifier function bits
P/F = poll bit when issued by the primary station, final bit when issued by the secondary station. (1 = Poll/Final)

Unnumbered format – U

The U format is used to provide additional link control functions. This format contains no sequence numbers. The encoding of the unnumbered commands is as defined in Table 3/X.25.

2.3.2.2 *Control field parameters*

The various parameters associated with the control field formats are described in the following sections.

2.3.2.3 *Modulus*

Each information frame is sequentially numbered and may have the value 0 through modulus minus one (where "modulus" is the modulus of the sequence numbers). The modulus equals 8 and the sequence numbers cycle through the entire range.

2.3.2.4 *Frame variables and sequence numbers*

2.3.2.4.1 *Send state variable V(S)*

The *send state variable* denotes the sequence number of the next in-sequence information frame to be transmitted. The *send state variable* can take on the value 0 through modulus minus one. The value of the *send state variable* is incremented by one with each successive information frame transmission, but cannot exceed N(R) of the last received frame by more than the maximum number of outstanding frames (k). The value of k is defined in 2.4.7.4 below.

2.3.2.4.2 *Send sequence number N(S)*

Only information frames contain N(S), the *send sequence number* of transmitted frames. Prior to transmission of an in-sequence information frame, the value of N(S) is updated to equal the value of the *send state variable.*

2.3.2.4.3 *Receive state variable V(R)*

The *receive state variable* denotes the sequence number of the next in-sequence information frame to be received. This *receive state variable* can take on the values 0 through modulus minus one. The value of the *receive state variable* is incremented by the receipt of an error free, in-sequence information frame whose *send sequence number* N(S), equals the *receive state variable.*

2.3.2.4.4 *Receive sequence number N(R)*

All information frames and supervisory frames contain N(R), the expected sequence number of the next received frame. Prior to transmission of a frame of the above types, the value of N(R) is updated to equal the current value of the *receive state variable.* N(R) indicates that the DTE or DCE transmitting the N(R) has correctly received all information frames numbered up to N(R) – 1.

2.3.3 *Functions of the Poll/Final bit*

The *Poll/Final* (P/F) bit serves a function in both command frames and response frames. In command frames the P/F bit is referred to as the P bit. In response frames it is referred to as the F bit.

The use of the P/F bit is described in 2.4.2 below.

2.3.4 *Commands and responses*

The following commands and responses will be used by either the DTE or DCE and are represented in Table 3/X.25.

TABLE 3/X.25 – **Commands and responses**

Format	Commands	Responses	Encoding							
			1	2	3	4	5	6	7	8
Information transfer	I – Information		0	N(S)			P	N(R)		
Supervisory		RR – Receive ready	1	0	0	0	F	N(R)		
		RNR – Receive not ready	1	0	1	0	F	N(R)		
		REJ – Reject	1	0	0	1	F	N(R)		
Unnumbered	SARM – Set asynchronous response mode		1	1	1	1	P	0	0	0
	DISC – Disconnect		1	1	0	0	P	0	1	0
		UA – Unnumbered acknowledge	1	1	0	0	F	1	1	0
		CMDR – Command reject	1	1	1	0	F	0	0	1

Note. – The need for, and use of, additional commands and responses are for further study.

The commands and responses are as follows:

2.3.4.1 *Information (I) command*

The function of the Information (I) command is to transfer across a data link sequentially numbered frames containing an information field.

2.3.4.2 *Receive ready (RR)*

The receive ready (RR) supervisory frame is used by the secondary to:

1) indicate it is ready to receive an information frame;

2) acknowledge previously received information frames numbered up to N(R) – 1.

RR may be used to clear a busy condition that was initiated by the transmission of RNR.

2.3.4.3 *Reject (REJ)*

The reject (REJ) supervisory frame is used by the secondary to request retransmission of information frames starting with the frame numbered N(R). Information frames numbered N(R) – 1 and below are acknowledged. Additional information frames pending initial transmission may be transmitted following the retransmitted information frame(s).

Only one REJ exception condition for a given direction of information transfer may be established at any time. The REJ exception condition is cleared (reset) upon the receipt of an I frame with an N(S) count equal to the N(R) of the REJ.

2.3.4.4 *Receive not ready (RNR)*

The receive not ready (RNR) supervisory frame is used by the secondary to indicate a busy condition; i.e., temporary inability to accept additional incoming information frames. Information frames numbered up to N(R) – 1 are acknowledged. Information frame N(R) and any subsequent information format frames received, if any, are not acknowledged; the acceptance status of these frames will be indicated in subsequent exchanges. Indication that the busy condition has cleared and information frames will now be accepted is communicated by the transmission of a valid UA, RR, or REJ.

2.3.4.5 *Set asynchronous response mode (SARM) command*

The SARM unnumbered command is used to place the addressed secondary in the Asynchronous Response Mode (ARM).

No information field is permitted with the SARM command. A secondary confirms acceptance of SARM by the transmission at the first opportunity of a UA response (UA). Upon acceptance of this command the secondary *receive state variable* is set to zero.

Previously transmitted frames that are unacknowledged when this command is actioned remain acknowledged.

2.3.4.6 *Disconnect (DISC) command*

The DISC unnumbered command is used to terminate the mode previously set. It is used to inform the secondary that the primary is suspending operation. No information field is permitted with the DISC command. Prior to actioning the command, the secondary confirms the acceptance of DISC by the transmission of a UA response (UA).

Previously transmitted frames that are unacknowledged when this command is actioned remain unacknowledged.

2.3.4.7 *Unnumbered acknowledge (UA) response*

The UA unnumbered response is used by the secondary to acknowledge the receipt and acceptance of the U format commands. Received U format commands are not actioned until the UA response is transmitted. The UA response is transmitted as directed by the received U format command. No information field is permitted with the UA response.

2.3.4.8 *Command reject (CMDR) response*

The CMDR response is used by the secondary to report an error condition not recoverable by retransmission of the identical frame; i.e., one of the following conditions resulted from the receipt of a frame without FCS error from the primary:

1. the receipt of a command that is invalid or not implemented;
2. the receipt of an I frame with an information field which exceeded the maximum established length;
3. the receipt of an invalid N(R) count from the primary;
4. the receipt of an invalid N(S) as defined in 2.4.6.2 below.

An invalid N(R) is defined as a count which points to an I frame which has previously been transmitted and acknowledged or to an I frame which has not been transmitted and is not the next sequential I frame pending transmission.

An information field which immediately follows the control field, and consists of 3 octets, is returned with this response and provides the reason for the CMDR response. This format is given in Table 4/X.25.

TABLE 4/X.25 – **CMDR field format**

Information field bits

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Rejected command Control field								0	N(S)			0	N(R)			W	X	Y	Z	0	0	0	0

- Rejected command control field is the control field of the received frame which caused the command reject.
- N(S) is the current *send state variable* value at the secondary (Bit 10 = low order bit).
- N(R) is the current *receive state variable* V(R) at the secondary (Bit 14 = low order bit).
- W set to 1 indicates the control field received and returned in bits 1 through 8 was invalid.
- X set to 1 indicates the control field received and returned in bits 1 through 8 was considered invalid because the frame contained an information field which is not permitted with this command. Bit W must be set to 1 in conjunction with this bit.
- Y set to 1 indicates the information field received exceeded the maximum established capacity of the secondary. This bit is mutually exclusive with bit W above.
- Z set to 1 indicates the control field received and returned in bits 1 through 8 contained an invalid N(R) count. This bit is mutually exclusive with bit W above.
- Bits 9 and 13, 21 to 24 shall be set to 0.

Note. – Both N(S) and Z are set to zero in the application described under 2. of the text.

2.3.5 *Exception condition reporting and recovery*

The error recovery procedures which are available to effect recovery following the detection/occurrence of an exception condition at the link level is described hereunder. Exception conditions described are those situations which may occur as the result of transmission errors, station malfunction or operational situations.

2.3.5.1 *Busy*

The busy condition results when a DTE or DCE is temporarily unable to continue to receive information frames due to internal constraints, e.g., receive buffering limitations. In this case an RNR Supervisory format frame is transmitted from the busy DCE or DTE. Information pending transmission may be transmitted from the busy DTE or DCE prior to or following the RNR. Clearing of the busy condition is indicated as described in 2.3.4.4 below.

2.3.5.2 *N(S) sequence error*

The information field of all I frames whose N(S) does not equal the *receive state variable* V(R) will be discarded.

An N(S) sequence exception occurs in the receiver when an information frame received error-free (no FCS error) contains an N(S) sequence count which is not equal to the *receive state variable* at the receiver. The receiver does not acknowledge (increment its *receive state variable*) the frame causing the sequence error or any I frame which may follow until an information frame with the correct N(S) sequence is received.

A secondary which receives one or more valid I frames having sequence errors but otherwise error-free shall accept the control information contained in the N(R) field to perform link control functions; e.g., to receive acknowledgement of previously transmitted information frames. Therefore, the retransmitted frame may contain an N(R) count that is updated from and therefore different from that contained in the originally transmitted I frame.

2.3.5.3 *REJ recovery*

The REJ is used to initiate an exception recovery (retransmission) following the detection of a sequence error.

Only one "sent REJ" exception condition from a DTE or DCE is established at a time. A "sent REJ" exception condition is cleared when the requested I frame is received.

A primary receiving REJ initiates sequential (re-)transmission of I frames starting with the I frame indicated by the N(R) count obtained in the REJ frame.

2.3.5.4 *Time-out recovery*

If a DTE or DCE, due to a transmission error, does not receive (or receives and discards) a single I frame or the last I frame in a sequence of I frames, it will not detect an out-of-sequence exception and therefore will not transmit REJ. The DTE or DCE which transmitted the unacknowledged I frame(s) shall, following the completion of a system specified time-out period, (see 2.4.7.1 below) take appropriate recovery action to determine at which frame retransmission must begin.

2.3.5.5 *FCS error*

Any frame received with an FCS error is not accepted by the receiver. The frame is discarded and no action is taken as the result of that frame.

2.3.5.6 *Rejection condition*

A rejection condition is established upon the receipt of an error free frame which contains an invalid command/response in the control field, an invalid frame format, an invalid N(R) count or an information field which exceed the maximum information field length which can be accommodated.

At the primary this exception is subject to recovery/resolution at a higher function level.

At the secondary this exception is reported by a CMDR response for appropriate primary action. Once a secondary has established a CMDR exception no additional I frames are accepted, except for examination of the N(R) count until the condition is reset by the primary. The CMDR response is repeated at each opportunity until recovery is effected by the primary.

2.4 *Description of the procedure*

2.4.1 *Procedure for addressing*

Frames containing commands transferred from the DCE to the DTE will contain the address A.

Frames containing responses transferred from the DTE to the DCE shall contain the address A.

Frames containing commands transferred from the DTE to the DCE shall contain the address B.

Frames containing responses transferred from the DCE to the DTE will contain the address B.

A and B addresses are coded as follows:

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

Note. – The action to be taken by the DCE following the receipt of an address other than A or B is for further study.

2.4.2 *Procedure for the use of the Poll/Final bit*

The DCE receiving a SARM, DISC or an information command frame with the Poll bit set to 1, will set the Final bit to 1 in the next response frame it transmits.

The response frame returned by the DCE to a SARM or DISC command with Poll bit set to 1 will be a UA Response with Final bit set to 1. The Response frame returned to an Information frame with Poll bit set to 1 will be an RR, REJ or RNR response in supervisory format with Final bit set to 1.

The P bit may be used by the DCE in conjunction with the time-out recovery condition (see 2.4.4.8 below).

Note. – Other use of the P bit by the DCE is a subject for further study.

2.4.3 *Procedure for link set-up*

2.4.3.1 *Link set-up*

The DCE will indicate that it is able to set up the link by transmitting contiguous flags (active channel state).

The DTE shall indicate a request for setting up the link by transmitting a SARM command to the DCE.

Whenever receiving a SARM command, the DCE will return a UA response to the DTE and set its *receive state variable* V(R) to zero.

Should the DCE wish to indicate a request for setting up the link, or when receiving from the DTE a first SARM command as a request for setting up the link, the DCE will transmit a SARM command to the DTE and start timer T1 (see 2.4.7 below). The DTE will confirm the reception of the SARM command by transmitting a UA response.

When receiving the UA response the DCE will set its *send state variable* to zero and stop its timer T1. If Timer T1 runs out before the *UA Response* is received by the DCE, the DCE will retransmit a SARM command and restart Timer 1.

After transmission of SARM N2 times by the DCE, appropriate recovery action will be initiated.

The value of N2 is defined in 2.4.7.2 below.

2.4.3.2 *Information transfer phase*

After having both received a UA response to a SARM command transmitted to the DTE and transmitted a UA response to a SARM command received from the DTE, the DCE will accept and transmit information and supervisory frames according to the procedures described in 2.4.4 below.

When receiving a SARM command, the DCE will conform to the resetting procedure described in 2.4.5 below. The DTE may also receive a SARM command according to this resetting procedure.

2.4.3.3 *Link disconnection*

During the information transfer phase the DTE shall indicate a request for disconnecting the link by transmitting a DISC command to the DCE.

Whenever receiving a DISC command, the DCE will return a UA response to the DTE.

During an information transfer phase, should the DCE wish to indicate a request for disconnecting the link, or when receiving from the DTE a first DISC command as a request for disconnecting the link, the DCE will transmit a DISC command to the DTE and start Timer T1 (2.4.7 below). The DTE will confirm reception of the DISC command by returning a UA response. After transmitting a SARM command, the DCE will not transmit a DISC command until a UA response is received for this SARM command or until Timer T1 runs out.

When receiving a UA repsonse to the DISC command, the DCE will stop its Timer T1. If Timer T1 runs out before UA response is received by the DCE, the DCE will transmit a DISC command and restart Timer T1. After transmission of DISC N2 times by the DCE appropriate recovery action will be initiated. The value of N2 is defined in 2.4.7 below.

2.4.4 *Procedures for information transfer*

The procedures which apply to the transmission of information frames in each direction during the information transfer phase is described hereunder.

In the following , "number one higher" is in reference to a continuously repeated sequence series, i.e. 7 is one higher than 6 and 0 is one higher than 7 for modulo eight series.

2.4.4.1 *Sending information frames*

When the DCE has an information frame to transmit (i.e. an information frame not already transmitted, or having to be retransmitted as described in 2.4.4.5 below), it will transmit it with an N(S) equal to its current *send state variable* V(S), and an N(R) equal to its current *receive state variable* V(R). At the end of the transmission of the information frame, it will increment its *send state variable* V(S) by one.

If the Timer T1 is not running at the instant of transmission of an information frame, it will be started.

If the *send state variable* V(S) is equal to the last value of N(R) received plus k (where k is the maximum number of outstanding frames – see 2.4.7 below) the DCE will not transmit any information frames, but may retransmit an information frame as described in 2.4.4.5 or 2.4.4.8.

When the secondary function at the DCE is in the busy or command rejection condition it may still transmit information frames as a primary function, provided that the DTE secondary is not busy itself.

2.4.4.2 *Receiving an information frame*

2.4.4.2.1 When the DCE is not in a busy condition and receives with correct FCS an information frame whose *send sequence number* is equal to the DCE *receive state variable* V(R), the DCE will accept the information field of this frame, increment by one its *receive state variable* V(R), and act as follows:

i) If an information frame is available for transmission by the DCE, it may act as in 2.4.4.1 above and acknowledge the received information frame by setting N(R) in the control field of the next transmitted information frame to the value of the DCE *receive state variable* V(R). The DCE may also acknowledge the received information frame by transmitting an RR with the N(R) equal to the value of the DCE *receive state variable* V(R).

ii) If no information frame is available for transmission by the DCE, it will transmit an RR with the N(R) equal to the value of the DCE *receive state variable* V(R).

2.4.4.2.2 When the DCE is in a busy condition, it may ignore the information contained in any received information frame.

2.4.4.3 *Incorrect reception of frames*

When the DCE receives a frame with incorrect FCS, this frame will be discarded.

When the DCE receives an information frame whose FCS is correct, but whose *send sequence number* is incorrect, i.e., not equal to the current DCE *receive state variable* V(R), it will discard the information content of the frame and transmit an REJ response with the N(R) set to one higher than the N(S) of the last correctly received information frame. The DCE will then discard the information content of all frames until the expected frame is correctly received. When receiving the expected frame the DCE will then acknowledge the frame as described in 2.4.4.2 above. The DCE will use the N(R) indication in the discarded I frames.

2.4.4.4 *Receiving acknowledgement*

When correctly receiving an information or supervisory frame (RR, RNR or REJ), even in the busy or command rejection condition, the DCE will consider the N(R) contained in this frame as an acknowledgement for all the frames it has transmitted with an N(S) up to the received N(R) – 1. The DCE will reset the Timer T1.

If there are outstanding frames still unacknowledged, it will restart the Timer T1. If the Timer then runs out the DCE will follow the retransmission procedure (in 2.4.4.5 and 2.4.4.8 below) in respect of the unacknowledged frames.

2.4.4.5 *Receiving Reject*

When receiving an REJ the DCE will set its *send state variable* V(S) to the N(R) received in the REJ control field. It will transmit the corresponding information frame as soon as it is available or retransmit it. Retransmission will conform to the following:

i) If the DCE is transmitting a Supervisory or Unnumbered command or response when it receives the REJ it will complete that transmission before commencing transmission of the requested frame.

ii) If the DCE is transmitting an information frame when the REJ is received, it may abort the frame and commence transmission of the requested frame immediately after abortion.

iii) If the DCE is not transmitting any frame when the REJ is received it will commence transmission of the requested frame immediately.

In all cases, if other unacknowledged information frames had already been transmitted following the one indicated in the REJ, then those frames will be retransmitted by the DCE following the retransmission of the requested frame.

2.4.4.6 *Receiving RNR*

After receiving an RNR, the DCE may transmit the information frame with the *send sequence number* equal to the N(R) indicated in the RNR. If the Timer T1 runs out after the reception of RNR the DCE will follow the procedure described in 2.4.4.8 below. In any case the DCE will not transmit any other information frame before receiving an RR or REJ.

2.4.4.7 *DCE busy condition*

When the DCE secondary function enters a busy condition, it will transmit an RNR response at the earliest opportunity. While in the busy condition, the DCE will accept and process supervisory frames and return an RNR response with the F bit set to one if it receives an information frame with the P bit set to one. To clear the busy condition, the DCE will transmit either an REJ or an RR with N(R) set to current *receive state variable* V(R) depending on whether or not it discarded information fields of correctly received information frames.

2.4.4.8 *Waiting acknowledgement*

The DCE maintains an internal *retransmission count variable* which is set to zero when the DCE receives a UA or RNR, or when the DCE correctly receives a frame with the N(R) higher than the last received N(R) (actually acknowledging some outstanding frames).

If the Timer T1 runs out, the DCE will enter the *timer recovery condition*, add one to its *retransmission count variable* and set an internal variable x to the current value of its *send state variable*.

The DCE will restart Timer T1, set its *send state variable* to the last N(R) received from the DTE and retransmit the corresponding information frame with the poll bit set to one.

The *timer recovery condition* is cleared when the DCE receives a valid Supervisory frame from the DTE, with the final bit set to one.

If, while in the *timer recovery condition*, the DCE correctly receives a frame with an N(R) within the range from its current *send state variable* to x included, on or before clearing the *timer recovery condition*, it will not enter a Rejection condition, and will set its *send state variable* to the received N(R).

If the *retransmission count variable* is equal to N2, the DCE initiates a resetting procedure for the direction of transmission from the DCE as described in 2.4.5 below. N2 is a system parameter (see 2.4.7 below).

Note. – Although the DCE will implement the internal variable x, other mechanisms do exist that achieve the identical functions. Therefore the internal variable x is not necessarily implemented in the DTE.

2.4.5 *Procedures for resetting*

2.4.5.1 The resetting procedure is used to reinitialize one direction of information transmission between a primary and the corresponding secondary, according to the procedure described below. The resetting procedure only applies during the Information transfer phase.

2.4.5.2 The DTE will indicate a resetting of the information transmission from the DTE by transmitting a SARM command to the DCE. When receiving a SARM command, the DCE will return, at the earliest opportunity, a UA response to the DTE, set its *receive state variable* V(R) to zero. This also clears the DCE busy condition if present.

2.4.5.3 The DCE will indicate a resetting of the information transmission from the DCE by transmitting a SARM command to the DTE and will start Timer T1 (see 2.4.7 below). The DTE will confirm reception of the SARM command by returning a UA response to the DCE. When receiving this UA response to the SARM command, the DCE will set its *send state variable* to zero and stop its Timer T1. If Timer T1 runs out before the UA response is received by the DCE, the DCE will retransmit a SARM command and restart Timer T1. After transmission of SARM N2 times appropriate recovery action will be initiated. The value of N2 is defined in 2.4.7 below.

The DCE will not act on any received response frame which arrives before the UA response to the SARM command. The value of N(R) contained in any correctly received information command frames arriving before the UA response will also be ignored.

2.4.5.4 When receiving a CMDR response from the DTE, the DCE will initiate a resetting of the information transmission from the DCE as described in 2.4.5.3 above.

2.4.5.5 If the DCE transmits a CMDR response, it enters the *command rejection condition*. This *command rejection condition* is cleared when the DCE receives a SARM or DISC command. Any other command received while in the *command rejection condition* will cause the DCE to retransmit this CMDR response. The coding of the CMDR response will be as described in 2.3.4.8 above. In the case of an invalid N(S) bits 17, 18, 19, 20 will be set to zero.

2.4.6 *Rejection conditions*

2.4.6.1 *Rejection conditions causing a resetting of the transmission of information from the DCE*

The DCE will initiate a resetting procedure as described in 2.4.5 above when receiving a frame with correct FCS, with the address A (coded 1 1 0 0 0 0 0 0) and with one of the following conditions:

- the frame type is unknown as one of the responses used;
- the information field is invalid;
- the N(R) contained in the control field is invalid;
- the response contains an F bit set to 1 except during a time-out recovery condition as described in 2.4.4.8 above.

A valid N(R) must be within the range from the lowest *send sequence number* N(S) of the still-unacknowledged frame(s) to the current DCE *send state variable* included, even if the DCE is in a *rejection condition*, but not if the DCE is in the *timer recovery condition* (see 2.4.4.8 above).

2.4.6.2 *Rejection conditions causing the DCE to request a resetting of the transmission of information from the DTE*

The DCE will enter the *command rejection* condition as described in 2.4.5.5 above when receiving a frame with correct FCS, with the address B (coded 1 0 0 0 0 0 0 0) and with one of the following conditions:

- the frame type is unknown as one of the commands used;
- the information field is invalid;
- the N(S) contained in the control field is invalid.

An invalid N(S) is defined as an N(S) which is equal to the *receive state variable* V(R) and is equal to the last transmitted N(R) + k, where k is the maximum number of outstanding frames.

2.4.7 *List of system parameters*

The system parameters are as follows:

2.4.7.1 *Primary Timer T1*

The Timer T1 at the end of which retransmission of a frame may be initiated according to the procedures described in 2.4.3 to 2.4.6 above is a system parameter agreed for a period of time with the Administration.

The proper operation of the procedure requires that Timer T1 be greater than the maximum time between transmission of a command frame (SARM, DISC or Information command) and the reception of the corresponding frame returned as an answer to this command frame (UA or acknowledging frame). Therefore, the DTE should not delay the response or acknowledging frame returned to a command by more than a value T2 less than T1, where T2 is a system parameter. The DCE will not delay the response or acknowledging frame returned to a command by more than T2.

2.4.7.2 *Maximum number of transmissions N2*

The value of the maximum number N2 of transmission and retransmissions of a frame following the running out of Timer T1 is for further study.

2.4.7.3 *Maximum number of bits in a frame N1*

The maximum number of bits in a frame is a system parameter which depends upon the maximum length of the information fields transferred across the DTE/DCE interface.

2.4.7.4 *Maximum number of outstanding frames k*

The maximum number (k) of sequentially numbered information frames that the DTE or DCE may have outstanding (i.e. unacknowledged) at any given time is a system parameter which can never exceed seven. It shall be agreed for a period of time with the Administration and shall have the same value for both the DTE and DCE.

Note. – As a result of the further study proposed in 2.2.4 above, the permissible maximum number of outstanding frames may be increased.

3. DESCRIPTION OF THE PACKET LEVEL DTE/DCE INTERFACE FOR VIRTUAL CALL AND PERMANENT VIRTUAL CIRCUIT FACILITIES (LEVEL 3)

This section of the Recommendation relates to the transfer of packets at the DTE/DCE interface. The procedures apply to packets which are successfully transferred across the DTE/DCE interface.

Each packet to be transferred across the DTE/DCE interface shall be contained within the link level information field which will delimit its length, and only one packet shall be contained in the information field.

Note. – Possible insertion of more than one packet in the link level information field is for further study.

To enable simultaneous virtual calls and/or permanent virtual circuits, logical channels are used. Each virtual call or permanent virtual circuit is assigned a logical channel group number (less than or equal to 15) and a logical channel number (less than or equal to 255). For virtual calls a logical channel group number and a logical channel number are assigned during the call set-up phase. For permanent virtual circuits a logical channel group number and a logical channel number are assigned in agreement with the Administration at the time of subscription to the service. The range of logical channels used for virtual calls is agreed with the Administration at the time of subscription to the service.

3.1 *Procedures for virtual calls*

Annex 1, Figures 15/X.25, 16/X.25 and 17/X.25 shows the state diagrams which give a definition of events at the packet level DTE/DCE interface for each logical channel used for virtual calls (Annex 2 defines the symbols used for the state diagrams).

Annex 3 gives details of the action taken by the DCE on receipt of packets in each state shown in Annex 1. Details of the actions which should be taken by the DTE are for further study.

Packet formats are given in 4. below.

3.1.1 *Ready state*

If there is no call in existence, a logical channel is in the *Ready* state.

3.1.2 *Call request packet*

The calling DTE shall indicate a call request by transferring a *call request* packet across the DTE/DCE interface. The logical channel selected by the DTE is then in the *DTE Waiting* state (p2). The *call request* packet includes the called DTE address. (See 3.6 below).

Note. – A DTE address may be a DTE network address, an abbreviated address or any other DTE identification agreed for a period of time between the DTE and the DCE.

3.1.3 *Incoming call packet*

The DCE will indicate that there is an incoming call by transferring across the DTE/DCE interface an *incoming call* packet. This places the logical channel in the *DCE Waiting* state (p3) (see 3.6 below).

The incoming call packet will use the logical channel in the *Ready* state with the lowest number. The incoming call packet includes the calling DTE address.

Note. – A DTE address may be a DTE network address, an abbreviated address or any other DTE identification agreed for a period of time between the DTE and the DCE.

3.1.4 *Call accepted packet*

The called DTE shall indicate its acceptance of the call by the transferring across the DTE/DCE interface a *call accepted* packet specifying the same logical channel as that of the *incoming call* packet. This places the specified logical channel in the *Data transfer* state (p4).

3.1.5 *Call connected packet*

The receipt of a *call connected* packet by the calling DTE specifying the same logical channel as that specified in the *call request* packet indicates that the call has been established and the logical channel is then in the *Data transfer* state (p4).

3.1.6 *Call collision*

Call collision occurs when a DTE and a DCE simultaneously transfer a *call request* packet and an *incoming call* packet specifying the same logical channel. The DCE will proceed with the call request and cancel the incoming call.

3.1.7 *Clearing by the DTE*

The DTE may indicate clearing by transferring across the DTE/DCE interface a *clear request* packet. The logical channel is then in the *DTE Clear request* state (p6). When the DCE is prepared to free the logical channel, the DCE will transfer across the DTE/DCE interface a *DCE clear confirmation* packet specifying the logical channel. The logical channel is now in the *Ready* state (p1) (see 3.6 below).

It is possible that subsequent to transferring a *clear request* packet the DTE will receive other types of packet, dependent on the state of the logical channel, before receiving a *DCE clear confirmation* packet.

3.1.8 *Clearing by the DCE*

The DCE will indicate clearing by transferring across the DTE/DCE interface a *clear indication* packet. The logical channel is then in the *DCE Clear indication* state (p7). The DTE shall respond by transferring across the DTE/DCE interface a *DTE clear confirmation* packet. The logical channel is now in the *Ready* state (p1) (see 3.6 below).

3.1.9 *Clear collision*

Clear collision occurs when a DTE and a DCE simultaneously transfer a *clear request* packet and a *clear indication* packet specifying the same logical channel. The DCE will consider that the clearing is completed and will not transfer a *DCE clear confirmation* packet.

3.1.10 *Unsuccessful call*

If a call cannot be established, the DCE will transfer a *clear indication* packet specifying the logical channel indicated in the *call request* packet.

3.1.11 *Call progress signals*

The DCE will be capable of transferring to the DTE *clearing call progress signals* as specified in Recommendation X.96.

Clearing call progress signals will be carried in *clear indication* packets which will terminate the call to which the packet refers. The method of coding *clear indication* packets containing call progress signals is detailed in 4. below.

3.1.12 *Data transfer phase*

The procedures for the control of packets between DTE and DCE while in the *Data transfer* state are contained in 3.3 below.

3.2 *Procedures for permanent virtual circuits*

Annex 1, Figures 16/X.25 and 17/X.25 shows the state diagrams which give a definition of events at the packet level DTE/DCE interface for logical channels assigned for permanent virtual circuits (Annex 2 defines the symbols used in the state diagrams). Annex 3, Tables 11/X.25 and 12/X.25 give details of the action taken by the DCE on receipt of packets in each state shown in Annex 1, Figures 16/X.25 and 17/X.25. Details of the action which should be taken by the DTE are for further study.

For permanent virtual circuits there is no call set-up phase and the logical channel is permanently in the data transfer state (p4).

3.3 *Procedures for data and interrupt transfer*

The data transfer procedure described in the following applies independently to each logical channel existing at the DTE/DCE interface.

3.3.1 *States for data transfer in virtual calls*

Data, interrupt, flow control and *reset* packets may be transmitted and received by a DTE in the *Data transfer* state of a logical channel at the DTE/DCE interface. In this state, the flow control and reset procedures described in 3.4 below apply to data transmission on that logical channel to and from the DTE. *Data, interrupt, flow control* and *reset* packets transmitted by a DTE will be ignored by the DCE when the logical channel is in the *DCE Clear indication* state.

Data, interrupt, flow control and *reset* packets may also be received by a DTE when the interface is in the *DTE Clear request* state.

3.3.2 *Numbering of data packets*

Each *data* packet transmitted at the DTE/DCE interface for each direction of transmission in a virtual call or permanent virtual circuit is sequentially numbered.

The sequence numbering scheme of the packets is performed modulo 8. The packet sequence numbers cycle through the entire range 0 to 7. As an additional facility, some Administrations will provide a sequence numbering scheme for packets being performed modulo 128. In this case, packet sequence numbers cycle through the entire range 0 to 127.

Only *data* packets contain this sequence number called the *packet send sequence number* P(S).

The first data packet to be transmitted across the DTE/DCE interface for a given direction of data transmission after the virtual call or permanent virtual circuit has been established, has a *packet send sequence number* equal to 0.

3.3.3 *Data field length*

In the absence of an optional user facility, the maximum data field length applying to a given DTE is fixed at subscription time and is common to all logical channels at the DTE/DCE interface (however, see 5.1.3 below). The maximum data field length of data packets is 128 octets. Additionally some Administrations may support other maximum data field lengths from the following list of powers of two, i.e. 16, 32, 64, 256, 512 and 1024 octets or exceptionally 255 octets.

The data field of *data* packets transmitted by a DTE may contain any number of bits up to the agreed maximum.

If a DTE wishes to indicate a sequence of more than one packet, it uses a *More data* mark as defined below:

In a full *data* packet a DTE may indicate that more data is to follow with a mark called *More data*. This indication has the effect that such a packet may be combined with the subsequent *data* packet within the network.

Two categories of *data* packets are defined:

Category 1	*a)* Packets which do not have the local maximum data field length. *b)* Packets having the local maximum data field length and no *More data* mark.
Category 2	Packets having the local maximum data field length and a *More data* mark.

Category 1 packets will not be combined with subsequent packets.

A complete packet sequence is defined as being composed of either a single category 1 packet or consecutive category 2 packets and a category 1 packet. The sequence shall not be preceded by a category 2 packet.

When transmitted by a source DTE, a complete packet sequence is always delivered to the destination DTE as a complete packet sequence.

Note. – A national network which provides a single maximum data field length need not take any action as a result of the *More data* mark.

3.3.4 *Data qualifier*

A packet sequence may be on one of two levels. If a DTE wishes to transmit data on more than one level, it uses an indicator called *Data qualifier.*

When only one level of data is being transmitted on a logical channel, the *Data qualifier* is always set to zero. If two levels of data are being transmitted, the *Data qualifier* in all packets of a complete packet sequence are all set to the same value, either zero or one. Within a complete packet sequence, different levels of data may not be intermixed. Packets are numbered consecutively regardless of their data level.

3.3.5 *Interrupt procedure*

The interrupt procedure allows a DTE to transmit data to the remote DTE, without following the flow control procedure applying to data packets (see 3.4 below). The interrupt procedure can only apply in the *Flow control ready* state (d1) within the *Data transfer* state (p4).

The interrupt procedure has no effect on the transfer and flow control procedures applying to the *data* packets on the virtual call or permanent virtual circuit.

To transmit an interrupt, a DTE transfers across the DTE/DCE interface a *DTE interrupt* packet. The DCE will then confirm the receipt of the interrupt by transferring a *DCE interrupt confirmation* packet. The DCE will ignore further *DTE interrupt* packets until the first one is confirmed with a *DCE interrupt confirmation* packet.

The DCE indicates an interrupt from the remote DTE by transferring across the DTE/DCE interface a *DCE interrupt* packet containing the same data field as in the *DTE interrupt* packet transmitted by the remote DTE. The DTE will confirm the receipt of the *DCE interrupt* packet by transferring a *DTE interrupt confirmation* packet.

3.4 *Procedures for flow control*

The following only applies to the data transfer phase and specifies the procedures covering flow control of *data* packets and reset on each logical channel used for a virtual call or a permanent virtual circuit.

3.4.1 *Procedure for flow control*

At the DTE/DCE interface of a logical channel used for a virtual call or permanent virtual circuit, the transmission of *data* packets is controlled separately for each direction and is based on authorizations from the receiver.

3.4.1.1 *Window description*

At the DTE/DCE interface of a logical channel used for a virtual call or permanent virtual circuit and for each direction of data transmission, a window is defined as the ordered set of W consecutive *packet send sequence numbers* P(S) of the *data* packets authorized to cross the interface.

The lowest sequence number in the window is referred to as the lower window edge. When a virtual call or permanent virtual circuit at the DTE/DCE interface has just been established, the window related to each direction of data transmission has a lower window edge equal to 0.

The *packet send sequence number* of the first *data* packet not authorized to cross the interface is the value of the lower window edge plus W (modulo 8, or 128 when extended).

In the absence of an optional user facility, the window size W for each direction of data transmission at a DTE/DCE interface is common to all the logical channels and agreed for a period of time with the Administration for the DTE. The value of W does not exceed 7, or 127 when extended (see 5.1.2 below).

3.4.1.2 *Flow control principles*

A number modulo 8 or 128 when extended, referred to as a *packet receive sequence number* P(R), conveys across the DTE/DCE interface information from the receiver for the transmission of *data* packets. When transmittd across the DTE/DCE interface, a P(R) becomes the lower window edge. In this way, additional *data* packets may be authorized by the receiver to cross the DTE/DCE interface.

When the *sequence number* P(S) of the next *data* packet to be transmitted by the DTE is within the window, the DCE will accept this *data* packet. When the *sequence number* P(S) of the next *data* packet to be transmitted by the DTE is outside of the window, the DCE will consider the receipt of this *data* packet from the DTE as a procedure error and will reset the virtual call or permanent virtual circuit. The DTE should follow the same procedure.

When the *sequence number* P(S) of the next *data* packet to be transmitted by the DCE is within the window, the DCE is authorized to transmit this *data* packet to the DTE. When the *sequence number* P(S) of the next *data* packet to be transmitted by the DCE is outside of the window, the DCE shall not transmit a data packet to the DTE.

The *packet receive sequence number*, P(R), is conveyed in *data*, *Receive ready* (RR) and *Receive not ready* (RNR) packets.

The value of a P(R) received by the DCE must be within the range from the last P(R) received by the DCE to the *packet send sequence number* of the next *data* packet to be transmitted by the DCE. Otherwise, the DCE will consider the receipt of this P(R) as a procedure error and will reset the virtual call or permanent virtual circuit. The DTE should follow the same procedure.

The only universal significance of a P(R) value is a local updating of the window across the packet level interface, but the P(R) value may be used within some Administrations' networks to convey an end-to-end acknowledgement.

3.4.1.3 *DTE and DCE Receive ready (RR) packets*

RR packets are used by the DTE or DCE to indicate that it is ready to receive the W *data* packets within the window starting with P(R), where P(R) is indicated in the *RR* packet.

3.4.1.4 *DTE and DCE Receive not ready (RNR) packets*

RNR packets are used by the DTE or DCE to indicate a temporary inability to accept additional *data* packets for a given virtual call or permanent virtual circuit. A DTE or DCE receiving an *RNR* packet shall stop transmitting *data* packets on the indicated logical channel.

The receive not ready situation indicated by the transmission of an *RNR* packet is cleared by the transmission in the same direction of an *RR* packet or by a reset procedure being initiated.

3.4.2 *Procedure for reset*

The reset procedure is used to reinitialize the virtual call or permanent virtual circuit and in so doing removes in each direction all *data* and *interrupt* packets which may be in the network. The reset procedure can only apply in the *Data transfer* state of the DTE/DCE interface. In any other state of the DTE/DCE interface, the reset procedure is abandoned.

For flow control, there are three states d1, d2 and d3 within the *Data transfer* state (p4). They are *Flow control ready* (d1), DTE *Reset request* (d2), and *DCE Reset indication* (d3) as shown in the state diagram in Annex 1, Figure 16/X.25. When entering state p4 the logical channel is placed in state d1. Annex 3, Table 11/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE.

When a virtual call or permanent virtual circuit at the DTE/DCE interface has just been reset, the window related to each direction of data transmission has a lower window edge equal to 0, and the numbering of subsequent data packets to cross the DTE/DCE interface for that direction of data transmission shall start from 0.

