INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

YELLOW BOOK

VOLUME VIII - FASCICLE VIII.3

DATA COMMUNICATION NETWORKS

TRANSMISSION, SIGNALLING AND SWITCHING, NETWORK ASPECTS, MAINTENANCE, ADMINISTRATIVE ARRANGEMENTS

RECOMMENDATIONS X.40-X.180

VII^TH PLENARY ASSEMBLY
GENEVA, 10-21 NOVEMBER 1980

Geneva 1981

INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

YELLOW BOOK

VOLUME VIII – FASCICLE VIII.3

DATA COMMUNICATION NETWORKS

TRANSMISSION, SIGNALLING AND SWITCHING, NETWORK ASPECTS, MAINTENANCE, ADMINISTRATIVE ARRANGEMENTS

RECOMMENDATIONS X.40-X.180

VIITH PLENARY ASSEMBLY
GENEVA, 10–21 NOVEMBER 1980

Geneva 1981

ISBN 92-61-01171-3

CONTENTS OF THE CCITT BOOK
APPLICABLE AFTER THE SEVENTH PLENARY ASSEMBLY (1980)

YELLOW BOOK

Volume I – Minutes and reports of the Plenary Assembly.

Opinions and Resolutions.

Recommendations on:
- the organization and working procedures of the CCITT (Series A);
- means of expression (Series B);
- general telecommunication statistics (Series C).

List of Study Groups and Questions under study.

Volume II

FASCICLE II.1 – General tariff principles – Charging and accounting in international telecommunications services. Serie D Recommendations (Study Group III).

FASCICLE II.2 – International telephone service – Operation. Recommendation E.100 - E.323 (Study Group II).

FASCICLE II.3 – International telephone service – Network management – Traffic engineering. Recommendations E.401 - E.543 (Study Group II).

FASCICLE II.4 – Telegraph and "telematic services"[1] operations and tariffs. Series F Recommendations (Study Group I).

Volume III

FASCICLE III.1 – General characteristics of international telephone connections and circuits. Recommendations G.101 - G.171 (Study Group XV, XVI, CMBD).

FASCICLE III.2 – International analogue carrier systems. Transmission media – characteristics. Recommendations G.211 - G.651 (Study Group XV, CMBD).

FASCICLE III.3 – Digital networks – transmission systems and multiplexing equipments. Recommendations G.701 - G.941 (Study Group XVIII).

FASCICLE III.4 – Line transmission of non telephone signals. Transmission of sound programme and television signals. Series H, J Recommendations (Study Group XV).

Volume IV

FASCICLE IV.1 – Maintenance; general principles, international carrier systems, international telephone circuits. Recommendations M.10 - M.761 (Study Group IV).

FASCICLE IV.2 – Maintenance; international voice frequency telegraphy and facsimile, international leased circuits. Recommendations M.800 - M.1235 (Study Group IV).

FASCICLE IV.3 – Maintenance; international sound programme and television transmission circuits. Series N Recommendations (Study Group IV).

FASCICLE IV.4 – Specifications of measuring equipment. Series O Recommendations (Study Group IV).

---

[1] "Telematic services" is used provisionally.

Volume V – Telephone transmission quality. Series P Recommendations (Study Group XII).

Volume VI

FASCICLE VI.1 – General Recommendations on telephone switching and signalling. Interface with the maritime service. Recommendations Q.1 - Q.118 *bis* (Study Group XI).

FASCICLE VI.2 – Specifications of signalling systems Nos. 4 and 5. Recommendations Q.120 - Q.180 (Study Group XI).

FASCICLE VI.3 – Specifications of signalling system No. 6. Recommendations Q.251 - Q.300 (Study Group XI).

FASCICLE VI.4 – Specifications of signalling systems R1 and R2. Recommendations Q.310 - Q.490 (Study Group XI).

FASCICLE VI.5 – Digital transit exchanges for national and international applications. Interworking of signalling systems. Recommendations Q.501 - Q.685 (Study Group XI).

FASCICLE VI.6 – Specifications of signalling system No. 7. Recommendations Q.701 - Q.741 (Study Group XI).

FASCICLE VI.7 – Functional Specification and Description Language (SDL). Man-machine language (MML). Recommendations Z.101 - Z.104 and Z.311 - Z.341 (Study Group XI).

FASCICLE VI.8 – CCITT high level language (CHILL). Recommendation Z.200 (Study Group XI).

Volume VII

FASCICLE VII.1 – Telegraph transmission and switching. Series R, U Recommendations (Study Group IX).

FASCICLE VII.2 – Telegraph and "telematic services"[1] terminal equipment. Series S, T Recommendations (Study Group VIII).

Volume VIII

FASCICLE VIII.1 – Data communication over the telephone network. Series V Recommendations (Study Group XVII).

FASCICLE VIII.2 – Data communication networks; services and facilities, terminal equipment and interfaces. Recommendations X.1 - X.29 (Study Group VII).

FASCICLE VIII.3 – Data communication networks; transmission, signalling and switching, network aspects, maintenance, administrative arrangements. Recommendations X.40 - X.180 (Study Group VII).

Volume IX – Protection against interference. Series K Recommendations (Study Group V). Protection of cable sheaths and poles. Series L Recommendations (Study Group VI).

Volume X

FASCICLE X.1 – Terms and definitions.

FASCICLE X.2 – Index of the Yellow Book.

[1] "Telematic services" is used provisionally.

CONTENTS OF FASCICLE VIII.3 OF THE YELLOW BOOK

Recommendations X.40 to X.180

Data communication networks

REMARKS

1 The Questions entrusted to each Study Group for the Study Period 1981-1984 can be found in Contribution No. 1 to that Study Group.

2 The status of annexes and appendices attached to the Series X Recommendations should be interpreted as follows:

- an *annex* to a Recommendation forms an integral part of the Recommendation;
- an *appendix* to a Recommendation does not form part of the Recommendation and only provides some complementary explanation or information.

CCITT NOTE

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

FASCICLE VIII.3

Recommendations X.40 to X.180

DATA COMMUNICATION NETWORKS

TRANSMISSION, SIGNALLING AND SWITCHING,
NETWORK ASPECTS, MAINTENANCE,
ADMINISTRATIVE ARRANGEMENTS

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

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 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 group;

(d) that Recommendation X.1 [1] defines the user classes of service for public data networks;

(e) that Recommendation X.1 [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 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, [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 [3] and R.38 B [4]);

(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 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 $n = 1, 2, \ldots, 12$ (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).

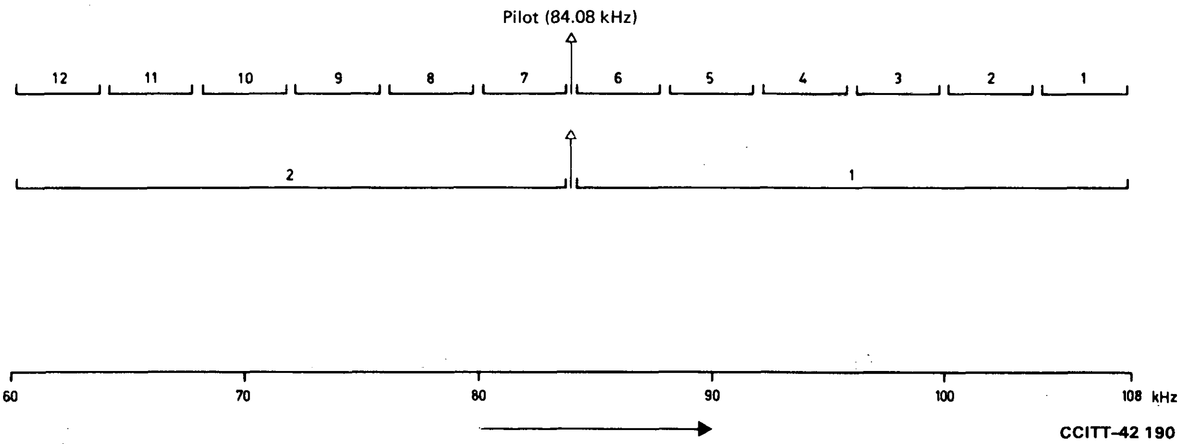


FIGURE 1/X.40

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 the Recommendation cited in [5], which 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 [6], R.35 *bis* [7], R.36 [8], R.37 [9], R.38 A [3] or R.38 B [4].

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.1.

[2] CCITT Recommendation *International user services and facilities in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.2.

[3] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 200 bauds with channels spaced at 480 Hz*, Vol. VII, Fascicle VII.1, Rec. R.38 A.

[4] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 200 bauds with channels spaced at 360 Hz usable on long intercontinental bearer circuits generally used with a 3-kHz spacing*, Vol. VII, Fascicle VII.1, Rec. R.38 B.

[5] CCITT Recommendation *Transmission of wide-spectrum signals (data, facsimile, etc.) on wideband group links*, Orange Book, Vol. III.2, Rec. H.52, § a) 2, ITU, Geneva, 1976.

[6] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 50 bauds*, Vol. VII, Fascicle VII.1, Rec. R.35.

[7] CCITT Recommendation *50 baud wideband VFT systems*, Vol. VII, Fascicle VII.1, Rec. R.35 *bis*.

[8] CCITT Recommendation *Coexistence of 50-baud/120-Hz channels, 100-bauds/240-Hz channels, 200-baud/360-Hz or 480-Hz channels on the same voice-frequency telegraph system*, Vol. VII, Fascicle VII.1, Rec. R.36.

[9] CCITT Recommendation *Standardization of FMVFT systems for a modulation rate of 100 bauds*, Vol. VII, Fascicle VII.1, Rec. R.37.

Recommendation X.50

FUNDAMENTAL PARAMETERS OF A MULTIPLEXING SCHEME FOR THE INTERNATIONAL INTERFACE BETWEEN SYNCHRONOUS DATA NETWORKS

(Geneva, 1972; amended at Geneva, 1976 and 1980)

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:

1 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 § 1.1c) above, Recommendation X.51 will apply.

1.3 Paragraph 2 of this Recommendation deals with the basic multiplexing parameters which shall be used in any application of this Recommendation.

1.4 Paragraph 3 of this Recommendation, in addition to § 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 Paragraph 4 of this Recommendation, in addition to § 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 [1] and X.21 *bis* [2], together with Recommendation X.71 for connections using decentralized signalling and with Recommendation X.60 for connections using common channel signalling.

2 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 subrate 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

1001101

and which is reproduced in Table 1/X.50, showing 8 bits ("A" to "H") reserved for housekeeping:

v) 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;

vi) the "A" bit shall be assigned such that:

"A" equals 1 means no alarm;

"A" equals 0 means alarm;

vii) 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 (last seven bits of the H row: 1 0 0 1 1 0 1)

2.4 For frame synchronization, the following general requirements are recommended:

i) the frame synchronization method should be insensitive as far as possible to bit errors, error bursts and short bursts of the alarm indication signal (AIS) generated by transmission equipment;

ii) when a slip occurs in the transmission equipment, a fast frame alignment should be possible.

2.5 In addition to § 2.4 above, the frame synchronization method should offer the following performances:

i) the frame alignment recovery time, after a slip and in absence of bit errors should be less than 120 envelopes, with 95% probability;

ii) the time from the start of a disturbance as defined in § 2.4 i) to any action affecting the data channels shall be [including the transmission of alarm to the distant end defined in § 2.3 v) and vi)] greater than x (x in the range 1-20 ms);

iii) a random error rate of 1 in 10^4 shall not cause any frame alignment recovery action.

3 Division 3

3.1 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, 6.4 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 subrate 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 Galois 2^5 field with the forcing configuration

01110

and is reproduced in Table 2/X.50;

v) the first F bit indicated as "A" in Table 2/X.50, is used as stated in § 2.3 v) above;

vi) the sense of "A" will be in accordance with § 2.3 vi) 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				

3.2 For frame synchronization, the general requirements and the performances should be as recommended in §§ 2.4 and 2.5 above.

4 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 interexchange 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 the 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.

5 Division 5

To regulate transmission of 64-kbit/s streams, the following will apply:

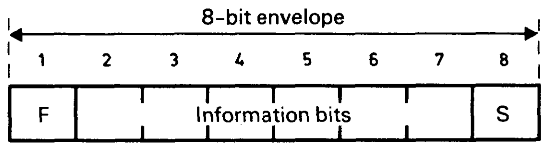
i) In networks where the 64-kbit/s transmission paths have an octet structure throughout (i.e. 8-bit time slots are generally available), the 8-bit envelopes of the data multiplex signal should be aligned with the octet structure. This relationship will be established across 64-kbit/s interfaces by means of the 8-kHz timing signal.

ii) In networks where an octet structure is not utilized throughout (i.e. 8-bit time slots are not generally available on 64-kbit/s transmission paths), the 8-bit envelopes need not necessarily be aligned with the octet structure. On 64-kbit/s interfaces the 8-kHz timing signal may not be used; in that case the framing information is conveyed across this interface fully within the multiplex.

iii) Whether on an international link the 8-bit envelopes have to be aligned with the octet structure is provisionally subject to bilateral agreement but further study is required.

Note 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).



CCITT-38 460

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.

Note 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 twenty 8-bit envelopes of the multiplexed stream, as in Figure 2/X.50.

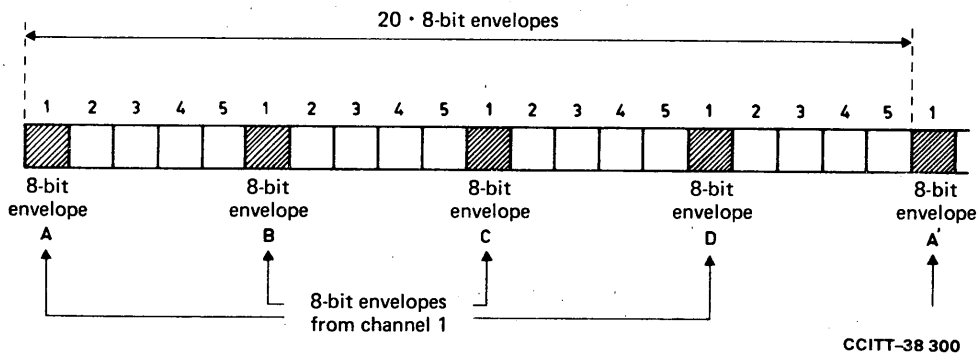


FIGURE 2/X.50

Note 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).

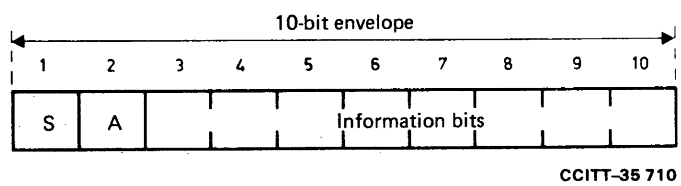


FIGURE 3/X.50

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.

References

[1] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for synchronous operation* on public data networks, Vol. VIII, Fascicle VIII.5, Rec. X.21.

[2] CCITT Recommendation *Use on public data networks of data terminal equipment (DTR) which is designed for interfacing to synchronous V-series modems*, Vol. VIII, Fascicle VIII.5, Rec. X.21 *bis*.

FUNDAMENTAL PARAMETERS OF A 48-kbit/s USER DATA SIGNALLING RATE TRANSMISSION SCHEME FOR THE INTERNATIONAL INTERFACE BETWEEN SYNCHRONOUS DATA NETWORKS

(Geneva, 1980)

1 General

1.1 This Recommendation sets out the fundamental parameters of a transmission scheme that should be used for 48-kbit/s data signalling rate for interworking of networks that make use of the following structures:

a) 8-bit envelope (see Explanatory Notes 1 and 2 of Recommendation X.50);

b) 10-bit envelope (see Explanatory Note 3 of Recommendation X.50); in the case where at least one of the networks is structured according to a).

1.2 For interworking between two networks both of which utilize the 10-bit envelope structure as identified in § 1.1 b) above, Recommendation X.51 *bis* will apply.

1.3 Paragraph 2 of this Recommendation deals with the basic parameters which shall be used in any application of this Recommendation and, in particular, for interworking between two networks, both of which utilize the 8-bit envelope structure.

1.4 Paragraph 3 of this Recommendation, in addition to § 2, applies to the interworking of networks with different envelope structures.

1.5 The use of the status bit, in addition to the indication given in this Recommendation, should comply with Recommendation X.21 [1] and X.21 *bis* [2], together with Recommendation X.71 for connections using decentralized signalling and with Recommendation X.60 for connections using common channel signalling.

2 Transmission scheme

2.1 The gross bit rate of 64 kbit/s should be standardized for international links.

2.2 The signal element of the 64-kbit/s channel should be assembled in 8-bit envelopes in which bit 1 is the F bit, bits 2-7 are information bits and bit 8 is the status bit S.

2.3 The use and the value to be assigned to the F bits of the 8-bit envelopes are under study.

3 Interworking of networks with different envelope structures

The problem of interworking of networks with different envelope structures should be further studied taking into account the recommendations in § 4 of Recommendation X.50.

References

[1] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for synchronous operation on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.21.

[2] CCITT Recommendation *Use on public data networks of data terminal equipment (DTE) which is designed for interfacing to synchronous V-series modems*, Vol. VIII, Fascicle VIII.5, Rec. X.21 *bis*.

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 for 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.

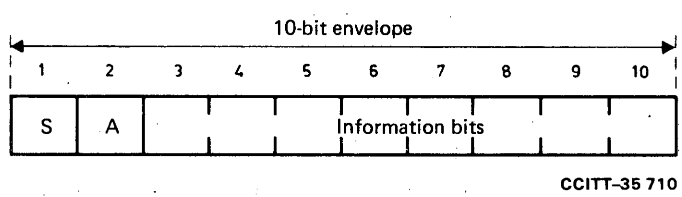


FIGURE 1/X.51

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 [1], X.21 *bis* [2], 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).

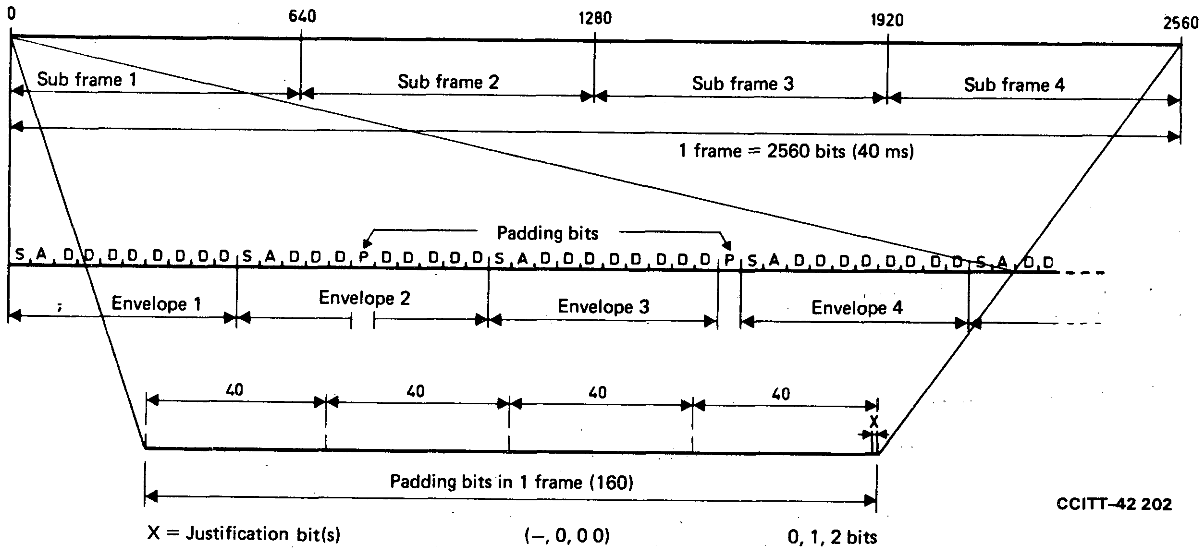


FIGURE 2/X.51

Multiplex frame structure

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

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

The 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 [3]) 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:

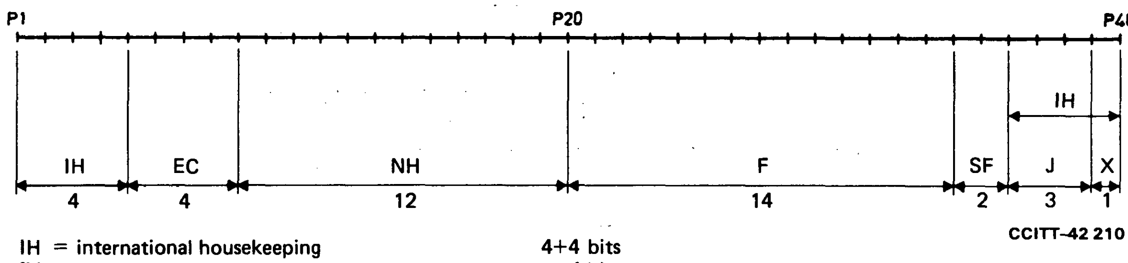
I – Synchronous transmission bearer

P37-P40	International housekeeping bits E, F, G and H (cf. Recommendation X.50)	

II – Asynchronous 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)

References

[1] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for synchronous operation on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.21.

[2] CCITT Recommendation *Use on public data networks of data terminal equiment (DTE) which is designed for interfacing to synchronous V-series modems*, Yellow Book, Vol. VIII, Fascicle VIII.5, Rec. X.21 *bis*.

[3] CCITT Recommendation *Code-independent error control system*, Vol. VIII, Fascicle VIII.3, Rec. V.41.

Recommendation X.51 *bis*

FUNDAMENTAL PARAMETERS OF A 48-kbit/s USER DATA SIGNALLING RATE TRANSMISSION SCHEME FOR THE INTERNATIONAL INTERFACE BETWEEN SYNCHRONOUS DATA NETWORKS USING 10-bit ENVELOPE STRUCTURE

(Geneva, 1980)

The CCITT,

considering

that there is a requirement for a 48-kbit/s user data signalling rate transmission 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 in the transmission scheme to carry the 48-kbit/s user data signalling rate between networks using the 10-bit envelope structure.

1 Transmission scheme

1.1 The gross bit rate of 64 kbit/s should be standardized for international links.

1.2 The signal elements of the 48-kbit/s channel shall be assembled in 10-bit envelopes, in which bit 1 is a status bit, bit 2 is an envelope alignment bit, and bits 3-10 are user data information bits as in Figure 1/X.51 *bis*.

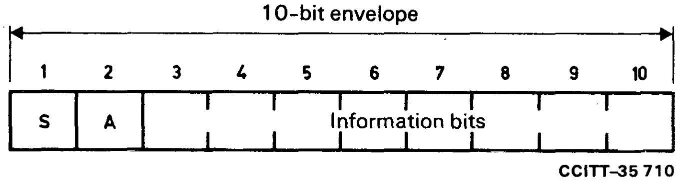


FIGURE 1/X.51 *bis*

1.3 The basic transmission scheme consists of consecutive 10-bit envelopes interleaved with padding bits occurring every 16th bit. Looking at a group of 32 consecutive bits of the 64-kbit/s bit stream containing 3 envelopes with 24 user data bits D, and numbering the bits starting with the S bit of envelope 1, the padding bits P shall be inserted in the bit positions 16 and 32 as in Figure 2/X.51 *bis*.

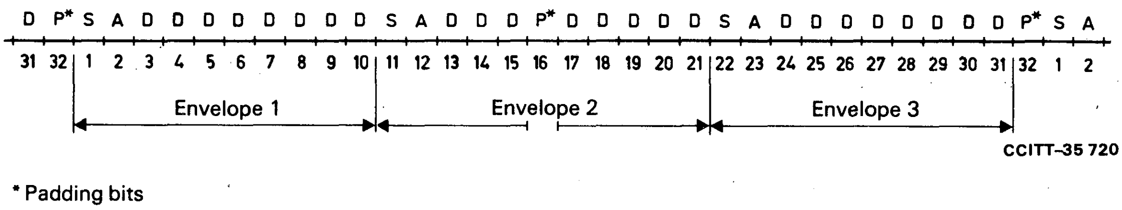


FIGURE 2/X.51 *bis*

1.4 The padding bits shall carry a simple framing pattern that shall be used to identify the envelopes, within the 64-kbit/s stream.

A tentative proposal for such a simple framing pattern would be the following:

i) the padding bit in the position 16 of Figure 2/X.51 *bis* is set to binary 0;

ii) the padding bit in the position 32 of Figure 2/X.51 *bis* is set to binary 1.

Note – Other more complex framing patterns, which allow the use of padding bits for such functions as, for example, housekeeping signalling or justification in the national network, are for further study.

1.5 The framing strategy is for further study.

1.6 The use of the framing pattern to monitor the error rate in the transmission path, which will be optional, is for further study.

1.7 The envelope alignment bit shall carry a pattern of alternating binary 0 and binary 1 in consecutive envelopes, i.e. the pattern on the A bits in Figure 2/X.51 *bis* can be either 010 or 101.

Note – Other patterns on the A bits, e.g. "all zeros" or "all ones" could be used for alarm signals from the distant end and this is for further study.

1.8 The use of the status bit should comply with Recommendations X.21 [1] and X.21 *bis* [2], together with Recommendation X.71 for connections using decentralized signalling, and with Recommendation X.60 for connections using common channel signalling.

References

[1] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for synchronous operation on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.21.

[2] CCITT Recommendation *Use on public data networks of data terminal equipment (DTE) which is designed for interfacing to synchronous V-Series modems*, Vol. VIII, Fascicle VIII.5, Rec. X.21 *bis*.

METHOD OF ENCODING ANISOCHRONOUS SIGNALS INTO A SYNCHRONOUS USER BEARER [1)]

(Geneva, 1980)

The CCITT,

considering that

(a) Recommendation X.1 [1] defines the user classes of service in public data networks;

(b) Recommendation X.2 [2] defines the international user facilities in public data networks;

(c) Recommendations X.21 [3] and X.21 *bis* [4] define the interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for synchronous operation;

(d) Recommendations X.50 and X.51 define the multiplexing scheme for the international interface between synchronous data networks;

(e) Recommendations X.60, X.61 and X.71 define the signalling system on international circuits between synchronous data networks;

(f) some circuits implementing synchronous data networks also will connect to those networks DTEs operating in user classes of service 1 and 2;

unanimously declares the following view:

1 Scope

1.1 In the case where two synchronous data networks offer service for DTEs in user classes of service 1 and 2, the transfer of the anisochronous signals between the networks shall be performed using a synchronous user channel of 600 bit/s in the standardized multiplexing schemes given in Recommendations X.50 and X.51 if one or both of the networks nationally use the synchronous user channel of 600 bit/s.

1.2 In the case where two synchronous data networks offer service for DTEs in user classes of service 1 and 2 but do not provide the 600-bit/s rate, the transfer of the anisochronous signals between those two networks shall be performed using a synchronous user channel of 2400 bit/s in the standardized multiplexing schemes given in Recommendations X.50 and X.51.

1.3 The method of encoding signals from DTEs in user classes of service 1 and 2 into the synchronous bearer shall be independent of the multiplexing scheme used.

1.4 The method of encoding shall be as defined in this Recommendation.

2 Encoding method

The encoding method implies that characters generated by DTEs in user classes of service 1 and 2 in accordance with Recommendation X.1 [1] are transferred on international links as characters on a synchronous user channel, i.e. the transfer of characters on a synchronous user channel shall include the start signal as well as the stop signal with the following convention:

start polarity = binary zero;

stop polarity = binary one.

Between any two characters on synchronous user channel the value of the bits shall be binary one.