3.4.2.1 *Reset request packet*

The DTE shall indicate a request for reset by transmitting a *reset request* packet specifying the logical channel. This places the logical channel in the *DTE Reset request* state (d2) (see 3.6 below).

3.4.2.2 *Reset indication packet*

The DCE shall indicate a reset by transmitting to the DTE a *reset indication* packet specifying the logical channel and the reason for the resetting. This places the logical channel in the *DCE Reset indication* state (d3). In this state, the DCE will ignore *data*, *interrupt*, *RR* and *RNR* packets (see 3.6 below).

3.4.2.3 *Reset collision*

Reset collision can occur when a DTE and a DCE simultaneously transmit a *reset request* packet, and a *reset indication* packet. In such a case, the second one of both those packets crossing the interface is considered as a reset confirmation. This places the logical channel in the *Flow control ready* state (d1).

3.4.2.4 *Reset confirmation packets*

When the logical channel is in the *DTE Reset request* state, the DCE will confirm reset by transmitting to the DTE a *DCE reset confirmation* packet. This places the logical channel in the *Flow control ready* state (d1).

When the logical channel is in the *DCE Reset indication* state, the DTE will confirm reset by transmitting to the DCE a *DTE Reset confirmation* packet. This places the logical channel in the *Flow control* state (d1) (see 3.6 below).

3.5 *Procedure for restart*

The restart procedure is used to simultaneously clear all the virtual calls and reset all the permanent virtual circuits at the DTE/DCE interface.

Annex 1, Figure 17/X.25 gives the state diagram which defines the logical relationships of events related to the restart procedure.

Annex 3, Table 12/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE. Details of the action which should be taken by the DTE are for further study.

3.5.1 *Restart by the DTE*

The DTE may at any time request a restart by transferring across the DTE/DCE interface a *restart request* packet. The interface for each logical channel is then in the *DTE Restart request* state.

The DCE will confirm the restart by transferring a *DCE Restart confirmation* packet placing the logical channels used for virtual calls in the *Ready* state (p1), and the logical channels used for permanent virtual circuits in the *Flow control ready* state (d1) (see 3.6 below).

3.5.2 *Restart by the DCE*

The DCE may indicate a restart by transferring across the DTE/DCE interface a *restart indication* packet. The interface for each logical channel is then in the *DCE Restart indication* state. In this state of the DTE/DCE interface, the DCE will ignore *data, interrupt, call set-up* and *clearing, flow control* and *reset* packets.

The DTE will confirm the restart by transferring a *DTE Restart confirmation* packet placing the logical channels used for virtual calls in the *Ready* state (p1), and the logical channels used for permanent virtual circuits in the *Flow control ready* state (d1) (see 3.6 below).

3.5.3 *Restart collision*

Restart collision can occur when a DTE and a DCE simultaneously transfer a *restart request* and a *restart indication* packet. Under this circumstance, the DCE will consider that the restart is completed and will not expect a *DTE Restart confirmation* packet, neither will it transfer a *DCE Restart confirmation* packet.

3.6 *List of system parameters*

The system parameters applying under 3. are for further study. This study should include considerations of both time-outs and numbers of re-tries.

4. PACKET FORMATS FOR VIRTUAL CALL AND PERMANENT VIRTUAL CIRCUIT FACILITIES

4.1 *General*

The possible extension of packet formats by the addition of new fields is for further study.

Bits of an octet are numbered 8 to 1 where bit 1 is the low order bit and is transmitted first. Octets of a packet are consecutively numbered starting from 1 and are transmitted in this order.

4.1.1 *General format identifier*

The general format identifier field is a four-bit binary coded field which is provided to indicate the general format of the rest of the header. The general format identifier field is located in bit positions 8, 7, 6 and 5 of octet 1, and bit 5 is the low order bit (see Table 5/X.25).

Two of the sixteen possible codes are used to identify the formats for the DTE/DCE interface defined herein, which provide for virtual call and permanent virtual circuit facilities. Two other codes are used to identify the similar formats in the case where the sequence numbering scheme of *data* packets is performed modulo 128. Other codes of the general format identifier are unassigned.

Note. – It is envisaged that unassigned codes could identify alternative packet formats associated with other facilities or simplified access procedures, for example, datagram facility or single access DTE procedures.

TABLE 5/X.25 – **General format identifier**

General format identifier		Octet 1 Bits 8	7	6	5
Data packets	Sequence numbering scheme modulo 8	X	0	0	1
	Sequence numbering scheme modulo 128	X	0	1	0
Call set-up and clearing, flow control interrupt, reset and restart packets	Sequence numbering scheme modulo 8	0	0	0	1
	Sequence numbering scheme modulo 128	0	0	1	0

Note. – A bit which is indicated as "X" may be set to either 0 or 1.

4.1.2 *Logical channel group number*

The logical channel group number appears in every packet except in restart packets (see 4.5 below) in bit positions 4, 3, 2 and 1 of octet 1. This field is binary coded and bit 1 is the low order bit of the logical channel group number.

4.1.3 *Logical channel number*

The logical channel number appears in every packet except in *restart* packets (see 4.5 below) in all bit positions of octet 2. This field is binary coded and bit 1 is the low order bit of the logical channel number.

4.1.4 *Packet type identifier*

Each packet shall be identified in the octet 3 of the packet according to Table 6/X.25.

TABLE 6/X.25 – **Packet type identifier**

Packet type		Octet 3 Bits							
From DCE to DTE	From DTE to DCE	8	7	6	5	4	3	2	1
Call set-up and clearing									
Incoming call	Call request	0	0	0	0	1	0	1	1
Call connected	Call accepted	0	0	0	0	1	1	1	1
Clear indication	Clear request	0	0	0	1	0	0	1	1
DCE clear confirmation	DTE clear confirmation	0	0	0	1	0	1	1	1
Data and interrupt									
DCE Data	DTE Data	X	X	X	X	X	X	X	0
DCE Interrupt	DTE Interrupt	0	0	1	0	0	0	1	1
DCE Interrupt confirmation	DTE Interrupt confirmation	0	0	1	0	0	1	1	1
Flow control and reset									
DCE RR	DTE RR	X	X	X	0	0	0	0	1
DCE RNR	DTE RNR	X	X	X	0	0	1	0	1
	DTE REJ	X	X	X	0	1	0	0	1
Reset indication	Reset request	0	0	0	1	1	0	1	1
DCE Reset confirmation	DTE Reset confirmation	0	0	0	1	1	1	1	1
Restart									
Restart indication	Restart request	1	1	1	1	1	0	1	1
DCE Restart confirmation	DTE Restart confirmation	1	1	1	1	1	1	1	1

Note. – A bit which is indicated as "X" may be set to either 0 or 1.

4.2 *Call set-up and clearing packets*

4.2.1 *Call request and incoming call packets*

Figure 1/X.25 illustrates the format of *call request* and *incoming call* packets.

Address lengths field

Octet 4 consists of field length indicators for the called and calling DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the called DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the calling DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

Address field

Octet 5 and the following octets consist of the called DTE address when present, then the calling DTE address when present.

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low order bit of the digit.

Starting from the high order digit, the address is coded in octet 5 and consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

The address field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

Note. – This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as the coding of those facilities is for further study.

Facility length field

Bits 6, 5, 4, 3, 2 and 1 of the octet following the address field indicate the length of the facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

Bits 8 and 7 of this octet are unassigned and set to 0.

Facility field

The facility field is present only when the DTE is using an optional user facility requiring some indication in the *call request* and *incoming call* packets.

The coding of this facility field is defined in 5. below.

The facility field contains an integral number of octets. The actual maximum length of this field depends on the facilities which are offered by the network. However, this maximum does not exceed 62 octets.

Call user data field

Following the facility field, user data may be present. The call user data field has a maximum length of 16 octets. The contents of the field are passed unchanged to the called DTE.

4.2.2 *Call accepted and Call connected packets*

Figure 2/X.25 illustrates the format of *call accepted* and *call connected* packets.

4.2.3 *Clear request and Clear indication packets*

Figure 3/X.25 illustrates the format of *clear request* and *clear indication* packets.

Clearing cause field

Octet 4 is the clearing cause field and contains the reason for the clearing of the call.

The coding of the clearing cause field in *clear indication* packets is given in Table 7/X.25.

The bits of the cause field in *clear request* packets are set to 0.

TABLE 7/X.25 – **Coding of clearing cause field in clear indication packet**

	Bits							
	8	7	6	5	4	3	2	1
DTE Clearing	0	0	0	0	0	0	0	0
Number busy	0	0	0	0	0	0	0	1
Out of order	0	0	0	0	1	0	0	1
Remote procedure error	0	0	0	1	0	0	0	1
Number refuses reverse charging	0	0	0	1	1	0	0	1
Invalid call	0	0	0	0	0	0	1	1
Access barred	0	0	0	0	1	0	1	1
Local procedure error	0	0	0	1	0	0	1	1
Network congestion	0	0	0	0	0	1	0	1
Not obtainable	0	0	0	0	1	1	0	1

4.2.4 *DTE and DCE Clear confirmation packets*

Figure 4/X.25 illustrates the format of the *DTE* and *DCE Clear confirmation* packets.

4.3 *Data and Interrupt packets*

4.3.1 *DTE and DCE data packets*

Figure 5/X.25 illustrates the format of the *DTE* and *DCE data* packets.

Note. – In the event that the sequence numbering scheme is performed modulo 128 (see 3.3.1.2 above), this format is effected.

Data qualifier

Bit 8 in octet 1 is used for *Data qualifier.*

Packet receive sequence number

Bits 8, 7 and 6 of octet 3 are used for indicating the *packet receive sequence number* P(R). P(R) is binary coded and bit 6 is the low order bit.

More data indication

Bit 5 in octet 3 is used for *More data* indication: 0 for no more data and 1 for more data.

Packet send sequence number

Bits 4, 3 and 2 of octet 3 are used for indicating the *packet send sequence number* P(S). P(S) is binary coded and bit 2 is the low order bit.

User data field

Bits following octet 3 contain user data.

4.3.2 *DTE and DCE Interrupt packets*

Figure 6/X.25 illustrates the format of the *DTE* and *DCE interrupt* packets.

Interrupt user data field

Octet 4 contains user data..

4.3.3 *DTE and DCE interrupt confirmation packets*

Figure 7/X.25 illustrates the format of the *DTE* and *DCE interrupt confirmation* packet.

4.4 *Flow control and reset packets*

4.4.1 *DTE and DCE receive ready (RR) packets*

Figure 8/X.25 illustrates the format of the *DTE* and *DCE RR* packets.

Note. – In the event that the sequence numbering scheme is performed modulo 128 (see 3.3.1.2 above), this format is effected.

Packet receive sequence number

Bits 8, 7 and 6 of octet 3 are used for indicating the *packet receive sequence number* P(R). P(R) is binary coded and bit 6 is the low order bit.

4.4.2 *DTE and DCE receive not ready (RNR) packets*

Figure 9/X.25 illustrates the format of the *DTE* and *DCE RNR* packets.

Note. – In the event that the sequence numbering scheme is performed modulo 128 (see 3.3.1.2 above), this format is effected.

Packet receive sequence number

Bits 8, 7 and 6 of the octet 3 are used for indicating the *packet receive sequence number* P(R). P(R) is binary coded and bit 6 is the low order bit.

4.4.3 *Reset request and reset indication packets*

Figure 10/X.25 illustrates the format of the *reset request* and *reset indication* packets.

Resetting cause field

Octet 4 is the resetting cause field and contains the reason for the reset. The coding of the resetting cause field in a *reset indication* packet is given in Table 8/X.25.

Diagnostic code

Octet 5 is the diagnostic code and contains additional information on the reason for the reset when the cause field indicates a local procedure error.

The bits of the diagnostic code field in a *reset request* packet are unassigned and set to 0.

The bits of the diagnostic code field in a *reset indication* packet are all set to 0 when no specific reason for the reset is supplied. Other values are not specified at this time.

TABLE 8/X.25 – **Coding of resetting cause field in reset indication packet**

	Bits							
	8	7	6	5	4	3	2	1
DTE Reset	0	0	0	0	0	0	0	0
Out of order	0	0	0	0	0	0	0	1
Remote procedure error	0	0	0	0	0	0	1	1
Local procedure error	0	0	0	0	0	1	0	1
Network congestion	0	0	0	0	0	1	1	1

Note. – The bits of the resetting cause field in a *reset request* packet are set to 0.

4.4.4 *DTE and DCE Reset confirmation packets*

Figure 11/X.25 illustrates the format of the *DTE* and *DCE reset confirmation* packets.

4.5 *Restart packets*

4.5.1 *Restart request and restart indication packets*

Figure 12/X.25 illustrates the format of the *restart request* and *restart indication* packets. Bits 4, 3, 2 and 1 of the first octet and all bits of the second octet are set to 0.

Restarting cause field

Octet 4 is the restarting cause field and contains the reason for the restart.

The coding of the restarting cause field in the *restart indication* packets is given in Table 9/X.25.

The bits of the restarting cause field in *restart request* packets are set to 0.

TABLE 9/X.25 – **Coding of restarting cause field in restart indication packets**

	Bits							
	8	7	6	5	4	3	2	1
Local procedure error	0	0	0	0	0	0	0	1
Network congestion	0	0	0	0	0	0	1	1

4.5.2 *DTE and DCE restart confirmation packets*

Figure 13/X.25 illustrates the format of the *DTE* and *DCE restart confirmation* packets. Bits 4, 3, 2 and 1 of the first octet and all bits of the second octet are set to 0.

4.6 *Packets required for optional user facilities*

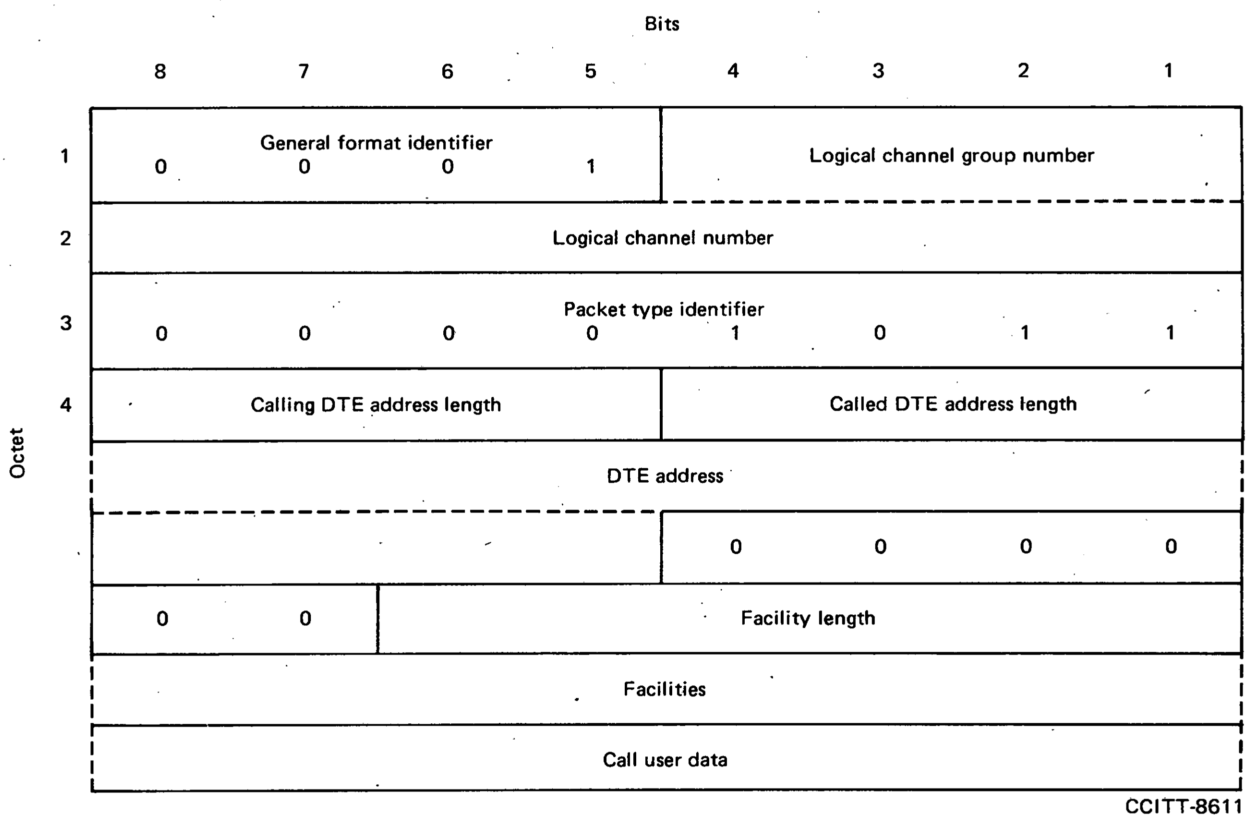
4.6.1 *DTE reject (REJ) packets*

Figure 14/X.25 illustrates the format of the *DTE REJ* packets, used in conjunction with the Packet Retransmission Facility described in 5. below.

Note. – In the event that the sequence numbering scheme is performed modulo 128 (see 3.3.1.2 above), this format is effected.

Packet receive sequence number

Bits 8, 7 and 6 of octet 3 are used for indicating the *packet receive sequence number* P(R). P(R) is binary coded and bit 6 is the low order bit.



Note. – The Figure assumes that a single address is present, consisting of an odd number of digits, and that the call user data field contains an integral number of octets.

FIGURE 1/X.25 – **Call request and incoming call packet format**

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	0	1	1	1	1

CCITT-8612-1

FIGURE 2/X.25 – **Call accepted and call connected packet format**

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	1	0	0	1	1
4	Clearing cause							

CCITT-8612-2

FIGURE 3/X.25 – **Clear request and clear indication packet format**

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	1	0	1	1	1

CCITT-8612-3

FIGURE 4/X.25 – **DTE and DCE clear confirmation packet format**

Octet \ Bits	8	7	6	5	4	3	2	1
1	Q	General format identifier 0	0	1	Logical channel group number			
2	Logical channel number							
3	P(R)			M	P(S)			0
	User data							

M = more data indication
Q = data qualifier

CCITT-8613

Note. – The Figure assumes that the user data field does not contain an integral number of octets.

FIGURE 5/X.25 – **DTE and DCE data packet format**

Octet \ Bits	8	7	6	5	4	3	2	1
1	0	General format identifier 0	0	1	Logical channel group number			
2	Logical channel number							
3	0	0	1	Packet type identifier 0	0	0	1	1
4	Interrupt user data							

CCITT-8614-1

FIGURE 6/X.25 – **DTE and DCE interrupt packet format**

Octet \ Bits	8	7	6	5	4	3	2	1
1	0	General format identifier 0	0	1	Logical channel group number			
2	Logical channel number							
3	0	0	1	Packet type identifier 0	0	1	1	1

CCITT-8614-2

FIGURE 7/X.25 – **DTE and DCE interrupt confirmation packet format**

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	P(R)			0	0	0	0	1

CCITT-8615-1

FIGURE 8/X.25 – **DTE and DCE RR packet format**

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	P(R)			0	0	1	0	1

CCITT-8615-2

FIGURE 9/X.25 – **DTE and DCE RNR packet format**

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	1	1	0	1	1
4	Resetting cause							
5	Diagnostic code							

CCITT-8616-1

FIGURE 10/X.25 – **Reset request and reset indication packet format**

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	1	1	1	1	1

CCITT-8616-2

FIGURE 11/X.25 – **DTE and DCE reset confirmation packet format**

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet type identifier 1	1	1	1	1	0	1	1
4	Restarting cause							

CCITT-8617-1

FIGURE 12/X.25 – **Restart request and restart indication packet format**

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet type identifier 1	1	1	1	1	1	1	1

CCITT-8617-2

FIGURE 13/X.25 – **DTE and DCE restart confirmation packet format**

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	P(R)			0	1	0	0	1

CCITT-8617-3

FIGURE 14/X.25 – **DTE REJ packet format**

5. PROCEDURES AND FORMATS FOR OPTIONAL USER FACILITIES TO BE STUDIED FOR VIRTUAL CALL AND PERMANENT VIRTUAL CIRCUIT FACILITIES

The following is a technical description of procedures and formats for user facilities which have been proposed for further study for inclusion in Recommendation X.2, this being for further study.

5.1 *Procedures for optional user facilities*

5.1.1 *Reverse Charging*

Reverse Charging is an optional user facility; it can be requested by a DTE for a given virtual call.

The Reverse Charging facility needs some indication in the *call request* and the *incoming call* packets.

5.1.2 *Flow Control Parameters Selection*

Flow Control Parameters Selection is an optional user facility agreed for a period of time; it can be used by a DTE for virtual calls.

This user facility allows a DTE to operate with a specific window size and/or maximum data field length depending on the throughput class requested for each direction, that is, the actual data transfer rate that the DTE does not have the need to exceed for this virtual call.

Specific throughput classes for a virtual call may be indicated to a called DTE using the optional user facility parameters in the *incoming call* packet.

If those throughput classes are not specified in the *incoming call* packet, the throughput classes considered at the DTE/DCE interface of the called DTE are the highest attainable one at this interface.

Specific throughput classes for virtual call may be selected by a calling DTE using the optional user facility parameters in the *call request* packet.

If those throughput classes are not specified in the *call request* packet, the throughput classes considered at the DTE/DCE interface of the calling DTE are the highest attainable one at this interface.

For each throughput class, a correspondence agreed with the Administration, for the DTE, for a period of time specifies either the window size, the maximum data field length, or both.

5.1.3 *Reverse Charging Acceptance*

Reverse Charging Acceptance is an optional user facility agreed for a period of time.

This user facility, if subscribed to, authorizes the DCE to transmit to the DTE incoming calls which request the Reverse Charging facility. In the absence of this facility, the DCE will not transmit to the DTE incoming calls which request the Reverse Charging facility.

5.1.4 *One-way Logical Channel*

One-way Logical Channel is an optional user facility agreed for a period of time.

This is a user facility which limits the use of a logical channel to either incoming or outgoing calls (incoming or outgoing access on logical channels).

5.1.5 *Packet Retransmission*

Packet Retransmission is an optional user facility agreed for a period of time.

This user facility allows a DTE to request retransmission of one or several consecutive *data* packets from the DCE (up to the window size) by transferring across the DTE/DCE interface a *DTE reject* packet specifying a logical channel number and a *sequence number* P(R).

When receiving a *DTE reject* packet, the DCE initiates on the specified logical channel retransmission of the *data* packets whose *packet send sequence numbers* start from P(R), where P(R) is indicated in the *DTE reject* packet. Until the DCE transfers across the DTE/DCE interface a *DCE data* packet with a *packet send sequence number* equal to the P(R) indicated in the *DTE reject* packet, the DCE will consider the receipt of another *DTE reject* packet as a procedure error and reset the virtual call or permanent virtual circuit.

Additional *data* packets pending initial transmission may follow the retransmitted *data* packet(s).

A DTE receive not ready situation indicated by the transmission of *RNR* packet is cleared by the transmission of a *DTE reject* packet.

The conditions under which the DCE ignores a *DTE reject* packet, or considers it as a procedure error, are those described for flow control packets in 2. and 3. above.

5.2 *Formats for Optional User Facilities*

5.2.1 *General*

The facility field is present only when a DTE is using an optional user facility requiring some indication in the call request packet or the incoming call packet.

The facility field contains a sequence of octet pairs. The first octet of each is a facility code field to indicate the facility or facilities requested and the second octet is the facility parameter field.

If any given user facility requires more than a single octet parameter field, several facility codes will be assigned to it. In the facility field, the octet pairs related to the same user facility are placed consecutively in the order specified for the parameters.

The facility code is binary coded. The coding of the facility parameter field is dependent on the facility being requested.

5.2.2 *Coding of facility field for particular facilities*

5.2.2.1 *Coding of Reverse Charging facility*

The coding of facility code field and parameters for Reverse Charging is the same in code request and incoming call packets.

Facility code field

The coding of the facility code field for Reverse Charging is:

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

Facility parameter field

The coding of the facility parameter field is as follows:

bit 1 = 0 for Reverse Charging not requested

bit 1 = 1 for Reverse Charging requested

Note. – Bits 8, 7, 6, 5, 4, 3 and 2 could be used for user facilities other than for Reverse Charging; if not, they are set to 0.

5.2.2.2 *Coding of Flow Control Parameters Selection facility*

The inclusion of facility code and parameter fields for Flow Control Parameters Selection is optional.

The coding in incoming call packets and in call request packets is the same.

Facility code field

The facility code field for Flow Control Parameters Selection is coded:

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

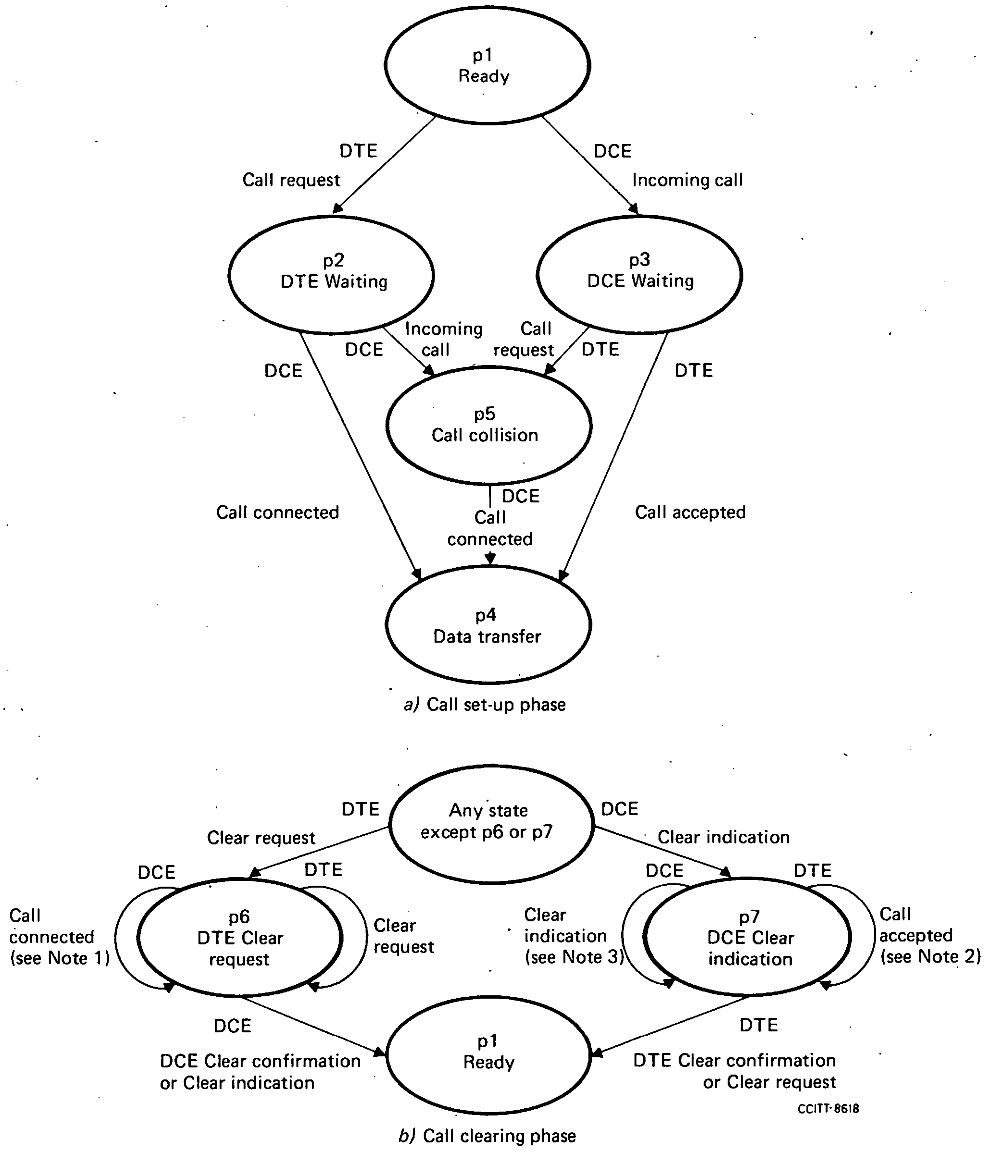
Facility parameter field

The throughput class for transmission from the calling DTE is indicated in bits 4, 3, 2, and 1. The throughput class for transmission from the called DTE is indicated in bits 8, 7, 6 and 5.

The four bits indicating each throughput class are binary coded and express the logarithm base 2 of the number of octets per second defining the throughput class. Bit 1 or 5 is the low order bit of each throughput class indicator.

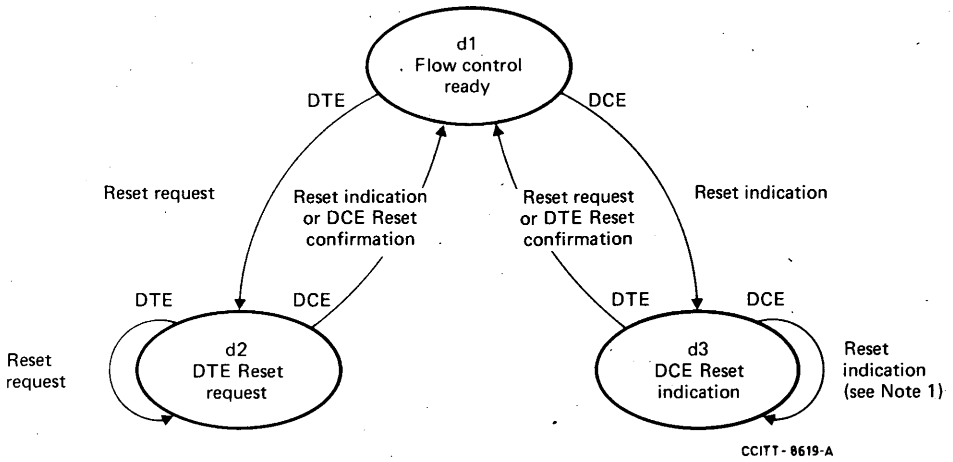
ANNEX 1
(to Recommendation X.25)

Packet level DTE/DCE interface state diagram for a logical channel



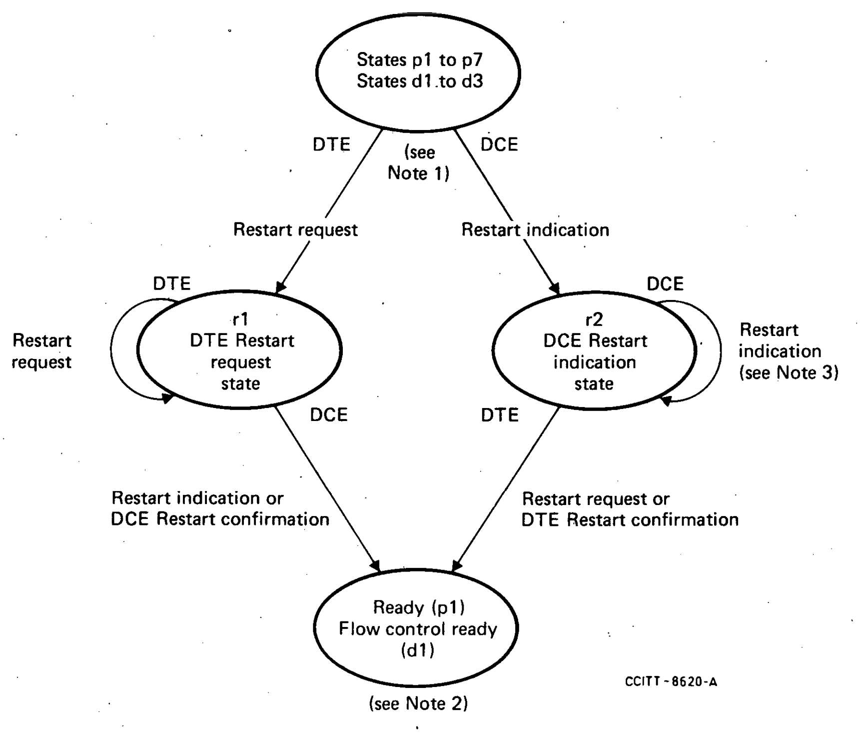
Note 1. – This transition is possible only if the previous state was *DTE Waiting* (p2).
Note 2. – This transition is possible only if the previous state was *DCE Waiting* (p3).
Note 3. – This transition will take place after a time-out in the network.

FIGURE 15/X.25



Note 1. – This transition will take place after a time-out in the network.

FIGURE 16/X.25 – **Reset phase**

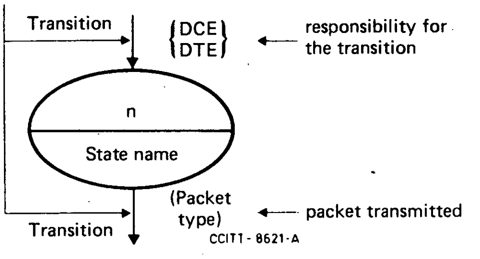


Note 1. – States p1 to p7 for virtual calls or states d1 to d3 for permanent virtual circuits.
Note 2. – State p1 for virtual calls or state d1 for permanent virtual circuits.
Note 3. – This transition will take place after a time-out in the network.

FIGURE 17/X.25 – **Restart phase**

ANNEX 2
(to Recommendation X.25)

Symbol definition of the state diagrams



Note 1. – Each state is represented by an ellipse wherein the state name and number are indicated.

Note 2. – Each state transition is represented by an arrow. The responsibility for the transition (DTE or DCE) and the packet it has successfully transmitted are indicated beside that arrow.

ANNEX 3
(to Recommendation X.25)

TABLE 10/X.25 – **Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface: call set-up and clearing**

Packet from the DTE \ State of the interface	Ready p1	DTE Waiting p2	DCE Waiting p3	Data transfer p4	Call collision p5	DTE Clear request p6	DCE Clear indication p7
Call request	NORMAL	ERROR	NORMAL	ERROR	ERROR	ERROR	ERROR
Call accepted	ERROR	ERROR	NORMAL	ERROR	ERROR	ERROR	NORMAL
Clear request	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
DTE Clear confirmation	ERROR	ERROR	ERROR	ERROR	ERROR	ERROR	NORMAL
Data, interrupt, reset or flow control	ERROR	ERROR	ERROR	See Table 11/X.25	ERROR	ERROR	NORMAL

NORMAL: the action taken by the DCE follows the normal procedures as defined in 3. of the text.

ERROR: the DCE indicates a clearing by transmitting to the DTE a *clear indication* packet, with an indication of Local Procedure Error. If connected through the virtual call, the distant DTE is also informed of the clearing by a *clear indication* packet, with an indication of Remote Procedure Error.

TABLE 11/X.25 – **Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface: flow control and data transfer**

State of the interface / Packet from the DTE	Data transfer (p4)		
	Flow control ready (d1)	DTE Reset request (d2)	DCE Reset indication (d3)
Reset request	NORMAL	NORMAL	NORMAL
DTE Reset confirmation	FLOW CONTROL ERROR	FLOW CONTROL ERROR	NORMAL
Data, interrupt or flow control	NORMAL	FLOW CONTROL ERROR	NORMAL

NORMAL: the action taken by the DCE follows the normal procedures as defined in 3. of the text.

FLOW CONTROL ERROR: the DCE indicates a reset by transmitting to the DTE a *reset indication* packet, with an indication of Local Procedure Error. The distant DTE is also informed of the reset by a *reset indication* packet, with an indication of Remote Procedure Error.

TABLE 12/X.25 – **Action taken by the DCE on receipt of packets in a given state of the packet level DTE/DCE interface: restart**

State of the interface / Packet from the DTE	Any state p1 to p7 and d1 to d3	DTE restart request state	DCE restart indication state
Restart request	NORMAL	NORMAL	NORMAL
DTE restart confirmation	ERROR	ERROR	NORMAL
Data, interrupt, call set-up and clearing, flow control or reset	See Note	ERROR	NORMAL

NORMAL: the action taken by the DCE follows the normal procedures as defined in 3. of the text.

ERROR: the DCE indicates a restarting by transmitting to the DTE a *restart indication* packet with an indication of Local Procedure Error.

Note. – See Table 10/X.25 for call set-up and clearing. See Table 11/X.25 for data, interrupt, flow control and reset.

Recommendation X.26

ELECTRICAL CHARACTERISTICS FOR UNBALANCED DOUBLE-CURRENT INTERCHANGE CIRCUITS FOR GENERAL USE WITH INTEGRATED CIRCUIT EQUIPMENT IN THE FIELD OF DATA COMMUNICATIONS

(For the text of this Recommendation, see Recommendation V.10 in Volume VIII.1 for which Study Group XVII is responsible.)

Recommendation X.27

ELECTRICAL CHARACTERISTICS FOR BALANCED DOUBLE-CURRENT INTERCHANGE CIRCUITS FOR GENERAL USE WITH INTEGRATED CIRCUIT EQUIPMENT IN THE FIELD OF DATA COMMUNICATIONS

(For the text of this Recommendation, see Recommendation V.11 in Volume VIII.1 for which Study Group XVII is responsible.)

Recommendation X.30

STANDARDIZATION OF BASIC MODEL PAGE-PRINTING MACHINE USING INTERNATIONAL ALPHABET No. 5

(For the text of this Recommendation, see Recommendation S.30 in Volume VII, for which Study Group VIII is responsible.)

Recommendation X.31

TRANSMISSION CHARACTERISTICS FOR START-STOP DATA TERMINAL EQUIPMENT USING INTERNATIONAL ALPHABET No. 5

(For the text of this Recommendation, see Recommendation S.31 in Volume VII, for which Study Group VIII is responsible.)

Recommendation X.32

ANSWER-BACK UNITS FOR 200- AND 300-BAUD START-STOP MACHINES IN ACCORDANCE WITH RECOMMENDATION S.30

(For the text of this Recommendation, see Recommendation S.32 in Volume VII, for which Study Group VIII is responsible.)

Recommendation X.33

STANDARDIZATION OF AN INTERNATIONAL TEXT FOR THE MEASUREMENT OF THE MARGIN OF START-STOP MACHINES USING INTERNATIONAL ALPHABET No. 5

(For the text of this Recommendation, see Recommendation S.33 in Volume VII, for which Study Group VIII is responsible.)