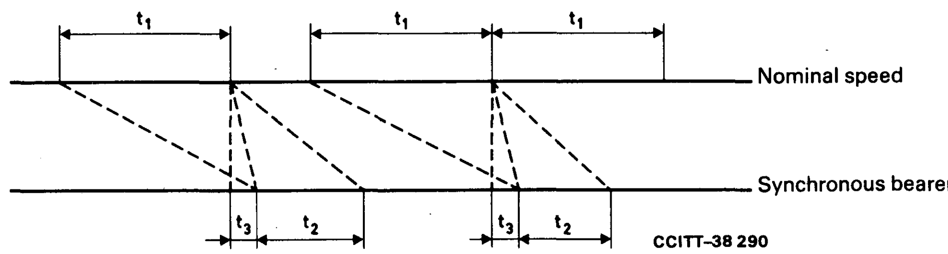
---

1) This Recommendation is only valid for interworking between synchronous data networks. For the interworking between anisochronous data networks the Series R Recommendations will apply.

The encoder and decoder shall be implemented in such a way that continuous start polarity (as well as continuous stop polarity) generated by a DTE can be transferred.

On the multiplexed link there need not be any relation between characters and envelopes.

The encoder shall be implemented in such a way that the time delay between the reception of a character at nominal speed and the start of sending the character on a synchronous user channel is less than 1 bit at the data signalling rate of the synchronous user channel used.



t_1 One character at nominal speed

t_2 One character at synchronous signalling rate

t_3 Time delay < 1.67 ms

FIGURE 1/X.52

ANNEX A

(to Recommendation X.52)

Location of the encoder

The location of the encoder, e.g. in the DCE in question or at a control point in the network, is a national matter. The location however will have no impact on the method described in this Recommendation.

When discussing the location of the encoder for harmonization reasons one should bear in mind that:

- in the case of a DCE located encoder, no special features for handling asynchronous signals are needed in network components such as concentrators and multiplexers and that all maintenance functions, subscriber line signalling scheme, local network modems, etc. implemented for the synchronous user classes of service can be used without any changes;
- if the encoder is placed at a central point, the data signalling rate on the local loop can be kept at the lowest possible rate allowing the use of a simple 2-wire modem and the sharing of conversion equipment at the central point by a number of subscribers.

ANNEX B

(to Recommendation X.52)

Higher data signalling rates

In the case where asynchronous DTEs operating at higher data signalling rates than given in Recommendation X.1 [1] are connected to synchronous data networks, the same principle for encoding as given in the text of this Recommendation could be used and the relationship between data signalling rate and bearer channel rate shall be as shown in Table B-1/X.52.

TABLE B-1/X.52

Data signalling rate	Bearer channel rate
600 bit/s 1200 bit/s 2400 bit/s 4800 bit/s	2400 bit/s 2400 bit/s 4800 bit/s 9600 bit/s

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.1.

[2] CCITT Recommendation *International user services and facilities in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.2.

[3] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for synchronous operation on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.21.

[4] CCITT Recommendation *Use on public data networks of data terminal equipment (DTE) which is designed for interfacing to synchronous V-Series modems*, Vol. VIII, Fascicle VIII.5, Rec. X.21 *bis*.

Recommendation X.53

NUMBERING OF CHANNELS ON INTERNATIONAL MULTIPLEX LINKS AT 64 kbit/s

(Geneva, 1980)

The CCITT,

considering that

Recommendations X.50 and X.51 define multiplexing schemes for international links at 64 kbit/s,

unanimously declares

the following view on the numbering of the tributary channels.

Tributary data channels conveyed within a 64-kbit/s multiplex link according to Recommendations X.50 and X.51, should be identified, for operational and maintenance purposes, by the following label:

i) One decimal digit D_1 indicating the multiplexing structure.

D_1 = 1 for the 80 8-bit envelope structure (Division 2 of Recommendation X.50).

D_1 = 2 for the 20 8-bit envelope structure (Division 3 of Recommendation X.50).

Note – This applies to multiplexing structures defined in Recommendation X.50 only.

ii) One decimal digit D_2 indicating the channel rate.

D_2 = 3, 4, 5, 6 for the rates of 600, 2400, 4800 and 9600 bit/s respectively.

Note – Digits 1 and 2 are reserved for user classes of service 1 and 2.

iii) Two decimal digits, D_3 and D_4, indicating the position "n" assigned in the frame with respect to the first envelope of the channel considered; $n \leq 80$ for the 80 envelopes frames defined in Recommendation X.50 (Division 2) and Recommendation X.51; $n \leq 20$ for the 20 envelopes frame defined in Recommendation X.50 (Division 3).

ALLOCATION OF CHANNELS ON INTERNATIONAL MULTIPLEX LINKS AT 64 kbit/s

(Geneva, 1980)

The CCITT,

considering that

Recommendations X.50 and X.51 define multiplexing schemes for international links at 64 kbit/s,

unanimously declares

the following view on the allocation of the tributary channels.

On international links carrying data channels multiplexed at 64 kbit/s according to Recommendations X.50 and X.51, the allocation of tributary channels at rates of 0.6, 2.4, 4.8 and 9.6 kbit/s within the multiplex frame, should be chosen, by bilateral agreement, among the configurations listed in Table 1/X.54.

Note – The phase number i (i = 1, . . . , 5) corresponds to the set of envelopes i + 5j (j = 0, . . . , 15 for 80 envelope frames; j = 0, . . . , 3 for 20 envelope frames) of each frame. Each phase contains either one 9.6-kbit/s or two 4.8-kbit/s or four 2.4-kbit/s or sixteen 0.6-kbit/s channels.

TABLE 1/X.54

Allocation of tributary channels in the 64-kbit/s multiplex frame

Configuration number	Phase number				
	1	2	3	4	5
01	9.6	9.6	9.6	9.6	9.6
02	9.6	9.6	9.6	9.6	4.8
03	9.6	9.6	9.6	9.6	2.4
04	9.6	9.6	9.6	9.6	0.6
05	9.6	9.6	9.6	4.8	4.8
06	9.6	9.6	9.6	4.8	2.4
07	9.6	9.6	9.6	4.8	0.6
08	9.6	9.6	9.6	2.4	2.4
09	9.6	9.6	9.6	2.4	0.6
10	9.6	9.6	9.6	0.6	0.6
11	9.6	9.6	4.8	4.8	4.8
12	9.6	9.6	4.8	4.8	2.4
13	9.6	9.6	4.8	4.8	0.6
14	9.6	9.6	4.8	2.4	2.4
15	9.6	9.6	4.8	2.4	0.6
16	9.6	9.6	4.8	0.6	0.6
17	9.6	9.6	2.4	2.4	2.4
18	9.6	9.6	2.4	2.4	0.6
19	9.6	9.6	2.4	0.6	0.6
20	9.6	9.6	0.6	0.6	0.6
21	9.6	4.8	4.8	4.8	4.8
22	9.6	4.8	4.8	4.8	2.4
23	9.6	4.8	4.8	4.8	0.6
24	9.6	4.8	4.8	2.4	2.4
25	9.6	4.8	4.8	2.4	0.6
26	9.6	4.8	4.8	0.6	0.6
27	9.6	4.8	2.4	2.4	2.4
28	9.6	4.8	2.4	2.4	0.6
29	9.6	4.8	2.4	0.6	0.6
30	9.6	4.8	0.6	0.6	0.6
31	9.6	2.4	2.4	2.4	2.4
32	9.6	2.4	2.4	2.4	0.6
33	9.6	2.4	2.4	0.6	0.6
34	9.6	2.4	0.6	0.6	0.6
35	9.6	0.6	0.6	0.6	0.6
36	4.8	4.8	4.8	4.8	4.8
37	4.8	4.8	4.8	4.8	2.4
38	4.8	4.8	4.8	4.8	0.6
39	4.8	4.8	4.8	2.4	2.4
40	4.8	4.8	4.8	2.4	0.6
41	4.8	4.8	4.8	0.6	0.6
42	4.8	4.8	2.4	2.4	2.4
43	4.8	4.8	2.4	2.4	0.6
44	4.8	4.8	2.4	0.6	0.6
45	4.8	4.8	0.6	0.6	0.6
46	4.8	2.4	2.4	2.4	2.4
47	4.8	2.4	2.4	2.4	0.6
48	4.8	2.4	2.4	0.6	0.6
49	4.8	2.4	0.6	0.6	0.6
50	4.8	0.6	0.6	0.6	0.6
51	2.4	2.4	2.4	2.4	2.4
52	2.4	2.4	2.4	2.4	0.6
53	2.4	2.4	2.4	0.6	0.6
54	2.4	2.4	0.6	0.6	0.6
55	2.4	0.6	0.6	0.6	0.6
56	0.6	0.6	0.6	0.6	0.6

COMMON CHANNEL SIGNALLING FOR CIRCUIT SWITCHED DATA APPLICATIONS

(Geneva, 1980)

The CCITT,

considering

(a) that public networks providing circuit-switched data transmission services are being established in various countries;

(b) that common channel signalling offers advantages when used for interexchange signalling in digital circuit-switched telecommunication networks;

(c) that a need has been established for a standardized common channel signalling system, known as CCITT Signalling System No. 7, for use in international and national applications in single service and multiservices digital networks;

(d) that Signalling System No. 7 has been defined with a functional structure clearly separating:

– the Message Transfer Part, common for all services and applications, and

– User Parts for different services and applications, and in particular, the Data User Part for circuit-switched data applications,

unanimously declares the view

that common channel signalling for international circuit-switched data applications be in accordance with Signalling System No. 7, i.e.:

i) that the data service call control related elements of the signalling system be as specified for the Data User Part in Recommendation X.61,

ii) that the message transfer related elements of the signalling system be as specified for the Message Transfer Part in Recommendations Q.701 – Q.707, [1] to [7].

Note 1 – Signalling System No. 7 including the Data User Part offers a basis for definition of common channel signalling for national data applications.

Note 2 – The implications of the use of the signalling system in multiservices networks and Integrated Service Digital Networks (ISDN) providing circuit-switched data services have not yet been fully studied.

References

[1] CCITT Recommendation *Functional description of the signalling system*, Vol. VI, Fascicle VI.7, Rec. Q.701.

[2] CCITT Recommendation *Signalling data link*, Vol. VI, Fascicle VI.7, Rec. Q.702.

[3] CCITT Recommendation *Signalling link*, Vol. VI, Fascicle VI.7, Rec. Q.703.

[4] CCITT Recommendation *Signalling network functions and messages*, Vol. VI, Fascicle VI.7, Rec. Q.704.

[5] CCITT Recommendation *Signalling network structure*, Vol. VI, Fascicle VI.7, Rec. Q.705.

[6] CCITT Recommendation *Signalling system performance*, Vol. VI, Fascicle VI.7, Rec. Q.706.

[7] CCITT Recommendation *Testing and maintenance*, Vol. VI, Fascicle VI.7, Rec. Q.707.

Recommendation X.61 [1)]

SIGNALLING SYSTEM NO. 7 – DATA USER PART

(Former Recommendation X.60, Geneva, 1976 amended at Geneva, 1980)

TABLE OF CONTENTS

1) This Recommendation appears in the Series Q Recommendations as Recommendation Q.741.

1 Functional description of the signalling system

1.1 *General*

Use of Signalling System No. 7 for call control or for facility registration and cancellation signalling for circuit-switched data transmission services requires:

- application of Data User Part (DUP) functions, in combination with
- application of an appropriate set of Message Transfer Part (MTP) functions.

A general description of the signalling system is given in Recommendation Q.701 [1]. That Recommendation also defines the division of functions and the requirements of interaction between the Message Transfer Part and the Data User Part.

1.2 *Data User Part*

The Data User Part specified in this Recommendation defines the necessary call control, and facility registration and cancellation related elements for international common channel signalling by use of Signalling System No. 7 for circuit-switched data transmission services. As regards call control and signalling procedures for international user facilities and network utilities, refer to Recommendation X.87.

The signalling system meets all requirements defined by CCITT concerning service features, user facilities and network utilities for circuit-switched data transmission services.

It can be used to control switching of various types of data circuits, including satellite circuits, to be used in worldwide circuit-switched data connections. It is designed for both-way operation of data circuits.

The signalling system is suitable for national circuit-switched data applications. Most data signalling message types and signals specified for international use are also required in typical national data applications. In addition to these, national data applications typically require additional types of signals; such requirements that have been identified are already provided for. The system provides ample spare capacity to cater for further additions of new message types and signals should such a need arise.

The label structures specified for data signalling messages require that all exchanges using the signalling system are allocated codes from code plans established for the purpose of unambiguous identification of signalling points, see Recommendations Q.701 [1] and Q.704 [2]. The principles to apply to the international signalling network are for further study.

1.3 *Message Transfer Part*

The Message Transfer Part of Signalling System No. 7 is specified in separate Recommendations. An overview description of the Message Transfer Part is contained in Recommendation Q.701 [1].

The Message Transfer Part defines a range of functions by which different signalling modes and different signalling network configurations may be realized. Any application of Signalling System No. 7 requires that an appropriate selection of these functions is applied depending on the intended use of the system and the characteristics of the telecommunications network concerned.

2 General function of data signalling messages, signals, indicators, codes and conditions

§ 2 describes general functions of data signalling messages, signals, indicators, codes and conditions which are used to set up a call, to control user facilities and to control and supervise a circuit. The requirements relating to the use of the signalling messages and their signalling information content are specified in §§ 3, 4, and 5.

2.1 *Signalling messages*

2.1.1 *Call and circuit related messages*

Call and circuit related messages are used to set up and clear a call or control and supervise the circuit state.

2.1.1.1 *Address message*

A message sent in the forward direction, containing signalling information required to route and connect the call to the called user. This message contains address information, class of service information, etc., and may also contain additional information such as, for example, calling line identity.

2.1.1.2 *Calling line identity message*

A message sent in the forward direction, containing the calling line identity or the originating network identity. This message is sent subsequently to an address message, which does not contain the calling line identity, when requested by the destination network.

2.1.1.3 *Call accepted message*

A message sent in the backward direction, containing information to indicate that connection of the call is allowed by the destination exchange. It may also contain additional information such as, for example, called line identity.

2.1.1.4 *Call rejected message*

A message sent in the backward direction containing a signal to indicate the cause of the failure of the call set-up as the response to the address message and initiating clearing of the call. The call rejected message will be sent as either the first response, or the second response after sending the call accepted message when the call fails to be completed at the destination exchange, e.g. because no call accepted signal was received from the called user.