SECTION 3

TRANSMISSION, SIGNALLING AND SWITCHING

Recommendation X.40

STANDARDIZATION OF FREQUENCY-SHIFT MODULATED TRANSMISSION SYSTEMS FOR THE PROVISION OF TELEGRAPH AND DATA CHANNELS BY FREQUENCY DIVISION OF A PRIMARY GROUP

(Geneva, 1972)

The CCITT,

considering

a) that some Administrations are planning the introduction of public data networks;

b) that, to facilitate interworking between some networks, it is desirable to standardize the characteristics of transmission systems for the provision of channels for certain maximum modulation rates;

c) that interest has been expressed in deriving channels by frequency division of a primary group;

d) that Recommendation X.1 defines the user classes of service for public data networks;

e) that Recommendation X.1 includes user classes 3, 4 and 5 which correspond to maximum user data signalling rates of 600 bit/s, 2400 bit/s and 9600 bit/s, the transmission channels for which can be economically provided by frequency division of a primary group;

Note. – In the case of synchronously operated terminals a method of keeping synchronism between the subscribers is necessary. This implies the need for a method to provide bit sequence independency in accordance with Recommendation X.2, e.g. a scrambler. This is provided external to this system but forms part of the network.

f) that, for the present, no interest has been shown in providing separate channels for 600 bauds;

g) that standardization of channels for modulation rates less than 600 bauds, for example 200 bauds, is the subject of other Recommendations (e.g. R.38 A and R.38 B);

h) that there could be economic advantages in providing 2400- and 9600-baud channels (and possibly, in due course, 600-baud) in the one system;

unanimously declares the following view:

1. A primary group will be used as a bearer circuit;

2. The nominal modulation rates should be standardized at 2400 bauds and 9600 bauds;

3. For the 2400-baud channels the nominal mean frequencies are: (110 – 4n) kHz, where $n = 1, 2, \dots, 12$ (Figure 1/X.40).

For the 9600-baud channels the nominal mean frequencies are 96 kHz for channel 1 and 72 kHz for channel 2 (Figure 1/X.40).

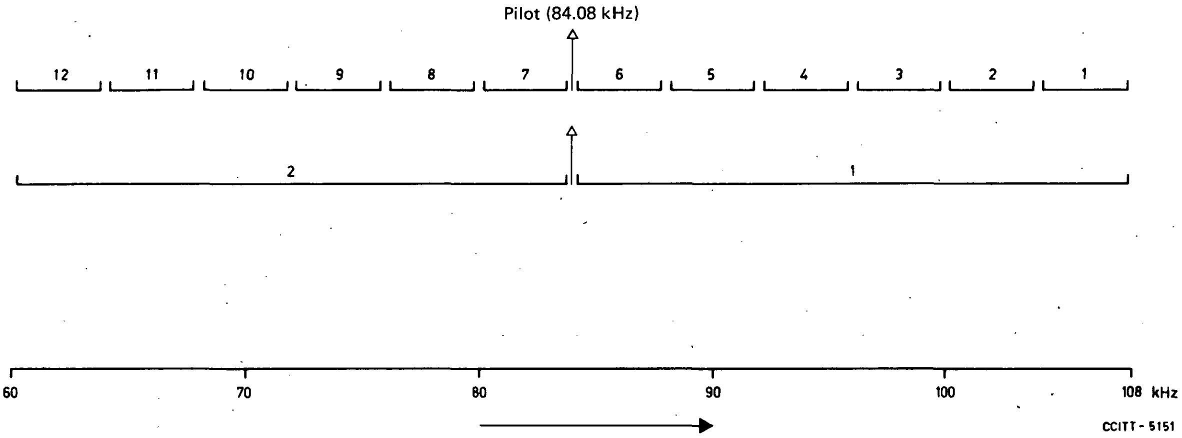


FIGURE 1/X.40 – **Division of the primary group into data channels for 2400 bauds and 9600 bauds**

The mean frequency F_0 is defined as the half-sum of the characteristic frequencies corresponding to the start polarity (F_A) and the stop polarity (F_Z).

4. The mean frequencies at the sending end should not deviate by more than ± 20 Hz both for 2400-baud channels and 9600-baud channels.

5. The difference between the two characteristic frequencies in the same channel is fixed at:

2 kHz in the case of 2400-baud channels;

8 kHz in the case of 9600-baud channels.

6. The maximum tolerance of this difference is ± 10% both for 2400-baud channels and 9600-baud channels.

7. The total average power transmitted to the primary group is limited to –4 dBm0 (400 µW at a point of zero relative level). This sets, for the average power of a derived channel, the limit of

– 15 dBm0 for the 2400-baud channels,

– 7 dBm0 for the 9600-baud channels,

in a fully equipped system.

Note Recommendation H.52, which in a) 2 says:

"In order to limit cross-modulation effects in wideband systems, the power level of any individual spectral component in the band 60-108 kHz should not exceed – 10 dBm0 (except for the environment of the pilot for which a separate Recommendation exists)."

"With regard to its effect on non-telephone type signals, a discrete component is defined as a signal of sinusoidal form with a minimum duration of about 100 ms."

To meet this requirement at 9600 bauds, a data scrambler may be used external to the system.

8. The in-service levels of the permanent "start" polarity and permanent "stop" polarity signals must not differ by more than 1.5 dB and the higher of these two signal levels must comply with those of 7. above.

9. The "start" polarity frequency is the lower of the two characteristic frequencies in the primary basic group and the "stop" polarity frequency is the higher one.

10. In the case of 9600 bauds where scramblers are used external to the system to comply with 7. above, it will also be necessary to drop the continuous −7 dBm0 "start" polarity signal to −10 dBm0 in the absence of channel modulator control.

11. The receiving equipment should operate satisfactorily when the receiving level falls to 6 dB below the nominal level. The receiving equipment should have been restored to start polarity when the receiving level has fallen to 12 dB below the nominal level.

The alarm-control level is left to the choice of each Administration.

12. The maximum degree of isochronous distortion on standardized text is provisionally fixed at 8% in the whole receiver level range (± 6 dB from nominal level) for closed circuit measurements.

13. Systems should be designed in such a manner that the combined use of 6 channels for 2400 bauds and 1 channel for 9600 bauds is possible.

14. As an optional facility it should be possible to replace any 2400-baud channel, in particular channels No. 1 and No. 12, by a channel translating equipment which enables the insertion of a VFT system according to Recommendations R.35, R.35 *bis*, R.36, R.37, R.38 A or R.38 B.

Recommendation X.50

FUNDAMENTAL PARAMETERS OF A MULTIPLEXING SCHEME FOR THE INTERNATIONAL INTERFACE BETWEEN SYNCHRONOUS DATA NETWORKS

(Geneva, 1972, amended at Geneva, 1976)

The establishment in various countries of public synchronous data networks creates a need to standardize a preferred multiplexing scheme to be used on international links between these countries.

The CCITT,

considering

that the resolution of the fundamental parameters of a multiplexing scheme is urgently needed for the interworking of data networks using different envelope structures;

unanimously declares the following view:

DIVISION 1

1.1 This Recommendation sets out the fundamental parameters of a multiplexing scheme for interworking of networks that make use of the following structures:

a) 8-bit envelope (see Explanatory note 1 below);

b) four 8-bit envelopes grouping (see Explanatory note 2 below);

c) 10-bit envelope (see Explanatory note 3 below),

in the case where at least one of the networks is structured according to *a)* or *b)*.

1.2 For interworking between two networks both of which utilize the 10-bit envelope structure as identified in 1.1 *c)* above, Recommendation X.51 will apply.

1.3 Division 2 of this Recommendation deals with the basic multiplexing parameters which shall be used in any application of this Recommendation.

1.4 Division 3 of this Recommendation, in addition to Division 2, applies to the interworking between two networks both of which utilize the 8-bit envelope structure, as identified in 1.1 *a)* above.

1.5 Division 4 of this Recommendation, in addition to Division 2, applies to the interworking of networks as identified in 1.1 above in cases other than those described in 1.2 and 1.4 above with due regard to the transit situations.

1.6 The use of the status bit, besides that indicated in this Recommendation, should comply with Recommendations X.21 and X.21 *bis*, together with Recommendation X.71 for connections using decentralized signalling and with Recommendation X.60 for connections using common channel signalling.

DIVISION 2

2.1 The multiplex gross bit rate of 64 kbit/s should be standardized for international links and framing information for the channels should be contained within the 64 kbit/s capability.

2.2 For the basic multiplexing of information bearer channels, the following applies:

i) structures suitable both for handling homogeneous (with respect to bearer rates) mixes of bearer channels and structures suitable for handling heterogeneous mixes of bearer channels are required;

ii) the signal elements of each individual channel should be assembled in 8-bit envelopes;

iii) an 8-bit envelope interleaved structure should be used;

iv) for the multiplex signal framing a distributed framing pattern should be used, employing the framing bits of consecutive 8-bit envelopes but taking into account the requirements for service digits (housekeeping digits).

v) these interleaved 8-bit envelopes will appear on the 64 kbit/s bearer as follows:

- 12.8 kbit/s channels will repeat every 5th 8-bit envelope;
- 6.4 kbit/s channels will repeat every 10th 8-bit envelope;
- 3.2 kbit/s channels will repeat every 20th 8-bit envelope;
- 800 bit/s channels will repeat every 80th 8-bit envelope.

2.3 The following multiplexing structure is recommended:

i) the multiplexing structure will comprise 80 8-bit envelopes;

ii) this structure will allow the multiplexing of channels at the bearer rates indicated in 2.2 v) above;

iii) within each 12.8 kbit/s channel, only a homogeneous mixture of sub-rate channels will be allowed;

iv) a 72-bit long framing pattern is recommended. This pattern is part of the 80-bit pattern which is generated according to the primitive polynomial:

$$1 + x^4 + x^7$$

of the 2^7 Galois field with the forcing configuration

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and which is reproduced in Table 1/X.50, showing 8 bits ("A" to "H") reserved for housekeeping;

v) the framing strategy is under study;

vi) the first F bit, indicated as "A" in Table 1/X.50 is used to convey to the distant end alarm indications detected at the local end corresponding to:

- absence of incoming pulses,
- loss of frame alignment;

vii) the "A" bit shall be assigned such that:

"A" equals 1 means no alarm,

"A" equals 0 means alarm;

viii) the other F bits indicated as "B", "C", "D", "E", "F", "G", and "H" in Table 1/X.50 are reserved to convey further international housekeeping information. The exact use of the remaining housekeeping bits is under study. Pending the resolution of the housekeeping requirements, these bits are provisionally fixed to:

"B" equals 1, "C" equals 1, "D" equals 0,

"E" equals 0, "F" equals 1, "G" equals 1, "H" equals 0.

TABLE 1/X.50

1st bit →

A	1	0	0	0	1	1	1	1	1	B	1	0	0	0	0	1	1	1	0
C	1	1	1	0	0	1	0	1	1	D	0	1	0	0	1	0	0	0	0
E	0	1	0	0	0	1	0	0	1	F	0	0	0	1	0	1	1	1	0
G	0	1	1	0	1	1	0	0	0	H	0	1	1	0	0	1	1	0	1

Forcing configuration (bracketed: 1 0 0 1 1 0 1)

DIVISION 3

For interworking between two networks, both of which utilize the 8-bit envelope structure, as identified in 1.1 a) above, each individual channel should be assembled into single 8-bit envelopes. As an alternative to the multiplexing structure recommended in 2.3 above, other structures may be used by bilateral agreement. One of the preferred structures is described below:

i) the multiplexing structure will comprise 20 8-bit envelopes;

ii) the structure will allow the multiplexing of channels at the bearer rates 12.8 kbit/s and 3.2 kbit/s indicated in 2.2 v) above;

iii) within each 12.8 kbit/s channel only a homogeneous mixture of 3.2 kbit/s channels will be allowed;

iv) a 19-bit long framing pattern is recommended. The pattern is part of the 20-bit pattern which is generated to the primitive polynomial:

$$1 + x^2 + x^5$$

of the 2^5 Galois field with the forcing configuration

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and is reproduced in Table 2/X.50;

v) the framing strategy is under study;

vi) the first F bit indicated as "A" in Table 2/X.50, is used as stated in 2.3 vi) above;

vii) the sense of "A" will be in accordance with 2.3 vii) above.

TABLE 2/X.50

1st bit →

A	1	1	0	1	0	0	1	0	0	0	0	1	0	1	0	1	1	1	0

Forcing configuration (bracketed: 0 1 1 1 0)

DIVISION 4

For the interworking of networks as identified in 1.1 above, in cases other than those described in 1.2 and 1.4, the following shall apply.

4.1 A network using the 10-bit envelope structure shall interwork with other networks, as identified in 1.1 *a)* and *b)* above, by offering the same characteristics as a network using the four 8-bit envelopes grouping. Therefore in the following, the term "network providing the four 8-bit envelopes grouping" will cover the case of a network using either four 8-bit envelopes grouping as identified in 1.1 *b)* or the 10-bit envelope structure, as identified in 1.1 c).

4.2 When either end of an international connection, carrying point-to-point or switched service, terminates in a network providing four 8-bit envelopes grouping, the use of the four 8-bit envelopes grouping may be required on the international connection carrying point-to-point or switched services. This is subject to further study.

4.3 The alignment of the four 8-bit envelopes grouping shall be subject to the following conditions:

i) the method of alignment shall allow switched and non-switched point-to-point data circuits to be conveyed,

ii) alignment shall be monitored and maintained at both ends of an international connection in the two networks providing the four 8-bit envelopes grouping by means of a pattern(s) on bit S_D of the four 8-bit envelopes grouping throughout the data phase of the call,

iii) transit exchanges shall not overwrite the S_D bit once they have through connected,

iv) alignment shall be established at both ends of an international connection in the two networks providing the four 8-bit envelopes grouping prior to the through connection of the originating exchange.

Note 1. – The inter-exchange signalling procedures are expected to allow iv) above without unacceptable delay in call set-up.

Note 2. – Problems caused by imitation of the S_D pattern(s) should be studied further.

4.4 The specific strategy of the four 8-bit envelopes grouping alignment would be the subject of further study.

4.5 In case where one of the networks is not providing the four 8-bit envelopes grouping, there is no relationship between any four 8-bit envelopes grouping and any character structure outgoing from that network. Moreover this network will not originate any alignment information for the outgoing four 8-bit envelopes grouping.

4.6 When links containing a four 8-bit envelopes grouping are connected in tandem to provide a trunk, the four 8-bit envelopes grouping alignment information shall be maintained across the connection.

4.7 In transit switching, the four 8-bit envelopes grouping alignment information shall be maintained once the transit exchange has through connected.

4.8 When links containing single 8-bit envelopes are connected in tandem to provide a trunk, the information and status bits of the 8-bit envelopes shall be transparently conveyed across the connection.

EXPLANATORY NOTES

1. *8-bit envelope*

In an 8-bit envelope, bit 1 is reserved for framing purposes, bits 2-7 are information bits of the channel, and bit 8 is a status bit (see Figure 1/X.50).

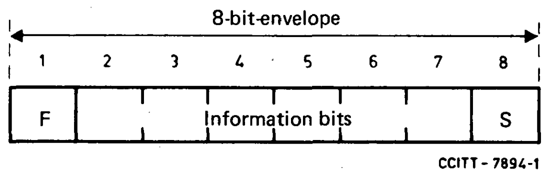


FIGURE 1/X.50

The addition of the framing and the status bits results in a 33% increase in bit rate, so that bearer channel rates are:

12.8 kbit/s for the 9.6 kbit/s data signalling rate;

6.4 kbit/s for the 4.8 kbit/s data signalling rate;

3.2 kbit/s for the 2.4 kbit/s data signalling rate;

800 bit/s for the 600 bit/s data signalling rate.

The status bit is associated with each envelope and, in conjunction with the information bits, conveys call control information.

2. *Four 8-bit envelopes grouping*

A group of four 8-bit envelopes is assembled on a single channel as a 32-bit group providing 24 information bits. This gives the possibility of accommodating three 8-bit characters, e.g. P, Q, R, as in Table 3/X.50.

TABLE 3/X.50

F	P1	P2	P3	P4	P5	P6	S_A	8-bit envelope A
F	P7	P8	Q1	Q2	Q3	Q4	S_B	8-bit envelope B
F	Q5	Q6	Q7	Q8	R1	R2	S_C	8-bit envelope C
F	R3	R4	R5	R6	R7	R8	S_D	8-bit envelope D

Status bit S_D is used to provide the alignment information of the four 8-bit envelopes grouping.

Status bits S_A, S_B and S_C in conjunction with the 24 information bits convey call control information.

When the three 8-bit characters P, Q and R are accommodated as above described, status bits S_A, S_B and S_C are respectively associated with those characters.

The four 8-bit envelopes grouping is applied on a per channel basis. For example, for the 12.8 kbit/s bearer rate, the four 8 bit envelopes group recurs after 20 8-bit envelopes of the multiplexed stream, as in Figure 2/X.50.

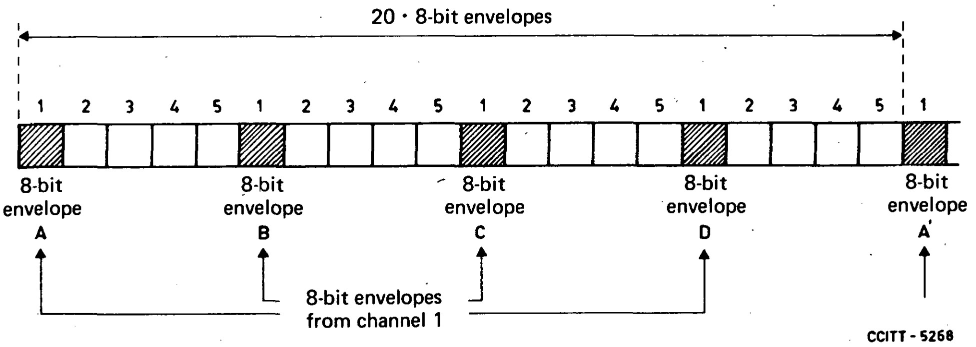


FIGURE 2/X.50

3. *10-bit envelope*

In a 10-bit envelope, bit 1 is a status bit, bit 2 is reserved for envelope alignment purposes and bits 3-10 are information bits of the channel (see Figure 3/X.50).

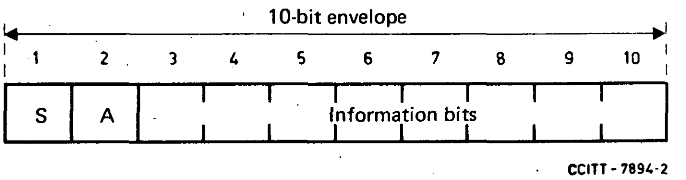


FIGURE 3/X.50

The addition of the envelope alignment and the status bits results in a 25% increase in bit rate, so that bearer channel rates are:

12.0 kbit/s for the 9.6 kbit/s data signalling rate;

6.0 kbit/s for the 4.8 kbit/s data signalling rate;

3.0 kbit/s for the 2.4 kbit/s data signalling rate;

750 bit/s for the 600 bit/s data signalling rate.

The status bit is associated with each envelope and, in conjunction with the associated 8-bit byte information bits, conveys call control information.

Recommendation X.51

FUNDAMENTAL PARAMETERS OF A MULTIPLEXING SCHEME FOR THE INTERNATIONAL INTERFACE BETWEEN SYNCHRONOUS DATA NETWORKS USING 10-BIT ENVELOPE STRUCTURE

(Geneva, 1976)

The CCITT,

considering,

a) that Recommendation X.50 sets out the fundamental parameters for a multiplexing scheme for the interworking of networks where at least one makes use of the 8-bit envelope structure or of the four 8-bit envelopes grouping,

b) that there is a requirement of a multiplexing scheme for the interworking between two networks where both use 10-bit envelope structure, *unanimously declares the view,*

that the following fundamental parameters shall be used between networks using the 10-bit envelope structure.

1. *Gross bit rate*

For transmission on the international link the multiplexed bit stream shall have a gross bit rate of 64 kbit/s. The fundamental multiplex structure shall have a gross bit rate of 60 kbit/s and shall utilize padding techniques for transmission on the 64 kbit/s international bearer.

2. *Fundamental multiplex*

For the fundamental multiplexing of information bearer channels, the following applies:

2.1 The signal elements of each individual channel shall be assembled in 10-bit envelopes, in which bit 1 is a status bit (see Note), bit 2 is an envelope alignment bit, and bits 3-10 are information bits, as in Figure 1/X.51.

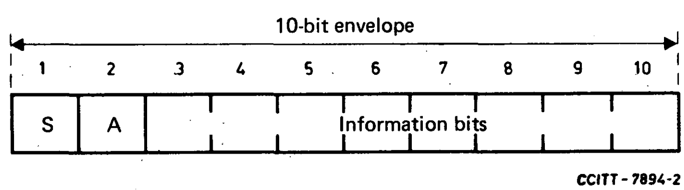


FIGURE 1/X.51

The addition of the status and the envelope alignment bits results in a 25% increase in bit rate, so that the bearer channel rates are:

12.0 kbit/s for the 9.6 kbit/s data signalling rate;

6.0 kbit/s for the 4.8 kbit/s data signalling rate;

3.0 kbit/s for the 2.4 kbit/s data signalling rate;

750 bit/s for the 600 bit/s data signalling rate.

Note. – A status bit is associated with each envelope and in conjunction with the associated 8-bit data byte conveys call control information (cf., Recommendations X.21, X.21 *bis*, X.60, X.71 and X.50).

2.2 A 10-bit envelope interleaved structure shall be used.

2.3 These interleaved envelopes will appear on the 60 kbit/s fundamental multiplex as follows:

12.0 kbit/s channels will repeat every 5th envelope;

6.0 kbit/s channels will repeat every 10th envelope;

3.0 kbit/s channels will repeat every 20th envelope;

750 bit/s channels will repeat every 80th envelope.

2.4 Both structures suitable for handling homogeneous (with respect to bearer rates) mixes of bearer channels and structures suitable for handling heterogeneous mixes of bearer channels are required, with the constraint that the division of any 12 kbit/s bearer channels of the multiplex shall be homogenous providing either two 6 kbit/s, four 3 kbit/s or sixteen 750 bit/s bearer channels.

3. *Method of framing*

3.1 *Overall structure*

The residual 4 kbit/s capacity obtained by carrying the fundamental 60 kbit/s multiplex on the 64 kbit/s bearer shall be distributed so that a padding bit is inserted after each group of 15 bits from the fundamental multiplex (see also Figure 2/X.51).

The frame length shall be 2560 bits in the case of a synchronized bearer, i.e. 2400 bits or 240 envelopes from the fundamental multiplex interleaved with 160 padding bits.

When justification is used (for national purposes) in the case of a non-synchronized bearer the last padding bit in the frame can be deleted or an extra padding bit added when needed, resulting in a variable frame length of 2560 ± 1 bit. (This can allow a maximum speed tolerance of approximately ± 4 parts in 10^4.)

The padding bits shall contain the framing pattern, justification service digits and housekeeping signalling (alarms, etc.).

3.2 *Framing*

3.2.1 *Frame alignment patterns*

The frame alignment method is based on the use of 4 equidistantly distributed frame alignment patterns written into the padding bits, dividing the frame into 4 subframes. Each subframe alignment pattern starts with the 14 bit pattern:

11111001101010

followed by a 2-bit subframe identifier unique to the subframe, i.e.:

SF1 = 00, SF2 = 01, SF3 = 10, SF4 = 11

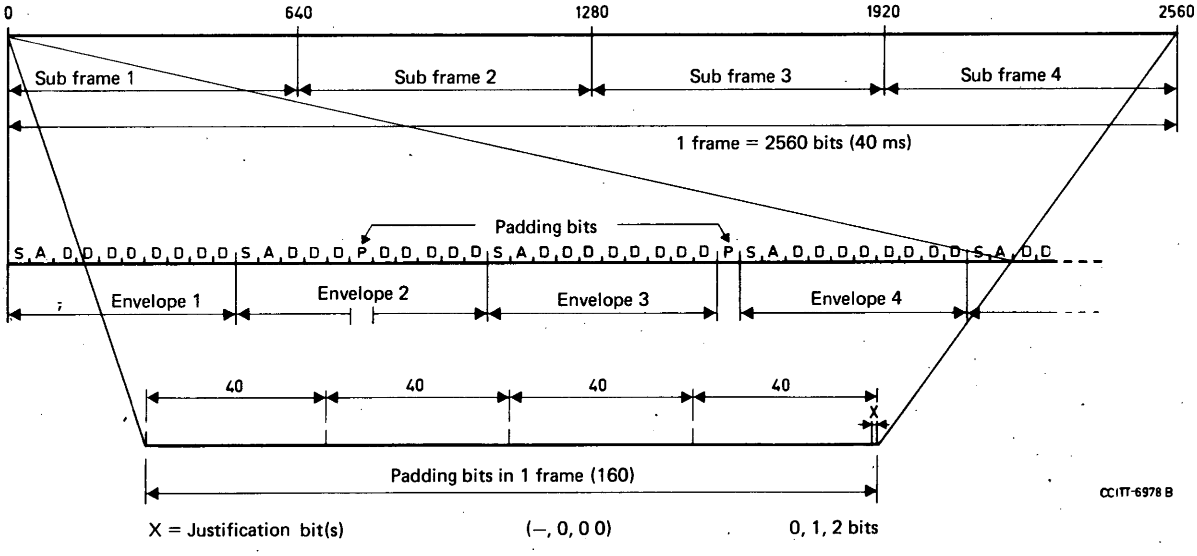


FIGURE 2/X.51 – **Multiplex frame structure**

3.2.2 *Framing strategy*

3.2.2.1 *Loss of frame alignment*

The criterion for loss of frame alignment shall be three consecutive frame alignment patterns including subframe identifier in error.

The frame alignment shall also be considered lost if the first received frame alignment pattern including subframe identifier after reframing is in error.

3.2.2.2 *Reframing*

The criterion for reframing shall be the detection of one valid frame alignment pattern.

3.2.2.3 *Reframing procedure*

After loss of frame alignment

- the outgoing envelopes shall be set to all ones,
- the state shall be signalled to the distant end, and
- a parallel hunt for a valid frame alignment pattern shall be started.

After a valid frame alignment pattern is found

- the two following padding bits shall be accepted as subframe identifiers and be used to set the frame and subframe counter(s) as applicable,
- the blocking of the outgoing data channels shall be removed, and
- the signalling of out of frame alarm to the distant end shall be terminated.

4. *Justification*

64 kbit/s bearer carrying the 10-bit envelope multiplex normally shall be locked to the data stream and therefore justification on international links is not required. However, justification could be required for national purposes. To achieve this, plus minus justification shall be used in which four repeated justification service signals occupy the 3 bits immediately following each subframe identifier. The last padding bit of the frame is used as a justification digit.

The repeated justification service signals are:

010 no justification (i.e. one padding bit at end of frame),

100 one justification bit has been added (i.e. two padding bits at end of frame),

001 the justification bit has been deleted (i.e. no padding bit at end of frame).

In evaluating the signals in one frame a majority decision of the four received signals is used. In case of no majority, no justification shall be assumed.

If framing is lost, no justification shall be assumed before reframing has occurred.

5. *Housekeeping signals and functions*

The padding bits not used for framing and justification shall be available for housekeeping information signals, for both international and national use. The definition and allocation of some of the available housekeeping bits is left for further study. The following allocation is recommended.

5.1 *International housekeeping bits*

Eight bits A, B, C, D, E, F, G, and H (cf. Recommendation X.50) are allocated for international housekeeping signals.

The bit A is used to convey to the distant end alarm indications detected at the local end corresponding to:

- absence of incoming pulses,
- loss of frame alignment,

and the bit A shall be assigned such that:

- A equals 1 means no alarm,
- A equals 0 means alarm.

The other bits B, C, D, E, F, G and H are reserved to convey further international housekeeping signals. The exact use is under study. Pending the result of the study these bits shall be set to binary 1.

5.2 *Cyclic error-control*

A cyclic error-control (cf. Recommendation V.41) to be used end-to-end on the international 64 kbit/s link is recommended but not mandatory. The multiplex frame (2560 bits) is divided modulo 2 by the polynomial $x^{16} + x^{12} + x^5 + 1$ and the resulting reminder (16 bits), the check bits, are sent in the next frame, 4 bits in each subframe. An error is detected at the receiving end by comparing the check bits generated locally, by dividing the received multiplex frame with the same polynomial, and the check bits received in the following frame. The error detection shall be blocked in the out-of-frame state.

5.3 *National housekeeping signals*

A total of 48 housekeeping bits, 12 in each subframe, remains for national housekeeping signals, of which the following are foreseen:

Network status	1-4 bits
Multiplex channel allocation (depending on number of speed classes and coding) . . .	5-10 bits
Internal and external alarms	1-4 bits

These signals could possibly be extended for international use. Housekeeping bits not used in one network shall be set to binary 1.

6. *Allocation and use of padding bits (40 bits) in one subframe (640 bits) for framing, justification and housekeeping*

The allocation of padding bits in one subframe numbered P1 to P40 is described below and shown in Figure 3/X.51.

P1-P4	International housekeeping bits A, B, C, and D (cf. Recommendation X.50)	
P5-P8	Error check bits	4 bits
P9-P20	National housekeeping bits	12 bits
P21-P34	Framing pattern . . . . Code 11111001101010	14 bits
P35-P36	Subframe identifier . . . . Code 00, 01, 10 or 11	2 bits

For P37-P40 two alternatives exist:

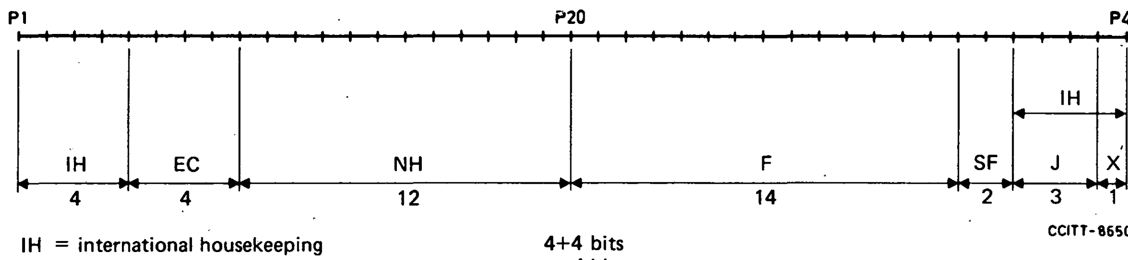
I – Synchronous transmission bearer

P37-P40	International housekeeping bits E, F, G and H (cf. Recommendation X.50)

II – A synchronous transmission bearer

P37-P39	Justification service signals . . . . Code 001, 010, 100	3 bits
P40(P41)	Justification bit(s) 0, 1, 2 bit(s) Code –, 0, 00	

Only the justification bit(s) in the last subframe (SF4) is used for justification.



IH = international housekeeping 4+4 bits
EC = error-control 4 bits
NH = national housekeeping 12 bits
F = frame alignment pattern 14 bits
SF = subframe identifier 2 bits
J = justification service signals 3 bits
X = justification bit 1 bit

FIGURE 3/X.51 – **Allocation of padding bits in one subframe (40 bits)**

Recommendation X.60

COMMON CHANNEL SIGNALLING FOR SYNCHRONOUS DATA APPLICATIONS – DATA USER PART

(Geneva, 1976)

CONTENTS

Introduction

General

It has been established that there is a need for a standardized common channel signalling system that is suitable for application in public synchronous data networks. Also, advantages can be gained by adoption, where possible, of common solutions for common channel signalling in such data networks and in other digital networks for circuit switched telecommunications services.

To meet the need for one common channel signalling system that is suitable for different services, it has been agreed to standardize a system consisting of one part, the Message Transfer Part, that is common, and separate parts, the User Parts (see note), that are individual for different services and applications. The signalling system and the conditions for its use are under further study (see Questions 9/VII, 2/XI and 3/XI). The characteristics of the Data User Part of the signalling system so far established are defined in this Recommendation.

Note. — The term "user" in this context refers to any functional sub-system using the message transfer function of the signalling system.

Objectives

The signalling system should be able to serve different dedicated services networks, e.g. new data networks. It will be suitable also for serving the needs of an *integrated services digital network.*

The signalling system is intended to be suitable for international and national data applications. For international working the specifications define the signalling on international links and also certain conditions applying for international data calls in national networks using common channel signalling.

In general, the functional requirements of signalling for international and national working are very similar. Also, certain specific national requirements have been taken into account in the specification of the Data User Part. The signalling system can therefore be used for, or provide a basis for, common channel signalling for national data applications.

General characteristics

The signalling system uses signalling links for transfer of signalling information in the form of signal messages. One signalling link has the capability to serve as a signalling medium for many inter-exchange data circuits. Arrangements are provided to ensure reliable transfer of signalling information in the presence of transmission disturbances and faults.

Since in this system the inter-exchange data circuits are not used for the transfer of signalling information, special means are provided to check the continuity of the data paths at call set-up. These means, which involve application and detection of certain conditions in the inter-exchange data channels, are inherent functions of the common channel signalling system.

The signal message transfer delay is independent of the data rate of the inter-exchange data circuits, and the signalling system provides the fast signal transfer necessary for meeting the objectives for short call set-up times for data calls. The inherent flexibility of the system provides a potential to cater for changing or additional requirements of the data service. It also provides a means for reliable communication within the network for administrative purposes.

DIVISION 1

Functional description of the signalling system

1.1 *Basic structure*

The main functions of any call control signalling system are the transfer of signalling information between exchanges and the handling of this information as part of the call control processes in the exchanges. The fundamental principle of the structure of this common channel signalling system is that these functions are clearly separated. The functions related to the transfer of signalling information constitute a Message Transfer Part. For each service (e.g. data and telephony) the functions related to the signalling information and the call control procedures form a User Part (see Note) that is defined separately from the User Parts for other services.

Note. – The term "user" in this context refers to any functional sub-system using the message transfer function of the signalling system.

As the message transfer function of the signalling system is clearly separated from the service dependent call control functions it is readily usable for communication needs other than call control signalling. For example, the message transfer function can be used for transfer of network management, maintenance, charging information or for other administrative purposes. Where such a use is made of the message transfer function, the functions related to the handling of the information transferred for a particular purpose form a separate User Part of the signalling system (e.g. a Network Management User Part, etc.).

The resulting basic functional structure of the common channel signalling system is shown in Figure 1/X.60.

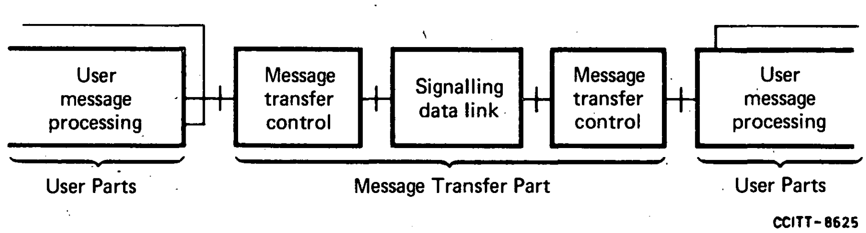


FIGURE 1/X.60 – **Functional diagram of the common channel signalling system**

1.2 *Message Transfer Part*

The Message Transfer Part uses signalling links, each of which comprises a signalling data link and the associated transfer control functions.

On each signalling link the information is arranged in fixed size signal units. Signal units carrying signalling information contain a fixed size signalling information field, a signal unit indicator and a service indication. The signal units also contain transfer control information (e.g. check bits and sequence numbers).

To ensure reliable transfer of signalling information in the presence of transmission errors, means for error detection and error correction are provided. Also, to ensure availability of the message transfer function in the case of transmission faults, signalling link security arrangements are provided based on provision of reserve facilities or by utilization of redundancy in a signalling network.

The Message Transfer Part is designed not to introduce out-of-sequence or double delivery of signalling information. It is optimized for operation over 64 kbit/s digital channels, but also allows the use of different types of bearers operating over a range of speeds and having short as well as long loop delays.

Note. – The Message Transfer Part is under study by Study Group XI.

1.3 *Data User Part*

The data call control processes related to the signalling information including the functions for formatting and coding of the signalling information form the Data User Part of the signalling system.

The relation between the Data User Part and the Message Transfer Part is defined by the functional interface described in 1.4 below. However, it is not possible to define a generally applicable functional interface between the Data User Part and exchange call control functions not specified as part of the common channel signalling system.

1.4 *Functional interface*

A functional interface between the Message Transfer Part on one hand and the User Parts on the other can be defined to illustrate the division of functions between these parts. The interface (see Figure 2/X.60) is purely functional; it is not an equipment interface and it need not appear as such in an implementation of the system.

The signal messages transferred over the interface contain the signalling information (e.g. label and address signals) and the message alignment and service indications.

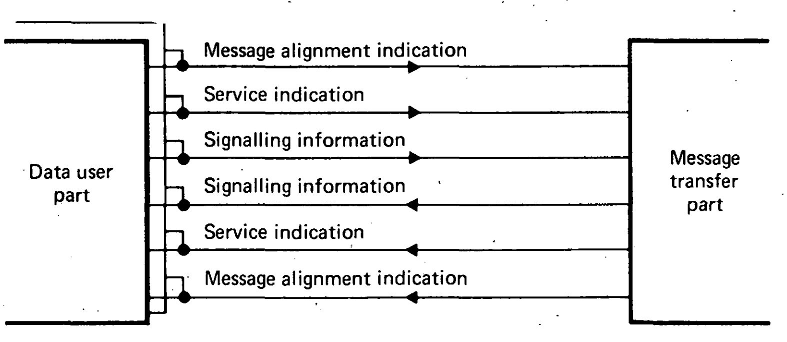


FIGURE 2/X.60 – **Functional interface between the Message Transfer Part and the User Parts**

The signalling information of a signal message is carried through the Message Transfer Part in the signalling information field of the signal units. The Message Transfer Part is in principle transparent to signalling information, i.e. the formats and codes applying for the content of the signalling information field can be defined independently of the functions of the Message Transfer Part.

The message alignment indication indicates the boundaries of a signal message and thereby allows the use of variable length messages. Depending on the amount of signalling information in a given signal message one or more signal units are used to carry that message over the signalling link. The message alignment information pertaining to a particular signal message is conveyed over the signalling link in the signal unit indicator(s) of the signal unit(s) used for that message. The signal unit indicator of a signal unit indicates whether it contains the whole message or whether it is the first, an intermediate or the final signal unit in the case when more than one signal unit is used to carry the message. The form and code of the message alignment indication are not standardized but are implementation dependent. The signal unit indicator is coded in accordance with rules that are common for the Message Transfer Part and all User Parts.

The service indication provides flexibility in the system by discriminating between signal messages belonging to different User Parts.

DIVISION 2

Definition and function of data signal messages, signals and conditions

The definitions hereunder are intended to indicate the main function of the messages, signals and conditions.

The requirements relating to their use are defined under 4. and 5. below.

2.1 *Signal messages*

The messages defined below are specific to call control aspects of the data service and pertain to a data call or to a data circuit.

2.1.1 **address messages**

A message sent in the forward direction containing the signalling information required to route and connect the call to the called line, e.g.:

- address information;
- class of service information;
- additional information relating to user and network facilities.

An Address Message may also contain the calling customer identity.

2.1.2 **calling line identity message**

A message sent in the forward direction containing the identity of the calling line. This message, when applicable, is sent subsequent to an Address Message which does not contain the identity of the calling line.

2.1.3 **response message**

A message sent in the backward direction containing:

- an indication of the called terminal line condition or of a network condition;
- information relating to user and network facilities;
- in the case of some user facilities, an address or identity.

2.1.4 **clear message**

A message sent in the forward and the backward direction containing a circuit-released or circuit-released-acknowledgement signal.

The Clear Message will contain an indication whether the message is in the forward or the backward direction.

2.2 *Signals transferred via the signalling link*

2.2.1 **address signal**

A signal containing one element (e.g. a decimal digit or an end-of-number indication) of the address of a customer, network facility, etc.

2.2.2 **destination address**

Information sent in the forward direction consisting of a number of address signals indicating the complete address of the called customer.

2.2.3 **destination-code indicator**

Information sent in the forward direction indicating whether or not the destination code (referring to destination country or network) is included in the destination address.

2.2.4 **alternative-routing indicator**

Information sent in the forward direction indicating that the call has been subjected to an alternative routing.

2.2.5 **national/international-call indicator**

Information sent in the forward direction indicating in the national network whether the call is a national or an incoming international call.

2.2.6 **user-class indicator**

Information sent in the forward direction indicating the user class of the calling customer according to Recommendation X.1 with additions where applicable.

2.2.7 **country-or-network identity**

Information sent in the backward direction consisting of a number of address signals indicating the identity of a country or network in which the call has been internationally transit switched.

2.2.10 **call accepted signal**

A signal sent in the backward direction indicating that the call can be completed. Normally the call will be charged to the calling customer.

2.2.11 **terminal-engaged signal**

A signal sent in the backward direction indicating that the call cannot be completed because the called terminal's access line to the exchange is engaged in another call.

2.2.12 **out-of-order signal** [1)]

A signal sent in the backward direction indicating that the call cannot be completed because either the called terminal or the called terminal's access line is out of service or faulty.

2.2.13 **controlled-not-ready signal**

A signal sent in the backward direction indicating that the call cannot be completed because the called number is in a controlled-not-ready condition.

2.2.14 **not-obtainable signal**

A signal sent in the backward direction indicating that the call cannot be completed because the called number is not in use or is in a different user class.

2.2.15 **access-barred signal**

A signal sent in the backward direction indicating that the call will not be completed because of a called or calling customer user facility. This may occur for instance as a result of failure of a closed user group validation check or because of the incoming calls barred facility.

2.2.16 **changed-number signal**

A signal sent in the backward direction indicating that the call cannot be completed because the called customer's number has been changed recently.

2.2.20 **(national) circuit-group-congestion signal**

A signal sent in the backward direction indicating the failure of the call set-up attempt due to congestion encountered on a circuit group in the national network.

2.2.21 **(national) switching-equipment-congestion signal**

A signal sent in the backward direction indicating the failure of the call set-up attempt due to congestion encountered at the switching equipment in the national network.

2.2.22 **international-congestion signal**

A signal sent in the backward direction indicating the failure of the call set-up attempt due to congestion encountered in the international network or destination national network.

2.2.23 **continuity-failure signal**

A signal sent in the backward direction indicating that the call cannot be completed due to failure of the forward continuity check.

2.2.24 **call-failure signal**

A signal sent in the backward direction indicating that the call cannot be completed due to time-out, fault or a condition that does not correspond to any other particular signal.

2.2.30 **circuit-released signal**

A signal sent in the forward and backward direction indicating that the inter-exchange data circuit has been released.

[1)] Signals to indicate "line-out-of-service" and "uncontrolled-not-ready" may be required following the study of Question 23/VII.

2.2.31 **circuit-released-acknowledgement signal**

A signal sent in the forward and backward direction in response to a *Circuit-released signal* indicating that an inter-exchange data circuit has been released.

2.2.40 **closed-user-group indicator**

Information sent in the forward direction and, in some circumstances, in the backward direction, indicating whether or not the calling customer belongs to a closed user group. In the positive case it also indicates that:

- an interlock code is included and outgoing access is not allowed; or
- an interlock code is included and outgoing access is allowed; or
- no interlock code is included because the call is a direct call.

2.2.41 **interlock code**

Information sent in the forward direction and, in some circumstances, in the backward direction, indicating the closed user group involved in the call.

2.2.42 **calling-line identity**

Information sent in the forward direction consisting of a number of *Address signals* indicating the complete calling line identity.

2.2.43 **calling-line-identification-request indicator**

Information sent in the backward direction indicating whether or not the calling line identity should be sent forward in a Calling Line Identity Message.

2.2.44 **called line identity**

Information sent in the backward direction consisting of a number of *Address signals* indicating the complete called line identity.

2.2.45 **called-line-identification-request indicator**

Information sent in the forward direction indicating whether or not the called line identity should be included in the Response Message.

2.2.46 **identification-not-provided signal**

A signal sent in response to a request for calling or called line identification when the corresponding facility is not provided in the originating or destination network respectively.

2.2.47 **redirect-to-new-address signal**

A signal sent in the backward direction indicating that the called customer has requested redirection of calls to another address.

2.2.48 **redirected-to-new-address signal**

A signal sent in the backward direction indicating that the call has been redirected to an address other than the destination address selected by the calling customer.

2.2.49 **redirection address**

Information sent in the backward direction consisting of a number of *Address signals* indicating the complete address to which the call is to be or has been redirected.

2.2.50 **redirected-call indicator**

Information sent in the forward direction indicating that the call is a redirected call.

2.2.51 **waiting-in-progress signal**

A signal sent in the backward direction indicating that the called customer, having the connect-when-free facility, is busy and that the call has been placed in a queue.

2.3 *Data channel signalling conditions*

Inter-exchange data channel conditions employed in the call set-up and clear-down procedures.

2.3.1 **trunk-free**

A condition sent forward or backward in the inter-exchange data channel when the circuit has been released by the sending exchange, i.e. when the circuit is considered to be idle (available for a new call) or while waiting for release by the other exchange. This condition appears as the clearing signals at the customer interface as defined in Recommendation X.21.

2.3.2 **trunk-seized**

A condition sent forward in the inter-exchange data channel when the circuit is seized. This condition appears as the *Connection in progress* state at the called customer interface as defined in Recommendation X.21.

2.3.3 **ready-for-data**

A condition appearing in the backward (forward) direction in the inter-exchange data channel indicating that all the succeeding (preceding) exchanges involved in the connection have through connected.

This condition is sent by the customer terminal and corresponds to the *Ready for data* state at the customer interface as defined in Recommendation X.21.

2.3.4 **clear request**

A condition, appearing in the forward and backward directions in the inter-exchange data channels, sent by the customer terminals, as specified in Recommendation X.21, when clearing.

DIVISION 3

Formats and codes

3.1 *Basic format characteristics*

3.1.1 *General*

Each signal unit carrying signalling information contains, apart from transfer control information, a signalling information field, a signal unit indicator and a service indication. These are the elements of a signal message that are common to all User Parts.

A signal message that is carried by one signal unit only is called a one-unit message and the corresponding signal unit is called a lone signal unit (LSU). A signal message that is carried by two or more signal units is called a multi-unit message (MUM).

3.1.2 **signalling information field**

The signalling information field comprises 40 bits. It contains signalling information pertaining to the whole or part of a signal message.

3.1.3 message alignment indication

The message alignment indication indicates whether the signal unit:

- contains a one-unit message;
- is the initial signal unit of a multi-unit message;
- is an intermediate signal unit of a multi-unit message;
- is the final signal unit of a multi-unit message.

The coding of the signal unit indicator is not yet defined (see Questions 9/VII, 2/XI and 3/XI).

3.1.4 service indication

The service indication indicates to which User Part the signal message belongs, i.e. a service indication in a data signal message has a code specific to the Data User Part. The actual codes to be used for service indications are not yet defined (see Questions 9/VII, 2/XI and 3/XI).

3.2 data signal message formats and codes

The formats and codes to apply for the signalling information of data signal messages are not yet defined (see Question 9/VII).

3.3 data channel signalling conditions

The following conditions are those appearing in the inter-exchange data channels that in some situations have to be applied and/or detected in an exchange.

The coding of the data channel conditions is determined by the codes of the corresponding customer interface states (Recommendation X.21) as conditions on the inter-exchange data channels also appear at the customer interface in certain stages of call set-up and clear-down.

The code of the trunk-free condition is also determined by the requirement of a check of the continuity of the data paths. No account has been taken of possible implications of this condition in other services. Also the impact of the all zeros condition in general requires further study.

The following codes apply (data bits/status bit):

- the trunk-free condition is coded 0 . . . 0/0;
- the trunk-seized condition is coded 1 . . . 1/0;
- the ready-for-data condition is coded 1 . . . 1/1;
- the clear-request condition is coded 0 . . . 0/0.

These codes imply that the code 0 of the status bit on an inter-exchange data channel results in the OFF-condition at the customer interface (Recommendation X.21) and that the code 1 results in the ON-condition.

DIVISION 4

Basic call control and signalling procedures

4.1 *General*

4.1.1 The basic call control procedure is divided into two phases, call set-up and call clear-down, which are separated from one another by the data phase. A combination of messages on the signalling link and changes of conditions in the inter-exchange data channels are used to establish and terminate the different phases of the call.

4.1.2 The procedures specified in the following, in principle only deal with basic calls, i.e. calls not involving any customer (user) facilities (as specified in Recommendation X.2). The additional requirements to be met in the cases of calls involving user facilities and network facilities are described in 5. below.

4.1.3 The inter-exchange data channel signalling conditions and the connect through procedures specified ensure that the conditions in the network are compatible with the customer interface conditions and procedures for synchronous data terminal equipments as specified in Recommendation X.21.

4.1.4 A data path continuity check is provided by means of checking changes in the conditions sent in the inter-exchange data channels during call set-up. The forward data path continuity check comprises that part of the connection which falls between the final connect through points in the originating and destination exchanges. It is achieved by using a trunk-free condition that is different from the trunk-seized condition. The backward data path continuity check comprises that part of the connection which falls between the called data terminal equipment and the final connect through point at the originating exchange. It is achieved by using a trunk-free condition that is different from the Ready-for-data condition sent by the called customer's terminal.

4.1.5 Link-by-link transfer of signalling information is used and address information is signalled with all the elements of an address contained in one message. The network numbering and routing to apply is not yet defined (see Question 4/VII).

4.2 *Normal call set-up*

4.2.1 *General call set-up procedure*

The general overall call set-up procedure is outlined hereunder. The detailed switching and signalling procedures are covered below.

4.2.1.1 When the originating exchange has received the complete selection information from the calling customer and has determined that the call is to be routed to another exchange it seizes a free inter-exchange data circuit and in parallel sends and Address Message on the signalling link and applies the trunk-seized condition to the data circuit. The Address Message in principle contains all of the information that is required to route and connect the call to the called customer and may also include the calling line identity and other information related to any network and user facilities that are required. The seizing function is implicit in the Address Message.

4.2.1.2 A transit exchange, on receipt of an Address Message, will analyse the destination address and the other routing information to determine the routing of the call. The transit exchange then seizes a free inter-exchange data circuit and sends an Address Message to the next exchange. At this stage, the transit exchange will normally connect the data path through the exchange. In the case of congestion at the transit exchange, it may select an alternative route or send a Response Message indicating congestion to the preceding exchange, followed by clearing of the inter-exchange data circuits as specified in 4.3 below.

4.2.1.3 Upon receipt of an Address Message the destination exchange will analyse the destination address to determine to which customer the call should be connected. It will also check the called customer's line condition and perform various checks to verify whether or not the connection is allowed. These checks will include correspondence of user class and any checks associated with user facilities. In the case where the connection is allowed, the destination exchange sends the *Incoming-call signal* to the customer. The called customer will normally respond to the *Incoming-call signal* with the *Call-accepted signal.* If the call cannot be completed due to, for instance, the called customer's terminal being busy, a Response Message indicating this is sent on the signalling link to the preceding exchange and clearing takes place as specified in 4.3 below.

4.2.1.4 When the called customer has returned the *Call-accepted signal* the destination exchange connects through after having sent a Response Message to the preceding exchange, sent any additional information to the called customer and verified forward data path continuity. The Response Message may be sent before or after the *Call-accepted signal* has been received from the called terminal.

Depending on the circumstances the Response Message may include information related to specific network conditions and any network or user facilities involved.

4.2.1.5 Upon receipt of a Response Message a transit exchange sends the corresponding Response Message to the preceding exchange. If it is an international transit exchange it includes the appropriate country-or-network identity in the Response Message.

4.2.1.6 When the originating exchange receives a Response Message indicating that the call can be completed, it prepares to connect through the data path. To ensure that the originating exchange is the last to connect through it will monitor the backward inter-exchange data channel for the ready-for-data (call-accepted) condition sent by the called customer's terminal. When the ready-for-data condition is detected the originating exchange connects through resulting in the ready-for-data condition being exchanged between the calling and the called customers. Also, when applicable, charging is started.

4.2.1.7 In the case when the Response Message received indicates that the call cannot be completed or when certain facilities are involved the appropriate call progress signal is sent to the calling customer before the data path is connected through in the latter case, or the call cleared down in the former case.

4.2.2 *Switching procedures*

4.2.2.1 *General*

The switching procedures specified hereunder define the switching actions to be performed during call set-up for data path continuity checking and connect through processes and the sequencing of these actions in relation to the handling of signal messages and data channel signalling conditions.

The trunk-free condition is sent on the idle inter-exchange data channels. Also, in all exchanges connect through must be performed in a way ensuring, where possible, that no spurious bits appear on the customer data channels.

The time-out supervisions to be performed in relation to inter-exchange signalling and the procedures to be followed in abnormal conditions are specified in 4.4 below.

4.2.2.2 *Originating exchange*

After having seized an inter-exchange data circuit, the originating exchange sends an Address Message on the signalling link to the succeeding exchange and applies the trunk-seized condition to the forward data channel. The sending of the Address Message and the application of the trunk-seized condition may be performed in parallel as independent actions. The originating exchange then waits for the reception of a Response Message.

Upon receipt of a Response Message indicating Call Accepted (i.e. that the call can be completed) the originating exchange prepares to connect through the data path. In the case where user facilities apply, call progress signals may be sent to the called terminal as specified in 5. below. The originating exchange then monitors the backward inter-exchange data channel for the presence of the ready-for-data condition. When the ready-for-data condition is detected, indicating that all succeeding exchanges have connected through and that backward data path continuity exists, the originating exchange connects through and initiates charging where applicable.

In the case when a Response Message indicating that the call cannot be completed is received the appropriate call progress signal is sent to the calling terminal and clearing is initiated as specified in 4.3 below.

Under some circumstances a second Response Message may be received indicating failure to complete the call (see 4.4.1 below).

4.2.2.3 *Transit exchange*

Having determined that the call is a transit call the transit exchange seizes a free inter-exchange data circuit and sends an Address Message on the signalling link to the next exchange. To ensure a complete check of the continuity of the data path through the transit exchange it is preferable that the data path should be connected through immediately after seizing of the inter-exchange data circuit.

If congestion is encountered on the outgoing circuits and an alternative route exists the transit exchange examines the Address Message to see if alternative routing is permitted. If it is, the transit exchange will attempt to set up the call via the alternative route following the procedure described in the previous paragraph. If a call cannot be completed, either because alternative routing is not permitted or because the alternative route(s) are themselves congested, a Response Message containing the appropriate congestion signal is sent to the preceding exchange and clearing takes place as specified in 4.3 below.

If a Response Message indicating Call Accepted is received from the succeeding exchange the transit exchange normally only has to send a Response Message indicating this to the preceding exchange. If the Response Message indicates that the call cannot be completed, the transit exchange sends an appropriate Response Message to the preceding exchange and clearing takes place as specified in 4.3 below.

As indicated above, it is preferable that the data path through the transit exchange is through connected immediately after seizing the inter-exchange data circuit to the succeeding exchange. The transit exchange may, however, delay through connection until it has received the Response Message. In this case the transit exchange will have to apply the trunk-seized condition to the forward inter-exchange data channel at the time of sending the Address Message (with this procedure the continuity of the forward data path through the transit exchange will not necessarily be checked). When the transit exchange receives a Response Message indicating Call Accepted it must, in this case, send the Response Message to the preceding exchange as well as connecting through the data path in order that the ready-for-data condition in the backward inter-exchange data channel can pass through to the originating exchange. Moreover, in order to perform the forward continuity check, in this case, the through connection must take place after the check of the trunk-seized condition on the incoming inter-exchange data channel. In the case of continuity failure the same procedure as specified in 4.4.2 below for the destination exchange should apply.

Under some circumstances a second Response Message may be received indicating failure to complete the call set-up. The transit exchange will in such circumstances send the appropriate Response Message to the preceding exchange and clearing takes place as specified in 4.3 below.

4.2.2.4 *Destination exchange*

The destination exchange first examines the Address Message to determine to which customer the call should be connected. It then proceeds to check if the called terminal is indicated as being ready to receive an incoming call or not and whether the connection is allowed. If the connection can be set up the destination exchange sends the *Incoming call signal* to the customer and subsequently also any additional signalling information that may be required in connection with any user facilities involved in the call (see 5. below). If the connection cannot be set up the destination exchange sends the appropriate Response Message to the preceding exchange and initiates clearing as specified in 4.3 below.

In the case where the call can be set up the destination exchange prepares to connect through after having sent the *Incoming call signal.* The destination exchange connects through when:

- the *Call-accepted signal* has been received from the called customer's terminal;
- the transmission of any additional signalling information, required for user facilities, to the called terminal has been completed; and
- forward data path continuity has been checked by receipt of the trunk-seized condition.

Where the call can be set up a Response Message indicating Call Accepted is sent on the signalling link to the preceding exchange. This message can be sent either before or after the *Call-accepted signal* from the customer's terminal has been detected at the destination exchange. Waiting for the receipt of the *Call-accepted signal* has the advantage that the sending of the Response Message is based on a positive indication that the call has been accepted by the called customer.

Sending the Response Message before receipt of the *Call-accepted signal* from the customer's terminal has the advantage that the call set-up time is reduced in the normal condition. If in this case the call fails to be completed at the destination exchange, e.g. because no *Call-accepted signal* was received, a second Response Message is sent to the preceding exchange (see 4.4.1 below).

4.2.3 *Detailed signalling procedures*

4.2.3.1 *Address Message*

The Address Message contains:

- the complete destination address of the called terminal,
- possibly the originating address (calling line identity),
- a destination-code indicator,
- a user-class indicator,
- an alternative-routing indicator,
- a national/international-call indicator,
- possibly additional signalling information relating to user facilities (see 5. below).

The procedures related to the above signalling information are described below:

a) *Calling line identity.* – This may be contained either in an Address Message or a Calling Line Identity Message depending on the particular implementation. If the calling line identity is not contained in the Address Message and the called line has requested the calling line identification facility the destination exchange includes the calling-line-identification-request indicator in the Response Message. On receipt of this indicator the originating exchange will send a Calling Line Identity Message to the destination exchange, (see also 5. below). If the facility is provided in the originating network (on international calls) the message will contain the calling line identity. If the facility is not provided, the message will contain the *Identification-not-provided signal.*

b) *Destination-code indicator.* – This indicates whether or not the destination code of the destination country or network is included in the destination address. The destination code should be included in the destination address when the Address Message is sent to an international transit exchange. The destination code is not included in the destination address when the Address Message is sent to the incoming gateway exchange of the destination country or network.

c) *User-class indicator.* – This indicates the user class of the calling terminal in accordance with Recommendation X.1 and the relevant additions to it. The same information may also be derived from the type of incoming data circuit. The user class information is used at transit exchanges to determine the type of inter-exchange data circuit to be selected. At the destination exchange the user class information is used to verify that the calling and called terminals belong to the same user class.

d) *Alternative-routing indicator.* – This indicates whether or not the call has been subjected to an alternative routing and may be used to prevent the call being set up over an alternative route more than once.

e) *National/International-call indicator.* – This is provided to allow differentiation of national and incoming international calls in the destination country or network and may be used in connection with some of the user facilities specified in 5. below. It may also be used for outgoing international calls to indicate that routing to a gateway exchange is required.

4.2.3.2 *Response Message*

The Response Message contains:

- a signal indicating the called terminal's line condition or a network condition,
- one or more country-or-network identities (used in international transit working),
- possibly additional signalling information relating to user facilities (see 5. below).

The procedures related to the above signalling information are described below:

a) *Call-accepted signal.* – This signal is used when the connection is allowed and the called terminal is indicated as being ready to receive an incoming call. At the originating exchange it results in through connection and charging as applicable.

b) *Terminal-engaged signal.* – This signal is used when the called terminal's access line to the exchange is engaged in another call. At the originating exchange it results in sending the call progress signal *Number busy* to the calling customer and clearing the call.

c) *Controlled-not-ready signal.* – This signal is used when the called terminal is in a controlled-not-ready condition. At the originating exchange it results in sending a call progress signal (not yet defined) to the calling customer and clearing the call.

d) *Out-of-order signal.* – This signal is used when either the called terminal or its access line is out of service or faulty. At the originating exchange this signal results in sending the call progress signal *Out of order* to the calling customer and clearing the call.

e) *Not-obtainable signal.* – This signal is used when the called number is not assigned or in a different user class. At the originating exchange it results in sending the call progress signal *Not obtainable* to the calling customer and clearing the call.

f) *Access-barred signal.* – This signal is used when the called customer's terminal is barred for incoming calls. It is also used in relation to the closed user group facility (see 5. above). At the originating exchange it results in sending the call progress signal *Access barred* to the calling customer and clearing the call.

g) *Changed-number signal.* – This signal is used when the called customer's number has been recently changed. At the originating exchange it results in sending the call progress signal *Changed number* to the calling customer and clearing the call.

h) *Congestion signals.* – These signals are used when congestion is encountered on route to the called customer. In the case of congestion at an international transit or gateway exchange the signal sent will be the *International-congestion signal.* At the incoming gateway exchange a received *National congestion signal* will be translated to the International-congestion signal. Normally the congestion signals result in sending the call progress signal *Network congestion* to the called customer and clearing the call. However, receipt of a congestion signal at an exchange could be used to initiate a second attempt.

i) *Country-or-network identity.* – This information is used in international transit operation to enable the outgoing international exchange to record the routing of the call, primarily for accounting purposes. In this case each transit exchange includes the appropriate identity, i.e. the destination code of the country or network to which the transit exchange belongs, in the Response Message.

j) *Called line identity.* – This information will be included in the Response Message if the Address Message received contained a called-line-identification-request indicator. If the facility is not provided in the destination network (on international calls) the Response Message will contain the *Identification-not-provided signal.*

4.2.4 *Head-on-collision*

When both-way working is used on a group of circuits, head-on-collision can occur, i.e. the exchanges at each end may seize the same inter-exchange data circuit at approximately the same time. In the case when both-way working is used the following arrangements are recommended to minimize the effects of head-on-collision.

For each inter-exchange data circuit one of the exchanges is nominated as a priority exchange. In the case of head-on-collision, i.e. when for a certain circuit an Address Message is received instead of a Response Message, the priority exchange ignores the Address Message received and proceeds with the call set-up in accordance with the normal procedure. The non-priority exchange withdraws from the circuit and accepts the Address Message received in accordance with the normal procedure. It then makes a repeat attempt to set up the outgoing call on another circuit.

Inverse order testing of inter-exchange data circuits is used, or a close approximation to it, by testing the route in small groups in fixed order always starting from the same position.

4.3 *Normal call clearing*

The clearing signals originated by a customer's terminal will pass through the local exchange and will appear on the inter-exchange data circuits and at the distant local exchange until such time as the clearing signals are acted upon and the connection is released. In order to ensure continuity of the clearing action the trunk-free condition applied to the inter-exchange data channels when released is the same as the clearing signals sent and received by the customer terminals. Hence the connection may be cleared down by the exchanges involved in the call independently and the clear signals may be acted on at either of the local exchanges irrespective of which customer clears first.

An inter-exchange data circuit is assumed to be free for a new call when both the forward and backward Clear Messages relating to that circuit have been sent or received and, where monitored, the inter-exchange data circuit is seen to be conveying the trunk-free condition in both directions.

Clearing procedures in abnormal condition are covered in 4.4 below.

4.3.1 *Originating and destination exchange*

Release of the connection is initiated by one of the following:

a) detection of clearing signals from the local customer;

b) detection of clearing signals from the inter-exchange data circuit;

c) failure to complete the call set-up attempt due to, for example, the called customer's terminal being busy, or

d) receipt of a *Circuit-released signal* from an adjoining exchange.

On release of the connection and, where applicable, after exchange of clearing signals with the local customer, a forward Clear Message is sent to the succeeding exchange, in the case of an originating exchange, or a backward Clear Message is sent to the preceding exchange, in the case of a destination exchange (after having sent the appropriate Response Message). In the cases *a), b)* and *c)* above the Clear Message will contain a *Circuit-released signal,* while in the case *d)* it will contain a *Circuit-released-acknowledgement signal.* The trunk-free condition is also applied to the released inter-exchange data circuit.

4.3.2 *Transit exchange*

Release of the connection is initiated:

i) by receipt of a circuit-released signal from an adjoining exchange;

ii) by failure to complete a call set-up attempt due to, for example, congestion on the route(s) to the next exchange; or

iii) optionally by receipt of a Response Message indicating that the call cannot be set up.

a) In case i), upon receipt of a *Circuit-released signal* from one of the adjoining exchanges a transit exchange will release the connection and send a *Circuit-released-acknowledgement signal* to that exchange and a *Circuit-released signal* to the other adjoining exchange. The transit exchange will also apply the trunk-free condition to the released inter-exchange data circuits. Subsequent reception of a Clear Message from the other adjoining exchange merely confirms the release of that inter-exchange data circuit and does not initiate the sending of more Clear Messages (see however 4.4.4.1 below).

b) In case ii), the transit exchange will release the connection and will send backward a *Circuit-released signal* to the preceding exchange.

c) In case iii), where implemented, the transit exchange will, on receipt of a Response Message indicating that the call cannot be set up, release the connection and send backward a *Circuit-released signal* to the preceding exchange (after having sent the appropriate Response Message) and forward a *Circuit-released signal* to the succeeding exchange. The transit exchange will also apply the trunk-free condition to the released inter-exchange data circuits.

4.4 *Call handling in abnormal conditions*

4.4.1 *Sending of a second Response Message*

As specified in 4.2.2.4 above the Response Message can be sent before receipt of the *Call-accepted signal* from the called customer. In this case the Response Message will indicate Call Accepted if the called terminal is indicated as being ready to receive an incoming call. If subsequently a condition occurs that prevents the call being completed a second Response Message indicating this condition is sent. Examples of such conditions are, call collision, failure of the customer line/terminal and subsequent forward continuity failure (see 4.4.2 below). In these abnormal conditions sending of a second Response Message is followed by clearing of the call. At the originating exchange receipt of the second Response Message will result in sending an appropriate call progress signal to the calling customer and clearing the call.

In some user facilities the sending of a second Response Message may apply in normal conditions (see 5.below).

4.4.2 *Continuity failure*

Continuity checking is described in 4.1.4 above and the related time-outs are specified in 4.4.3 below.

If the continuity check fails in the forward direction, i.e. the trunk-seized condition is not received at the destination exchange, the Response Message sent will contain a *Continuity failure signal.* Receipt of this signal at the originating exchange will either initiate a repeat attempt (where provided) or clear the call down after having sent the call progress signal *Network congestion* to the calling customer. No more than one repeat attempt is allowed.

The preferred procedure at the destination exchange is to wait for the completion of the forward continuity check before the Response Message is sent. However, as an option the Response Message may be sent early. Subsequent failure of the forward continuity check would then result in the sending of a second Response Message containing a *Continuity-failure signal* followed by clearing of the call.

With the procedures specified in 4.2.2.4 above it is possible for an *Incoming-call signal* to be sent to the called customer before the forward continuity check is completed. If, in this case, the forward continuity check subsequently fails, the called customer's terminal will be cleared. If a repeat attempt is initiated by the originating exchange the customer will subsequently be called again which requires fast call clear-down at the destination exchange.

Failure of the backward continuity check is covered by the time supervision of the receipt of the ready-for-data condition at the originating exchange.

4.4.3 *Time-out supervision*

At various stages in the call set-up and clear-down procedures it is necessary to wait for receipt of a signal or condition from an adjoining exchange or customer. The duration of such periods has to be controlled by appropriate time-outs.

4.4.3.1 *Originating exchange*

The following time-outs are necessary:

T1 – The time between the sending of the Address Message and the receipt of the Response Message.

T2 – The time between the receipt of the Response Message and the detection of the ready-for-data condition. (This time should allow for the receipt of a second Response Message and the sending of a Calling Line Identity Message where appropriate).

4.4.3.2 *Destination exchange*

The following time-out is necessary in the case when the *Incoming-call signal* or Response Message is not sent until forward continuity check is complete:

T3 – The time between the receipt of the Address Message and the detection of the trunk-seized condition.

The following time-outs are always necessary:

T4 – The time between the sending of the *Incoming-call signal* to the called customer and the receipt of the *Call-accepted signal* from the called customer.

T5 – The time between the sending of a Response Message containing a calling-line identification-request indicator (where applicable) and the receipt of a Calling Line Identification Message.

4.4.3.3 *Transit exchange*

In the case of early connect through of the transit exchange no time-out is necessary.

In the case of connect through on receipt of the Response Message the following time-out is required:

T6 – The time between the sending of the Address Message and the receipt of the Response Message.

4.4.3.4 *Clearing*

Expiry of time-outs T1-T6 result in the clearing of the call.

In connection with the sending of Clear Messages the following time-out is required at all exchanges:

T7 – The time between the sending of a *Circuit-released signal* and the receipt of either a *Circuit-released* or a *Circuit-released-acknowledgement signal* (relating to the same inter-exchange data circuit).

On expiry of time-out T7 at any exchange the *Circuit-released signal* will be repeated. Should clearing continue to be ineffective a maintenance alarm will be activated. No time-out will apply following the sending of a *Circuit-released-acknowledgement signal.*

4.4.4 *Procedures relating to call clear-down before completion of call set-up*

4.4.4.1 *General*

In some circumstances of call clear-down in abnormal conditions, signalling information relating to the call may subsequently be received. With exception of simulated Clear Messages (see 4.4.6 below) such information will in all cases be discarded.

4.4.4.2 *Premature customer clearing*

In the case when customer clearing is detected during the call set-up phase the call set-up process is terminated and normal call clear-down is performed. If the originating exchange has seized an inter-exchange data circuit this will be released but a Clear Message will not be sent unless an Address Message has already been sent.

4.4.4.3 *Premature receipt of a Clear Message*

If at any exchange a Clear Message is received during call set-up the further call set-up process is terminated and normal call clear-down is performed. If at a transit exchange an inter-exchange data circuit has been seized this will be released but a forward Clear Message relating to that circuit will not be sent unless an Address Message has already been sent.

4.4.4.4 *Procedure on expiry of a time-out*

For further study.

Note. – Some text concerning the detailed procedures for call clear-down following the expiry of the time-outs detailed in 4.4.3 above can be found in Annex 3 to Question 9/VII.

4.4.5 *Forced call clear-down*

It may be required to clear a call for management or maintenance purposes. This can be achieved by initiating at any exchange the clearing procedures.

4.4.6 *Receipt of unreasonable signalling information*

The error control method to be employed in the Message Transfer Part of the common channel signalling system will avoid the sending of out-of-sequence messages and the double sending of messages to the Data User Part. However, undetected errors in the signal units may produce unreasonable signalling information, that is, signalling information which is either ambiguous or inappropriate. Unreasonable signalling information may also be produced by malfunction of call control software/hardware in the exchanges.

In order to resolve some possible ambiguities when a Clear Message is either simulated or lost the following procedures will apply:

a) If a *Circuit-released signal* is received relating to an idle inter-exchange data circuit it will be acknowledged with a *Circuit-released-acknowledgement signal.*

b) If a *Circuit-released-acknowledgement signal* is received relating to an idle inter-exchange data circuit it will be discarded.

c) If a *Circuit-released-acknowledgement signal* is received relating to a busy inter-exchange data circuit for which a *Circuit-released signal* has not been sent a *Circuit-released signal* will be sent.

Any other unreasonable signalling information received will be discarded. If the discarding of the information prevents a call from being completed that call will eventually be cleared by the expiry of a time-out.

DIVISION 5

Signalling procedures for user facilities

5.1 *General*

The particular procedures applicable for user facilities when common channel signalling is used is specified in the following. In all cases the basic call control and signalling procedures specified under 4. above apply unless otherwise explicitly stated below. Also, unless otherwise stated, the specifications below describe the situations when a call is accepted.

The international application of user facilities is standardized in Recommendation X.2.

5.2 *Closed user group*

The procedures for the Closed User Group facility are based on a validation check by comparison of the interlock codes associated to the calling and called customers respectively. Each particular closed user group has a unique interlock code within each particular national network (see Note).

Note. – Further study is required concerning administrative and technical aspects of the method to provide the closed user group facility taking into account alternative methods.

In the case of a call from a customer belonging to only one closed user group the interlock code stored for that customer in the originating exchange is included in the Address Message. In the case of a call from a customer belonging to more than one closed user group the interlock code included in the Address Message is selected from those stored for that customer in the originating exchange according to the closed user group identified by the customer for that call. In both cases the closed-user-group indicator is also set.

With the possible exception of the outgoing and incoming international exchange (see below) each transit exchange transfers the closed user group information received to the Address Message sent to the succeeding exchange.

At the destination exchange a validation check is performed in the case where either the calling or called customer belongs to a closed user group. The call is accepted only if the interlock code received in the Address Message is the same as an interlock code stored in the destination exchange for that called customer. If correspondence is not found, including the case where either of the customers does not belong to a closed user group, the call is rejected and an *Access-barred signal* is sent in the Response Message and clearing takes place as specified in 4.3 above. At the originating exchange the reception of the *Access-barred signal* results in sending the call progress signal *Access barred* to the calling customer and clearing the call.

For an international call the interlock code is converted at the outgoing international exchange unless the same interlock code is used in both the originating and destination networks for the closed user group concerned. The interlock code may possibly also be converted at the incoming international exchange depending on the arrangements in the destination network.

For a direct call within a closed user group a simplified procedure [2] not involving a validation check can possibly be used. In this case no interlock code is included and the closed-user-group indicator included in the Address Message indicates that the calling customer belongs to a closed user group and that the call should be allowed without a validation check at the destination exchange.

In the case of redirection of an international closed user group call some additional procedures will be required (see Annex 3 to Question 9/VII).

5.3 *Closed user group with outgoing access*

The procedures for this facility are based on the same principles adopted for the Closed User Group facility (see 5.2 above).

The originating exchange includes the interlock code in the Address Message in the same way as for a closed user group call, but the closed-user-group indicator is set to indicate that outgoing access is allowed.

Each transit exchange handles the call in the same way as a closed user group call.

At the destination exchange the call is handled as:

– a closed user group call (see 5.2 above) if the called customer belongs to a closed user group, or

– a basic call if the called customer does not belong to a closed user group.

5.4 *Calling line identification*

The Calling Line Identification is a user facility which applies to all the incoming calls to a customer having this facility.

In the case when Calling Line Identification applies and the calling customer identity is included in the Address Message, the destination exchange sends this identity to the called customer as defined in the appropriate Recommendation for the DTE/DCE interface.

In the case when Calling Line Identification applies and the calling line identity is not included in the Address Message, the destination exchange sets the calling-line identification-request indicator in the Response Message. Upon receipt of this indication the originating exchange sends a Calling Line Identity Message containing the calling line identity, which then is sent by the destination exchange to the called customer as spcified in Recommendation X.21.

In both cases the destination exchange must not connect through until the calling line identity has been completely sent to the called customer.

For an international call the identity sent through the international network will include the destination code of the originating country or network. In the case when the calling line identification facility is not provided in the originating network, the *Identification-not-provided signal* is sent in the Calling Line Identity Message. The corresponding action of the destination exchange towards the called customer is not yet defined.

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[2] The implications of this procedure for international application remain to be studied.

5.5 *Called line identification*

The Called Line Identification is a user facility which applies to all the outgoing calls from a customer having this facility.

In the case when Called Line Identification applies the originating exchange sets the called-line-identification-request indicator in the Address Message. Upon receipt of this indication the destination exchange includes the called line identity in the Response Message. The originating exchange then sends this identity to the calling customer as defined in the appropriate Recommendation for the DTE/DCE interface. The originating exchange must not connect through until the called line identity has been completely sent to the calling customer.

For an international call the identity sent through the international network will include the destination code of the destination country or network. In the case when the Called Line Identification facility is not provided in the destination network, the *Identification-not-provided signal* is sent in the Response Message. The corresponding action of the originating exchange towards the calling customer is not yet defined.

In the case when the call is redirected (see 5.6 below) the identity sent to the calling customer is that of the new address to which the call has been redirected.

5.6 *Redirection of calls*

5.6.1 *General*

This specification assumes:

- that the redirection address (i.e. the new address) is stored at the destination exchange associated to the called customer, and
- that an appropriate call progress signal indicating that the call has been redirected is sent to the calling customer.

The international application of this facility is for further study (see Question 2/VII); therefore in the following only the case of redirection of national calls is specified.

Note. – Possible procedures relating to international calls are described in Annex 3 to Question 9/VII.

5.6.2 *National calls*

When the redirection address is at the same destination exchange the call is connected to that address and a *Redirected-to-new-address signal* is included in the Response Message. At the originating exchange the receipt of this signal initiates the sending of an appropriate call progress signal (not yet defined) to the calling customer.