2.1.1.5 *Clear message*

A message sent in either direction, containing information about the clearing of the call.

2.1.1.6 *Circuit state message*

A message sent in either direction, containing signals to control and supervise a circuit.

2.1.2 *Facility registration and cancellation related messages*

Facility registration and cancellation related messages are used to exchange information between originating and destination exchanges to register and cancel information related to user facilities. The exchange of this type of message is generally not associated with a call between two users.

2.1.2.1 *Facility registration/cancellation request message*

A message sent in the forward direction to register or cancel a user facility. This message contains information which identifies the user requesting facility registration or cancellation and information relating to the facility concerned.

2.1.2.2 *Facility registration/cancellation request accepted message*

A message sent in the backward direction, containing information that registration or cancellation is completed or accepted at the destination exchange.

2.1.2.3 *Facility registration/cancellation request rejected message*

A message sent in the backward direction, containing information that the registration or cancellation is not completed or accepted at the destination exchange with information indicating a reject cause.

2.2 *Service information*

The service information provides the highest level of discrimination between different sets of signalling messages. It contains the following components.

2.2.1 *Service indicator*

Information used to identify the User Part to which the signalling message belongs.

2.2.2 *National indicator*

Information used for discrimination between international and national messages. In case of national messages, it may for example also be used for discrimination between different label alternatives for national use.

2.3 *Signalling information transferred in the signalling messages*

2.3.1 *Label components*

In the case of call and circuit related messages, the label is used for message routing and, in general, for identification of the data circuit selected for the call. In the case of facility registration and cancellation messages, the label only provides a message routing function. The standard label structure consists of the following components.

2.3.1.1 *Destination point code*

Information identifying the signalling point to which the message is to be routed.

2.3.1.2 *Originated point code*

Information identifying the signalling point from which the message has been originated.

2.3.1.3 *Bearer identification code*

Information identifying the 64-kbit/s bearer among those interconnecting the destination point and originating point.

2.3.1.4 *Timeslot code*

Information identifying the submultiplexed circuit at a lower bit rate on the 64-kbit/s bearer which is itself identified by the bearer identification code.

2.3.2 *Message format identifiers*

2.3.2.1 *Heading*

Information discriminating, as applicable, between different groups of individual types of messages within the set of messages identified by the service information. The heading is split into two levels. The first level discriminates between different message groups. The second level either discriminates between different message types or contains a signal.

2.3.2.2 *Field length indicator*

Information associated with and indicating the length of a variable length field.

2.3.2.3 *Field indicator*

Information associated with and indicating the presence or absence of an optional field.

2.3.3 *Basic call set-up address information*

2.3.3.1 *Address signal*

A signal containing an element of a Data Country Code (DCC), Data Network Identification Code (DNIC) or a data number.

2.3.3.2 *Destination address*

Information sent in the forward direction consisting of a number of address signals indicating the complete data number of the called user.

2.3.4 *Basic call set-up indicators*

2.3.4.1 *National/international call indicator*

Information (for national use only) sent in the forward direction indicating whether the call is a national or international call. In the destination network, it may for example be used in connection with user facilities requiring separate handling of international calls.

2.3.4.2 *DCC/DNIC indicator*

Information (for national use only) sent in either direction, associated with a data number, indicating whether the DCC/DNIC is included in that data number.

2.3.4.3 *Alternative routing indicator*

Information sent in the forward direction indicating that the call has been subjected to an alternative routing and which may be used to prevent the call being set up over an alternative route more than once.

Note – This signal is provided provisionally, and will be subject to change when the necessary network capabilities for routing have been determined.

2.3.4.4 *User class indicator*

Information sent in the forward direction, indicating the user class of service of the calling user. This indicator may be used to determine the type of interexchange data circuit to be selected and to verify that the calling and called users belong to the same user class.

2.3.5 *Basic call set-up response signals*

2.3.5.1 *Call accepted signal*

A signal sent in the backward direction, indicating that the call can be completed. At the originating exchange, it results in preparing for data path through-connect and charging.

2.3.5.2 *Transit through-connect signal*

A signal sent in the backward direction, specifically provided for interworking with decentralized signalling (see Recommendation X.80), indicating that the call can be completed and that through-connection of transit exchanges using decentralized signalling may take place.

2.3.5.3 *Network failure signal*

A signal sent in the backward direction indicating that the call cannot be completed because of a temporary fault condition within the network, e.g. expiry of a time-out or line fault. At the originating exchange it results in sending a *no connection* call progress signal to the calling user and clearing the call.

2.3.5.4 *Number busy signal*

A signal sent in the backward direction, indicating that the call cannot be completed because the called user's access line to the exchange is engaged in another call. At the originating exchange it results in sending a *number busy* call progress signal to the calling user and clearing the call.

2.3.5.5 *Access barred signal*

A signal sent in the backward direction, indicating that the call cannot be completed because a user facility prevents connection of the call to the called user, e.g. as a result of failure of a closed user group validation check. At the originating exchange, it results in sending an *access barred* call progress signal to the calling user and clearing the call.

2.3.5.6 *Changed number signal*

A signal sent in the backward direction, indicating that the call cannot be completed because the called number has been changed recently. At the originating exchange, it results in sending a *changed number* call progress signal to the calling user and clearing the call.

2.3.5.7 *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 assigned. At the originating exchange, it results in sending a *not obtainable* call progress signal to the calling user and clearing the call.

2.3.5.8 *Out of order signal*

A signal sent in the backward direction, indicating that the call cannot be completed because either the called user's terminal or the called user's access line is out of service or faulty. At the originating exchange, it results in sending an *out of order* call progress signal to the calling user and clearing the call.

2.3.5.9 *Controlled not ready signal*

A signal in the backward direction, indicating that the call cannot be completed because the called user's terminal is in a *controlled not ready* condition. At the originating exchange, it results in sending a *controlled not ready* call progress signal to the calling user and clearing the call.

2.3.5.10 *Uncontrolled not ready signal*

A signal sent in the backward direction, indicating that the called user's terminal is in an *uncontrolled not ready* condition. At the originating exchange, it results in sending an *uncontrolled not ready* call progress signal to the calling user and clearing the call.

2.3.5.11 *DCE power off signal*

A signal sent in the backward direction, indicating that the called user's DCE is switched off. At the originating exchange, it results in sending a *DCE power off* call progress signal to the calling user and clearing the call.

2.3.5.12 *Network fault in local loop signal*

A signal sent in the backward direction, indicating that a fault has been detected in the local access connection for the called user. At the originating exchange, it results in sending a *network fault in local loop* call progress signal to the calling user and clearing the call.

2.3.5.13 *Call information service signal*

A signal sent in the backward direction, indicating that the called terminal is not available for reasons which have been indicated to the information service, and which are not covered by another specific signal. At the originating exchange, it results in sending a *call information service* call progress signal to the calling user and clearing the call.

2.3.5.14 *Incompatible user class of service signal*

A signal sent in the backward direction, indicating that the called user's terminal is incompatible with the characteristics of the calling user's terminal, e.g. different user class of service. At the originating exchange, it results in sending an *incompatible user class of service* call progress signal to the calling user and clearing the call.

2.3.5.15 *Network congestion signal*

A signal sent in the backward direction, indicating that the call cannot be completed because of temporary congestion or temporary fault conditions encountered on the route to the called customer. At the originating exchange this signal results in sending a *network congestion* call progress signal to the calling user and clearing the call.

2.3.5.16 *Degraded service signal*

A signal sent in the backward direction, indicating that a part of the network, due to faulty conditions, has a very much reduced grade of service, which is likely to persist for some time. At the originating exchange, it results in sending a *long-term network congestion* call progress signal to the calling user and clearing the call.

2.3.5.17 *Charge/no charge indicator*

Information (for national use only) sent in the backward direction that may be used to indicate that the call should not be charged at the originating exchange.

2.3.6 *Basic call clearing and circuit state signals*

2.3.6.1 *Circuit released signal*

A signal sent in either direction indicating that the interexchange data circuit has been released.

2.3.6.2 *Circuit released acknowledgement signal*

A signal sent in either direction in response to the *circuit released* signal and indicating that the interexchange data circuit has been released.

2.3.6.3 *Reset circuit signal*

A signal sent to return the interexchange data circuit to the idle state at both ends in situations where, due to memory mutilation or other causes, the state of the circuit is ambiguous.

2.3.6.4 *Blocking signal*

A signal sent for maintenance purposes indicating to the exchange at the other end of the interexchange data circuit that the circuit has to be blocked for outgoing calls.

2.3.6.5 *Unblocking signal*

A signal sent to cancel the blocked condition at the exchange at the other end of the interexchange data circuit caused by an earlier *blocking* signal.

2.3.6.6 *Blocking acknowledgement signal*

A signal sent in response to a *blocking* signal indicating that the interexchange data circuit has been blocked.

2.3.6.7 *Unblocking acknowledgement signal*

A signal sent in response to an *unblocking* signal indicating that the interexchange data circuit has been unblocked.

2.3.7 *Additional signals relating to the closed user group facilities*

2.3.7.1 *Closed user group call indicator*

Information sent in the forward direction and in some circumstances in the backward direction, indicating whether or not the call involves a closed user group, whether an interlock code is included in the message and whether or not outgoing access is allowed for the calling user.

2.3.7.2 *Interlock code*

Information sent in the forward direction, and in some circumstances, in the backward direction, identifying a closed user group to which the calling user belongs.

2.3.8 *Additional signals relating to the bilateral closed user group and the bilateral closed user group with outgoing access facilities*

2.3.8.1 *Bilateral closed user group call indicator*

Information sent in the forward direction, indicating whether or not the call is a call within a bilateral closed user group.

2.3.8.2 *Registration request signal*

A signal sent in the forward direction, indicating that facility registration is required.

2.3.8.3 *Cancellation request signal*

A signal sent in the forward direction, indicating that facility cancellation is required.

2.3.8.4 *Registration completion signal*

A signal sent in the backward direction, indicating that facility registration is completed at the destination exchange. At the originating exchange, it results in sending a *registration/cancellation confirmed* call progress signal to the calling user.

2.3.8.5 *Registration accepted signal*

A signal sent in the backward direction, indicating that facility registration is accepted at the destination exchange. At the originating exchange it results in sending a *registration/cancellation confirmed* call progress signal to the calling user.

2.3.8.6 *Cancellation completed signal*

A signal sent in the backward direction, indicating that facility cancellation is completed at the destination exchange. At the originating exchange it results in sending a *registration/cancellation confirmed* call progress signal to the calling user.

2.3.8.7 *Local index*

Information sent in the forward direction and backward direction at bilateral closed user group registration. It indexes the subscriber file to identify the particular bilateral closed user group at the originating or destination exchange.

2.3.9 *Additional signals relating to the calling line identification facility*

2.3.9.1 *Calling line identification request indicator*

Information sent in the backward direction, indicating whether or not the calling line identity should be sent forward.

2.3.9.2 *Calling line identity indicator*

Information sent in the forward direction, indicating whether, and what form of, a calling line identity is included in the message.

2.3.9.3 *Calling line identity*

Information sent in the forward direction, consisting of a number of address signals indicating the (international) data number of the calling user.

2.3.10 *Additional signals relating to the called line identification facility*

2.3.10.1 *Called line identification request indicator*

Information sent in the forward direction, indicating whether or not the called line identity should be returned.

2.3.10.2 *Called line identity indicator*

Information sent in the backward direction, indicating whether, and what form of,the called line identity is included in the message.

2.3.10.3 *Called line identity*

Information sent in the backward direction, consisting of a number of address signals indicating the (international) data number of the called user.

2.3.11 *Additional signals relating to redirection of calls facility*

2.3.11.1 *Redirection request signal*

A signal (for national use only) sent in the backward direction, indicating that the called user has requested redirection of calls to another address.

2.3.11.2 *Redirection address indicator*

Information (for national use only) sent in the backward direction, indicating that a redirection address is included in the message.

2.3.11.3 *Redirection address*

Information (for national use only) sent in the backward direction, consisting of a number of address signals, indicating the data number to which the call is to be redirected.

2.3.11.4 *Redirected call indicator*

Information (for national use only) sent in the forward direction, indicating that the call is a redirected call. This indicator is used to prevent a further redirection, if the user at the new address has also requested redirection of calls.

2.3.11.5 *Redirected call 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 user. At the originating exchange, it results in sending a *redirected* call progress signal.

2.3.12 *Additional signals relating to the connect when free and waiting allowed facilities*

2.3.12.1 *Connect when free signal*

A signal sent in the backward direction, indicating that the called user, having the *connect when free* facility, is busy and that the call has been placed in a queue. At the originating exchange it results in sending a *connect when free* call progress signal to the calling user if he has the *waiting allowed* facility or, if not, in sending the *number busy* call progress signal and clearing the call.

2.3.13 *Additional signals relating to the reverse charging and reverse charge acceptance facilities*

2.3.13.1 *Reverse charging request indicator*

Information sent in the forward direction, indicating that reverse charging is requested by the calling user.

2.3.13.2 *Reverse charge acceptance not subscribed signal*

A signal sent in the backward direction, indicating rejection of the call because the called user does not subscribe to the *reverse charge acceptance* facility. At the originating exchange it results in sending a *reverse charge acceptance not subscribed* call progress signal to the calling user.

2.3.14 *Additional signals relating to manual answer*

2.3.14.1 *Terminal called*

A signal sent in the backward direction, indicating that the called user operates with manual answer. At the originating exchange it results in sending a *terminal called* call progress signal to the calling user.

2.3.15 *Additional signals relating to the RPOA selection facilities*

2.3.15.1 *RPOA selection indicator*

Information (for national use only) sent in the forward direction, indicating whether or not the calling user requires selection of an RPOA for international call routing at the international gateway. When RPOA selection is required, it also indicates that a RPOA transit network identity is included in the message.

2.3.15.2 *RPOA transit network identity*

Information (for national use only) sent in the forward direction, identifying the requested RPOA transit network by its DNIC.

2.3.15.3 *RPOA out of order signal*

A signal (for national use only) sent in the backward direction, indicating that the call cannot be completed, because the selected RPOA transit network is not available for service. At the originating exchange, it results in sending an *RPOA out of order* call progress signal to the calling user.

2.3.16 *Additional signals relating to the network identification utilities*

2.3.16.1 *Network identity*

Information sent in either direction, identifying an originating, a transit or destination network by its DNIC.

2.3.16.2 *Originating network identification request indicator*

Information sent in the backward direction, indicating whether or not the originating network identity should be sent forward.

2.4 *Data channel signalling conditions*

These are interexchange data channel conditions employed in the call set-up and clear-down procedures. The conditions defined in § 2.4 are based on the characteristics of the relevant DTE/DCE interfaces for the circuit-switched service. The implications of other possible new DTE/DCE interfaces on these conditions have not yet been determined.

2.4.1 *Trunk free condition*

A condition transmitted in the forward or backward interexchange data channels when the circuit is free or under release at the sending exchange.

2.4.2 *Trunk seized condition*

A condition transmitted in the forward interexchange data channel when the circuit is seized but not through-connected.

2.4.3 *Call accepted condition*

A condition appearing in the backward interexchange data channel, indicating that all the succeeding exchanges involved in the connection have connected through. This condition is sent by the called user and corresponds to the *call accepted* state at the DTE/DCE interface.

2.4.4 *Clear request condition*

A condition, appearing in the forward and backward interexchange data channels, sent by the user when requesting to clear the call.

3 Formats and codes

3.1 *Basic format characteristics*

3.1.1 *General*

The data signalling messages are carried on the signalling data link by means of Signal Units (SU), the format of which is described in the specifications of the Message Transfer Part (MTP), see Recommendation Q.703 [3].

The data signalling messages are divided into two categories, call and circuit related messages and facility registration and cancellation related messages. The Service Indicator (SI) included in each signal unit identifies to which category the message belongs.

The signalling information of each message constitutes the Signalling Information Field (SIF) of the corresponding SU signal unit and consists of an integral number of octets. It basically contains the label, the heading code and one or more signals and/or indicators.

3.1.2 *Service information octet*

3.1.2.1 *Format*

The service information octet comprises the service indicator and the subservice field.

The service indicator is used to associate signalling information with a particular User Part and is only used with message signal units (see Recommendation Q.703 [3]).

The information in the subservice field permits a distinction to be made between national and international signalling messages. In national applications when this discrimination is not required, possibly for certain national User Parts only, the subservice field can be used independently for different User Parts.

The format of the service information octet is shown in Figure 1/X.61.

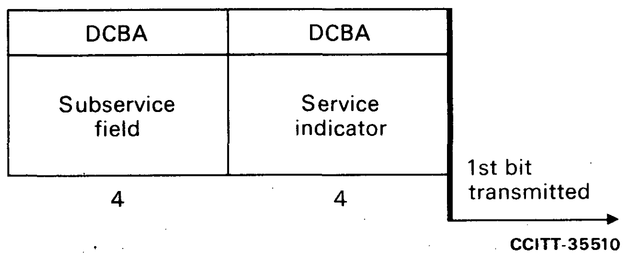


FIGURE 1/X.61
Service information octet

3.1.2.2 *Service indicator*

The service indicator will be coded as follows:

Bits: DCBA

0 1 1 0 call and circuit related messages
0 1 1 1 facility registration and cancellation messages.

The use of other service indicator codes is specified in Recommendation Q.704 [2].

3.1.2.3 *Subservice field*

The subservice field is coded as shown in Table 1/X.61.

TABLE 1/X.61

Bits:	BA	Spare
	DC	National indicator
	0 0	international message
	0 1	spare (for international use)
	1 0	national message
	1 1	reserved for national use

Note – Bits A and B are spare for possible needs that may require a common solution for all international User Parts and MTP level 3. Each bit is coded 0.

3.1.3 *Format principles*

The user generated information in the signalling information field is, in general, divided into a number of subfields which may be of either fixed or variable length. The first field is the label field, see § 3.2. Following the label field is a heading code H0 which, possibly together with a following subheader H1, identifies the structure of the message. Other fields may be mandatory or optional on a per individual message basis, the presence or absence of optional fields being indicated by field indicators. Each field indicated below is mandatory unless explicitly indicated as optional.

3.1.4 *Order of bit transmission*

Within each defined subfield the information is transmitted least significant bit first.

3.1.5 *Coding of spare bits*

Each spare bit is coded 0 unless otherwise indicated.

3.1.6 *Indicators for national use only*

A number of indicators specified are indicated as for national use only. In international use the corresponding bits are coded 0 and are, as regards their interpretation, equivalent to spare bits.

3.2 *Label*

3.2.1 *General*

The label is an item of information which forms part of every signalling message and is used by the message routing function at MTP Level 3 to select the appropriate signalling route and by the User Part function to identify the particular transaction (e.g. the call) to which the message pertains.

In general, the label information encompasses an explicit or implicit indication of the message source and destination and, depending on the application, various forms of transaction identification.

For call and circuit related messages the transaction is conveniently identified by including the corresponding circuit identity in the label. In the following, two such label structures are specified:

- a basic label structure which, consistent with the standard telephone label structure (Recommendation Q.723 [4]), is designed to meet the requirements for identification of data circuits derived from standard data multiplexers (see Recommendations X.50 and X.51);
- an alternative label structure, identical to the standard telephone label structure, which may be used in applications where the data circuits use full 64-kbit/s digital circuits without submultiplexing.

For facility registration and cancellation related messages the specified label structure is equivalent to the standard routing label of the MTP, see [2].

Note – The indication (48) below the label field in Figures 5/X.61 to 11/X.61 refers to the basic label, which is described in § 3.2.2, but is intended to show that other label lengths are possible.

3.2.2 *Basic label for call and circuit related messages*

3.2.2.1 *General*

The basic label has a length of 48 bits and is placed at the beginning of the signalling information field. The format is as shown in Figure 2/X.61.

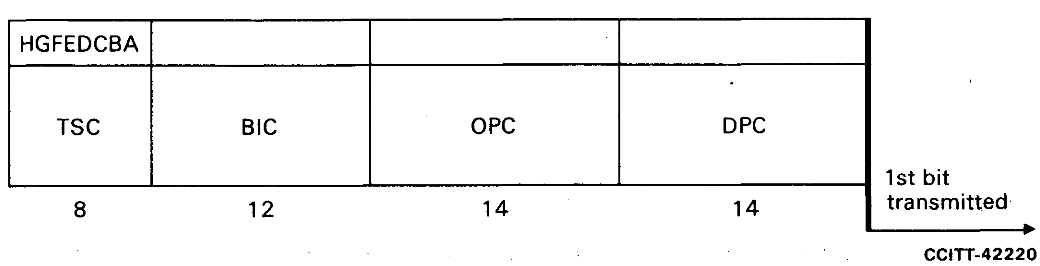


FIGURE 2/X.61

Basic label for data call and circuit related messages

The general function of the label components is defined in § 3.2.1. The portion of the basic label that consists of the Destination Point Code (DPC) and Originating Point Code (OPC) fields and the four least significant bits of the Bearer Identification Code (BIC) field corresponds to the standard routing label specified in Recommendation Q.704 [2].

3.2.2.2 *Destination and originating point codes*

The standard structure requires that each data switching exchange in its role as a signalling point is allocated a code from a code plan established for the purpose of unambiguous identification of signalling points.

Separate code plans will be used for the international signalling network and for different national signalling networks.

The principles of code allocation which apply to the international signalling network are for further study.

The destination point code will be the code applicable to the data switching exchange to which the message is to be delivered. The originating point code will be the code applicable to the data switching exchange from which the message is sent.

3.2.2.3 *Bearer identification code*

The allocation of bearer identification codes to individual bearers is determined by bilateral agreement and/or in accordance with applicable predetermined rules.

For bearers which form part of a 2.048-Mbit/s PCM system according to Recommendation G.734 [5], the bearer identification code contains in the 5 least significant bits a binary representation of the actual number of the time slot which is assigned to the bearer. The remaining bits of the bearer identification code are used where necessary, to identify one among several systems, interconnecting the originating point and destination point.

For bearers which form part of a 8.448-Mbit/s PCM system the bearer identification code will be coded in accordance with the scheme specified for the circuit identification code for the corresponding case in Recommendation Q.723 [4].

3.2.2.4 *Time slot code*

The coding of the time slot code (TSC) is as follows (bit numbering as in Figure 2/X.61):

a) In the case where the data circuit is derived from the data multiplex carried by the bearer, identified by the bearer identification code:

   – bits ABCD will contain, in pure binary representation, the channel number of the circuit within the 12.8-kbit/s (Recommendation X.50) or 12-kbit/s (Recommendation X.51) phase; the channel number being in the range (see Recommendations X.50, X.51, X.53 and X.54):

     0-15 for 600-bit/s circuits
     0- 3 for 2400-bit/s circuits
     0- 1 for 4800-bit/s circuits
     0 for 9600-bit/s circuits

   – bits EFG will contain, in pure binary representation, the number of the 12.8-kbit/s or 12-kbit/s phase, the phase number being in the range 0-4;

   – bit H will be coded 0.

b) In the case where the data circuit uses the full 64-kbit/s bearer rate, the time slot code will be 01110000.

3.2.3 *Alternative label for call and circuit related messages*

In applications where all data circuits use full 64-kbit/s digital circuits, a label structure as shown in Figure 3/X.61 may be used in mutual agreement.

This label structure is equivalent to the standard telephone label structure specified in Recommendation Q.704 [2]. The destination point code (DPC) and originating point code (OPC) fields are as in the basic label structure and the Circuit Identification Code (CIC) is as the bearer identification code field in the basic label structure (see § 3.2.2).

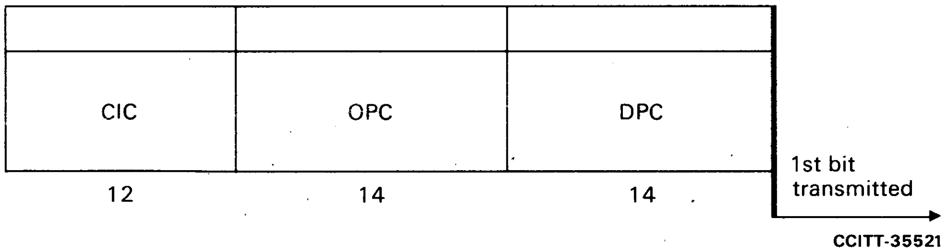


FIGURE 3/X.61
Alternative label for data and circuit related messages

3.2.4 *Standard label for facility registration and cancellation messages*

Facility registration and cancellation messages will have a label in accordance with Figure 4/X.61.

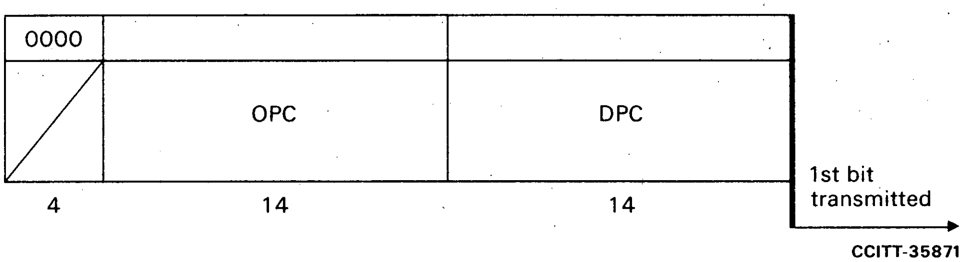


FIGURE 4/X.61
Standard label for facility registration and cancellation messages

This label structure is equivalent to the standard routing label specified for the MTP (see Recommendation Q.704 [2]). The destination point code (DPC) and originating point code (OPC) fields are used as for the basic label, see § 3.2.2.

3.2.5 *Modified label*

In cases where the data transmission service is provided by public data networks comprising few exchanges and signalling relations, it may be attractive to use shorter labels than those specified in §§ 3.2.2 to 3.2.4. In such applications a modified label, having the same order and function, but possibly different sizes, of subfields may be used in mutual agreement. In such a case the label used for MTP Level 3 messages should be modified accordingly. Also, in some national applications it may be necessary to use an extended modified label.

3.3 *Formats and codes for call and circuit related messages*

3.3.1 *Heading*

The different heading codes (H0) for the call and circuit control messages are allocated as shown in Table 2/X.61.

TABLE 2/X.61

0000	spare
0001	address message
0010	calling line identification messages
0011	spare
0100	call accepted messages
0101	call rejected messages
0110	clear messages
0111	circuit state messages
1000 to 1111	spare

3.3.2 *Address message*

3.3.2.1 The format of the address message is as shown in Figure 5/X.61.

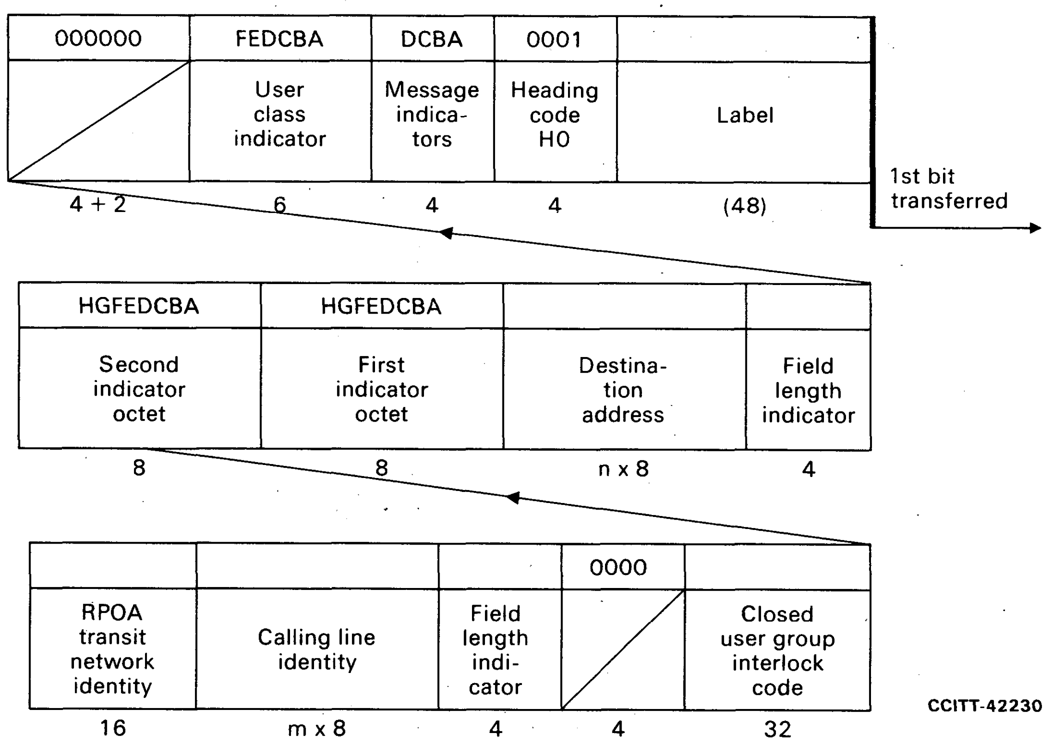


FIGURE 5/X.61
Address message

The fields, subfields and codes are as follows:

3.3.2.2 *Label*

See § 3.2.