In the case when an inter-exchange call is redirected to an exchange other than the destination exchange the call is released back to the originating exchange and then set up to the new address as follows:

a) The first destination exchange includes the *Redirect-to-new-address signal* and the redirection address in the Response Message and initiates clearing as specified in 4.3 above.

b) Upon receipt of the *Redirect-to-new-address signal*:

- each transit exchange sends the Response Message backwards.
- the originating exchange clears the forward connection and sets up the call to the new address. The redirected-call indicator in the Address Message is set to indicate that the call is a redirected call.

c) The new destination exchange connects the call to the new address and includes the *Redirected-to-new-address signal* in the Response Message. The redirected-call indicator received may be used to prevent a further redirection if the customer at the new address has also requested redirection of calls in which case an *Access-barred signal* is included in the Response Message.

d) Upon receipt of the *Redirected-to-new-address signal* the originating exchange sends an appropriate call progress signal (not yet defined) to the calling customer.

5.7 *Connect when free*

5.7.1 *General*

This specification assumes:

- that a call to a busy customer having this facility is automatically placed in a queue;
- that an appropriate call progress signal indicating this condition is sent to the calling customer;
- that the calling customer has the possibility to wait (and be charged) or to clear the connection; and
- that the complete connection is held during the waiting period.

The application of this facility for incoming international calls is for further study (see Question 2/VII).

5.7.2 *National calls*

In the case of a call to a busy customer having this facility, the call is placed in a queue at the destination exchange and the *Waiting-in-progress signal* is included in the Response Message. At the originating exchange the receipt of this signal initiates the sending of an appropriate call progress signal (not yet defined) and the calling customer is charged for waiting unless he clears the call within a given time.

A second Response Message is sent by the destination exchange when the call is completed (or rejected). The originating exchange through connects when it has received the second Response Message indicating completion of the call, and detected the ready-for-data condition in the backward inter-exchange data channel.

Appendix

(to Recommendation X.60)

Definitions of terms relating to common channel signalling

This Appendix contains definitions which were drawn up jointly by Study Group VII and XI during the period 1973-1976 and approved by the VIth Plenary Assembly of the CCITT.

1. *General terms relating to common channel signalling*

The following definitions are considered to be applicable to any common channel signalling system. However, for a particular common channel signalling system it may be of advantage to use for some of these terms definitions that are more restrictive and specific to the characteristics of that system.

Note. – Definitions applicable to signalling System No. 6 are given in the *Glossary of terms specific to Signalling System No. 6*, Volume VI.2.

common channel signalling

A signalling technique in which signalling information relating to a multiplicity of circuits, and other information such as that used for network management, is conveyed over a single channel by addressed messages.

continuity check

A check made of a circuit or circuits in a connection to verify that a path (for transmission of data, speech, etc.) exists.

label

Information within a signal message used to identify the particular circuit to which the message is related.

Note. – Messages not relating to call control may not contain a label.

multi-unit message (MUM)

A signal message which is transmitted using more than one signal unit.

one-unit message

A signal message which is transmitted using one signal unit.

signalling data link

A combination of two data channels operating together in a single signalling system. The data channels operate in opposite directions and at the same data rate.

(functional) signalling link

As a functional concept – A functional entity within a signalling system comprising one signalling data link and the transfer control functions associated with that link.

signal unit (SU)

A group of bits which is encompassed by a single error check process in a common channel signalling system. A signal unit includes the check bits. All information transferred by the signalling system is formatted in signal units.

2. *Terms relating to the common channel signalling system for integrated digital networks*

message alignment indication

Information transferred in a message between a User Part and the Message Transfer Part to identify the boundaries of that message.

Note. – On the signalling link the corresponding information is conveyed by the signal unit indicator(s).

signal unit indicator

The field within a signal unit used to identify different signal unit types.

message transfer part

The functional part of the common channel signalling system which transfers signal messages and performs the necessary functions (e.g. error control and signalling link security) related to this transfer.

service indication

Information within a signal message used to indicate to which User Part the message belongs.

signalling information

The information content of a signal message that is related to a call control, management action, etc. The message alignment and service indications are not part of the signalling information.

Note. – This term is different from the term "signal information" used in System No. 6.

signalling information field

The fixed size field of a signal unit in which signalling information is carried.

Note. – This field does not necessarily exist in all signal units.

(signal) message

An assembly of signalling information pertaining to a call, management action, etc., and including the associated message alignment and service indications, that is transferred via the Message Transfer Part. A message may be a one-unit message or a multi-unit message.

user (of the common channel signalling system)

Any functional sub-system that uses the message transfer function of the signalling system.

Note. – The functions of such a sub-system that are specified as part of the common channel signalling system form a particular User Part.

user part

A functional part of the common channel signalling system which sends signal messages to and receives signal messages from the Message Transfer Part. Different types of User Parts exist (e.g. for telephony and data), each of which is specific to a particular use of the signalling system.

Recommendation X.70

TERMINAL AND TRANSIT CONTROL SIGNALLING SYSTEM FOR START-STOP SERVICES ON INTERNATIONAL CIRCUITS BETWEEN ANISOCHRONOUS DATA NETWORKS

(Geneva, 1972, amended at Geneva, 1976)

With the appearance of public data networks in various countries it becomes necessary to establish the appropriate international control signalling schemes for interworking in order to facilitate the introduction of such networks as much as possible. The main objective of public data networks is to offer to the user a great range of data signalling rates with a minimum of restrictions, very short call set-up and clear-down times and a variety of new service facilities. These requirements can be fulfilled only by a specially conceived signalling system which caters for all foreseeable needs and which is flexible enough to provide also for new, not yet defined, services.

For these reasons, the CCITT

unanimously declares the view that

for interworking between anisochronous data networks the following control signalling scheme should be used on international circuits:

Note 1. – The start-stop user classes of service are specified in Recommendation X.1. Class 2 is the only user class appropriate to this Recommendation. User class 1 (300 bit/s) is assumed to use a similar method of signalling but utilizes an 8-unit control signalling code. This method is for urgent further study.

Note 2. – The signalling for synchronous user classes of service provided on anisochronous networks is the subject of further study.

Note 3. – The signalling on links between synchronous and anisochronous networks is the subject of further study.

1. *General switching and signalling principles*

1.1 The control signallng should be at 200 bit/s.

Telex service based upon 50-baud trunks does not form part of this Recommendation [3].

1.2 Decentralized signalling will apply, the same channel being used for control signalling and data transmission.

1.3 Both terminal and transit operation will be required. Due to the inclusion of transit operation, link-by-link signalling control of calls will be adopted.

Onward selection from transit and incoming terminal centres should be arranged to overlap the receipt of selection signals, this in order to minimize call set-up times.

Selection signals will be transmitted by the originating country at automatic speed in a single block.

1.4 The schedule of telex destination codes laid down in Recommendation F.69 will apply to data networks of the anisochronous type. The same codes will be used for network identification purposes.

Note. – This conclusion is provisional and Question 5/VII provides for further study of this matter and possible alternatives. This matter is for urgent resolution.

In general, destination codes and network identification signals will be transmitted on transit calls but not on terminal calls. However, these codes and signals will be sent on all calls terminating in a country if required by the incoming country. Under such circumstances the incoming exchange in the country will be regarded as a transit exchange.

1.5 Alternative routing will be permitted. The principle of high-usage circuits will be adopted, with overflow on to adequately provided routes between centres.

In order to prevent repeated alternative routing causing traffic to circulate back to the originating point, alternative routing will be restricted to once per call.

1.6 Both-way operation will be assumed and inverse order testing of circuits on both-way routes, or a close approximation to it by testing the route in small groups in fixed order always starting the search from the same position will be specified in order to minimize head-on collisions.

1.7 The accounting principle assuming that in all cases, including that of transit switching, the originating country will be responsible for recording accounting information, will apply to public data networks of the anisochronous type.

1.8 The grade of service to apply for the provision of circuits for links between public data networks of anisochronous type which carry traffic overflowed from other routes or from which overflow was not permitted would not be worse than one lost call in 50.

For high-usage direct links, circuits would be provided at a grade of service of not worse than one lost call in 10.

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[3] See Recommendation U.12 for telex and similar switched telegraph services.

1.9 Sufficient switching equipment will be provided to ensure that congestion will not be signalled on more than 0.4% of calls in the busy hour, and only then when congestion has been positively identified.

1.10 The target setting-up time for the user classes of service applicable to these types of data networks will be one second.

2. *Specific signalling characteristics*

Notes applicable to this section

Note 1. – X denotes the international centre that originates the call under consideration on the international link concerned. Y denotes the international centre that receives the call under consideration on the international link.

Note 2. – Timings shown are within the centre concerned with no allowance being made for propagation and other delays, such as slow sending of selection signals from the originating terminal.

Note 3. – The times for permanent start polarity (A) and stop polarity (Z) are generally indicated in the following signal descriptions as integral multiples of a character (see Note 4).

Note 4. – The control signalling code (CSC) used in this signalling system is described in Table 8/X.70.

2.1 The signalling system between two data networks of anisochronous type is described in Table 1/X.70.

2.2 The incoming equipment may release the connection if the calling signal exceeds the specified maximum period (see Remarks column of Table 1/X.70). Start polarity will be maintained on the backward signalling path from centre Y to centre X.

2.3 The first forward path signal following the calling signal (class-of-traffic character) is distinctive from the first backward path signal to provide a guard against head-on collisions in the case of both-way operation.

A head-on collision is detected by the fact that centre X receives a first class-of-traffic character instead of the reception-confirmation signal or reception-congestion signal.

When a head-on collision is detected, the switching equipment at each end of the circuit should make another attempt to select a free circuit, either on the same group of circuits or on a group of overflow circuits, if facilities for alternative routing exist, and there are no free circuits on the primary route. In the event of a further head-on collision on the second attempt, no further attempt will be made and the call will be cleared down. In the case of a transit centre, the *Call progress signal No. 30* followed immediately by the *Clearing signal*, will be returned to the preceding centre after the *Reception-confirmation signal* and the *Network identification signals.*

2.4 Failure to receive the *Reception-confirmation* or *Reception- congestion signal* within 4 seconds from the start of the calling signal or the reception of a spurious signal, as indicated by a character other than a first class-of-traffic character, the *Reception-confirmation signal* or *Reception-congestion signal,* should initiate the *Automatic re-test signal* on the circuit concerned.

In the case of failure to receive the correct *Reception-confirmation* or *Reception-congestion signal,* another attempt to select a circuit should be made (once only). In the case of transit calls, if the second attempt is unsuccessful, the *Call progress signal No. 30* (or 31 or 32 if appropriate) followed immediately by the *Clearing signal,* will be returned to the preceding centre after the *Reception-confirmation signal* and the *Network identification signals.*

2.5 *Selection signals* can be divided into two parts. The first part, designated as the *Network selection signals,* contains information regarding network and user requirements and may be composed of one to nine (or possibly more) characters (see Tables 2/X.70, 3/X.70, 4/X.70, 4a/X.70 and 5/X.70). The second part comprises the *Address signals* (the called subscriber number which is preceded by the destination code in the case of a transit call).

The *Network selection signals* used in the forward direction (see also Appendix 2) are further subdivided and assembled as follows (see 2.5.1 to 2.5.4 below) for signalling purposes.

Note that the term "user class of service" is abbreviated in the following to "user class".

TABLE 1/X.70 – **Decentralized signalling between anisochronous data networks**

Note. – For the Control Signalling Code (CSC) numbers mentioned refer to Table 8/X.70.

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Free line	Start polarity (polarity A)	Start polarity (polarity A)	
Calling signal	Stop polarity (polarity Z) for a minimum period of one character and a maximum period of two characters followed immediately by *Selection signals*		The equipment at centre Y should be ready to receive *Selective signals* within one character period. The minimum and consequently the maximum periods will be lengthened at the request of the incoming country Y. (*Note.* – The duration of the *Calling signal* may require review in the light of false *Calling signals.*)
Reception-confirmation signal		Stop polarity followed by CSC No. 14	Stop polarity returned within three character periods after the end of receipt of the first class-of-traffic character. The return of CSC No. 14 shall commence within one to two character periods after the inversion to stop polarity. The *Reception-confirmation signal* will have to be absorbed by the switching equipment of X and should not be able to go through that equipment to arrive at the preceding centre.
Selection signals	At least one (first class-of-traffic-character only) or possibly several *Network selection signals* depending on the network requirement (see Appendix 1), the digits of the destination code of the called network, the digits of the called terminal number, and *End-of-selection signal* (CSC No. 11)		These signals are transmitted immediately after the *Calling signal* without awaiting the reception at X of the *Reception-confirmation signal.* The *Selection signals* are transmitted according to the control signalling code at 200 bit/s and at automatic speed in a single block.
Network identification signals		CSC No. 12 followed by the destination code of the network	For transit calls the CSC No. 12 follows the *Reception-confirmation signal* at automatic speed within one to two character periods. These signals must go through centre X and arrive at the originating network. For terminal calls, the CSC No. 12 follows the last *Call progress signal* at automatic speed within one to two character periods, when the *Call progress signal* is due to a network condition.

TABLE 1/X.70 *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Reception-congestion signal		Stop polarity for a period of one or two characters followed by the clearing signal	This signal is returned within 0-5 character periods after the start of receipt of the *Calling signal* when the *Selection signals* cannot be received. This signal should be absorbed by centre X and not allowed to be received by a preceding exchange.
Call progress signals without clearing		CSC No. 11 followed by 2 digits (see Table 7a/X.70) followed by the waiting signal	Examples would be *Re-directed call* or *Terminal called call progress signal*, which are followed by a return to the *Waiting signal.*
Call-connected signal		One CSC character (see Table 7/X.70)	See 2.14 of the text and Appendix 3.
Called line identification (if applicable)		Combinations of the *Called line identification signals* transmitted at automatic speed within two character periods of the transmission of the *Call-connected signal.*	The *Called* or *Calling line identification signal* consists of the destination code followed by the digits of the subscribers' number and CSC No. 12. Where no identification is available, only CSC No. 12 is sent.
Calling line identification (if applicable)	Combinations of the *Calling line identification signals* transmitted at automatic speed within one to two character periods of receipt of the *Call-connected signal.*		
Terminating through-connection signal (if applicable)		CSC No. 13	For definition see 2.14 of the text and for further details see Appendix 3.
Originating through-connection signal	ACK character (combination 0/6 of IA5)		For definition see 2.14 of the text and for further details see Appendix 3.
Call progress signals with clearing		CSC No. 11 followed by 2 digits (see Table 7a/X.70) possibly followed by the *Network identification signals* (see 2.9 of the text) and followed by the *Clearing signal.*	

TABLE 1/X.70 *(concluded)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Waiting signal	Stop polarity	Stop polarity	
Clearing signal	Inversion to start polarity in the direction of clearing. The minimum recognition time is 210 ms and the maximum time is 420 ms		The minimum period of start polarity on one signalling path which in itself ensures the complete release of the connection is 420 ms.
Clear confirmation signal	Inversion to continuous start polarity in the opposite direction after a minimum duration of 210 ms of *Clearing signal* and a maximum duration of 490 ms		The minimum and maximum periods for the release of the international circuit by an exchange are 210 ms and 490 ms respectively.
Incoming guard delay	Period of 390-420 ms measured from the moment when start polarity has been established on both signalling paths by: – either recognizing or transmitting the *Clearing signal* on one signalling path, and – either transmitting or recognizing the *Clear confirmation signal* on the other signalling path		A new incoming call shall not be accepted until this guard period has elapsed.
Outgoing guard delay	Period of 840 ms measured from the moment when start polarity has been established on both signalling paths by: – either recognizing or transmitting the *Clearing signal* on one signalling path, and – either transmitting or recognizing the *Clear confirmation signal* on the other signalling path		A new outgoing call shall not be originated until this guard period has elapsed.
Automatic retest signal	Stop polarity for 1-2 character periods followed by CSC No. 13 stop polarity for 4 seconds and then start polarity for a period of 56 seconds and the signal sequence is then repeated		See 2.17 of the text.
Backward busy signal		Continuous stop polarity for a maximum period of 5 minutes	

2.5.1 *First class-of-traffic character (see Table 2/X.70)*

The calling signal is always followed by at least one class-of-traffic character. The bit functions of this character were so chosen that no further characters are needed for most connections.

If there is a need for indication of further requirements, a second class-of-traffic character (see 2.5.3) may be used. Whether a second class-of-traffic or user-class characters follow or not, will be indicated by the bits b_3 and b_4 of the first class-of-traffic character.

TABLE 2/X.70 – **First CSC[a] character on the forward and backward paths**

Combination				Condition signalled
b_4	b_3	b_2	b_1	
A	A			No further network selection signal follows[b]
A	Z			Second class-of-traffic character follows (see Table 4/X.70)[b]
Z	A			User-class character follows (see Table 3/X.70)[b]
		A		Alternative routing not allowed[b]
		Z		Alternative routing allowed[b]
			A	Transit traffic[b]
			Z	Terminal traffic[b]
Z	Z	A	A	Retest signal[b]
Z	Z	A	Z	Reception confirmation
Z	Z	Z	A	Not allocated
Z	Z	Z	Z	Not allocated

[a] CSC = Control Signalling Code.
[b] First class-of-traffic character.

2.5.2 *User class character (indication of speed and code) (see Table 3/X.70)*

This character, if used, will follow the first class-of-traffic character and will be required when, for example, this information cannot be derived from the incoming line.

As eight user classes in Table 3/X.70 are not sufficient, a second user-class character may be added by means of an escape character. Whether a second user-class character follows or not, will be indicated by the bits b_1, b_2 and b_3 of the first user-class character. Whether a second class-of-traffic character follows or not will be indicated by bit b_4 of the first user-class character.

TABLE 3/X.70 – **First user class character**

Combination				Condition signalled from X to Y[a]
b_4	b_3	b_2	b_1	
A				No second class-of-traffic character follows
Z				A second class-of-traffic character follows (see Table 4/X.70)
	A	A	A	Reserve
	A	A	Z	Reserve
	A	Z	A	50 bit/s (user class 2)
	A	Z	Z	100 bit/s (user class 2)
	Z	A	A	110 bit/s (user class 2)
	Z	A	Z	134.5 bit/s (user class 2)
	Z	Z	A	200 bit/s (user class 2)
	Z	Z	Z	A second user class character follows[b]

[a] The user class character may be omitted if, for example, the information can be derived from the incoming line.
[b] If expansion of user classes is required this will conform to Table 3a/X.71.

TABLE 4/X.70 – **Second class-of-traffic character**

Combination				Condition signalled from X to Y
b_4	b_3	b_2	b_1	
A				No third class-of-traffic character follows
Z				Third class-of-traffic character follows (see Table 4a/X.70)
	A			No closed user group character follows
	Z			Closed user group character follows (see Table 5/X.70)
		A		Called line identification not required
		Z		Called line identification required
			A Z	Reserved for future needs

TABLE 4a/X.70 – **Third class-of-traffic character**

Combination				Condition signalled from X to Y
b_4	b_3	b_2	b_1	
A				No fourth class-of-traffic character follows
Z				Fourth class-of-traffic character follows[a]
	A			Redirection not allowed[b]
	Z			Redirection allowed[b]
		A		Not multiple address call[b]
		Z		Multiple address call[b]
			A Z	Not allocated

[a] Reserved for future needs.
[b] The international use of this signal requires further study.

2.5.3 *Second and subsequent class-of-traffic characters (see Tables 4 and 4a/X.70)*

These characters follow any user-class characters required. The number of these class-of-traffic characters depends on the number of user facilities available.

The bit b_4 of the second or subsequent class-of-traffic characters indicate whether another class-of-traffic character follows or not.

2.5.4 *Closed user group characters (see Table 5/X.70)*

These characters are only used in conjunction with the second and possibly subsequent class-of-traffic signals which may follow.

The closed user group number comprises a variable number of decimal digits followed by an end-of-closed-user-group character signal.

Note. – Further study is required concerning administrative and technical aspects of the method to provide the closed user group facility taking into account the alternative methods.

TABLE 5/X.70 – **Closed user group characters**

Combination				Condition signalled from X to Y	
b_4	b_3	b_2	b_1		
A	A	A	A	0	Closed user group digits
A	A	A	Z	1	
A	A	Z	A	2	
A	A	Z	Z	3	
A	Z	A	A	4	
A	Z	A	Z	5	
A	Z	Z	A	6	
A	Z	Z	Z	7	
Z	A	A	A	8	
Z	A	A	Z	9	
Z	A	Z	A	End-of-closed user group character for call without outgoing access	
Z	A	Z	Z	End-of-closed user group character for call with outgoing access	
Z	Z	A	A	No closed user group digit is included[a]	
Z	Z	A	Z	Not allocated	
Z	Z	Z	A		
Z	Z	Z	Z		

[a] Character sent to indicate that the closed user group validation check has already been performed in the originating centre (e.g. can be used if the call is a direct call).

2.5.5 The numerical characters used for the second part of the *Selection signals* are shown in Table 6/X.70. When the first class-of-traffic character indicates a terminal call, the destination code will be omitted.

TABLE 6/X.70 – **Miscellaneous forward path signals**

Combination				Condition signalled from X to Y	
b_4	b_3	b_2	b_1		
A	A	A	A	0	Digits for: – destination code, – called subscriber's number, – calling line identification signals.
A	A	A	Z	1	
A	A	Z	A	2	
A	A	Z	Z	3	
A	Z	A	A	4	
A	Z	A	Z	5	
A	Z	Z	A	6	
A	Z	Z	Z	7	
Z	A	A	A	8	
Z	A	A	Z	9	
Z	A	Z	A	End-of-selection signal	
Z	A	Z	Z	End-of-calling-line-identification signal[a]	
Z	Z	A	A	Not allocated	
Z	Z	A	Z		
Z	Z	Z	A		
Z	Z	Z	Z		

[a] This signal is also used alone when the calling line identification is not available.

TABLE 6a/X.70 – **Other forward path signals**

IA5 character	Condition signalled from X to Y
0/6	Originating through-connection

2.6 The incoming equipment should maintain start polarity on the backward signalling path by releasing the connection if the first received character is spurious, as indicated by a character other than a first valid class-of-traffic character. This procedure prevents the possibility of regarding a second *Selection signal* as a first class-of-traffic character and provides a further safeguard against false calls.

In the case of receipt of a spurious signal as indicated by a parity error or by a character other than a valid selection signal (with the exception of the first class-of-traffic character), the incoming equipment should return the appropriate *Call progress signal* to the preceding centre (after the *Reception-confirmation signal*, preceded or followed by the *Network identification signals*, followed by the *Clearing signal*.

The incoming equipment may release the connection if all of the *Selection signals* are not correctly received within a period of 15 seconds from the reception of the first class-of-traffic character. In this event, the appropriate *Call progress signal* is returned to the preceding centre (after the *Reception-confirmation signal*, preceded or followed by the *Network identification signals*, followed by the *Clearing signal*.

2.7 The maximum number of digits which comprise the *Address signals* is for further study.

2.8 In the case of receipt of the *Reception-congestion signal* at a transit centre, the *Call progress signal No. 32* should be returned to the preceding centre (after the *Reception-confirmation* and *Network identification signals*) and followed by the *Clearing signal*.

2.9 The *Network identification signals* shall be sent following the *Reception-confirmation signal* in all cases of transit calls but not for terminal calls. However, when a *Call progress signal* is returned from the destination network for reasons other than failure or congestion of the called subscriber line, or the called number is unassigned, it should be followed immediately by the *Network identification signals*.

If several transit networks are involved in setting-up a call the calling network will receive the network identifications one after the other. If a transit centre fails to receive the first character of the *Network identification signals*, if applicable, within two seconds of the *Reception-confirmation signal*, it will return to the preceding centre, the *Call progress signal No. 30*, (after the *Reception-confirmation* and *Network identification signals*), followed by the *Clearing signal*.

The *Network identification signals* could be useful for retracing the route followed by a call (for traffic statistics, international accounts, analysis of unsuccessful calls and the clearing of faults).

It is possible for a transit centre to receive backward path signals such as *Network identification signals*, *Call-connected signal* or *Call progress signals* from subsequent centres, while the backward path signals originated locally are still being sent. It is necessary for the transit centre to ensure that the received signals are passed to the preceding centre without mutilations or loss.

2.10 The backward path signals indicating effective and ineffective call conditions are scheduled in Tables 7 and 7a/X.70.

2.11 If the *Call progress*, *Call-connected* or *Alternatively terminating-through-connection signals* are not received within 30 seconds from the end of selection, then the *Call progress signal No. 33*, will be returned to the preceding centre (after the *Reception-confirmation* and *Network identification signals*), followed by the *Clearing signal*.

2.12 If the called station is not able to receive information immediately, the return of the *Call-connected* and following signals to the calling station should be delayed accordingly.

2.13 In this type of signalling, originating and terminating national centres contain the identification of the calling or called subscribers respectively. These identifications may be exchanged within the network as an optional subscriber's feature.

If the called or calling line identification has been requested but is not available, the appropriate centre in the connection should send only the *End-of-line identification signal* (CSC character No. 12).

2.14 The *Terminating-through-connection signal* confirms that, if applicable, the calling line identification has been completely received by the terminating centre and passed to the called subscriber (see Appendix 3).

The *Originating-through-connection signal* confirms that the *Call-connected signal* has been received by the originating centre and when applicable, that the called line identification has been completely received by the originating centre and passed to the calling subscriber, and when applicable that the *Terminating-through-connection signal* has been received (see Appendix 3).

The *Terminating-through-connection signal* is sent on the backward path by the terminating centres. The *Originating-through-connection signal* is sent by the originating centre both to calling and called subscribers.

The maximum difference in time between the start of transmission of the *Through-connection signals* in the forward and backward directions in addition to the time required for the setting-up of the connection must be less than 20 ms (see Appendix 3). This limit follows from the condition given in Recommendation X.20 for the beginning of data transmission.

The connection must be switched through in the terminating centre within one character period after transmission of the *Call-connected* or *Terminating-through-connection signal* or after the complete transmission of the *Called line identification signals.* Which of the previously mentioned conditions have to be observed depends on whether or not and in what direction *Line identification signals* have to be transmitted (see Appendix 3).

In transit centres the connection can be switched through earlier provided that data losses and mutilations are avoided.

Complete network through-connection is assured when the *Originating-connect-through signal* is received by the data terminals.

TABLE 7/X.70 – **Miscellaneous backward path signals**

Combination				Condition signalled from Y to X
b_4	b_3	b_2	b_1	
A	A	A	A	0
A	A	A	Z	1
A	A	Z	A	2
A	A	Z	Z	3
A	Z	A	A	4 Digits for: – network identification signals, – called line identification signals, – call progress signal.
A	Z	A	Z	5
A	Z	Z	A	6
A	Z	Z	Z	7
Z	A	A	A	8
Z	A	A	Z	9
Z	A	Z	A	Start-of-call-progress signal (see Table 7a/X.70)
Z	A	Z	Z	End-of-called-line-identification signal[a] Start-of-network-identification signal
Z	Z			Call-connected signal[b]
		A		Calling line identification not required (and no terminating through-connection signal will follow)
		Z		Calling line identification required (a terminating through-connection signal will follow)
			A	Call metering
			Z[c]	No call metering

[a] This signal is also used alone when the called line identification is not available.
[b] CSC character No. 13 is terminating through-connection signal (see Table 8/X.70).
[c] b_1 may be used in the future as an escape possibility. The international use of this signal requires further study.

TABLE 7a/X.70 – **Call progress signals**[a]

Equivalent numerical code[b]	Category	Meaning for data service	Code for telex service
00 01 02 03	Without clearing	Terminal called Redirected call Connect when free No identification[c]	– RDI MOM NI
10 11 12	With clearing, due to subscriber – short-term[d]	Number busy Selection error[c] (procedure) Selection error[c] (transmission)	OCC FMT NC
20 21 22 23 24 25	With clearing, due to subscriber – long-term[d]	Not obtainable Access barred Controlled not ready Out of order Number changed Call information service	NP NA ABS DER NCH INF
30 31 32 33 34 35 36	With clearing, due to network	Network congestion Trunk congestion Equipment congestion Network error Trunk error Equipment error Out of order	NC

[a] The use of two digits (CSC characters) to indicate call progress signal codes is provisional and requires further study.
[b] Codes not allocated in 00-79 range are reserved for international use. The remaining codes are available for national use.
[c] These signals are normally only utilized between first centre and subscriber and are not signalled on inter-network links.
[d] "Short-term" in this context approximates to the holding time of a call, whilst "long-term" implies a condition that can persist for some hours or even days.

2.15 If the destination centre fails to receive the first character of the *Calling line identification signals* within 4 seconds after having sent the appropriate *Call-connected signal*, it will return to the preceding centre the *Call progress signal No. 33* followed by the *Network identification signals* and the *Clearing signal.*

2.16 The guard delays on clearing are measured from the moment when start polarity has been established on both signalling paths by:

– either recognizing or transmitting the *Clearing signal* on one signalling path, and

– either transmitting or recognizing the *Clear-confirmation signal* on the other signalling path.

For incoming calls this guard period shall be 390-420 ms. A new incoming call shall not be accepted until this guard period has elapsed. This is on the assumption that the terminating centre will be able to accept the first *Selection signal* after a negligible period of stop polarity and will also be able to return the *Reception-confirmation signal* within a negligible delay after the receipt of the first class-of-traffic character.

The guard period on clearing for outgoing calls should be a period of at least 840 ms. A new outgoing call shall not be originated until this guard period has elapsed.

If exchanges are able to distinguish between the different clearing conditions, shorter periods may be introduced accordingly.

2.17 The automatic *Re-test signal* will be initiated as indicated in 2.4 below.

This signal transmitted over the forward signalling path is composed of a maximum of five successive cycles, each cycle incorporating:

- stop polarity for 1-2 character periods (see Note) followed by CSC No. 13, followed by stop polarity for a maximum period of 4 seconds;
- start polarity for a period of 56 seconds.

Note. – The minimum and consequently the maximum periods will be lengthened at the request of the incoming country Y (see Remarks column of Table 1/X.70).

The circuit should be tested up to 5 times at nominal intervals of one minute and a check made to confirm the receipt of the *Reception-confirmation signal* on the backward path in response to each test. If the *Reception-confirmation signal* has not been received at the end of this first group of tests, the re-test will continue with a further group of up to 5 tests at either 5 or 30 minute nominal intervals. If 5 minute intervals are used and the *Reception-confirmation signal* has not been received at the end of this second group of tests, further re-tests will be made at 30 minute intervals. An alarm will be given at an appropriate time. However, this re-test procedure may be discontinued at any stage at the discretion of the outgoing Administration.

If, however, during the above sequence of re-tests, the *Reception-confirmation signal* is received, a *Clearing signal* will be transmitted in place of the *Re-test signal.* Following a valid *Clear-confirmation signal,* the incoming and the outgoing sides of the trunk circuit should not be returned to service until after expiry of the appropriate guard delay time. In order to cater for the possibility that a faulty circuit may be seized at both ends, the automatic re-test equipment should be arranged to allow an incoming call to be received during the start polarity period. An Administration may, however, ignore such calls which occur during the incoming guard delay period.

The interval between the tests at the two ends of the trunk circuit should be made different by increasing the nominal interval by 20% at one end, to be sure that successive re-tests do not overlap at both ends.

Where an exchange has knowledge of a transmission system failure it is desirable that the *Re-test signals* shall not be applied to the circuits affected.

In order to avoid simultaneous seizure of too many registers at the distant centre, it is advisable that the *Re-test signals,* which may be sent simultaneously on various circuits subjected to this test, should be out of phase with one another.

The use of a special first class-of-traffic character for re-test permits the incoming centre to be informed about re-tests on its incoming circuits.

2.18 If at the receiving end, parity does not check during the establishment of the connection, provisionally the connection should be cleared down unless otherwise specified. However, the possibility of different actions remains open for further study.

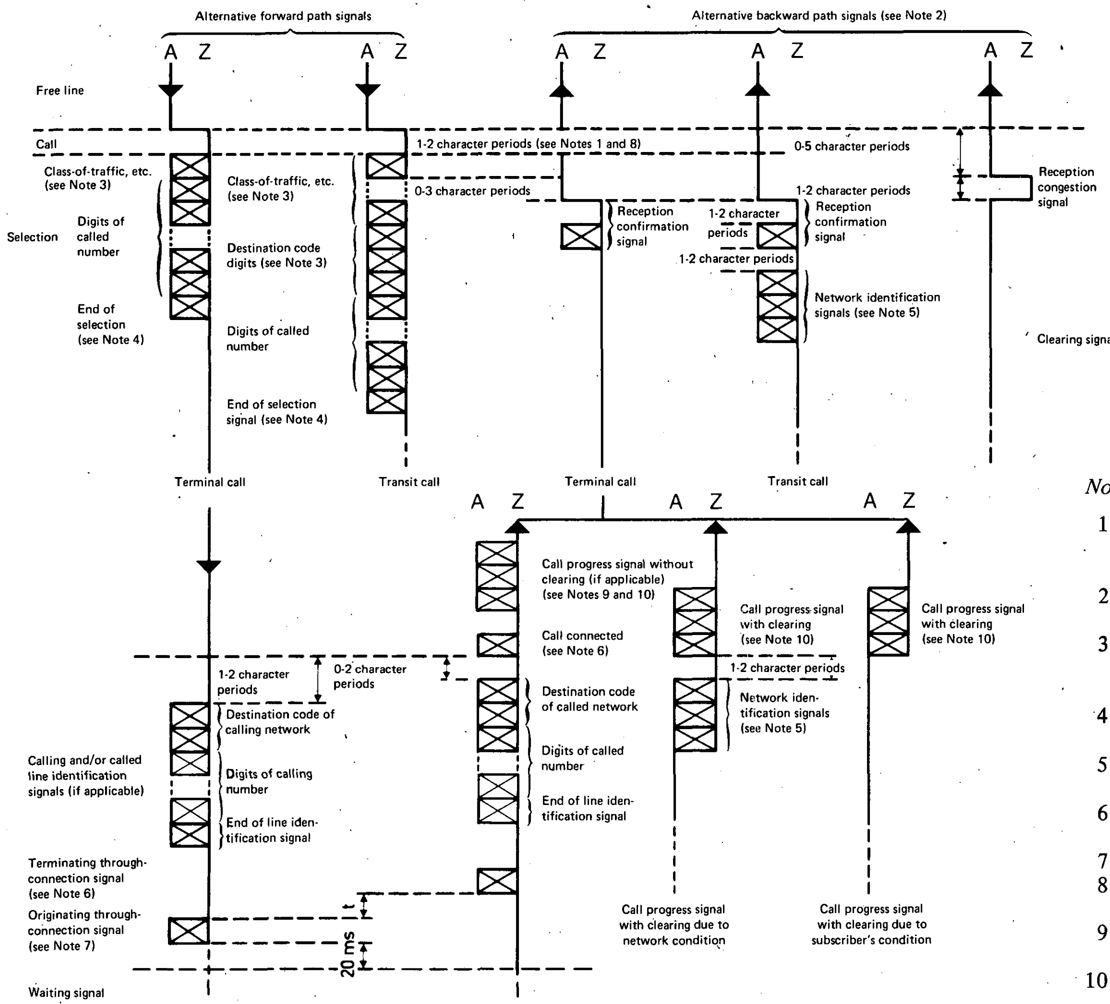
TABLE 8/X.70 – **Control signalling code (CSC)**

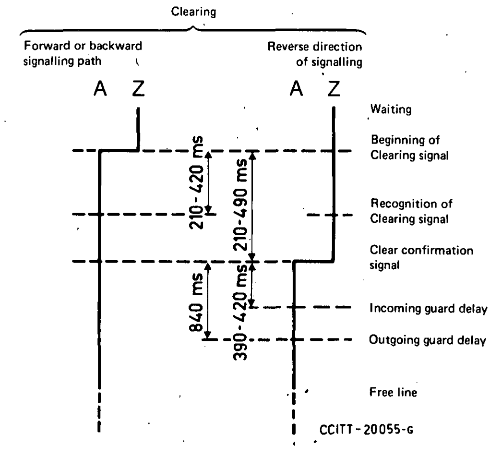
CSC character number	CSC character structure				
	b_5	b_4	b_3	b_2	b_1
1	A	A	A	A	A
2	Z	A	A	A	Z
3	Z	A	A	Z	A
4	A	A	A	Z	Z
5	Z	A	Z	A	A
6	A	A	Z	A	Z
7	A	A	Z	Z	A
8	Z	A	Z	Z	Z
9	Z	Z	A	A	A
10	A	Z	A	A	Z
11	A	Z	A	Z	A
12	Z	Z	A	Z	Z
13	A	Z	Z	A	A
14	Z	Z	Z	A	Z
15	Z	Z	Z	Z	A
16	A	Z	Z	Z	Z

Note 1. – The 4-unit code with one parity check bit used in this control signalling system is listed in the table. A complete control signalling code (CSC) character consists of a one-unit start element, four information bits (b_1, b_2, b_3 and b_4), a parity check bit (b_5) and a two-unit stop element.

Note 2. – The parity bit of the signal should correspond to even parity with regard to unit elements of Z polarity. The individual bits should be transmitted at the nominal data signalling rate (200 bit/s) with the low order bit (b_1) first and completed by the parity check bit (b_5).

Note 3. – The transmitting part of the signalling device shall send the control character at the nominal modulation rate of 200 bauds ± 0.2 % with a maximum degree of gross start-stop distortion of 5 %. The receiving part of the signalling device shall have an effective net margin of not less than 40 %.