3.3.2.3 *Heading code H0*

See § 3.3.1.

3.3.2.4 *Message indicator*

The coding is shown in Table 3/X.61.

TABLE 3/X.61

Bit	
A	Field indicator of first indicator octet
0	first indicator octet not included
1	first indicator octet included
B	DCC/DNIC indicator (national use only, see § 3.1.6)
0	DCC/DNIC included in destination address
1	DCC/DNIC not included in destination address
C	National/international call indicator (national use only, § 3.1.6)
0	international call
1	national call
D	Alternative routing indicator
0	no alternative routing made
1	alternative routing made

3.3.2.5 *User class indicator*

The coding is shown in Table 4/X.61.

TABLE 4/X.61

Bits FEDCBA		
000000 to 100000	spare	
100001 to 100110	asynchronous user classes, as applicable; bits ABC coded as bits b1, b2, b3 of first user class character in Recommendation X.71	
100111 to 101111	spare	
110000	600 bit/s (user class 3)	Synchronous user classes corresponding to second user class charter in Recommendation X.71
110001	2400 bit/s (user class 4)	
110010	4800 bit/s (user class 5)	
110011	9600 bit/s (user class 6)	
110100	48000 bit/s (user class 7)	
110101 to 111011	spare	
111100 to 111111	reserved for national use	

3.3.2.6 *Spare bits*

3.3.2.7 *Field length indicator*

A code expressing in pure binary representation the number of address signals in the destination address.

3.3.2.8 *Destination address field*

This field is divided into an even number of semi-octets. The decimal value of each destination address digit is expressed in pure binary representation of an address signal. The digits are sent in descending order with most significant digit first. In case of an odd number of address signals a 4-bit 0000 filler code is included in the last semi-octet of the field.

3.3.2.9 *First indicator octet*

This is an optional field that is included if indicated in bit A of the message indicators. The coding is shown in Table 5/X.61.

TABLE 5/X.61

Bits B A	Calling line identity indicator
0 0	calling line identity not included
0 1	calling line identity without DCC/DNIC included (national use only)
1 0	DCC/DNIC only included
1 1	calling line identity with DCC/DNIC included
D C	CUG call indicator
0 0	ordinary call
0 1	spare
1 0	CUG call, outgoing access allowed
1 1	CUG call, outgoing access not allowed
E	BCUG call indicator
0	ordinary call
1	BCUG call
F	Reserved for charging information indicator; coded 0
G	Reserved for an additional routing information indicator; coded 0
H	Field indicator of the second indicator octet
0	second indicator octet not included
1	second indicator octet included

3.3.2.10 *Second indicator octet*

This is an optional field that is included if indicated in bit H of the first indicator octet. The coding is shown in Table 6/X.61.

TABLE 6/X.61

Bit A	Redirected call indicator (national use only, see § 3.1.6)
0	ordinary call
1	redirected call
B	RPOA selection indicator (national use only, see § 3.1.6)
0	no RPOA code included
1	RPOA code included
C	Reverse charging request indicator
0	no reverse charging request
1	reverse charging request
D	Called line identification request indicator
0	no called line identification requested
1	called line identification requested
E, F, G	Spare
H	Reserved for field indicator for third indicator octet; coded 0

3.3.2.11 *Closed user group interlock code*

This is an optional field that is included only when indicated in bits CD in the first indicator octet. The format of the interlock code is in accordance with Figure 6/X.61.

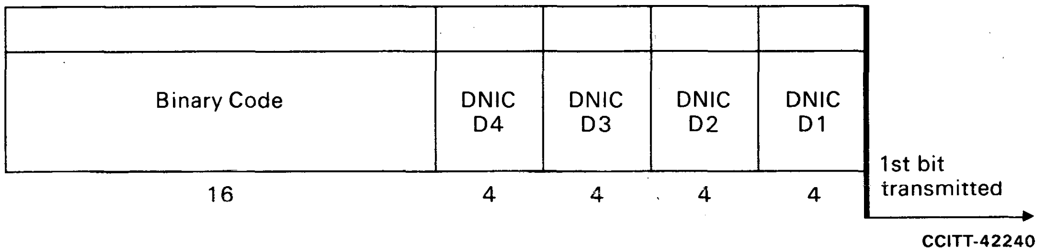


FIGURE 6/X.61
Format of interlock code

Each of the first four semi-octets contains a decimal digit, the value of which is expressed in pure binary representation, of the DNIC (or DCC plus one digit) of the coordinating Administration of the closed user group concerned (see Recommendation X.87). The 16-bit binary code is the code assigned to the closed user group concerned.

3.3.2.12 *Spare bits*

Included only when the calling line identity is included.

3.3.2.13 *Field length indicator*

This is an optional field that is included only when the calling line identity is included. It is a code expressing in pure binary representation the number of address signals in the calling line identity included.

3.3.2.14 *Calling line identity*

This is an optional field that is included only if indicated in bits AB of the first indicator octet. This field is divided into an even number of semi-octets. It contains a number of decimal digits of the national or international data number of the calling line or of the DNIC of the originating network. The coding of each digit, their order of transmission and the use of a filler code is as specified in § 3.3.2.8.

3.3.2.15 *RPOA transit network identity*

This is an optional field that is included only if indicated in bit B in the second indicator octet. This field is divided into four semi-octets, each of which contains a decimal digit of the applicable DNIC. The coding and order of transmission of these digits is as specified in § 3.3.2.8.

3.3.3 *Call accepted message*

3.3.3.1 The format of the call accepted message is as shown in Figure 7/X.61.

The fields, subfields and codes are as follows:

3.3.3.2 *Label*

See § 3.2.

3.3.3.3 *Heading code H0*

See § 3.3.1.

3.3.3.4 *Signal*

The signal information is coded as shown in Table 7/X.61 (corresponding call progress signal digits, as applicable, are indicated within brackets).

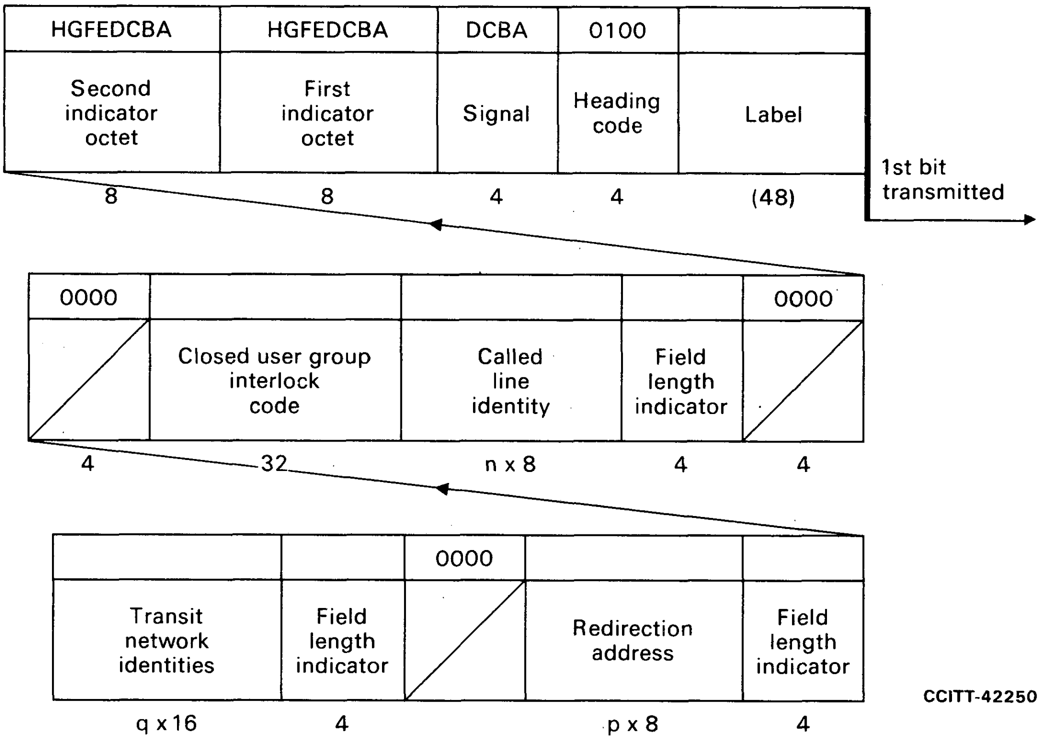


FIGURE 7/X.61

Call accepted message

TABLE 7/X.61

Bits DCBA	
0000	reserved for call progress signal code 00
0001	terminal called (01)
0010	redirected call (02)
0011	connect when free (03)
0100 to 1001	spare
1010	call accepted
1011	transit through connect
1100	redirection request
1101 to 1111	spare

3.3.3.5 *First indicator octet*

The coding is shown in Table 8/X.61.

TABLE 8/X.61

Bits	B A	Called line identity indicator
	0 0	called line identity not included
	0 1	called line identity without DCC/DNIC included (national use only)
	1 0	DCC/DNIC only included
	1 1	called line identity with DCC/DNIC included
	C	Charge/no charge indicator (national use only, see § 3.1.6)
	0	normal charging
	1	no charging
	D	Calling line identity request indicator
	0	calling line identification not requested
	1	calling line identification requested
	E	Originating network identification request indicator
	0	originating network identification not requested
	1	originating network identification requested
	F	Transit network identity indicator
	0	no transit network identity included
	1	one or more transit network identity(ies) included
	G	Spare
	H	Field indicator of the second indicator octet
	0	second indicator octet not included
	1	second indicator octet included

3.3.3.6 *Second indicator octet*

An optional field that is included if indicated in bit H of the first indicator octet. The coding is shown in Table 9/X.61.

TABLE 9/X.61

Bits	B A	Redirection address indicator (national use only, see § 3.1.6)
	0 0	redirection address not included
	0 1	redirection address without DCC/DNIC included
	1 0	spare
	1 1	redirection address with DCC/DNIC included
	D C	CUG call indicator (national use only, see § 3.1.6)[a)]
	0 0	ordinary call
	0 1	spare
	1 0	CUG call, outgoing access allowed
	1 1	CUG call, outgoing access not allowed
	E, F, G	Spare
	H	Reserved for field indicator of a third indicator octet; code 0

[a)] Note that CUG information is only applicable to CUG calls that are redirected, see Recommendation X.87.

3.3.3.7 *Spare bits*

Included only when the called line identity is included.

3.3.3.8 *Field length indicator*

An optional field that is included only when the called line identity is included. It is a code expressing in pure binary representation the number of address signals in the called line identity included.

3.3.3.9 *Called line identity*

An optional field that is included only if indicated in bits AB in the first indicator octet. This field is divided into an even number of semi-octets. It contains a number of decimal digits of the national or international data number of the called line or of the DNIC of the destination network. The coding of each digit, their order of transmission and the use of the filler code is as specified in § 3.3.2.8.

3.3.3.10 *Closed user group interlock code*

An optional field that is included only if indicated in bits CD of the second indicator octet. The format and code of the interlock code is as specified in § 3.3.2.11.

3.3.3.11 *Spare bits*

An optional field that is included only when a redirection address is included.

3.3.3.12 *Field length indicator*

An optional field that is included only when a redirection address is included. It is a code expressing in pure binary representation the number of address signals in the redirection address included.

3.3.3.13 *Redirection address*

An optional field that is included only if indicated in bits AB of the second indicator octet. This field is divided into an even number of semi-octets. It contains a number of decimal digits. The coding of each digit, their order of transmission and the use of the filler code is as specified in § 3.3.2.8.

3.3.3.14 *Spare bits*

Included only when at least one transit network exchange is included.

3.3.3.15 *Field length indicator*

An optional field that is included when at least one transit network identity is included. It is a code expressing in pure binary representation the number of transit network identities, i.e. the number of 16-bit subfields in the transit network identity field.

3.3.3.16 *Transit network identities*

An optional field that is included only when indicated in bit F of the first indicator octet. This field contains one or more 16-bit subfields, each divided into 4 semi-octets. The coding of each digit and their order of transmission is as specified in § 3.3.2.8.

3.3.4 *Call rejected message*

3.3.4.1 The format of the call rejected message is as shown in Figure 8/X.61.

			DCBA	0101	
Network identity of origin	Second digit	First digit	Indi-cators	Heading code	Label
16	4	4	4	4	(48)

1st bit transmitted →

CCITT-35550

FIGURE 8/X.61
Call rejected message

The fields, subfields and codes are as follows:

3.3.4.2 *Label*

See § 3.2.

3.3.4.3 *Heading code*

See § 3.3.1.

3.3.4.4 *Indicators*

The coding is shown in Table 10/X.61.

TABLE 10/X.61

Bit	A	Reserved for a field indicator of a possible optional field for extended call progress information
	B	Field indicator of network identity of origin
	0	network identity of origin not included
	1	network identity of origin included
	C	Spare
	D	Reserved for a possible indication that immediate clearing should not take place; coded 0

3.3.4.5 *First and second digit*

Each of the two fields contains a decimal digit expressed in pure binary representation. The combination of the two decimal digits expresses the signal indicating the cause for call rejection. The values of the decimal digits are as shown in Table 11/X.61. This coding should be consistent with the corresponding coding of DTE/DCE interface call progress signals, see Recommendation X.21 [6].