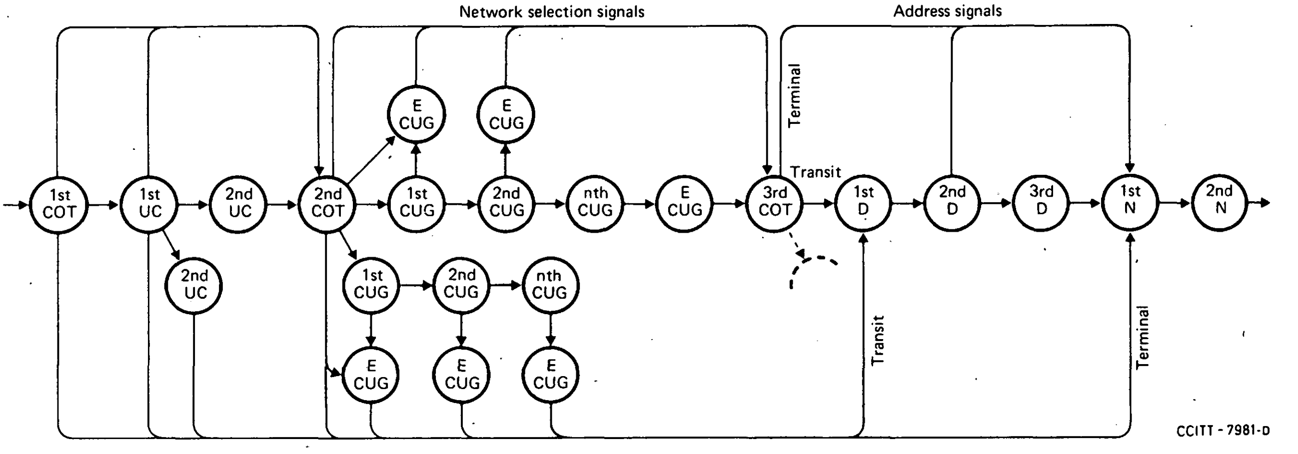
Notes

1. Timings are shown as character periods of the 4 (+1 parity) bit code at 200 bit/s. Switching and propagation delays are not included.
2. Forward path signals may also appear on the backward path, indicating a head-on collision on both-way circuits.
3. *Network selection signals* (class-of-traffic, user class characters etc.) see Tables 2-5/X.70. Destination codes may comprise 2 or 3 digits.
4. *Selection signals* will always be sent as a single block by the originating network with an *End-of-selection signal* in all cases.
5. The *Network identification signals* comprise a distinctive character followed by the destination code of the network concerned.
6. For additional information regarding *Call-connected* and *Through-connection signals*, see 2.14 and Appendix 3.
7. For value of *t* and further details refer to 2.14 and Appendix 3.
8. The minimum and consequently the maximum periods will be lengthened at the request of the incoming country Y.
9. *Call progress signals* without clearing may be included to indicate such facilities as call redirection.
10. *Call progress signals* comprise a distinctive character followed by a 2-digit number.

FIGURE 1/X.70 – **Decentralized signalling between data networks of anisochronous type**

APPENDIX 1
(to Recommendation X.70)

Possible sequences of network selection signals



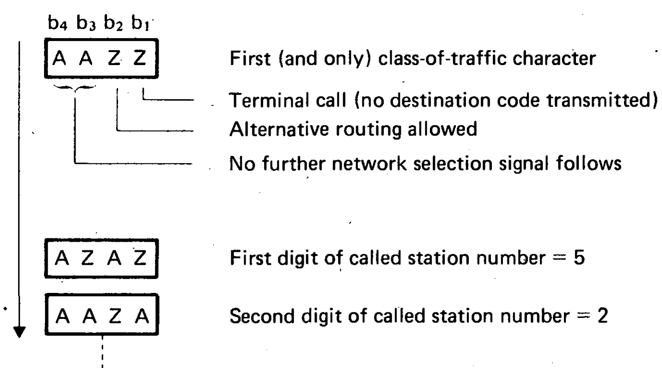
COT = class-of-traffic character,
UC = user class character
CUG = closed user group character
D = destination code digit
N = called number digit
E CUG = end of closed user group character
Dotted lines: reserved for further extension

APPENDIX 2
(to Recommendation X.70)

Examples of network selection signals

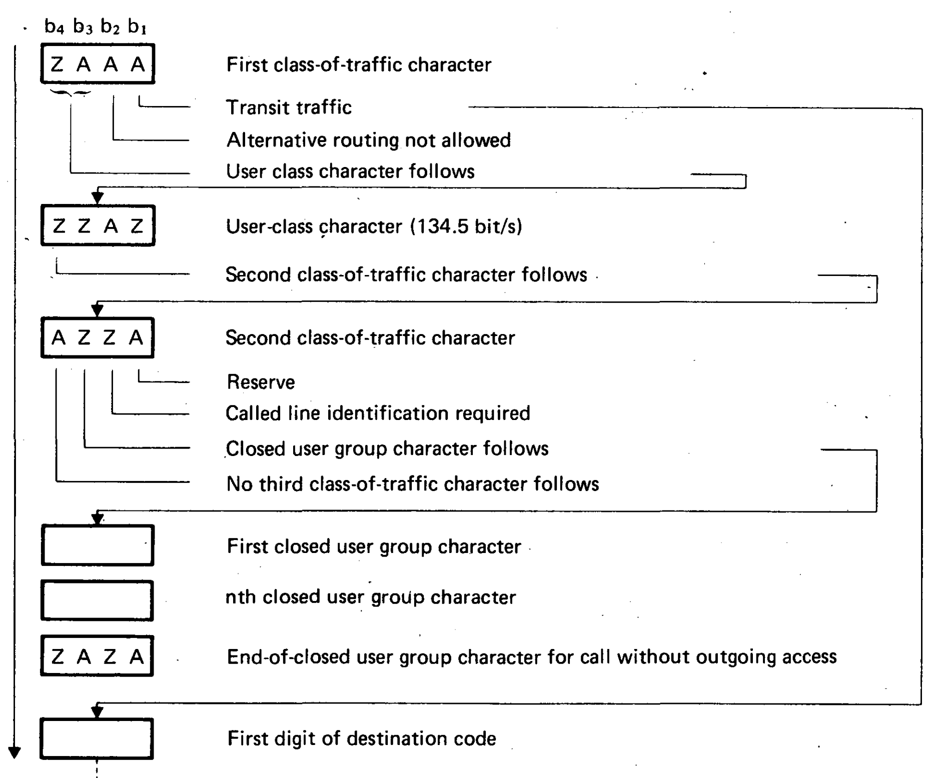
1. *First example* (minimum sequence of network selection signals)

This example shows a sequence of minimal length. (The preceding calling signal, the start and stop elements and the parity bit are not shown. The bits are shown in the order of b_4, b_3, b_2 and b_1.)



CCITT - 8944 - A

2. *Second example* (a sequence of network selection signals including closed user group characters)



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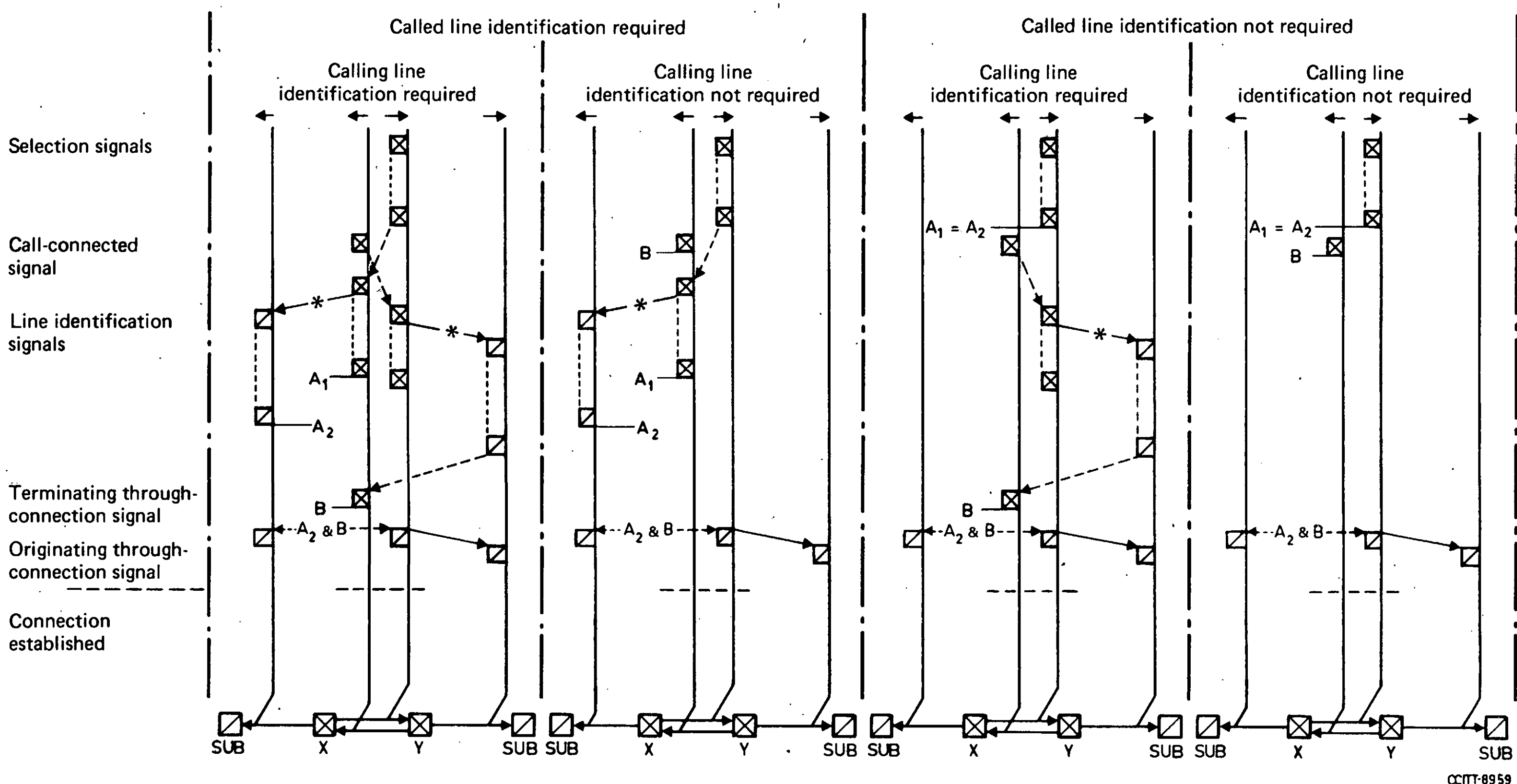
APPENDIX 3
(to Recommendation X.70)

Through-connection procedures



—→ Normal transmission

—*→ Retransmission with code conversion

- - - -→ Correlation line

- - - - - Instant of established connection

⊠ CSC character

▨ IA5 character

X,Y Data centres

SUB Subscribers

Through-connection conditions:

– at originating centre: with condition A_2 and B (within 20 ms)
– at transit centre: with Call-connected signal
– at terminal centre: with condition A_1 and B (within 20 ms)

Note. – The originating *Through-connection signal* is generated by the originating or first type X.70 centre within 1 to 2 character periods from condition A_2 and B.

Recommendation X.71

DECENTRALIZED TERMINAL AND TRANSIT CONTROL SIGNALLING SYSTEM ON INTERNATIONAL CIRCUITS BETWEEN SYNCHRONOUS DATA NETWORKS

(Geneva, 1976)

With the appearance of public data networks in various countries it becomes necessary to establish the appropriate international control signalling schemes for interworking in order to facilitate the introduction of such networks as much as possible. The main objective of public data networks is to offer to the user a great range of data signalling rates with a minimum of restrictions, very short call set-up and clear-down times and a variety of new service facilities. These requirements can be fulfilled only by specially conceived signalling systems which cater for all foreseeable needs and which are flexible enough to provide also for new, not yet defined, services.

For these reasons, the CCITT

unanimously declares the view that

for interworking between synchronous data networks utilizing decentralized control signalling techniques the following scheme should be used on international circuits:

Note 1. – The synchronous user classes of service are as specified in Recommendation X.1.

Note 2. – The signalling on links between synchronous and anisochronous networks is the subject of further study.

Note 3. – The interworking between networks using common channel and decentralized signalling is a subject for further study.

1. *General switching and signalling principles*

1.1 Signalling will be at bearer rates appropriate to the synchronous user classes of data only. It is expected that start-stop user classes of data and telex, etc., will be assembled and transmitted at the rate corresponding to class 3 (600 bit/s).

1.2 The control signalling should employ bits transmitted at the maximum data signalling rate of the links provided.

1.3 Decentralized signalling will apply, the same channel being used for control signalling and data transmission.

1.4 Both terminal and transit operation will be required. Due to the inclusion of transit operation, link-by-link signalling control of calls will be adopted.

In general, destination codes and *Network identification signals* will be transmitted on transit calls but not on terminal calls. However, these codes and signals will be sent on all calls terminating in a country if required by the incoming country. In such circumstances the incoming exchange in the country will be regarded as a transit centre.

Onward selection from transit and incoming terminal centres should be arranged in order to commence as soon as possible.

Selection signals will be transmitted by the originating or transit country, or network, in a single block.

1.5 A numbering scheme in a Recommendation yet to be agreed, will apply to data networks of the synchronous type. The same codes will be used for network identification purposes.

1.6 Alternative routing will be permitted. The principle of high-usage circuits will be adopted, with overflow on to adequately provided routes between centres. Overflow on to higher speed circuits will not be permitted.

In order to prevent repeated alternative routing causing traffic to circulate back to the originating point, alternative routing will be restricted to once per call.

1.7 Both-way operation will be assumed and inverse order testing of circuits on both-way routes or a close approximation to it by testing the route in small groups in fixed order always starting the search from the same position, will be specified in order to minimize head-on collisions.

1.8 The accounting principle assuming that in all cases, including that of transit switching, the originating country or network will be responsible for recording accounting information, will apply to public data networks of synchronous type.

1.9 The grade of service to apply for the provision of circuits for links between public data networks of synchronous type which carry traffic overflowed from other routes or from which overflow was not permitted would be not worse than one lost call in 50.

For high-usage direct links, circuits would be provided at a grade of service of not worse than one lost call in 10.

1.10 Sufficient switching equipment will be provided to ensure that congestion will not be signalled by return of a *Reception congestion signal* or absence of a *Proceed-to-select signal* on more than 0.4% of calls in the busy hour and, in the first case, only then when congestion has been positively identified.

1.11 The target setting-up time for the user classes of service applicable to these types of data networks is for further study (see Question 3/VII).

2. *Specific signalling characteristics*

Notes applicable to 2.

Note 1. – X denotes the international centre which originates the call under consideration on the international link concerned. Y denotes the international centre which receives the call under consideration on the international link.

Note 2. – Timings shown are within the centre concerned, excluding propagation and other transmission delays.

Note 3. – The signalling plan will employ 8-bit signalling characters and continuous 0s [4] and 1s.

During the control signalling stage, the status bits are 0s. Upon the final through connection in the originating centre, the status bits on both signalling paths are 1s.

For the case of signalling characters, the parity of the characters will be odd, and hence will be consistent with Recommendation X.4 for links and connections using end-to-end synchronous operation, and with Recommendation X.21. For the case of signals being continuous 0s, or continuous 1s, parity is undefined inasmuch as no characters are employed. Moreover, character synchronization is not maintained over a period of continuous 0s or 1s, but must be re-established when further signalling characters are sent.

All groups of contiguous characters will be preceded by at least two repetitions of International Alphabet No. 5 (IA5) character 1/6 (SYN). The term "at least" means two SYN characters for the 600 bit/s user class. For the higher speed user classes, the number of SYN characters could be two or more but the total number of SYN characters should not unnecessarily prolong the setting-up time. If two signalling groups are combined to form one group of contiguous characters, the SYN characters may be omitted from within this group.

The *End-of-selection signal* will be the IA5 character 2/11 (+). The *Call confirmation and proceed-to-select signals* will use IA5 character 2/10 (*).

Apart from the above-mentioned signals (namely, continuous 0s, continuous 1s, 1/6, 2/10 and 2/11), all signals will be characters chosen from column 3 of IA5 (see Table 1/X.71). This choice helps ensure that the synchronization and other characters specified above are uniquely separable from the IA5 column 3 signalling characters.

An example of three successive signalling characters within five octets of one channel of the Recommendation X.50 multiplex structure is shown in Appendix 4. In the Recommendation X.50 multiplex structure, the signalling characters will be aligned with the 8 + 2 envelope.

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[4] The impact of the all zeros pattern is left for further study.

TABLE 1/X.71 – **Decentralized signalling between synchronous data networks**

Notes

– The status bit may be OFF (= 0) or ON (= 1).
– For Call Confirmation (CC) protocol and Proceed-to-select (PTS) protocol see 2.1.

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Free line	S = 0, continuous repetitions of 0s	S = 0, continuous repetitions of 0s	
Calling signal	S = 0, continuous repetitions of 1s		
	For CC protocol, this signal is continuous for a minimum period of 10 ms or 16 information bits whichever is the greater in time and for a maximum period of 15 ms or 24 information bits whichever is the greater in time[a]		The equipment at centre Y should be ready to receive *Selection signals* within a period of 10 ms or 16 information bits whichever is the greater in time from the start of the *Received calling signal.*
	For PTS protocol, this signal is continuous until the *Proceed-to-select signal* is received		The *Proceed-to-select signal* should be returned when the equipment is ready to receive *Selection signals.*
Call-confirmation signal (CC protocol)		S = 0, continuous repetitions of IA5 character 2/10 maintained until the first class-of-traffic character is recognized and always preceded by at least two SYN characters (1/6)	Returned within 10 ms or 16 information bits of receipt of the *Calling signal* whichever is the greater in time. For terminal calls the *Call-confirmation signal* shall be followed by the *Waiting signal* within 50 ms of receipt of the first class-of-traffic character if no other signalling characters follow contiguously. For transit calls the *Call-confirmation signal* shall be followed by the *Network identification signal* within 50 ms of receipt of the first class-of-traffic character, and then followed by the *Waiting signal* if no other signalling characters follow contiguously. The *Call-confirmation signal* will have to be absorbed at centre X and should not be able to go through the equipment to arrive at the preceding centre.

[a] The duration of the calling signal and return of the Call-confirmation signal is for further study in the light of experience.

TABLE 1/X.71 *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Proceed-to-select signal (PTS protocol)		S = 0, continuous repetitions of IA5 character 2/10 maintained until the first class-of-traffic character is recognized and always preceded by at least two SYN characters (1/6)	Returned within 3 seconds from the start of the *Received calling signal.* For terminal calls, the *Proceed-to-select signal* shall be followed by the *Waiting signal* within 50 ms of receipt of the first class-of-traffic character if no other signalling characters follow contiguously. For transit calls, the *Proceed-to-select signal* shall be followed by the *Network identification signal* within 50 ms of receipt of the first class-of-traffic character, and then followed by the *Waiting signal* if no other signalling characters follow contiguously. The *Proceed-to-select signal* will have to be absorbed at centre X and should not be able to go through the equipment to arrive at the preceding centre.
Selection signals	S = 0, at least one (first class-of-traffic character only) and possibly several network *Selection signals* depending on the network requirement (see Appendix 1), the digits of the destination code of the called network, the digits of the called terminal number, and an end-of-selection character (2/11) and then followed by the *Waiting signal*		The *Selection signals* are transmitted at the maximum data signalling rate of the links provided. The destination code is omitted for terminal calls. For CC protocol, these signals, preceded by at least two SYN characters are transmitted immediately after the *Calling signal* without awaiting the reception at X of the *Call-confirmation signal.* For PTS protocol, these signals, preceded by at least two SYN characters are transmitted immediately after reception at X of the *Proceed-to-select signal.*
Network identification signal		S = 0, IA5 character 3/11 followed by the destination code of the network, followed by the *Waiting signal* if no other signalling characters follow contiguously	For transit calls the character 3/11 follows the *Call-confirmation* or *PTS signal.* These signals, preceded by at least two SYN characters (1/6) when they follow a *Waiting signal* must go through centre X and arrive at the originating network. For ineffective terminal calls the character 3/11 follows the last *Call progress signal* with clear within 10 ms or 16 information bits, whichever is the greater in time, when the *Call progress signal* is due to a network condition.

TABLE 1/X.71 *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Waiting signal	S = 0, repetitions of 1s for a period of at least 15 information bits		This signal must be sent if two groups of signalling characters cannot be combined to form one group of contiguous characters.
Reception congestion signal		S = 0, repetitions of 1s for a minimum period of 10 ms or 16 information bits whichever is the greater in time and for a maximum period of 24 information bits or 15 ms, whichever is the greater in time, followed by the *Clearing signal*	It may be possible that this signal will be preceded by the *Call-confirmation signal* or a part of it. This signal is returned as soon as possible and the target time will be within 15 ms or 24 information bits of the start of the *Calling signal*, whichever is the greater in time, when the *Selection signals* cannot be received. This signal should be absorbed by X and not allowed to be received by a preceding centre. This signal should be provided in networks using the CC protocol and may be provided in networks using the PTS protocol.
Call progress signal without clearing (if required)		S = 0, one IA5 character 3/10 and then 2 characters according to Table 7b/X.71 followed by the *Waiting signal* if no other signalling characters follow contiguously	These signals are preceded by at least two SYN characters (1/6) when they follow a *Waiting signal.* Examples would be *Redirected-call* or terminal-called call progress signal, which are followed by a return to the *Waiting signal.*
Call connected signal		S = 0, one IA5 character, 3/12-15, according to Table 7/X.71, followed by the *Waiting signal* if no other signalling characters follow contiguously	See 2.13 of the text and Appendix 3. This signal is preceded by at least two SYN characters (1/6) if it follows a *Waiting signal.*
Called line identification signal (if applicable)		S = 0, *Called line identification signal* transmitted between 50 ms and 60 ms after the *Call connected signal*	The *Line identification signal* comprises the destination code followed by the digits of the subscribers' line number and then the end-of-identification character (3/11) (see 2.13 of the text and Appendix 3). If the calling or called line identification is requested and is not available within the network receiving the request, a dummy identification should be sent. In this case an end-of-identification character (3/11) only is transmitted. This signal is preceded by at least two SYN character (1/6) when it follows a *Waiting signal.*
Calling line identification signal (if applicable)	S = 0, *Calling line identification signal* transmitted between 10 ms and 60 ms after the *Call connected signal* is received		

TABLE 1/X.71 *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Terminating through-connection signal		Continuous repetitions of 1s (S = 1) from the called DTE received by the originating centre (or transit centres if applicable)	Through-connection in both directions of transmission in the destination exchange (see 2.13 of the text and Appendix 3). Through-connection in transit centres will normally take place after reception of the *Call-connected signal*, but see also 2.13 of the text.
Originating through-connection signal	Continuous repetitions of 1s (S = 1) received by the called DTE from the calling DTE		Through-connection in both directions of transmission in the originating centre (see 2.13 of the text and Appendix 3).
Call progress signals with clearing		S = 0, at least two SYN characters (1/6) followed by character 3/10 followed by 2 digits (see Table 7b/X.71) possibly followed by the *Network identification signals* (see 2.9 of the text) and followed by the *Clearing signal*	These signals are preceded by at least two SYN characters (1/6) when they follow a *Waiting signal.*
Clearing signal	Continuous repetitions of 0s (S = 0) in the direction of clearing. The minimum recognition time is 16 bits and the maximum time is 60 ms		The minimum period of one signalling path which in itself ensures the complete release of the connection is 60 ms.
Clear confirmation signal	Continuous repetitions of 0s (S = 0) in the opposite direction to clearing within 60 ms after reception of the *Clearing signal*		The minimum and maximum periods for the release of the international circuit by a centre are 16 bits and 60 ms respectively.
Incoming guard delay	Period of 60-70 ms measured from the moment when continuous 0s (S = 0) has been established on both signalling paths by : – either recognizing or transmitting the *Clearing signal* on one signalling path, and – either transmitting or recognizing the *Clear confirmation signal* on the other signalling path		A new incoming call shall not be accepted until this guard period has elapsed.
Outgoing guard delay	Period of 130 ms measured from the moment when continuous 0s (S = 0) has been established on both signalling paths by : – either recognizing or transmitting the *Clearing signal* on one signalling path, and – either transmitting or recognizing the *Clear confirmation signal* on the other signalling path		A new outgoing call shall not be originated until this guard period has elapsed.

TABLE 1/X.71 *(concluded)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Automatic retest signal	S = 0, continuous repetitions of 1s for a period of 4 seconds followed by continuous repetitions of 0s for a period of 56 seconds and the signal sequence is then repeated		See 2.16 of the text.
Backward busy signal		S = 0, continuous repetitions of 1s for a maximum period of 5 minutes	

2.1 The signals between two data networks of synchronous type are described in Table 1/X.71. There are two protocols, the Call Confirmation Protocol (CCP) and the Proceed-to-select Protocol (PTSP). The CCP is the basic method of this Recommendation and the PTSP is an option for an interim period at the discretion of the incoming network.

2.2 The incoming equipment may release the connection as follows:

2.2.1 *Call Confirmation Protocol*

If the calling signal exceeds the specified maximum period, but not before at least one call confirmation character has been transmitted.

2.2.2 *Proceed-to-select Protocol*

If the first selection signal is not received within 2 seconds after having sent the *Proceed-to-select signal.*

2.3 A head-on collision is detected by the fact that exchange X receives calling signal (repetitions of 1s) followed by SYN characters instead of *Call confirmation* or *Proceed-to-select signal* (SYN characters followed by repetitions of 2/10) or *Reception-congestion signal* (repetitions of 1s followed by clearing signal).

When a head-on collision is detected, the switching equipment at each end of the circuit should make another attempt to select a free circuit, either on the same group of circuits or on a group of overflow circuits, if facilities for alternative routing exist and there are no free circuits on the primary route. In the event of a further head-on collision on the second attempt, no further attempt will be made and the call will be cleared down. In the case of a transit centre, the *Call progress signal No. 30* is returned to the preceding centre within a sequence of signals ordered as follows: *Call confirmation* or *Proceed-to-select, Network identification,* the *Call progress signal* and *Clearing.*

2.4 Failure to receive *Reception-congestion, Call-confirmation* or *Proceed-to-select signal* within 4 seconds from the start of the *Calling signal,* the reception of a spurious signal as indicated by a signal other than *Reception-congestion, Call-confirmation* or *Proceed-to-select signal,* or by a head-on collision, can initiate the automatic *Re-test signal* on the circuit concerned.

The need for an automatic *Re-test signal* may not be so great in a digital environment, its purpose being met by alternative methods. If an automatic *Re-test signal* is used, however, it will conform to 2.16 below.

In the case of failure to receive *Reception-congestion, Call-confirmation* or *Proceed-to-select signal,* an attempt to select another circuit should be made (once only). In the case of transit calls, if the second attempt is unsuccessful, the *Call progress signal No. 30* (or 31 or 32, if appropriate) is returned to the preceding centre within a sequence of signals ordered as follows: *Call-confirmation* or *Proceed-to-select, Network identification,* the *Call progress signal* and *Clearing.*

2.5 *Selection signals* can be divided into 2 parts. The first part, designated the *Network selection signals,* contains information regarding network and user requirements and may be composed of one to nine (or possibly more) characters (see Tables 2/X.71, 3/X.71, 3a/X.71, 4/X.71, 4a/X.71, and 5/X.71). The second part comprises the *Address signals* (the called subscriber number which is preceded by the destination code in the case of a transit call – see Tables 6/X.71 and 6a/X.71).

The *Network selection signals* used in the forward direction (see also Appendix 2) are further subdivided and assembled as follows (see 2.5.1 to 2.5.4 below) for signalling purposes.

Note that the term "user class of service" is abbreviated in the following sections to "user class".

2.5.1 *First class-of-traffic character (see Table 2/X.71)*

The *Calling signal* is always followed by at least one class-of-traffic character in addition to at least 2 SYN characters. The bit functions of the class-of-traffic character were so chosen that no further characters are needed for most connections.

If there is a need for indication of further requirements, a second class-of-traffic character (see 2.5.3 below) may be used. Whether the second class-of-traffic or user class characters follow or not, will be indicated by the bits b_3 and b_4 of the first class-of-traffic character.

TABLE 2/X.71 – **First class-of-traffic character**[a]

First four bits of character				Condition signalled from X to Y
b_4	b_3	b_2	b_1	
0	0			No further network selection signal follows
0	1			Second class-of-traffic character follows (see Table 4/X.71)
1	0			User class character follows (see Table 3/X.71)
		0		Alternative routing not allowed
		1		Alternative routing allowed
			0	Transit traffic
			1	Terminal traffic
1	1	0	0	Not allocated
1	1	0	1	
1	1	1	0	
1	1	1	1	

[a] All characters are in column 3 ($b_5 = 1, b_6 = 1, b_7 = 0$) of International Alphabet No. 5. The eighth bit (b_8) is chosen to give odd parity over the character.

2.5.2 *User class character (indication of speed and code) (see Tables 3 and 3a/X.71)*

This character, if used, will follow the first class-of-traffic character and will be required when, for example, this information cannot be derived from the incoming line.

As eight user classes in Table 3/X.71 are not sufficient, a second user class character may be added by means of an escape character. Whether a second user class character follows or not will be indicated by the bits b_1, b_2 and b_3 of the first user class character. Whether a second class-of-traffic character follows or not will be indicated by bit b_4 of the first user class character.

TABLE 3/X.71 – **First user class character** [a]

First four bits of character				Condition signalled from X to Y [b]
b_4	b_3	b_2	b_1	
0				No second class-of-traffic character follows
1				A second class-of-traffic character follows (see Table 4/X.71)
	0	0	0	Synchronous classes derived from line
	0	0	1	300 bit/s (user class 1)
	0	1	0	50 bit/s (user class 2)
	0	1	1	100 bit/s (user class 2)
	1	0	0	110 bit/s (user class 2)
	1	0	1	134.5 bit/s (user class 2)
	1	1	0	200 bit/s (user class 2)
	1	1	1	A second user class character follows (see Table 3a/X.71)

[a] All characters are in column 3 ($b_5 = 1$, $b_6 = 1$, $b_7 = 0$) of International Alphabet No. 5. The eighth bit (b_8) is chosen to give odd parity over the character.

[b] The user class character(s) may be omitted if, for example, the information can be derived from the incoming line.

TABLE 3a/X.71 – **Second user class character**[a]

First four bits of character				Condition signalled from X to Y[b]
b_4	b_3	b_2	b_1	
0	0	0	0	600 bit/s (user class 3)
0	0	0	1	2 400 bit/s (user class 4)
0	0	1	0	4 800 bit/s (user class 5)
0	0	1	1	9 600 bit/s (user class 6)
0	1	0	0	48 000 bit/s (user class 7)
0	1	0	1	Service (50 bit/s)
0	1	1	0	Telex (50 bit/s)
0	1	1	1	Gentex (50 bit/s)
1	0	0	0	TWX
1	0	0	1	Unallocated
1	0	1	0	Unallocated
1	0	1	1	Unallocated
1	1	0	0	Unallocated
1	1	0	1	Unallocated
1	1	1	0	Unallocated
1	1	1	1	Unallocated

[a] All characters are in column 3 ($b_5 = 1$, $b_6 = 1$, $b_7 = 0$) of International Alphabet No. 5. The eighth bit (b_8) is chosen to give odd parity over the character.

[b] The user class character(s) may be omitted if, for example, the information can be derived from the incoming line.

2.5.3 *Second and further class-of-traffic characters (see Tables 4/X.71 and 4a/X.71)*

These characters follow either the first class-of-traffic character or any user class characters required. The number of these class-of-traffic characters depends on the number of user facilities available.

The bit b_4 of the second or subsequent class-of-traffic characters indicate whether another class-of-traffic character follows or not.

TABLE 4/X.71 – **Second class-of-traffic character** [a]

First four bits of character				Condition signalled from X to Y
b_4	b_3	b_2	b_1	
0				No third class-of-traffic character follows
1				Third class-of-traffic character follows (see Table 4a/X.71)
	0			No closed user group character follows.
	1			Closed user group character follows (see Table 5/X.71)
		0		Called line identification not required
		1		Called line identification required
			0	Reserved for future needs
			1	Reserved for future needs

TABLE 4a/X.71 – **Third class-of-traffic character** [a]

First four bits of character				Condition signalled from X to Y
b_4	b_3	b_2	b_1	
0				No fourth-class-of-traffic character follows
1				Fourth class-of-traffic character follows [b]
	0			Redirection not allowed [c]
	1			Redirection allowed [c]
		0		Not multiple address call [c]
		1		Multiple address call [c]
			0	Not allocated
			1	Not allocated

[a] All characters are in column 3 ($b_5 = 1$, $b_6 = 1$, $b_7 = 0$) of International Alphabet No. 5. The eighth bit (b_8) is chosen to give odd parity over the character.

[b] Reserved for future needs.

[c] The international use of this signal requires further study.

2.5.4 *Closed user group characters* (*see Table 5/X.71*)

These characters are only used in conjunction with the second and possibly subsequent class-of-traffic characters which may follow.

The closed user group number comprises a variable number of decimal digits followed by an end-of-closed user group character signal.

Note. – Further study is required concerning administrative and technical aspects of the method to provide the closed user group facility, taking into account the alternative methods.

TABLE 5/X.71 – **Closed user group character**[a]

First four bits of character				Condition signalled from X to Y
b_4	b_3	b_2	b_1	
0	0	0	0	0 Closed user group digits
0	0	0	1	1 Closed user group digits
0	0	1	0	2 Closed user group digits
0	0	1	1	3 Closed user group digits
0	1	0	0	4 Closed user group digits
0	1	0	1	5 Closed user group digits
0	1	1	0	6 Closed user group digits
0	1	1	1	7 Closed user group digits
1	0	0	0	8 Closed user group digits
1	0	0	1	9 Closed user group digits
1	0	1	0	End-of-closed user group character for call without outgoing access
1	0	1	1	End-of-closed user group character for call with outgoing access
1	1	0	0	No closed user group digit is included[b]
1	1	0	1	Not allocated
1	1	1	0	Not allocated
1	1	1	1	Not allocated

[a] All characters are in column 3 ($b_5 = 1, b_6 = 1, b_7 = 0$) of International Alphabet No. 5. The eighth bit (b_8) is chosen to give odd parity over the character.

[b] Character sent to indicate that the closed user group validation check has already been performed in the originating centre (e.g. can be used if the call is a direct call).

2.5.5 The numerical characters used for the second part of the *Selection signals* are shown in Table 6/X.71. When the first class-of-traffic character indicates a terminal call, the destination code will be omitted.

2.6 The incoming equipment should maintain continuous 0s on the backward signalling path if the received character is spurious as indicated by a character other than continuous 1s (*Calling signal*). This procedure provides a safeguard against false calls.

TABLE 6/X.71 – **Miscellaneous forward path signals** [a]

First four bits of character				Condition signalled from X to Y
b_4	b_3	b_2	b_1	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9
				Digits 0–9 for: – destination code, – called subscriber's number, – calling line identification signal.
1	0	1	0	Not allocated
1	0	1	1	End-of-calling-line-identification signal [b]
1	1	0	0	Not allocated
1	1	0	1	Not allocated
1	1	1	0	Not allocated
1	1	1	1	Not allocated

[a] All characters comprising these signals are in column 3 ($b_5 = 1$, $b_6 = 1$, $b_7 = 0$) of International Alphabet No. 5. The eighth bit (b_8) is chosen to give odd parity over the character.

[b] This signal is also used alone when the calling line identification is not available.

TABLE 6a/X.71 – **Other forward path signals (with odd parity)**

IA5 character	Condition signalled from X to Y
1/6	SYN
2/11	End of selection

In the case of receipt of a spurious signal as indicated by a parity error or by a character other than a valid *Selection signal* (with the possible exception of SYN. characters), the incoming equipment should return the appropriate *Call progress signal* to the preceding exchange (after the *Call-confirmation* or *Proceed-to-select signal*, preceded or followed by the *Network identification signal*) followed by a *Clearing signal.*

The incoming equipment may release the connection if all of the *Selection signals* are not correctly received within a period of 2 seconds from the recognition of the *Calling signal* for the CC Protocol or from the start of transmission of the *Proceed-to-select signal* for the PTS Protocol. In this event, the appropriate *Call progress signal* is returned to the preceding centre (after the *Call-confirmation* or *Proceed-to-select signal*, preceded or followed by the *Network identification signal*) followed by the *Clearing signal.*

2.7 The maximum number of digits which comprise the *Address signal* is for further study.

2.8 In the case of receipt of the *Reception congestion signal* at a transit centre, the *Call progress signal No. 32* should be returned to the preceding centre (after the *Call-confirmation* or *Proceed-to-select signal, Network identificaton signal*) followed by the *Clearing signal.*

2.9 The *Network identification signal* shall be sent following the *Call confirmation* or *Proceed-to-select signal* in all cases of transit calls but not for terminal calls. However, when a *Call progress signal* is returned from the destination network for reasons other than failure or congestion of the called subscriber line, or the called number is unassigned, it should be followed by the *Network identification signal.*

If several transit networks are involved in setting-up a call, the calling network will receive the network identificatons one after the other. If a centre fails to receive the first character of a *Network identification signal*, if applicable, within 2 seconds of the *End-of-selection signal*, it will return to the preceding centre, the *Call progress signal No. 30* (after the *Call confirmation* or *Proceed-to-select signal, Network identification signal*) followed by the *Clearing signal.*

The *Network identification signals* could be useful for retracing the route followed by a call (for traffic statistics, international accounts, analyses of unsuccessful calls and the clearing of faults).

It is possible for a transit centre to receive backward path signals such as *Network identification signals, Call progress signals* without *Clear, Call-connected signal* or *Call progress signals* from subsequent exchanges, whilst the backward path signals originated locally are still being being sent. It is necessary for the transit centre to ensure that the received signals are passed to the preceding centre without mutilation or loss.

2.10 The backward path signals indicating effective and ineffective call conditions are scheduled in Tables 7 and 7b/X.71.

2.11 If the *Call progress, Call-connected* or *Alternatively terminating-through-connection signals* are not received within 15 seconds from the end of selection, then the *Call progress signal No. 33* will be returned to the preceding centre (after the *Call-confirmation* or *Proceed-to-select signal, Network identification signal*), followed by the *Clearing signal.* The further action to be taken in the case of reception of *Call progress signals* without clear is for further study.

2.12 In this type of signalling originating and terminating national centres contain the identification of the calling and called subscribers respectively. These identifications may be exchanged within the network as an optional subscribers' feature.

If the called or calling line identification has been requested but is not available, the appropriate centre in the connection should send only the *End of line identification signal* (3/11).

2.13 The *Terminating-through-connection signal* confirms for the originating centre (by change of status bit from 0 to 1) that all transit through-connections have been made (see Appendix 3) and that, if applicable, the identification of the calling subscriber has been completely received by the terminating centre and passed to the called subscriber.

TABLE 7/X.71 – **Miscellaneous backward path signals**[a]

First four bits of character				Condition signalled from Y to X	
b_4	b_3	b_2	b_1		
0	0	0	0	0	Digits for: – network identification signal, – called line identification signal, – call progress signal.
0	0	0	1	1	
0	0	1	0	2	
0	0	1	1	3	
0	1	0	0	4	
0	1	0	1	5	
0	1	1	0	6	
0	1	1	1	7	
1	0	0	0	8	
1	0	0	1	9	
1	0	1	0	Start of call progress signal (see Table 7b/X.71)	
1	0	1	1	End-of-called-line identification signal[b] Start-of-network-identification signal	
1	1			Call connected signal	
		0		Calling line identification not required	
		1		Calling line identification required	
			0	Call metering	
			1[c]	No call metering	

[a] All characters are in column 3 ($b_5 = 1$, $b_6 = 1$, $b_7 = 0$) of International Alphabet No. 5. The eighth bit (b_8) is chosen to give odd parity over the character.

[b] This signal is also used alone when the called line identification is not available.

[c] b_1 may be used in the future as an escape facility. The international use of this facility requires further study.

TABLE 7a/X.71 – **Other backward path signals (with odd parity)**

IA5 character	Condition signalled from Y to X
1/6	SYN
2/10	Call confirmation or proceed-to-select

TABLE 7b/X.71 – **Call progress signals**[a, b]

Equivalent numerical code[c]	Category	Meaning for data service	Code for telex service
00	Without clearing	Terminal called	–
01		Redirected call	RDI
02		Connect when free	MOM
03		No identification[d]	NI
10	With clearing, due to subscriber – short-term[e]	Number busy	OCC
11		Selection error[d] (procedure)	FMT
12		Selection error[d] (transmission)	NC
20	With clearing, due to subscriber – long-term[e]	Not obtainable	NP
21		Access barred	NA
22		Controlled not ready	ABS
23		Out of order	DER
24		Number changed	NCH
25		Call information service	INF
30	With clearing, due to network	Network congestion	NC
31		Trunk congestion	
32		Equipment congestion	
33		Network error	
34		Trunk error	
35		Equipment error	
36		Out of order	

[a] All characters comprising these signals are in column 3 ($b_5 = 1$, $b_6 = 1$, $b_7 = 0$) of International Alphabet No. 5. The eighth bit (b_8) is chosen to give odd parity over the character.

[b] The use of two digits (CSC characters) to indicate call progress signal codes is provisional and requires further study.

[c] Codes not allocated in the 00-79 range are reserved for international use. The remaining codes are available for national use.

[d] These signals are normally only utilized between the first centre and the subscriber and are not signalled on inter-network links.

[e] "Short term" in this context approximates to the holding time of a call, whilst "long term" implies a condition that can persist for some hours or even days.

The *Originating-through-connection signal* confirms for both DTEs (by change of status bit from 0 to 1) that the *Call-connected signal* has been received by the originating centre, that the destination through-connection and all transit through-connections have been made and, if applicable, that the identification of the called subscriber has been completely received by the originating centre and passed to the calling subscriber. Data transfer may now commence (see Appendix 3).

In the terminating centre the connection can be switched through (forward and backward path nominally at the same time) after the calling line identification, if any, has been passed to the called DTE and the *Call-connected signal* possibly in combination with the called line identification, if any, has been passed to the originating centre (see Appendix 3).

In the originating centre the connection can be switched through (forward and backward path nominally at the same time) after the called line identification, if any, has been passed to the calling DTE and the *Termination through-connection signal* (change of status bit from 0 to 1) has been received (see Appendix 3).

In each transit centre the connection should be switched through (forward and backward nominally at the same time) after the transit centre has received the *Call-connected signal* and within 10 ms of retransmitting it.

If the time available for switching by this method is insufficient the through-connection can take place when the *Terminating through-connection* has been received. The instant of switching in transit exchanges remains for further study.

Note. – Although it is not essential for a decentralized synchronous signalling system, it has been decided to adopt the principle, in line with common channel signalling and decentralized anisochronous signalling, of the originating centre being the last to complete the connection. Therefore, a distinction has been made between terminating- and originating-through-connections.

2.14 If the destination centre fails to receive the first character of the calling line identification signal within 4 seconds after having sent the appropriate *Call-connected signal*, it will return to the preceding centre the *Call progress signal No. 33*, followed by the *Network identification signal* and *Clearing signal.*

2.15 The guard delays on clearing are measured from the moment when continuous 0s (S = 0) has been established on both signalling paths by:

- either recognizing or transmitting the *Clearing signal* on one signalling path, and
- either transmitting or recognizing the *Clear-confirmation signal* on the other signalling path.

For incoming calls this guard period shall be 60-70 ms.

A new incoming call shall not be accepted until this guard period has elapsed. This is on the assumption that the terminating centre will be able to send the *Call confirmation signal* after a negligible period from receipt of the *Calling signal.*

The guard period on clearing for outgoing calls should be a period of at least 130 ms. A new outgoing call shall not be originated until this guard period has elapsed.

If exchanges are able to distinguish between the different clearing conditions, shorter periods may be introduced accordingly.

2.16 The automatic *Re-test signal* will be initiated, as indicated in 2.4 below.

This signal transmitted over the forward signalling path is composed of a maximum of five successive cycles, each cycle incorporating:

S = 0, continuous repetitions of 1s for a period of 4 seconds,

followed by:

S = 0, continuous repetitions of 0s for a period of 56 seconds.

The circuit should be marked "unavailable" for outgoing traffic and tested up to 5 times at nominal intervals of one minute, and a check made to confirm the receipt of the *Call-confirmation* or *Proceed-to-select signal* on the backward path in response to each test. If the *Call-confirmation* or *Proceed-to-select signal* has not been received at the end of this first group of tests, the re-test will continue with a further group of up to 5 tests at either 5 or 30 minute nominal intervals. If 5 minute intervals are used and the *Call-confirmation* or *Proceed-to-select signal* has not been received at the end of this second group of tests, further re-tests will be made at 30 minute intervals. An alarm will be given at an appropriate time. However, this re-test procedure may be discontinued at any stage at the discretion of the outgoing Administration.

If, however, during the above sequence of re-tests, the *Call-confirmation* or *Proceed-to-select signal* is received, a *Clearing signal* will be transmitted in place of the *Re-test signal.* Following a valid *Clear-confirmation signal,* the incoming and the outgoing sides of the trunk circuit should not be returned to service until after expiry of the appropriate guard delay time.

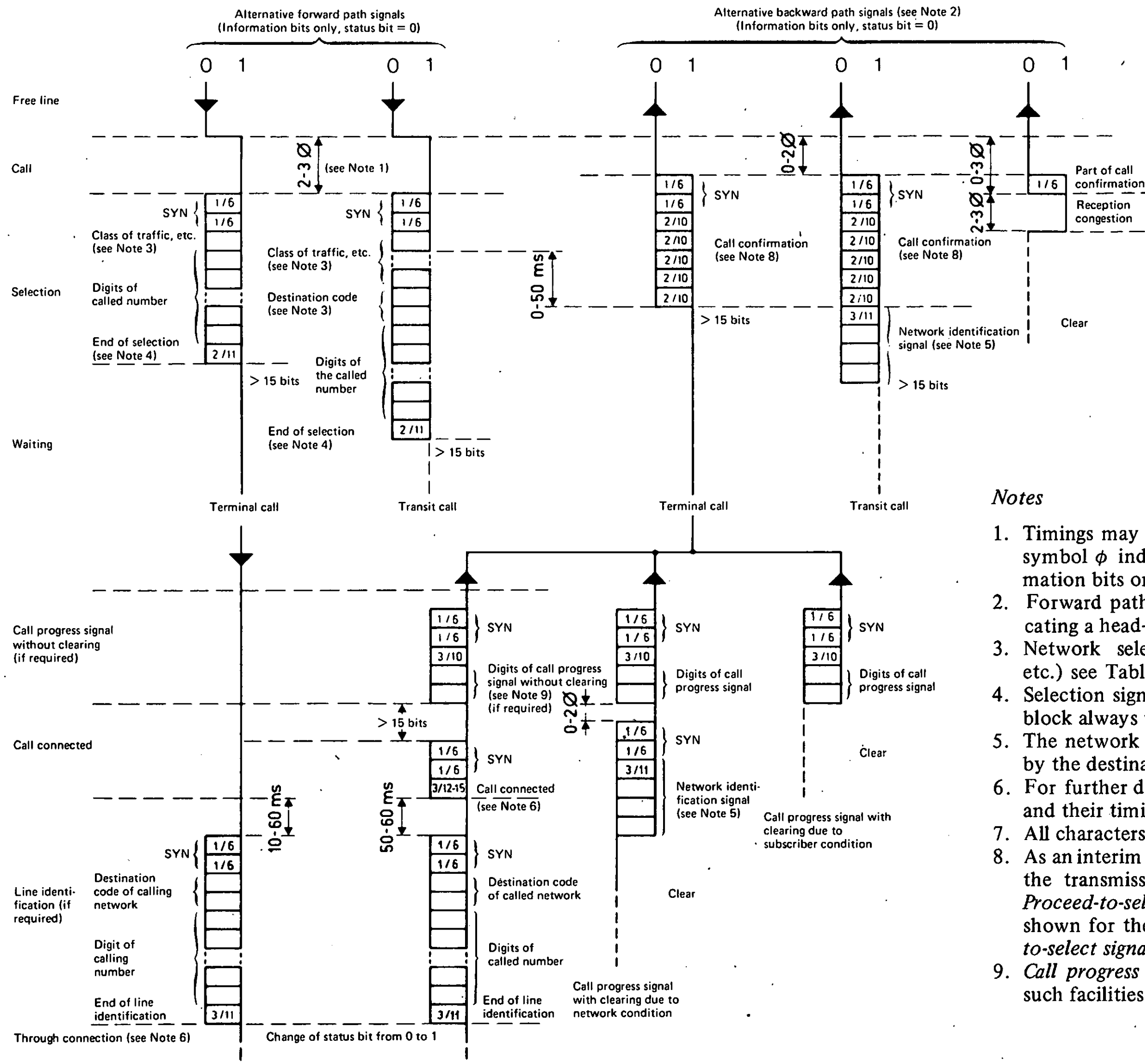
In order to cater for the possibility that a faulty circuit may be seized at both ends, the automatic re-test equipment should be arranged to allow an incoming call to be received during continuous repetitions of 0s (S = 0). Administrations may, however, ignore such calls which occur during the incoming guard delay period.

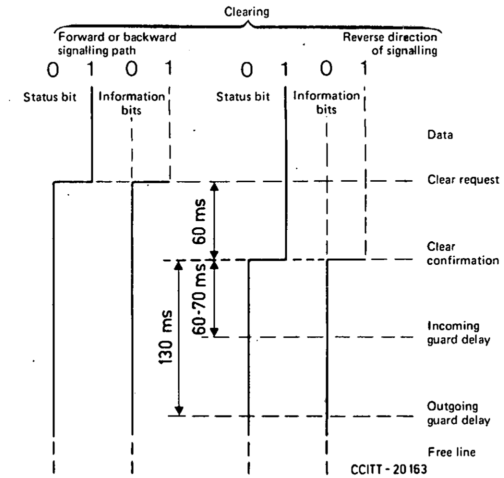
The interval between the tests at the two ends of the trunk circuit should be made different by increasing the nominal interval by 20% at one end, to be sure that successive re-tests do not overlap at both ends.

Where an exchange has knowledge of a transmission system failure, it is desirable that the *Re-test signals* shall not be applied to the circuits affected.

In order to avoid simultaneous seizure of too many registers at the distant centre, it is advisable that the *Re-test signals,* which may be sent simultaneously on various circuits subjected to this test, should be out of phase with one another.

2.17 If at the receiving end parity does not check, provisionally the connection should be cleared down unless otherwise specified. However, the possibility of different actions remains open for further study.

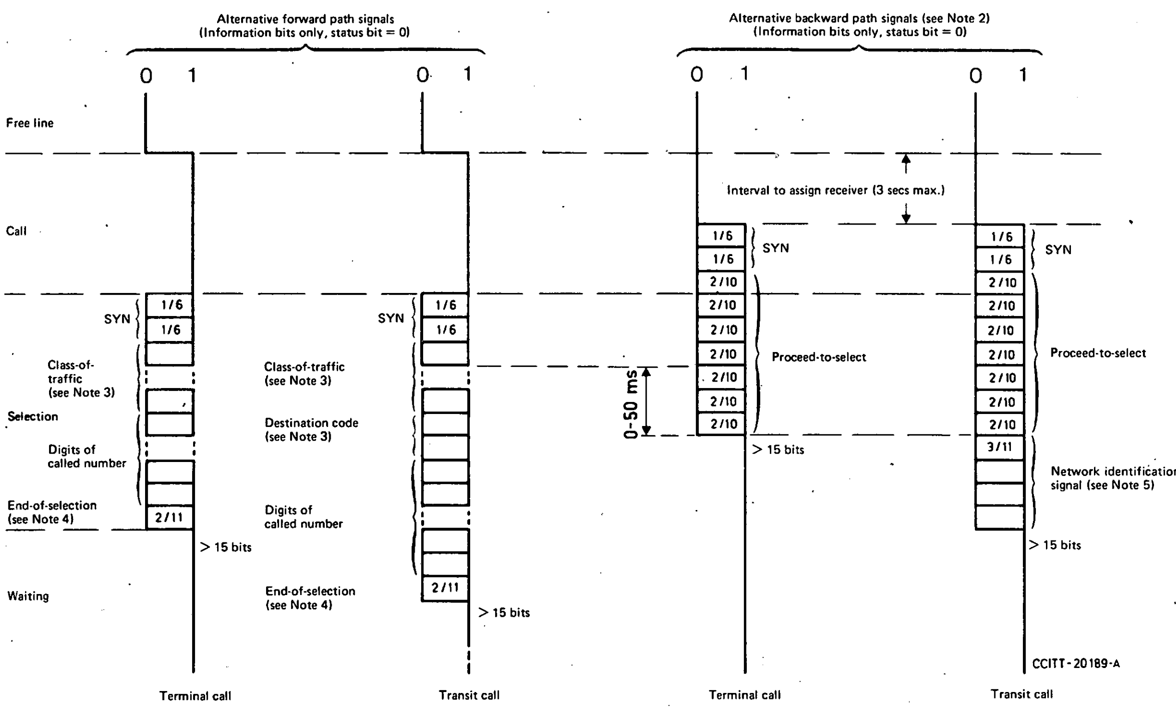




Notes

1. Timings may be shown in ms or in periods of information bits. The symbol ϕ indicates that the interval may be in multiples of 8 information bits or 5 ms whichever is greatest in time.
2. Forward path signals may also appear on the backward path, indicating a head-on collision on both-way circuits.
3. Network selection signals (class-of-traffic, user class characters, etc.) see Tables 2-5/X.71. Destination codes may comprise ... digits.
4. Selection signals will be sent by the originating network in a single block always with an end-of-selection signal.
5. The network identification signal comprises character 3/11 followed by the destination code of the network concerned.
6. For further details on call-connected and through-connection signals and their timings see 2.12 of the text and Appendix 3.
7. All characters shown are from the International Alphabet No. 5.
8. As an interim arrangement at the discretion of the incoming network, the transmission of the selection signals may be delayed until a *Proceed-to-select signal* has been received. In this case the characters shown for the *Call confirmation signal* will be used for the *Proceed-to-select signal*.
9. *Call progress signals* without clearing may be included to indicate such facilities as call redirection.

FIGURE 1/X.71 – **Decentralized signalling between data networks of the synchronous type**



Note. – Where reference is made, these are the notes of Figure 1/X.71.

FIGURE 1a/X.71 – **Initial phases of calls when the Proceed-to-select Protocol is employed**

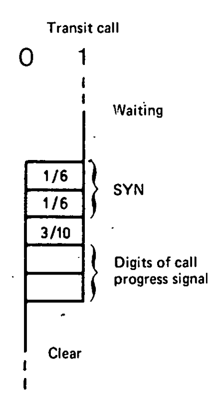
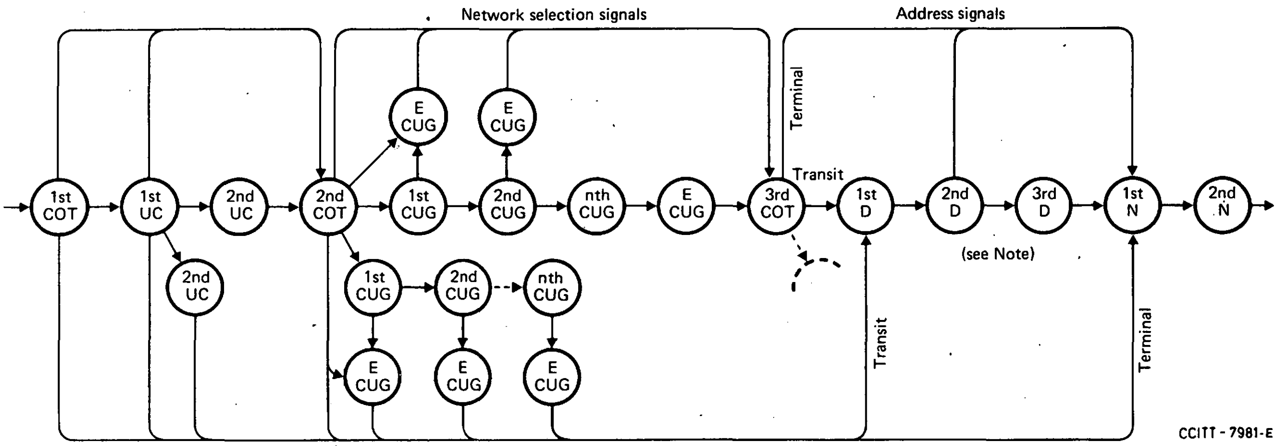


FIGURE 2/X.71 – **Call progress signal for a transit call**

APPENDIX 1
(to Recommendation X.71)

Possible sequences of network selection signals



COT = class-of-traffic character
UC = user class character
CUG = closed user group character
D = destination code digit
N = called number digit
E CUG = end of closed user group character
Dotted lines: reserved for further extension

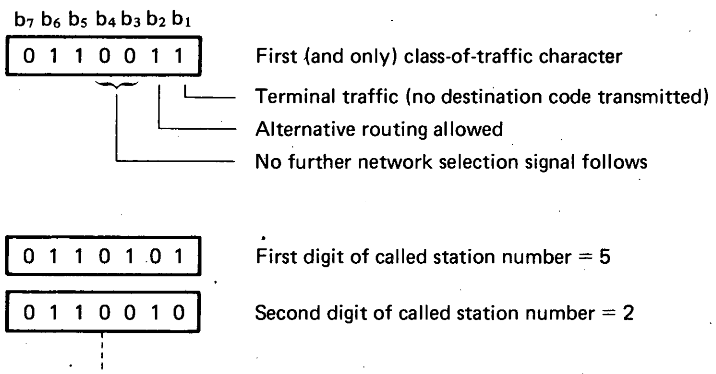
Note. – The number of destination code digits is dependent on the choice of the numbering scheme.

APPENDIX 2
(to Recommendation X.71)

Examples of network selection signals

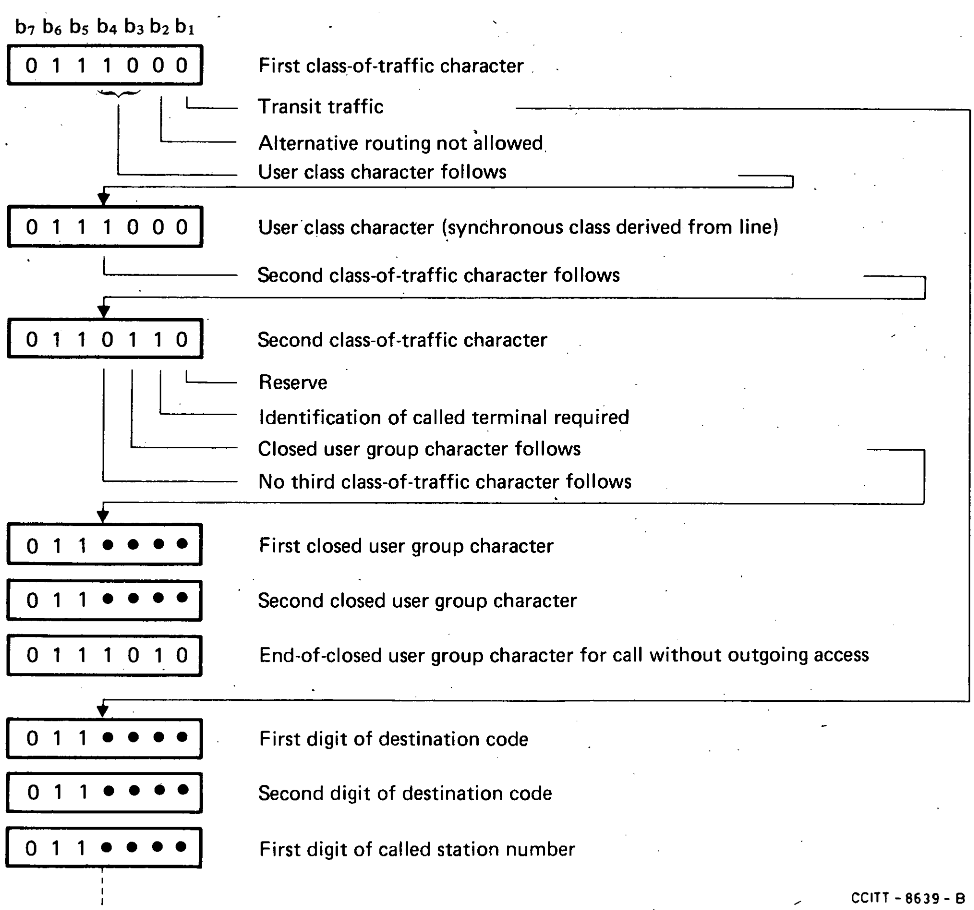
1. *First example* (minimum sequence of network selection signals)

This example shows a sequence of minimal length. (The remaining bits in each complete envelope and the preceding calling signal are not shown. The bits are shown in the order of b_7, b_6, b_5, b_4, b_3, b_2 and b_1.)



CCITT-8638-A

2. *Second example* (a sequence of network selection signals including closed user group characters)



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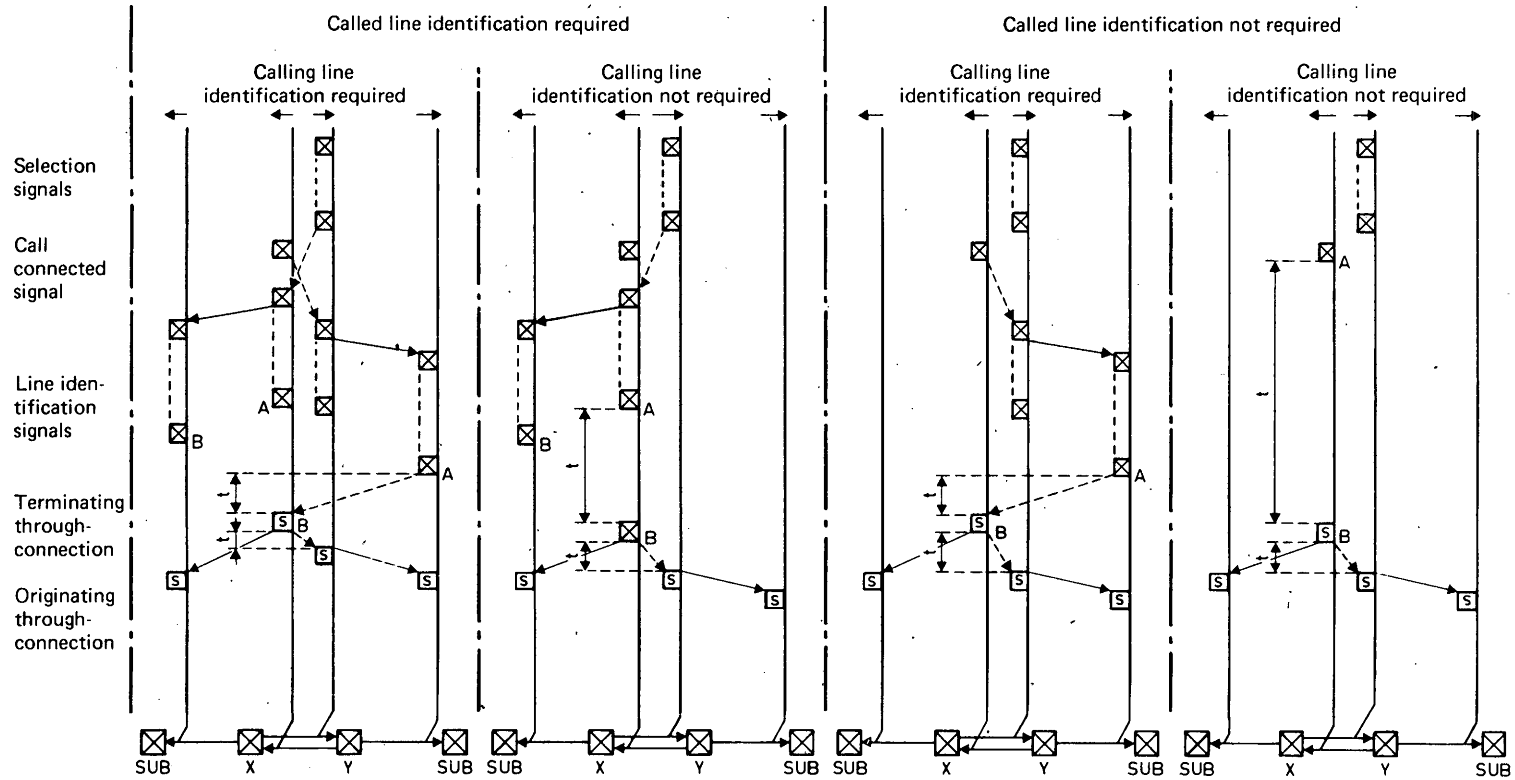
APPENDIX 3
(to Recommendation X.71)

Through-connection procedures



Normal transmission

Correlation line concerning line identification

t 0-16 information bits or 0-10 ms whichever is greater in time

IA5 character

S Status bit changes from 0 to 1

X,Y Data centres

SUB Subscribers

Notes

1. It is assumed that the status bit condition between DTE and DSE is at 1 at the time of through connection.
2. The status bit inversion from DSEY to DSEX occurs within 16 information bits or 10 ms whichever is the greater in time of all applicable points A occurring.
3. The status bit inversion from DSEX to DSEY occurs within 16 information bits or 10 ms whichever is the greater in time of all applicable points B occurring.
4. The time to connect through in Note 2 or 3 may be relaxed to 200 ms maximum for an interim period to meet the needs of some networks.

Appendix 4

(to Recommendation X.71)

An example of three successive signalling characters within five octets of one channel of the Recommendation X.50 multiplex structure

				a_1	a_2	a_3	0
F	a_4	a_5	a_6	a_7	a_8	b_1	0
F	b_2	b_3	b_4	b_5	b_6	b_7	0
F	b_8	c_1	c_2	c_3	c_4	c_5	0
F	c_6	c_7	c_8				

Status bits are 0s.

$a_1 \ldots a_8$ is a signalling character
$b_1 \ldots b_8$ is a signalling character
$c_1 \ldots c_8$ is a signalling character

The framing bits F will be assigned on the multiplexed stream according to Recommendation X.50. No alignment of signalling characters with the envelopes of the multiplex structure is assumed or required.

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SECTION 4

NETWORK PARAMETERS AND HYPOTHETICAL REFERENCE CONNECTIONS

Recommendation X.92

HYPOTHETICAL REFERENCE CONNECTIONS FOR PUBLIC SYNCHRONOUS DATA NETWORKS

(Geneva, 1976)

The CCITT

bearing in mind

a) the international user classes of service indicated in Recommendation X.1;

b) the overall user-to-user performance objectives;

c) the need to standardize the procedures for use over public synchronous data networks;

d) in the case of packet switching, the need to standardize several procedural levels;

unanimously recommends

the use of the five hypothetical reference connections contained in this Recommendation.

1. The five hypothetical reference connections set down in the present Recommendation (see Figure 1/X.92) are intended for assessing the overall customer-to-customer performance objectives, for determining some data characteristics requirements of the various items in the connections and for setting limits to the impairments these items may introduce.

These hypothetical reference connections should be used for circuit switched services, packet switched services and leased line services in public synchronous data networks.

Other hypothetical reference connections may be set up in the future after experience of the design of synchronous public data networks has been gained.

2. The hypothetical reference connections of Figure 1/X.92 are intended for the user data signalling rates as recommended in Recommendation X.1.

Between points X and Y, transmission takes place over 64 kbit/s digital paths. Such paths may include digital sections using modems over analogue facilities.

It should be assumed that the signalling for the circuit switched data-call control follows the same route as the data connection.

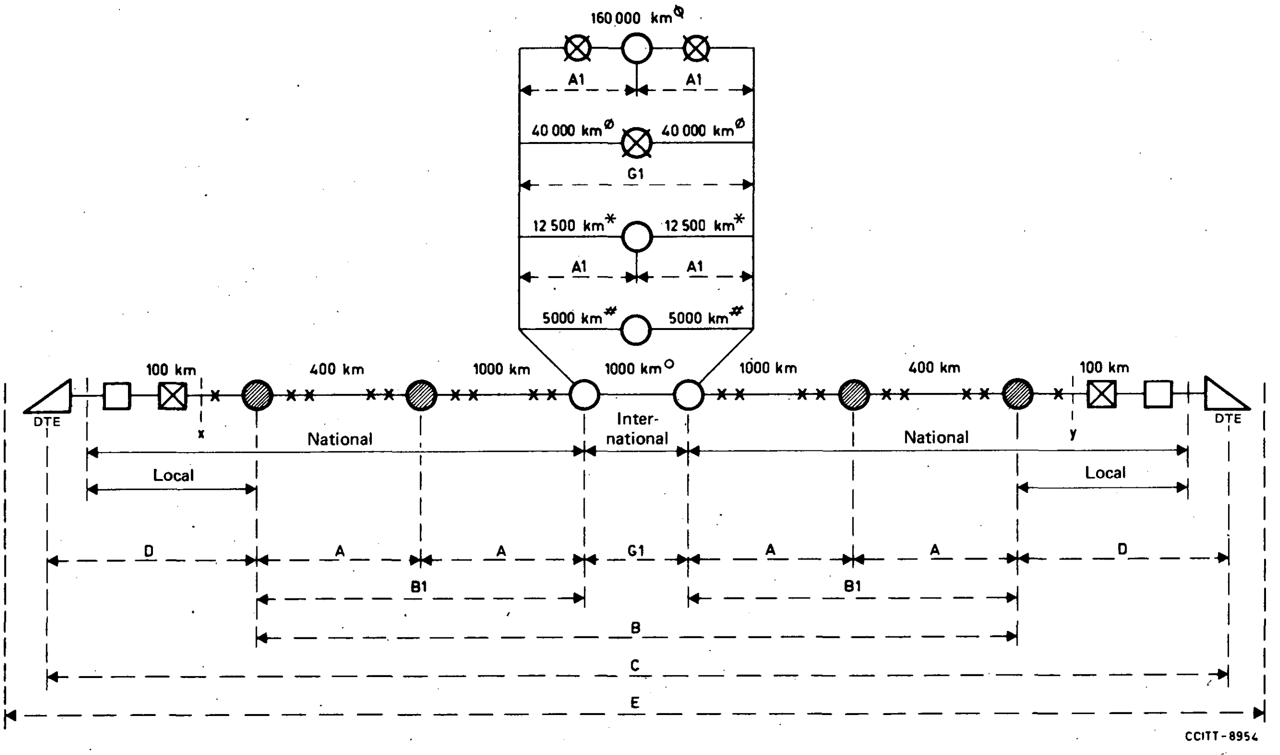
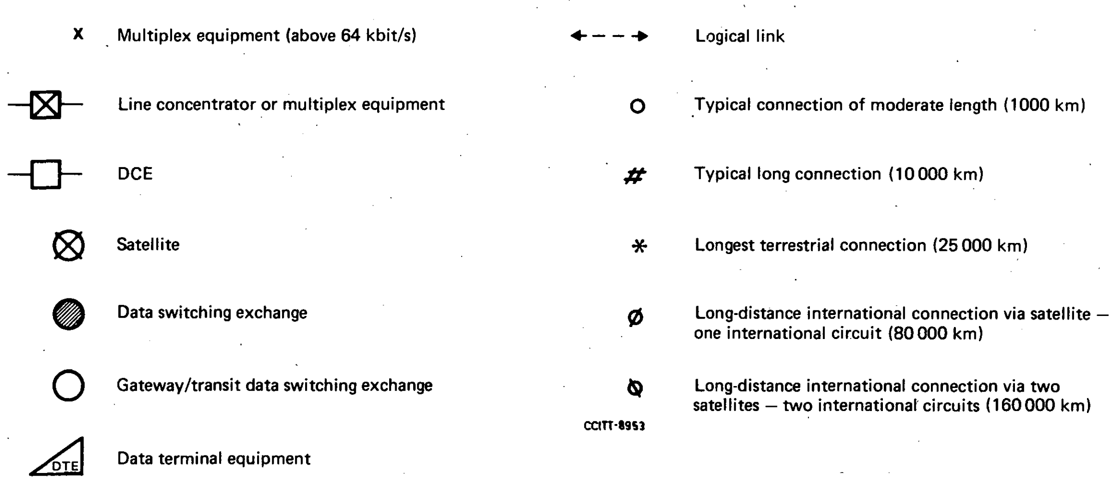


FIGURE 1/X.92 – **Hypothetical reference connections for public synchronous data networks**

3. The legend to the symbols used in Figure 1/X.92 is as follows:



4. a) The logical links to be considered in the case of packet switching are indicated on Figure 1/X.92 by the dotted lines. The legend is as follows:

Link A = data link between two adjacent data switching exchanges in a national network

Link A1 = data link between two adjacent gateway data switching exchanges in an international connection

Link B = data link between a source DSE and a destination DSE

Link B1 = data link between a local DSE and a gateway DSE

Link G1 = data link between a source gateway DSE and a destination gateway DSE in an international connecton

Link C = data link between source DTE and destination DTE

Link D = data link between source DTE and the source local DSE or the data link between destination DTE and destination local DSE

Link E = data link between communicating processes

b) To allow for the incorporation of packet assembly/disassembly facilities, the variants to logical Link D, shown in Figure 2/X.92, are recognized.

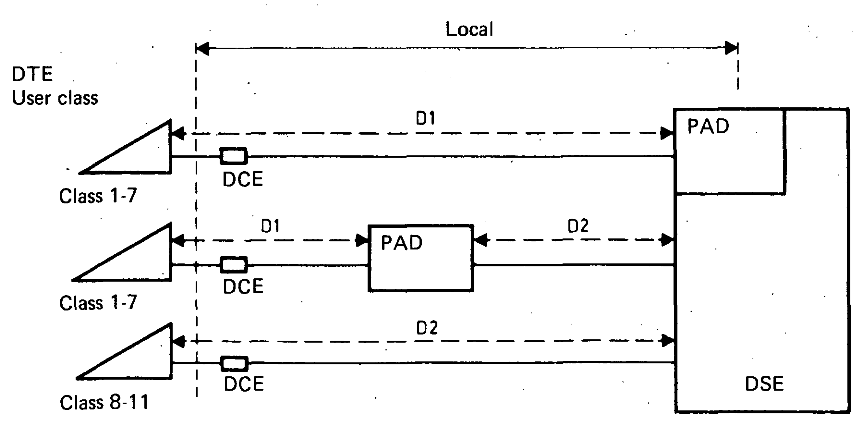
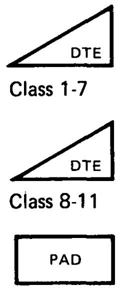


FIGURE 2/X.92 – Variants of logical link D

The legend to the symbols used is as follows:



Class 1-7 — Data terminal equipment in user classes of service 1-7

Class 8-11 — Packet mode data terminal equipment in user classes of service 8-11

PAD — Packet assembly/disassembly equipment

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Link D_1 = data link between a data terminal equipment in user class of service 1-7 and a packet assembly/disassembly equipment

Link D_2 = data link between a data terminal equipment in user class of service 8-11 or a packet assembly/disassembly equipment and a local data switching exchange.

Note 1 – A user may see two different types of logical interfaces with the network (Link D_1 and D_2).

Note 2. – Link D_2 could provide an interface for a single access terminal as well as for a multiple access terminal.

Recommendation X.95

NETWORK PARAMETERS IN PUBLIC DATA NETWORKS

(Geneva, 1976)

The CCITT

bearing in mind

a) the need to standardize the basic network parameters relevant to public data networks to facilitate international interworking;

b) the need to standardize the user interfaces to public data networks;

unanimously declares the view

that the network parameters inherent in any public data network should be as indicated in Tables 1/X.95 and 2/X.95.

TABLE 1/X.95 – **Network parameters for circuit switched and leased circuit services**

Network parameter	User classes of service			Definition reference
	1	2	3-7	
Timing from the network				
a) Bit timing	N	N	P	–
b) Byte timing (8-bit)	N	N	S	–
Bit sequence independence	N	N	P	52.52
Data signalling rate transparency	N	S	N	53.362
Symmetrical duplex channels	P	P	P	53.765
Time out	P	P	P	52.605

TABLE 2/X.25 – **Network parameters for packet-switched services**

Network parameter	User classes of service			Definition reference
	1-2	3-7	8-11	
Timing from the network				
a) Bit timing	N	P	P	–
b) Byte timing (8-bit)	N	S	S	–
Packet format	N	N	P	53.55
Transmit flow control	see Note 1	see Note 1	P	53.635
Interworking between data terminals in different user classes of service	P	P	P	52.471
Error-correcting system	see Note 2	see Note 2	P	52.34

P = inherent network parameter
S = network parameter inherent in some public data networks
N = parameter not applicable

Note 1. – Awaiting further study.

Note 2. – Not applicable over the data circuit between the data terminal equipment and the packet assembly/disassembly equipment.

Recommendation X.96

CALL PROGRESS SIGNALS IN PUBLIC DATA NETWORKS

(Geneva, 1976)

The CCITT,

bearing in mind

that the establishment of public data networks for data transmission in various countries and the subsequent international interconnection of these networks creates the possibility that, in certain circumstances, a switched connection requested by a user will not be established to the called number,

unanimously declares the view

that *Call progress signals* should be returned to the caller to indicate the circumstances which have prevented the connection being established to a called number;

that *Call progress signals* should be returned to the caller to indicate in some circumstances the progress made towards establishing the connection requested.

The circumstances giving rise to *Call progress signals* in public data networks are under study within the CCITT and Tables 1/X.96 and 2/X.96 summarize the outcome of the study to date.