Note 1 – An interexchange signal not corresponding to a specific DTE/DCE interface call progress signal will, as required, be coded by over-decadic combination of the two digits.

Note 2 – Some of the call progress signal code groups specified in Recommendation X.21 [6] correspond to other message types than the call rejected message.

Note 3 – The reverse charge acceptance not subscribed signal has not yet been assigned a code.

TABLE 11/X.61

Digits	20	network failure
	21	number busy
	41	access barred
	42	changed number
	43	not obtainable
	44	out of order
	45	controlled not ready
	46	uncontrolled not ready
	47	DCE power off
	48	invalid facility request [a]
	49	network fault in local loop
	51	call information service
	52	incompatible user class of service
	61	network congestion
	71	degraded service
	72	RPOA out of order

[a] Applicable to the facility registration/cancellation request rejected message only, see § 3.4.4.4.

3.3.4.6 *Network identity of origin*

This is an optional field that is included only if indicated in bit A of the indicator field. It contains the network identity of the exchange rejecting the call and thus originating the message. This field is divided into four semi-octets, each of which contains a decimal digit of the DNIC of the origin of the message. The coding and order of transmission of these digits is as specified in § 3.3.2.8. Inclusion of this field is mandatory for international traffic.

3.3.5 *Clear message*

3.3.5.1 The format of the clear message is as shown in Figure 9/X.61.

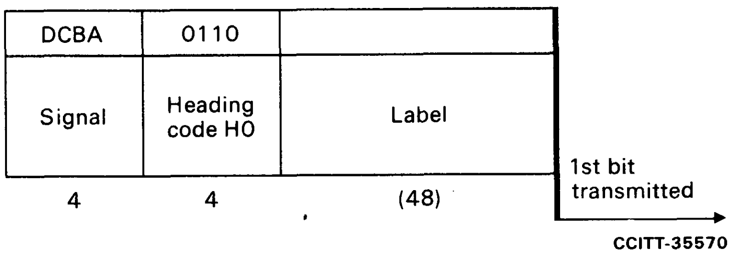


FIGURE 9/X.61
Clear message

The fields and codes are as follows:

3.3.5.2 *Label*

See § 3.2.

3.3.5.3 *Heading code H0*

See § 3.3.1.

3.3.5.4 *Signal*

The coding is shown in Table 12/X.61.

TABLE 12/X.61

Bits DCBA	
0000	spare
0001	spare
0010	circuit released (forward)
0011	circuit released acknowledgement (forward)
0100 to 1001	spare
1010	circuit released (backward)
1011	circuit released acknowledgement (backward)
1100 to 1111	spare

3.3.6 *Circuit state message*

3.3.6.1 The format of the circuit state message is as shown in Figure 10/X.61.

DCBA	0111	
Signal	Heading code H0	Label
4	4	(48)

1st bit transmitted

CCITT-35570

FIGURE 10/X.61

Circuit state message

The fields and codes are as follows:

3.3.6.2 *Label*

See § 3.2.

3.3.6.3 *Heading code H0*

See § 3.3.1.

3.3.6.4 *Signal*

The coding is shown in Table 13/X.61.

TABLE 13/X.61

Bits DCBA	
0 0 0 0	spare
0 0 0 1	spare
0 0 1 0	blocking
0 0 1 1	blocking acknowledgement
0 1 0 0	unblocking
0 1 0 1	unblocking acknowledgement
0 1 1 0	spare
0 1 1 1	reset circuit
1 0 0 0 to 1 1 1 1	spare

3.3.7 *Calling line identity message*

3.3.7.1 The format of the calling line identity message is as shown in Figure 11/X.61.

		0000	DCBA	0010	
Calling line identity	Field length indicator		Indicators	Heading code H0	Label
m x 8	4	4	4	4	(48)

1st bit transmitted

CCITT-35551

FIGURE 11/X.61

Calling line identity message

The fields, subfields and codes are as follows:

3.3.7.2 *Label*

See § 3.2.

3.3.7.3 *Heading code H0*

See § 3.3.1.

3.3.7.4 *Indicators*

The coding is showm in Table 14/X.61.

TABLE 14/X.61

Bits	BA	Calling line identity indicator
	0 0	calling line identity not included[a]
	0 1	calling line identity without DCC/DNIC included (national use only)
	1 0	DCC/DNIC only included
	1 1	calling line identity with DCC/DNIC included
	C, D	Spare

[a] As presently defined, this message always includes the calling line identity.

3.3.7.5 *Spare bits*

Included only when the calling line identity is included.

3.3.7.6 *Field length indicator*

This is an optional [2] field that is included only when the calling line identity is included. It is a code expressing in pure binary representation the number of address signals in the calling line identity.

3.3.7.7 *Calling line identity*

This is an optional [2] field that is included only if indicated in bits AB of the indicator field. See also § 3.3.2.14.

3.4 *Formats and codes for facility registration and cancellation messages*

3.4.1 *Heading*

The different heading codes (H0) for the facility registration and cancellation messages are shown in Table 15/X.61.

TABLE 15/X.61

0000	spare
0001	facility registration/cancellation request message
0010	facility registration/cancellation accepted messages
0011	facility registration/cancellation rejected messages
0100 to 1111	spare

[2] As presently defined, this message always includes the calling line identity.

3.4.2 *Facility registration/cancellation request message*

3.4.2.1 The format of the facility registration/cancellation request message is as shown in Figure 12/X.61.

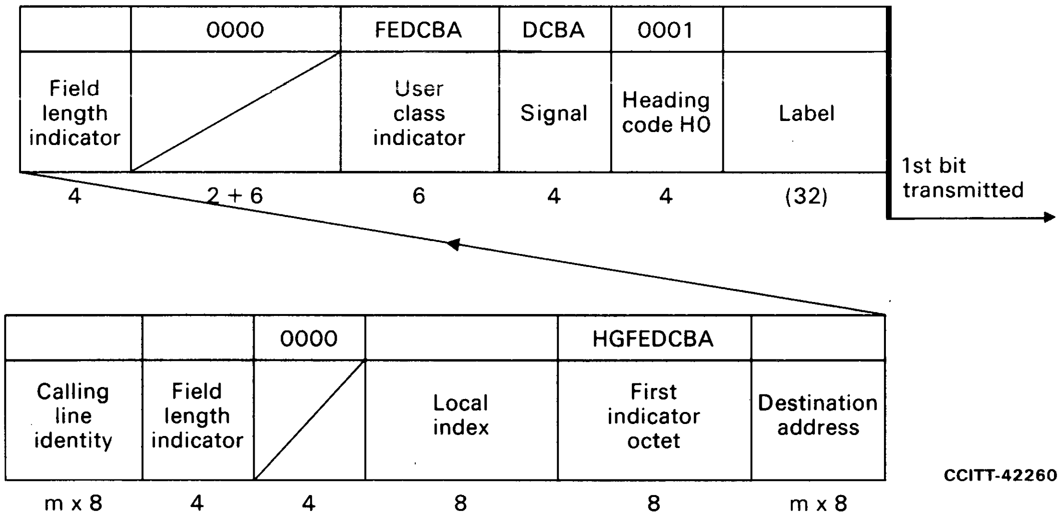


FIGURE 12/X.61
Facility registration/cancellation request message

The fields, subfields and codes are as follows:

3.4.2.2 *Label*

See § 3.2.

3.4.2.3 *Heading code H0*

See § 3.4.1.

3.4.2.4 *Signal*

The coding is shown in Table 16/X.61.

TABLE 16/X.61

Bits DCBA	
0000	spare
0001	registration request
0010	cancellation request
0011 to 1111	spare

3.4.2.5 *User class indicator*

See § 3.3.2.5.

3.4.2.6 *Spare bits*

3.4.2.7 *Field length indicator*

See § 3.3.2.7.

3.4.2.8 *Destination address*

See § 3.3.2.8.

3.4.2.9 *First indicator octet*

The coding is shown in Table 17/X.61.

TABLE 17/X.61

Bits		
	BA	Calling line identity indicator
	0 0	calling line identity not included
	0 1	calling line identity without DCC/DNIC included (national use only)
	1 0	DCC/DNIC only included
	1 1	calling line identity with DCC/DNIC included
	C	BCUG indicator
	0	no BCUG registration/cancellation
	1	BCUG registration/cancellation
	D	Field indicator for local index
	0	local index not included
	1	local index included
	E, F, G	Spare
	H	Reserve for field indicator for second indicator octet; coded 0

3.4.2.10 *Local index*

This is an optional field that is included only if indicated in bit D in the first indicator octet. In the case of registration request it is the local index assigned by the user requesting registration. In the case of cancellation request it is the local index assigned by the remote user in the BCUG being cancelled.

3.4.2.11 *Spare bits*

Included only when the calling line identity is included.

3.4.2.12 *Field length indicator*

This is an optional field that is included only when the calling line identity is included. The code is as specified in § 3.3.2.13.

3.4.2.13 *Calling line identity*

This is an optional field that is included only if indicated in bits AB in the first indicator octet. The structure and codes are as specified in § 3.3.2.14.

3.4.3 *Facility registration/cancellation request accepted message*

3.4.3.1 The format of the facility registration/cancellation request message is as shown in Figure 13/X.61.

	HGFEDCBA			0000	DCBA	0010	
Local index	First indicator octet	Destination address	Field length indicator	/	Signal	Heading code H0	Label
8	8	n x 8	4	4	4	4	(32)

1st bit transmitted →

CCITT-42270

FIGURE 13/X.61

Facility registration/cancellation request accepted message

The fields, subfields and codes are as follows:

3.4.3.2 *Label*

See § 3.2.

3.4.3.3 *Heading code H0*

See § 3.4.1.

3.4.3.4 *Signal*

The coding is shown in Table 18/X.61.

TABLE 18/X.61

Bits	0000	spare
	0001	registration completion
	0010	registration accepted
	0011	cancellation completed
	0100 to 1111	spare.

3.4.3.5 *Spare bits*

3.4.3.6 *Field length indicator*

See § 3.3.2.7.

3.4.3.7 *Destination address*

See § 3.3.2.8.

3.4.3.8 *First indicator octet*

The coding is shown in Table 19/X.61.

TABLE 19/X.61

Bits	A	Spare
	B	BCUG indicator
	0	no BCUG registration/cancellation
	1	BCUG registration/cancellation
	C	Field indicator for local index
	0	local index not included
	1	local index included
	D-G	Spare
	H	Reserved for field indicator for second indicator octet; coded 0

3.4.3.9 *Local index*

This is an optional field that is included only if indicated in bit C of the first indicator octet. It contains the local index of the user at the exchange from which the message is originated.

3.4.4 *Facility registration/cancellation request rejected message*

3.4.4.1 The format of the facility registration/cancellation request rejected message is as shown in Figure 14/X.61.

				0011	
Destination address	Field length indicator	Second digit	First digit	Heading code H0	Label
n x 8	4	4	4	4	(32)

1st bit transmitted →

CCITT-35550

FIGURE 14/X.61

Facility registration/cancellation request rejected message

The fields, subfields and codes are as follows:

3.4.4.2 *Label field*

See § 3.2.

3.4.4.3 *Heading code*

See § 3.4.1.

3.4.4.4 *First and second digit*

Each of the two fields contains a decimal digit expressed in pure binary representation. The combination of the two decimal digits expresses the signal indicating the cause for facility registration/cancellation request rejection. The values of the decimal digits are as specified in § 3.3.4.5 for the relevant signals.

3.4.4.5 *Spare bits*

3.4.4.6 *Field length indicator*

See § 3.3.2.7.

3.4.4.7 *Destination address*

See § 3.3.2.8.

3.5 *Data channel signalling conditions*

The following conditions are those appearing in the interexchange data channels that in certain phases of a call have to be transmitted and/or detected in an exchange.

The coding of the presently specified data channel conditions is determined by the codes of the corresponding DTE/DCE interface states consistent with Recommendation X.21 [6].

The data channel signalling conditions will be coded as follows (data bits/status bit):

a) *trunk free* condition: 0 . . . 0/0 (see Notes 1 and 3),

b) *trunk seized* condition: 1 . . . 1/0,

c) *call accepted* condition: 1 . . . 1/1,

d) *call request* condition: 0 . . . 0/0.

The above codes imply that the code 0 of the status bit on an interexchange data channel results in the OFF condition at the DTE/DCE interface consistent with Recommendation X.21 [6], and that the code 1 results in the ON condition.

Note 1 – The code to be used for the *trunk free* condition in networks that cannot support bit sequence independence is for further study.

Note 2 – The implications for the data channel conditions, and their codes, of potential ISDN applications and/or of possible new DTE/DCE interfaces are a subject for further study.

Note 3 — As a national option, the data bits in the even positions of each envelope may be permanently inverted both at the transmitting and at the receiving ends of the interexchange data channels. Such inversion implies that the above specified codes (as well as information transferred during the data phase) will appear on the data channel correspondingly inverted. This option enables the *trunk free* condition in the case of the 8-bit envelope to be the same as the idle pattern for telephone channels as generated by a digital exchange complying with the standards related to the A-law.

4 Basic call control and signalling procedures

4.1 *General*

4.1.1 The call control procedures specified in this § 4 are based on the requirements of the circuit-switched data transmission service as presently defined in the Series X Recommendations. In particular, the requirements specified for exchange through-connection and data channel conditions are dependent on the characteristics of the present DTE/DCE interfaces for the circuit-switched service. Also, the implications of ISDN applications of common channel signalling for circuit-switched data transmission services have not yet been fully determined.

4.1.2 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 exchanges of conditions in the interexchange data channels are used to establish and terminate the different phases of the call.

4.1.3 The procedures specified in this § 4 in principle only relate to basic calls, i.e. calls not involving any user facilities. The additional requirements to be met in the cases of calls involving user facilities and network utilities are specified in § 5 and Recommendation X.87.