TABLE 1/X.96 – **Circuit switched data transmission services**
(see notes 1-3)

Call progress signal	Brief description of circumstances
Selection signal procedure error	The selection signals received did not conform to the specified procedure.
Selection signal transmission error	A transmission error was detected in the selection signals by the first DSE.
Invalid call	Facility request invalid.
Access barred	The calling DTE is not permitted to obtain a connection to the called DTE. Incompatible closed user group or incoming calls barred are examples.
Not obtainable	The called number is not assigned, or is no longer assigned or there is an incompatible user class of service.
Number busy	The called number is engaged in another call.
Out of order	The called number is out of order (DTE "uncontrolled" not ready). Possible reasons include: 1) DTE not functioning; 2) mains power off to DTE/DCE; 3) line fault between DSE and DCE.
Changed number	The called number has recently been assigned a new number.
Call the information service	The called number is temporarily unobtainable, call the information service for details.
Network congestion	The establishment of the connection has been prevented due to: 1) temporary congestion conditions; 2) temporary fault conditions, e.g. expiry of a time-out.
Terminal called (see Note 2)	The incoming call was signalled to the DTE and call acceptance is awaited.
Controlled not ready (see Note 3)	The called DTE is in the *Controlled not ready* state.

TABLE 2/X.96 – **Packet switched data transmission service – Virtual calls only**
(see notes 1 and 4-8)

Call progress signal	Brief description of circumstances
Access barred	The calling DTE is not permitted to obtain the connection to the called DTE. Incompatible closed user group would be an example.
Not obtainable	The called DTE is not assigned, or is no longer assigned.
Number busy	The called DTE is engaged in other calls on all its logical channels and cannot accept another call.
Invalid call	Facility request invalid.
Local procedure error	The call is cleared because of a local procedure error.
Remote procedure error	The call is cleared because of a remote procedure error.
Out of order	The call number is out of order. Possible reasons include: 1) DTE not functioning; 2) Mains power off to DTE/DCE; 3) Line fault between DSE and DCE; 4) Access link not functioning; 5) Link access procedure level not in operation.
Network congestion	Congestion conditions within the network temporarily prevent the requested virtual call from being established.

Notes

1. Call progress signal format shall be in accordance with Recommendation X.20 or X.20 *bis* for user classes of service 1 and 2 and Recommendation X.21 for user classes of service 3 to 7.
2. This is a "positive" *Call progress signal* and is not accompanied by a *Clearing signal*. The international implications of "manual answering" are for further study.
3. The international implications concerning the use of *Controlled not ready* are for further study.
4. Call progress signal format and codes shall be in accordance with Recommendation X.25 for user classes of service 8-11.
5. Whilst *Call progress signals* may only be transmitted by the network to the DTE during the call set-up phase, in the packet switched service certain other service or advisory signals may be transmitted by the network to the DTE during the data transfer phase and the call clearing phase of a virtual call. The possible signals are for further study.
6. The call progress signals *Terminal called* and *Controlled not ready* are for further study in relation to packet switched data transmission services.
7. The fact that a DTE is also out of order when the link access procedure level is not operating correctly is a subject for further study.
8. The *Call progress signals* (if any) for the Datagram facility is a subject for further study.

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PART III

QUESTIONS ON PUBLIC DATA NETWORKS ENTRUSTED TO STUDY GROUP VII FOR THE PERIOD 1977-1980

(For the annexes to these Questions, reference should be made to Contribution No. 1 of the period 1977-1980 of Study Group VII)

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QUESTIONS ON PUBLIC DATA NETWORKS ENTRUSTED TO STUDY GROUP VII FOR THE PERIOD 1977-1980

Chairman: Mr. V.C. MacDonald (Canada)

Vice-Chairmen: Mr. J. Chapman (United Kingdom)
Mr. N.R. Crane (Australia)
Mr. M. Kato (Japan)
Mr. A. Texier (France)

List of Questions

Question No.	Title	Remarks
1/VII	Standardization of user classes of service for public data networks	
2/VII	Standardization of user facilities	
3/VII	Call set-up and clear-down time	Concerns also Study Groups IX and XVIII
4/VII	What numbering plan should be adopted for public data networks?	Concerns also Study Group XVIII
5/VII	Grade of service	Concerns also Study Group XVIII
6/VII	Use of data networks in the international telex service	To be studied in conjunction with Study Group X (Question 6/X)
7/VII	Standardization of signalling for international connections between anisochronous public data networks	Concerns also Study Group X
8/VII	Standardization of decentralized control signalling for international connections between synchronous public data networks	
9/VII	Standardization of the data user part of the common channel signalling system	Concerns also Study Groups XI and XVIII
10/VII	The provision of features in the DTE-DCE interface for fault identification and isolation	
11/VII	The connection to public data networks of DTEs which are designed for interfacing existing Series V Recommendations modems	Concerns also Study Group XVII
12/VII	Specification of common channel signalling requirement for telex and gentex	To be studied in conjunction with Study Group X (Question 13/X)
13/VII	DTE-DCE basic interface in public data networks	
14/VII	Further study of current recommendations for DTE-DCE interfaces in public data networks	
15/VII	Definition of terms arising during the study of public data networks	Concerns also Study Groups XI, XVII and XVIII

Question No.	Title	Remarks
16/VII	Quality of service in public data networks	Concerns also Study Group XVIII and CMBD
17/VII	Maintenance of public data networks	To be studied in liaison with Study Groups IV, IX, XVIII and CMBD
18/VII	Standardization of signalling for interworking for data service between different types of public data networks and between public data networks and other public networks	Concerns also Study Groups I, II, III, IX, X, XI and XVII
19/VII	Digital switching for data user signalling rates of 48 kbit/s and below)	To be studied in liaison with Study Groups X, XI and XVIII
20/VII	For DTEs connected to public data networks the methods of responding to incoming calls	
21/VII	Standardization of the inter-network interface for interworking between a DTE on a public data network and a DTE on another public network	Concerns also Study Groups IX and XVII
22/VII	Network parameters	
23/VII	Call progress signals	
24/VII	Interworking of networks offering packet switched data transmission service	
25/VII	Further study of packet mode operation on public data networks	
26/VII	Multiplex structure for international links between synchronous networks	
27/VII	Timing and synchronization	To be studied in close cooperation with Study Group XVIII (Question 3/XVIII)
28/VII	Provision of user classes of service 1 and 2 in public data networks	
29/VII	Use of 64 kbit/s time slots to carry single lower-speed network-synchronous data channels	
30/VII	Representation of information at the DTE-DCE interface for call control purposes	
31/VII	Interchange circuits	Concerns also Study Group XVII
32/VII	Bit sequence independence of 64 kbit/s digital paths	Concerns also Study Groups IX, XI, XVII and XVIII
33/VII	Mutual influence and alignment of Series X Recommendations	
34/VII	Subscribers' service in public data networks	

Question 1/VII – Standardization of user classes of service for public data networks

(continuation of the study of Question 1/VII, point A, Geneva, 1972, amended at Geneva, 1976)

The study should include:

1. consideration of the inclusion of a 75 bit/s (7.5 units/character) data signalling rate as a specific rate in class 2 for leased circuit service;
2. consideration of the possible need for data signalling rates higher than 48 000 bit/s;
3. consideration of the consequences of inclusion in user classes of service 1 and 2 of data terminals which transmit 10 units/character;
4. consideration of the inclusion of a user class of service at 600 bit/s for the packet data terminal operating mode;
5. consideration of the undesirable consequences of a possible proliferation of user classes of service.

Question 2/VII – Standardization of user facilities

(continuation of the study of Question 1/VII, point B, Geneva, 1972, amended at Geneva, 1976)

Bearing in mind the international user facilities recommended in Recommendation X.2, what factors affecting international operation need to be considered concerning their implementation, e.g. the technique for implementing the Closed User Group?

Furthermore, what additional user facilities should be recommended for the various data transmission services?

1. *Circuit switched data transmission services*

Consideration should include:

a) Redirection of calls, points to be considered are:

i) should redirection be at the user's request?

ii) should redirection be on a national or international basis bearing in mind the technical and tariff implications?

b) selective direct calling (special abbreviated calling)

Should this facility, which combines the simple and fast call set-up procedure of the direct call facility but does not exclude normal address calling, be included in Recommendation X.2 as an optional user facility per call?

c) connect when free.

Should this facility be provided as an optional user facility? (Refer to Contribution COM VII-No. 2 for the study period 1977-1980.)

2. *Packet switched data transmission services*

Consideration should include:

a) redirection of calls, consideration as in 1.*a)* above.

b) calling and called line identification – should these facilities be provided as optional user facilities for the packet switched data transmission services? Under certain circumstances are they network parameters in such a service?

c) packet delivery confirmation – should such a facility be provided for the Datagram and Virtual Call services?

d) direct call – can a direct call facility be provided in a packet switched data service or is it an alternative to a permanent virtual circuit?

e) abbreviated address calling – should this facility, if feasible, be provided for user classes of service 7-9?

f) multi-address calling – should this facility be provided for the packet switched data transmission service and if so does it need a single delivery confirmation packet?

g) priority – should users be given the option of specifying a priority to be given packets?

h) sub-addressing – should such a facility be available to a user?

i) flow control parameters selection – if this facility were to be provided as an optional facility per call, should it be a national or international option?

j) packet length selection – if this facility were to be provided as an optional facility per call should it be a national or international option?

k) reverse charging acceptance – if this facility were to be provided as an optional user facility should it be on a per call basis or on an agreed contractual basis? Is it to be a national or international facility?

l) reverse charging – if this facility were to be provided as an optional user facility should it be on a per call basis or on an agreed contractual basis? Is it to be provided as an international facility?

Aspects arising from study of Question 25/VII:

m) Maximum window size.

n) Process type.

o) Word length.

p) Terminal mode.

q) Station service class.

r) Terminal type identifier.

3. *Leased circuit data transmission service*

Consideration should be given to:

a) multipoint facility – should a multipoint facility be provided in public data networks?

b) demand leased circuit service.

4. *Interworking*

The following interworking situations:

a) Interworking between a DTE having an interface to a circuit switched service and a DTE having an interface to a packet switched service.

b) Interworking between a DTE having an interface to either a circuit switched or a packet switched service on a public data network and:

i) a DTE having an interface to a data service provided on a public telephone network.

ii) a DTE having an interface to a data service provided on a public telex network.

Note 1. – The feasibility of such interworking is being studied in Questions 18/VII (network signalling) and 21/VII (interface). The scope of Question 2/VII, 4) is to:

– determine whether the facility is required;

– determine whether such connections are "permitted without defined performance criteria" or are a recognized and defined service.

Note 2. – The technical feasibility and economics of such facilities need to be assured when determining that the facility is required.

5. The possible provision of existing leased message switching services in public data networks.

Question 3/VII – Call set-up and clear-down time

(continuation of the study of Question 1/VII, point D, Geneva, 1972, amended at Geneva, 1976)

(also concerns Study Groups IX and XVIII)

What objectives should be set for call set-up and clear-down time?

The study of this Question should be based on the hypothetical reference connections for both synchronous and anisochronous circuit switched public data networks as well as for packet switched networks. Recommendation X.92 specifies hypothetical reference connections for public synchronous data networks which should be used for circuit switched services and packet switched services. Hypothetical reference connections for anisochronous network are being studied under 4. of Question 6/IX.

Note. – In relation to the clear-down times, two objectives are applicable. First, the time to disconnect a call in order that a new call may be initiated and second, the time to release the connection in the network.

The Annex outlines the guidelines to be observed when calculating call set-up and clear-down times in the case of public synchronous data networks. There is a need to also define guidelines to be observed when calculating call set-up and clear-down times for anisochronous networks.

Question 4/VII – What numbering plan should be adopted for public data networks?

(continuation of the study of Question 1/VII, point E, Geneva, 1972, amended at Geneva, 1976)

(also concerns Study Group XVIII)

1. The possible need for interworking between data terminals on a public data network and data terminals on public telex and telephone networks.

2. The proposal that public data networks adopt the telex destination codes listed in Recommendation F.69.

3. Possible alternatives to 2. above.

Note. – Several documents were received on this Question during the 1973-1976 period and these are republished as white contributions. Canada introduced the concept of a data network identification code (DNIC), which now has general acceptance. The Annex to this Question reports the conclusions reached during 1973-1976.

Question 5/VII – Grade of service

(continuation of the study of Question 1/VII, point F, Geneva, 1972, amended at Geneva, 1976)

(also concerns Study Group XVIII)

What should be the overall grade of service in a public data network?

Note. – The study of this Question requires the definition of traffic engineering parameters suitable for circuit switching and packet switching networks. For guidance, reference might also be made to the following Recommendations:

E.540 Overall grade of service of the international part of an international connection

E.541 Overall grade of service for the international connections (subscriber-subscriber)

Question 6/VII – Use of data networks in the international telex service

(continuation of the study of Question 1/VII, point H, Geneva, 1972, amended at Geneva, 1976)

(to be studied in conjunction with Study Group X; see Question 6/X)

1. With the emergence of Recommendations for synchronous data networks, the possibility of providing the telex service over such a network is envisaged by some countries. In view of this, study should be made of the problems involved, particularly the signalling between the national data networks concerned.

2. More generally, different methods of providing the telex service may be used in the future, for example, by conventional telex or public data networks. There are many possibilities, including the following, to be taken into account when studying the interworking problems which arise:

a) new public data networks in different countries may be based on synchronous or anisochronous procedures;

b) in some countries these networks will carry the telex service as well as data transmission services;

c) in most cases there will be a transitional period during which the telex service on a new public data network will be required to coexist with telex on an existing network;

d) new "defined" telex services may be introduced at a higher signalling rate than 50 bit/s with the possibility of interworking;

e) international telex gateway centres for any country may be part of an existing telex network or a public data network or in both during a transitional period;

f) international transit facilities for telex may be required on either public data networks or existing telex networks.

Question 7/VII – Standardization of signalling for international connections between anisochronous public data networks

(continuation of the study of Question 1/VII, point I, Geneva, 1972, amended at Geneva, 1976)

(also concerns Study Group X)

Further consideration of Recommendation X.70 in the light of experience and further study.

Points to be covered include:

– the reflection into this Recommendation of the work concerning the implementation of user and network facilities and any decisions on such aspects as numbering schemes;

– the signalling for the synchronous user classes of service provided on this type of network;

– the need for as close alignment as practicable with Recommendations X.71 and U.12;

– the accommodation in the signalling system of user class 1 (300 bit/s) for 8-unit signalling code, which has been provisionally assumed;

– the constraints imposed on the signalling system by code sensitive transmission systems, e.g. those specified in Recommendation R.101;

– the allocation of call progress signal codes (Table 7a/X.70 shows a provisional allocation which has been assumed);

– the method of through connection in transit exchanges.

Note. – The inter-data switching exchange signalling requirements of common channel and decentralized signalling systems resulting from customer and management facilities are shown in the Annex to this Question.

Question 8/VII – Standardization of decentralized control signalling for international connections between synchronous public data networks

(continuation of the study of Question 1/VII, point V, Geneva, 1972, amended at Geneva, 1976)

Further consideration of Recommendation X.71 in the light of experience and further study.

Points to be covered include:

– the reflection into this Recommendation of the work concerning the implementation of user and network facilities and any decisions on such aspects as numbering schemes;

– the need for as close alignment as practicable with Recommendations X.70 and U.12 and Recommendations relating to the common channel method of signalling;

– the allocation of call progress signal codes (Table 7b/X.71 shows a provisional allocation which has been assumed);

– the method of through connection in transit exchanges.

Note. – The inter-data switching exchange signalling requirements of common channel and decentralized signalling systems resulting from customer and management facilities are shown in the Annex to Question 7/VII.

Question 9/VII – Standardization of the data user part of the common channel signalling system

(continuation of the study of Question 1/VII, point U, Geneva, 1972, amended at Geneva, 1976)

(concerns Study Groups XI and XVIII)

Considering that

a) Administrations are planning to introduce synchronous public data networks providing the circuit switched data transmission service;

b) there is a need to define common channel signalling for international data network applications;

c) many Administrations wish to standardize common channel signalling for national use, bearing in mind the studies concerning the implementation of user and network facilities and decisions on such aspects as numbering schemes;

d) it has been agreed that the signalling system shall have a functional structure clearly separating:

i) the Message Transfer Part – common to all services and applications;

ii) the User Parts – individually specified for each service or application;

(This division is defined in Annex 1 to this Question);

e) the main characteristics of the Data User Part are defined in Recommendation X.60;

f) interworking between common channel signalling and other signalling systems in public data networks are studied under 1. of Question 18/VII;

g) it is desirable that the User Parts defined for different services and applications are specified in accordance with the commonality approach;

h) certain data application requirements on the Message Transfer Part have been defined (see Annex 2 to this Question);

i) recommendations for the common Message Transfer Part will be prepared from studies by Study Group XI;

j) the system will be suitable also for serving the needs of an Integrated Services Digital Network as under study by Study Group XVIII;

k) a complete and detailed specification of the common channel signalling system is required at the end of the 1977-1980 study period for the public data and telephone network transmission service,

it is necessary to study the following:

1. What Recommendations should apply for the Data User Part of the common channel signalling system?

2. What further statements are required for the data application requirements of the Message Transfer Part in order that:

   i) the data application requirements may be catered for when the Message Transfer Part is specified by Study Group XI;

   ii) the results of the study of the Message Transfer Part may, as they emerge, be evaluated by Study Group VII with regard to their suitability for data network applications?

3. What Recommendations should apply regarding the application and use of common channel signalling in public synchronous data networks?

Question 10/VII – The provision of features in the DTE-DCE interface for fault identification and isolation

(continuation of the study of Question 1/VII, point K, Geneva, 1972, amended at Geneva, 1976)

Aspects to be covered include:

study of points arising from the implementation of Recommendations X.20, X.20 *bis*, X.21, X.21 *bis* and X.25, with particular reference to:

a) the duration of the period before *DCE Clear indication* should be sent in the case of loss of incoming line signal and/or loss of alignment,

b) consideration of the need for and implementation of automatic (remote) control of the DCE customer loop for test of the DTE and interconnecting cable.

Question 11/VII – The connection to public data networks of DTEs which are designed for interfacing existing Series V Recommendations modems

(continuation of the study of Question 1/VII, point L, Geneva, 1972, amended at Geneva, 1976)

(of interest to Study Group XVII)

Aspects to be covered include:

– study of points arising from the implementation of Recommendations X.20 *bis* and X.21 *bis*, especially with respect to manual and automatic calling and the need for an interface sequence diagram;

– implications for the public data network of the results of further studies in Study Group XVII on modem interfaces;

– the method of signalling through the network the condition of circuit 105 at the interface when the half-duplex facility is implemented.

Question 12/VII – Specification of the common channel signalling requirement for telex and gentex

(Geneva, 1976)

(to be studied in conjunction with Study Group X, Question 13/X)

Study Group X has agreed that responsibility for the inclusion of the signalling and switching requirements for the telex and gentex networks in integrated digital networks may be undertaken by Study Group VII, along with the requirements for data, following definition of the telex and gentex requirements by Study Group X.

What specifications concerning common channel signalling are required to cater for the possible provision of the telex and gentex services in synchronous data networks?

Question 13/VII – DTE-DCE basic interface in public data networks

(continuation of the study of Question 1/VII, point Q2, Geneva, 1972, amended at Geneva, 1976)

Considering that

a) interface characteristics have been recommended (Recommendations X.20, X.20 *bis*, X.21, X.21 *bis*, X.25) which take account of existing and proposed DTE requirements and provide for the opening phase of public data networks;

b) a proliferation of different types of interface for different types of data transmission services is undesirable;

c) the principles of commonality of design of equipment in integrated digital networks should be observed,

What are the functional characteristics of the DTE-DCE interface which meet the requirements of all user classes of service and what are the special procedural characteristics required by each user class of service?

Note 1. – Although it is recognized that data terminals operating by means of start-stop modulation at the DTE-DCE interface will continue to exist for some time, it is expected that the long-range development direction of terminals for asynchronous character-by-character operation will be towards the use of the synchronous mode of transmission at the DTE-DCE interface.

Note 2. – Consideration should be given to the need for both burst isochronous and continuous isochronous operation.

Note 3. – The implications for the interface procedures of implementing the facilities included in Recommendation X.2 should be taken into account.

Question 14/VII – Further study of current Recommendations for DTE-DCE interfaces in public data networks

(continuation of the study of Question 1/VII, points C, P and Q1, Geneva, 1972, amended at Geneva, 1976)

Expansion of the current Recommendations may be necessary,

1. to include procedures for individual services listed in Recommendation X.2 where a common set of interchange circuits is used for the different services (see Annexes 1 and 2 to this Question);

2. to include aspects arising from the continued study of Questions 1/VII, 2/VII and 20/VII;

3. to include features which, while not considered to be international facilities, may be standardized to the advantage of users. The facilities identified so far are shown below for the circuit and packet switched data transmission services respectively:

i) *Circuit switched data transmission services*

a) multiple lines at the same address;

b) outgoing calls barred;

c) incoming calls barred;

d) multiplexed link to a user (user classes of service 5-6 only).

ii) *Packet switched data transmission services*

a) multiple lines at the same address;

b) multiplexed link to a user (user classes of service 5-6 only);

c) echo-plex mode (user classes of service 1-2 only);

d) test centre facilities;

e) the subject of failure states and test loop is for further study.

For both services it may be feasible for calls to be made and answered by manual or automatic means as indicated in the appropriate Recommendation;

4. to include procedures and packet formats for the datagram facility;

5. to take account of Recommendation X.96, and in particular to define what DTE actions should be taken upon receipt of *Call progress signals* and what is the limitation on the number of re-tries allowed upon receipt of negative *Call progress signals.*

Note 1. – Experience in implementing Recommendations X.1, X.2, X.70 and X.71 should be taken into account.

Note 2. – The requirement during the 1973-1976 study period of maximum possible commonality of interchange circuit functions, information coding and formats, and procedures for all DTE/DCE interface Recommendations should be borne in mind. Consideration should be given to restructuring the interface Recommendations to reflect such commonality.

Question 15/VII – Definition of terms arising during the study of public data networks

(continuation of the study of Question 1/VII, point R, Geneva, 1972, amended at Geneva, 1976)

(also concerns Study Groups XI, XVII and XVIII)

Continue the preparation of definitions which arise during the study of all Questions entrusted to Study Group VII.

Note. – See Contribution COM VII-No. 11 for terms to be studied further by Study Group VII during the current study period.

Question 16/VII – Quality of service in public data networks

(Geneva, 1976)

(to be studied in liaison with Joint Study Group CMBD, also concerns Study Group XVIII)

Administrations and users each have interests in ensuring that a good "quality of service" is provided in public data networks. As providers of the service, Administration wish to be assured that the required standard of service is being maintained and the users of the service wish to be assured that the integrity of their data processing system is being maintained. The following aspects should therefore be studied:

1. How should "quality of service" be characterized for public data networks and which are the relevant characteristics? This study might include, for example, whether the following indicators are useful:

a) misrouted calls;

b) misdirected traffic (i.e., data traffic delivered to a wrong destination after an initial data transfer with the correct destination).

2. Should limits on the relevant characteristics be recommended? Are such limits to be recommended:

– for different parts of the network (e.g., DTE, subscriber line including DCE, DSE, data trunk channel, etc.)?

– as design objectives?

– to qualify a "minimum operationally acceptable quality of service"?

– to qualify an "operationally unacceptable quality of service"?

3. To what extent should hypothetical reference circuits and hypothetical reference connections be used when recommending limits on the relevant characteristics?

4. Should a distinction be made according to:

– the type of service (circuit switching, packet switching, leased circuit);

– the user class;

– the type of signalling system;

– the phase (call set-up, call clear-down, data-phase)?

5. What details are appropriate for:

– Administrations;

– subscribers?

6. To assist the evaluating data services, Administrations are requested to provide operational and performance characteristics and test results.

Question 17/VII – Maintenance of public data networks

(Geneva, 1976)

(to be studied in liaison with Study Groups IV, IX, XVIII and Joint Study Group CMBD)

What recommendations should be made pertaining to the maintenance of public data networks?

The following points, for example, need to be studied:

1. guiding principles for the maintenance organization of the public data network;

2. bringing into service of new data transmission links;

3. maintenance measurements;

   a) what characteristics should be measured, supervised and/or monitored, at what points of the network and by which means?

   b) what faults and/or failures should be detected, at what points of the network and by which means?

   c) are there any differences between the requirements of packet switching and circuit switching?

4. fault reporting procedure and subsequent action:

   a) to what points of the network should the fault- and/or failure-indicators be conveyed (fault report points)?

   b) what subsequent action is to be taken after a fault/failure has been reported or detected?

   c) which facilities should be provided in the network either on demand of the subscriber and/or the maintenance staff? Are loops necessary? If so, at what points and how should such loops be established manually or automatically?

Note 1. – Attention is drawn to the Annex to Question 4/XVIII.

Note 2. – Consideration should be given to the reply to Question 1/VII, point K (1973-1976) (see Annex to this Question).

Note 3. – Study Group IX has set the following Question for study: Question 10/IX – Automatic identification and removal of faulty telegraph-type international circuits from service. The study of this Question relates to 3. above and will be of interest to Study Group VII.

Note 4. – Recommendation R.101 specifies "Code and speed dependent time-division multiplex system for anisochronous telegraph and data transmission using bit interleaving". The control of channel outputs in this equipment is relevant to 4. above.

Question 18/VII – Standardization of signalling for interworking for data service between different types of public data networks and between public data networks and other public networks

(Geneva, 1976)

(also concerns Study Groups I, II, III, IX, X, XI and XVII)

1. Bearing in mind that it is possible for anisochronous networks using signalling in accordance with Recommendation X.70 to provide the start-stop user classes of service, while networks of a synchronous type may use decentralized signalling (Recommendation X.71) or common channel signalling (Recommendation X.60) when establishing connections for the start-stop and synchronous user classes of service, it is necessary to study the various interworking possibilities between the following networks:

- public data networks of anisochronous types (Recommendation X.70 signalling);
- public data networks of synchronous type using decentralized signalling (Recommendation X.71);
- public data networks of synchronous type using common channel signalling (Recommendation X.60).

2. It is also necessary to study the feasibility of interworking from a signalling standpoint between the above networks and public data networks operating on the packet switching principle.

3. Consideration should be given to the signalling requirements between a public data network providing circuit-switched services or packet-switched services or both and:

   i) a public telephone network which provides data transmission services;

   ii) a telex network which provides data transmission services.

The study of this aspect is to include the signalling requirements necessary to establish a data transmission circuit at the interface between the networks which would enable the interworking to take place.

4. Connection of a subscriber in one country which has not yet established a switched public data network to a switched public data network in another country.

Note 1. – The scope of 3. above covers the feasibility of interworking from a network signalling point of view while Question 21/VII covers interface aspects. Replies on Questions 18/VII and 21/VII will be taken into account when studying point 4. of Question 2/VII.

Note 2. – The study of 3. above will be of interest to Study Groups I, II, IX, X, XI and XVII.

Note 3. – In the early years of development of switched public data networks it may be desirable to extend the range of connections permitted to switching centres so that the switched service can be made more widely available. It is therefore necessary to study whether it is desirable and feasible to connect a subscriber in one country to a switched public data network in another country. The conditions under which such connections might be permitted would need to be established, as would the technical aspects concerned, for example, the use of Series V Recommendations modems to extend circuits and packet switched network service from a switching centre across an international frontier, over an international leased line to a subscriber.

The study of 4. above will be of interest to Study Groups III, IX and XVII.

Question 19/VII – Digital switching for data (user signalling rates of 48 kbit/s and below)

(Geneva, 1976)

(to be studied in liaison with Study Groups X, XI and XVIII; see also Annex 1 to Question 1/XI – draft Recommendation on digital switching)

Considering that

a) data networks using circuit-switched and packet-switched methods have been proposed and are being implemented;

b) for public data networks a range of user classes of service having different data signalling rates is recommended (Recommendation X.1 and Question 1/VII);

c) specialized user facilities will be available in public data networks (Recommendation X.2 and Question 2/VII);

d) telex and gentex and data services are already being implemented by means of a common transmission and switching network;

e) commonality with the switching of other services is highly desirable (see Questions 6/VII and 9/VII).

What parameters for the digital switching of data should be contained in Recommendations and what are the characteristics of these parameters?

Question 20/VII – For DTEs connected to public data networks the methods of responding to incoming calls

(Geneva, 1976)

Considering that

a) In the 1973-1976 period there was general, but not unanimous, agreement that the network should recognize a basic *Controlled not ready (CNR) signal* from a DTE which is in a local mode of operation, and that a *Call progress signal* would be sent to any calling DTE to advise it of this fact. The basic *CNR signal* would be simple, and the same for all DTEs, and there would be a charge made for calls encountering the CNR condition.

b) In the case of more intelligent DTEs an interest has been expressed to have a family of CNR situations. During the 1973-1976 period it was agreed that the preferred interface procedure for terminals requiring multiple conditions of CNR is that a facility requests a call to a special service number (address) to cause one of the multiple conditions to be registered with the network. When this terminal subsequently signals the *CNR state* defined in the interface Recommendation, the network recognizes the registered condition. A DTE which then called during this CNR situation would be sent one of a corresponding family of *Call progress signals,* containing information which would enable it to decide when to repeat its call.

c) A majority of Administrations have indicated that manual answering will not be supported in their networks, *it is necessary to study:*

1. In the case of *Controlled not ready (CNR):*

   i) should a family of controlled not ready indications be part of the switched service available on public data networks?

   ii) if the answer to i) is yes, how should the facilities be implemented? What is the implication, if any, on the requirement for manual answering?

   iii) what are the consequences for the originating country if the destination country has not implemented network recognition of the CNR for terminals operating in the local mode?

2. In the case of manual answering:

   i) should manual answering be supported in public data networks?

   ii) what are the consequences for the originating country if the destination country permits manual answering?

   iii) is it feasible that the international service operate in such a way that answering appears to be automatic but that manual answering may still be accommodated in the destination country?

Question 21/VII – Standardization of the inter-network interface for interworking between a DTE on a public data network and a DTE on another public network

(Geneva, 1976)

(of interest to Study Groups IX and XVII)

Considering that

a) Administrations recognize the interest that some users would have in interworking between different types of network;

b) the technical feasibility and economics of such interworking must be established before a user requirement can be determined.

What are the interface requirements for data communication between DTEs connected to the public telephone or telex networks and DTEs connected to public data networks, both circuit-switched and packet-switched?

Note 1. – In order that the demand for such interworking, assuming it is technically feasible, may be established it is necessary to take economic considerations into account.

Note 2. – The scope of Question 21/VII covers the DTE/DCE interface while 3. of Question 18/VII covers the feasibility of interworking from a network signalling point of view. Replies on Questions 21/VII and 18/VII will be taken into account when studying 4. of Question 2/VII.

Question 22/VII – Network parameters

(Geneva, 1976)

1. Bearing in mind Recommendation X.95, what additional network parameters are inherent in the design of public data networks?

2. Consideration of additional network parameters for packet switched services should include but not be restricted to:

   a) variation of network transfer delay for the transmission of separate packets (this aspect could form part of a list of items effecting the overall quality of service);

   b) packet sequencing for virtual calls and permanent virtual circuits;

c) the possibility of different packet sizes being delivered between two communicating DTEs and the related usage of the *More data* mark;

d) the usage of the *Data qualifier* mark;

e) the usage of the *Interrupt* facility;

f) delivery confirmation including end-to-end acknowledgement.

3. Should called line identification and calling line identification be network parameters under certain circumstances in packet-switched data services?

Question 23/VII – Call progress signals

(Geneva, 1976)

1. Bearing in mind Recommendation X.96, what additional *Call progress signals* and codes should be standardized in public data networks?

Consideration should be given for example, to the following:

a) the need for positive *Call progress signals*, should facilities such as *Redirection of calls* and *Connect when free* be added to Recommendation X.2,

b) the possible inclusion of negative *Call progress signals* such as *No answer* which may be relevant to the circuit-switched data service,

c) the possible inclusion of the following additional *Call progress signals* relevant to the packet switched data service:

Problem	Brief description of circumstances
Selection signal procedure error	The election signals received did not conform to the specified procedure

2. Bearing in mind that Recommendation X.96 relates to *Call progress signals* in public data networks should the service signals which may be transferred during the data transfer phase of a call or during the call clearing phase be standardized?

Consideration could be given to the following, some of which might only apply to a packet switched data service:

Possible service signals during the data transfer phase and during the call clearing phase of a call.

Problem	Brief description of circumstances
Delivery confirmation	Information that a given packet has been delivered
Discarded packet	Information that it has not been possible to deliver a given packet and that it has been discarded
Remote DTE in local mode	The distant DTE has entered a local mode
Reset in progress	Follows collision within the network of a packet from one DTE and a reset from the other. It is sent to the DTE not requesting the reset

Note. – A number of service signals describing in detail the contravention may be necessary. Examples are:

a) use of a logical channel reference not supporting a virtual call at that time;

b) flow control rules contravened;

c) sequence number of packet incorrect.

The question of whether *Call progress* packets are required has not been agreed upon. A call progress packet type can be required if *Call progress signals* are defined other than those which lead to the clearing of a virtual call.

3. Bearing in mind Recommendation X.96, what DTE actions should be desirable upon receipt of a *Call progress signal* and what limitations on the number of re-tries allowed upon the receipt of negative *Call progress signals.*

Question 24/VII – Interworking of networks offering packet switched data transmission service

(Geneva, 1976)

1. What are the characteristics required of international transmission facilities used to convey packets within the international transit network? (See the Annex to this Question).

2. What are the characteristics of the transfer control principles to be used across such transmission facilities? (See the Annex to this Question).

3. How should control signalling over international links for the interworking of national packet switched services be implemented?

Question 25/VII – Further study of packet mode operation on public data networks

(continuation of the study of Question 1/VII, point C, Geneva, 1972, amended at Geneva, 1976)

What coding should be applied to additional user facilities.

Note. – See Question 14/VII for further study of Recommendation X.25.

Question 26/VII – Multiplex structure for international links between synchronous networks

(continuation of the study of Question 1/VII, point S, Geneva, 1972, amended at Geneva, 1976)

Further consideration of Recommendations X.50 and X.51 in the light of experience and further study.

Points to be covered include:

– housekeeping requirements and consequently use of the reserved housekeeping bits;

– criteria of loss and acquisition of frame alignment;

– four octet alignment strategy;

– assignment of S bits;

– consequence on the multiplexing plant of providing the half-duplex facility.

Question 27/VII – Timing and synchronization

(continuation of the study of Question 1/VII, point T, Geneva, 1972, amended at Geneva, 1976)

(to be studied in close cooperation with Study Group XVIII; see Question 3/XVIII)

1. What techniques should be used for the synchronization of data networks?

2. What are the performance characteristics which should be recommended for the network synchronization of data networks?

3. What influence will satellite digital links have on consideration for international synchronization?

Note. – Studies under this Question should take into account Recommendation G.811, Plesiochronous operation of international digital links.

Question 28/VII – Provision of user classes of service 1 and 2 in public data networks

(Geneva, 1976)

Bearing in mind that there is a need to provide user classes of service 1 and 2 in public data networks it is necessary to study the various network problems which may arise.

In the case when user classes of service 1 and 2 are provided in synchronous data networks, it is necessary to study:

– multiplexing possibilities for the subscriber loop;

– interface implications;

– signalling implications;

– interworking between networks.

Question 29/VII – Use of 64 kbit/s time slots to carry single lower-speed network-synchronous data channels

(Geneva, 1976)

In certain parts of service-integrated networks, 64 kbit/s time slots may be used for carrying single lower-speed data channels by padding. This method will be applied under favourable economic circumstances only, e.g., excluding the subscriber line and the trunk network. Both the interface to the customer as well as the the multiplex used at the international interface, remain unaffected by appropriate recoding (padding/compression). Though the problems related to this method are therefore primarily of national concern (i.e. a question of implementation), it is felt that the technique has some influence on other domains, particularly:

– maintenance;

– signalling;

– housekeeping signals.

It is proposed to study these problems as well as the padding method.

Question 30/VII – Representation of information at the DTE-DCE interface for call control purposes (for example, *Facility request, Called and Calling line identification* and *Call progress signals*)

(Geneva, 1976)

Considering,

a) that Recommendations X.20, X.21 and X.25 define formats for transferring information across the DTE-DCE interface;

b) that Recommendation X.2 defines user facilities which may be requested on a call-by-call basis;

c) that Recommendation X.96 lists *Call progress signals.*

1. How shall call control information be represented at the DTE-DCE interface?

2. What are the particular requirements when a multiplicity of facilities is requested?

Note. – It will be necessary to study means of control of facilities when information is stored in the network on behalf of users (e.g. direct call, abbreviated address call).

Question 31/VII – Interchange circuits

(Geneva, 1976)

(also concerns Study Group XVII)

Further study may be necessary, arising from the implementation of Recommendation X.24 and the continued studies under Question 14/VII.

Question 32/VII – Bit sequence independence of 64 kbit/s digital paths

(Geneva, 1976)

(also concerns Study Groups IX, XI, XVII and XVIII)

Considering

the existence of digital line sections whose characteristics do not permit the transmission of long sequences of zeroes;

1. What means should be recommended to achieve a high degree of bit sequence independence of 64 kbit/s digital paths which are carried by digital line sections that are not bit sequence independent?

Note. – One possible means might be the insertion of scramblers at the 64 kbit/s interface in the country where the digital path is not bit sequence independent.

2. What will be the technical impact of such studies on the international interworking between public data networks?

Note. – Part 1 of this Question should be studied by Study Group XVIII (see Question 18/XVIII) in cooperation with Study Groups VII, IX, XI and XVII.

Part 2 of this Question should be studied by Study Group VII.

Question 33/VII – Mutual influence and alignment of Series X Recommendations

(Geneva, 1976)

Taking into account that

a) three types of services (e.g. leased line, circuit switching, packet switching) have been agreed for public data networks;

b) a certain number of Recommendations concerning public data networks have been agreed,

it is necessary to study:

1. How do the Administrations intend to use the Recommendations to provide the agreed services on an international basis?

2. Is there a need for other Recommendations to make the provision of the agreed services possible?

Question 34/VII – Subscribers' service in public data networks

(Geneva, 1976)

The following items, inter alia, are to be studied:

– operational procedures for data transmission services and facilities in public data networks;

– directories;

– directives for subscribers;

– status information provided by the network.

ISBN 92-61-00461-X

PRINTED IN SWITZERLAND