4.1.4 The interexchange data channel signalling conditions and the connect-through procedures specified ensure that the conditions in the network are compatible with the conditions and procedures for the present DTE/DCE interfaces.

4.1.5 Link-by-link transfer of signalling information assembled in messages is used and address information is signalled with all the elements of an address contained in one message. The network numbering is specified in Recommendation X.121. The network routing to apply is defined in Recommendation X.110.

4.1.6 Requirements of interworking with decentralized signalling are specified in Recommendation X.80.

4.2 *Overall call set-up and clear-down procedures*

The overall call set-up and clear-down procedures are outlined hereunder. The detailed signalling and switching procedures are covered in §§ 4.3 and 4.4 respectively. These procedures are illustrated in Tables 20/X.61 and 21/X.61.

4.2.1 *Call set-up*

4.2.1.1 When the originating exchange has received the complete selection information from the calling user and has determined that the call is to be routed to another exchange, it seizes a free interexchange data circuit and sends an address message on the signalling link. The address message in principle contains all of the information that is required to route and connect the call to the called user and may also include the calling line identity and other information related to any user facilities and network utilities that are required.

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 interexchange data circuit and sends an address message to the next exchange and connects through the data path. In the case of congestion at the transit exchange it may select an alternative route, or send a call rejected message to the preceding exchange indicating congestion and clearing of the call.

4.2.1.3 Upon receipt of an address message the destination exchange will analyse the destination address to determine to which user the call should be connected. It will also check the called user's line condition and perform various checks to verify whether or not the connection is allowed. These checks will include correspondance of user class and any checks associated with user facilities. In the case where the connection is allowed, the destination exchange will call the called user in accordance with the applicable DTE/DCE interface protocol. The called user will normally respond with a *call accepted* (or corresponding) signal. If the call cannot be completed due to, for instance, the called user being busy, a call rejected message indicating this is sent to the preceding exchange and clearing takes place.

4.2.1.4 At connection of the call the destination exchange normally sends a call accepted message to the preceding exchange. Depending on the circumstances the call accepted message may include information related to specific network conditions and any user facilities or network utilities involved (see § 5).

4.2.1.5 Upon receipt of a call accepted message a transit exchange sends the corresponding call accepted message to the preceding exchange. If it is an international transit exchange the applicable transit network identity (see § 5.11) will be included in the call accepted message.

4.2.1.6 When the originating exchange receives a call accepted message indicating that the call can be completed, it prepares to connect through the data path. The originating exchange then connects through and starts charging, as applicable. In certain cases, e.g. when certain user facilities are involved, data path through-connection is preceded by the sending of a call progress signal or other information to the calling user.

4.2.1.7 In the cases when the call cannot be completed, the originating exchange will send an appropriate call progress signal, indicating the cause of call rejection, to the calling user and clear the call.

4.2.2 *Call clear-down*

4.2.2.1 Normally the clearing action initiated by a user will propagate rapidly along the connection and initiate release at each exchange involved. When both users clear at approximately the same time, clearing will propagate from both ends.

4.2.2.2 When detecting a valid *clearing* signal from the local user, the originating or destination exchange will release the connection and send a clear message to the adjoining exchange. The *clearing* signals originated by a user will pass through the local exchange and will appear on the interexchange data circuits and at the distant local exchange until such time as the *clearing* signals are acted upon and the connection is released. The actions at the exchange releasing the connection, including the condition sent on the interexchange data circuits when released, are therefore specified to be consistent with the clearing procedures of the DTE/DCE interfaces.

4.2.2.3 Clearing may also be initiated by a data exchange during call set-up when the call cannot be connected due to a user or network condition.

4.2.2.4 After release of the connection the clearing procedure is completed for each interexchange data circuit individually. A data circuit is assumed to be free for a new call at an exchange when both the forward and backward clearing indications relating to that data circuit have been sent and received.

4.3 *Normal switching procedures*

4.3.1 *General*

4.3.1.1 The switching procedures specified hereunder define the actions to be performed at call set-up and clear-down and the sequencing of these actions in relation to the handling of signalling messages and data channel signalling conditions. The specified connect-through and release actions and the coding of the data channel signalling conditions (see § 3.4) are based on the requirement for consistency with the present DTE/DCE interface protocol for the circuit- switched service.

Note – The implications for the procedure specified hereunder of possible new DTE/DCE interfaces for the circuit-switched service are for further study.

4.3.1.2 The *trunk free* condition is sent on the free interexchange data channels. Also, at release of an interexchange data circuit, the *trunk free* condition is immediately applied to its transmit channel. Both directions of transmission must be through-connected at (approximately) the same time.

TABLE 20/X.61

Call set-up and clear-down procedure for successful basic call

Originating exchange	Interexchange data circuit →	Interexchange data circuit ←	Interexchange signalling link →	Interexchange signalling link ←	Transit exchange	Interexchange signalling link →	Interexchange signalling link ←	Interexchange data circuit →	Interexchange data circuit ←	Destination exchange
Trunk free condition	TF	TF			Trunk free condition			TF	TF	Trunk free condition
	I	I						I	I	
Selection information received	I	I						I	I	
Determine routing	I	I						I	I	
Free circuit seized	I	I						I	I	
Trunk seized sent	TS	I						I	I	
Address message sent	I	I	AM					I	I	
	I	I						I	I	
	I	I			Address message received			I	I	
	I	I			Routing determined			I	I	
	I	I			Free circuit seized			I	I	
	I	I			Data path connected			TS	I	
	I	I			Address message sent	AM		I	I	
	I	I						I	I	
	I	I						I	I	Address message received
	I	I						I	I	Called user determined
	I	I						I	I	State and validity checked[a]
	I	I						I	I	User called
	I	I						I	I	
	I	I						I	CA	Call accepted received
	I	I						I	I	Data path connected
	I	I					CAM	I	I	Call accepted message sent[a]
	I	I						I	I	
	I	I			Call accepted message received			I	I	
	I	I		CAM	Call accepted message sent			I	I	
	I	I						I	I	
Call accepted message received	I	I						I	I	
Call accepted condition received	I	CA						I	I	
Data path connected	I	I						I	I	
Charging started	I	I						I	I	

[a] Alternatively, the call accepted message can be sent before called user response.

[b] Optionally, remote user clear request condition may also be used as a release criterion.

Data circuit conditions

- TF Trunk free condition
- TS Trunk seized condition
- CA Call accepted condition
- RD Ready for data condition
- CR Clear request condition
- I Contiguous transmission of previous condition

Messages on signalling link

- AM Address message
- CAM Call accepted message
- CRM Call rejected message
- CLM Clear message

TABLE 20/X.61 *(continued)*

Call set-up and clear-down procedure for successful basic call

Originating exchange	Interexchange data circuit		Interexchange signalling link		Transit exchange	Interexchange signalling link		Interexchange data circuit		Destination exchange
	→	←	→	←		→	←	→	←	
Ready for data received	RD	RD						RD	RD	Ready for data received
by calling user	I	I						I	I	by called user
	I	I						I	I	
Data phase	Data	Data			Data phase			Data	Data	Data phase
	I	I						I	I	
Clear request received	CR	I						CR	I	Clear request received
from calling user	I	I						I	I	by called user[b)]
Data path released	I	I						I	I	
Clear message sent	I	I	CLM					I	I	
Trunk free sent	TF	I			Clear message received			I	CR	Clear request received
Clear confirmation	I	I			Data path released			I	I	from called user
sent to calling user	I	CR		CLM	Clear message sent on	CLM		I	I	Data path released
	I	I			both sides		CLM	I	I	Clear message sent
	I	TF			Free trunk sent on			TF	TF	Free trunk sent
Clear message received	I	I			both sides			I	I	Clear confirmation
(Outgoing) circuit free	I	I			(Incoming) circuit free			I	I	sent to called user
	I	I						I	I	
	I	I			Clear message received			I	I	Clear message received
	I	I			(Outgoing) circuit free			I	I	(Incoming) circuit free

a) Alternatively, the call accepted message can be sent before called user response.

b) Optionally, remote user clear request condition may also be used as a release criterion.

Data circuit conditions

TF Trunk free condition
TS Trunk seized condition
CA Call accepted condition
RD Ready for data condition
CR Clear request condition
I Contiguous transmission
I of previous condition

Messages on signalling link

AM Address message
CAM Call accepted message
CRM Call rejected message
CLM Clear message

TABLE 21/X.61

Call set-up and clear-down procedure for basic call with number busy

Originating exchange	Interexchange data circuit		Interexchange signalling link		Transit exchange	Interexchange signalling link		Interexchange data circuit		Destination exchange
	→	←	→	←		→	←	→	←	
Trunk free condition	TF	TF			Trunk free condition			TF	TF	Trunk free condition
Call set up as for successful call	TS		AM							
					Call set up as for successful call	AM		TS		
										Address message received
										Called user busy
										Call released
							CRM			Call rejected message sent
Call rejected message received					Call rejected message received					
Call released					Call released					
Calling user cleared				CRM	Call rejected message sent					
Clear message sent			CLM		Clear message sent	CLM				
Trunk free sent	TF	TF			Trunk free sent			TF		Clear message sent
(Outgoing) circuit free					(Outgoing) circuit free					(Incoming) circuit free

Note – For legends see end of Table 20/X.61.

4.3.1.3 The signalling information content in the signalling messages is specified in § 4.4. The time-out supervisions to be performed in relation to interexchange signalling and the procedures to be followed in abnormal conditions are specified in § 4.5.

4.3.2 *Call set-up*

4.3.2.1 *Originating exchange*

The call set-up actions are illustrated by means of a Specification and Description Language (SDL) diagram (see Recommendation Z.101 [7]) in Figure 15/X.61.

After having seized an interexchange data circuit, the originating exchange 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 call accepted message or call rejected message.

Upon receipt of a call accepted message 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 calling user as applicable. The originating exchange then monitors the backward interexchange data channel for the presence of the *call accepted* condition. When this condition is detected, indicating that all succeeding exchanges have connected through, the originating exchange connects through and initiates charging where applicable.

In the cases when a call rejected message is received, the appropriate call progress signal is sent to the calling user and clearing takes place. Receipt of a call rejected message may also occur after receipt of a previous call accepted message.

Note – The possible implications for the originating exchange connect-through procedures of the provision of start-stop services, by means of the Recommendation X.20 [8] interface, in a network using common channel signalling are for further study.

4.3.2.2 *Transit exchange*

The call set-up actions are illustrated by means of an SDL diagram [7] in Figure 16/X.61.

Having seized a free interexchange data circuit and sent an address message to the succeeding exchange, the transit exchange connects through the data path.

If a call accepted message is received from the succeeding exchange the transit exchange sends a corresponding message to the preceding exchange. If a call rejected message is received, the corresponding message is sent and clearing takes place. Receipt of a call rejected message may also occur subsequent to the receipt of a previous call accepted message.

4.3.2.3 *Destination exchange*

The call set-up actions are illustrated by means of an SDL diagram [7] in Figure 17/X.61.

In the case where the call is to a user that is indicated as ready to receive a call, the destination exchange sends the *incoming call* (or corresponding) signal to the user. The destination exchange usually connects through the data path when:

- the *call accepted* (or corresponding) signal has been received from the user, and
- the transmission to the called user of any additional information, e.g. related to user facilities, has been completed in accordance with the applicable DTE/DCE interface protocol.

It is necessary to ensure that the *trunk seized* condition is present in the receive data channel of the interexchange data circuit before through-connection for consistency with the called user DTE/DCE interface protocol when this is in accordance with the present standards, e.g. [6], for the circuit-switched service, cf Note to § 4.3.3.2.

In the case where the call can be connected a call accepted message is sent to the preceding exchange. This message may be sent either before or after the *call accepted* (or corresponding) signal has been received from the called user. Waiting for the receipt of the *call accepted* or corresponding signal has the advantage that sending of the call accepted message is based on a positive indication that the call has been accepted by the called user. Sending the call accepted message earlier, e.g. in conjunction with the sending of the *incoming call* (or corresponding) signal to the user, has the advantage that the call set-up time is reduced in the normal condition.

In the case where certain user facilities apply, see § 5 and Recommendation X.87, through-connection normally takes place in conjunction with the sending of a second call accepted message.

In the case where the call cannot be connected and completed, a call rejected message is sent to the preceding exchange and clearing takes place.

4.3.3 *Call clear-down*

4.3.3.1 *Originating exchange*

The clearing actions are illustrated by means of SDL diagrams [7] in Figures 15/X.61 and 18/X.61. Release of the connection is initiated by one of the following criteria (see also the Note to § 4.3.3.2):

a) detection of a *clear request* condition from the calling user,

b) optionally, detection of a *clear request* condition from the called user on the backward channel of the interexchange data circuit,

c) receipt of a call rejected message, or

d) receipt of a backward clear message.

After release of the connection a clear message is sent to the succeeding exchange and the calling user is cleared in accordance with the applicable DTE/DCE interface protocol.

4.3.3.2 *Transit exchange*

The clearing actions are illustrated by means of SDL diagrams [7] in Figures 16/X.61 and 18/X.61. Release of the connection is initiated by one of the following criteria:

a) failure to complete call set-up,

b) receipt of a call rejected message, or

c) receipt of a forward or backward clear message.

After release of the connection:

- a call rejected message is sent to the preceding exchange in the cases a) and b),
- a clear message is sent to the preceding exchange in the case c),
- a clear message is sent to the succeeding exchange in the cases b) or c).

Note – In the case where satellite data circuits are served by a terrestrial common channel signalling network, there is a probability that a clear message initiated by user clearing may arrive at the other end of the satellite circuit before all user data transmitted immediately before clearing has passed that end. Therefore, the action initiated by receipt of a clear message relating to a satellite circuit must be delayed by an appropriate time interval unless other release criteria have been met. The necessary arrangements to cater for such a situation are for further study.

4.3.3.3 *Destination exchange*

The clearing actions are illustrated by means of SDL diagrams [7] in Figures 17/X.61 and 18/X.61. Release of the connection is initiated by one of the following criteria (see also the Note to § 4.3.3.2):

a) failure to complete call set-up,

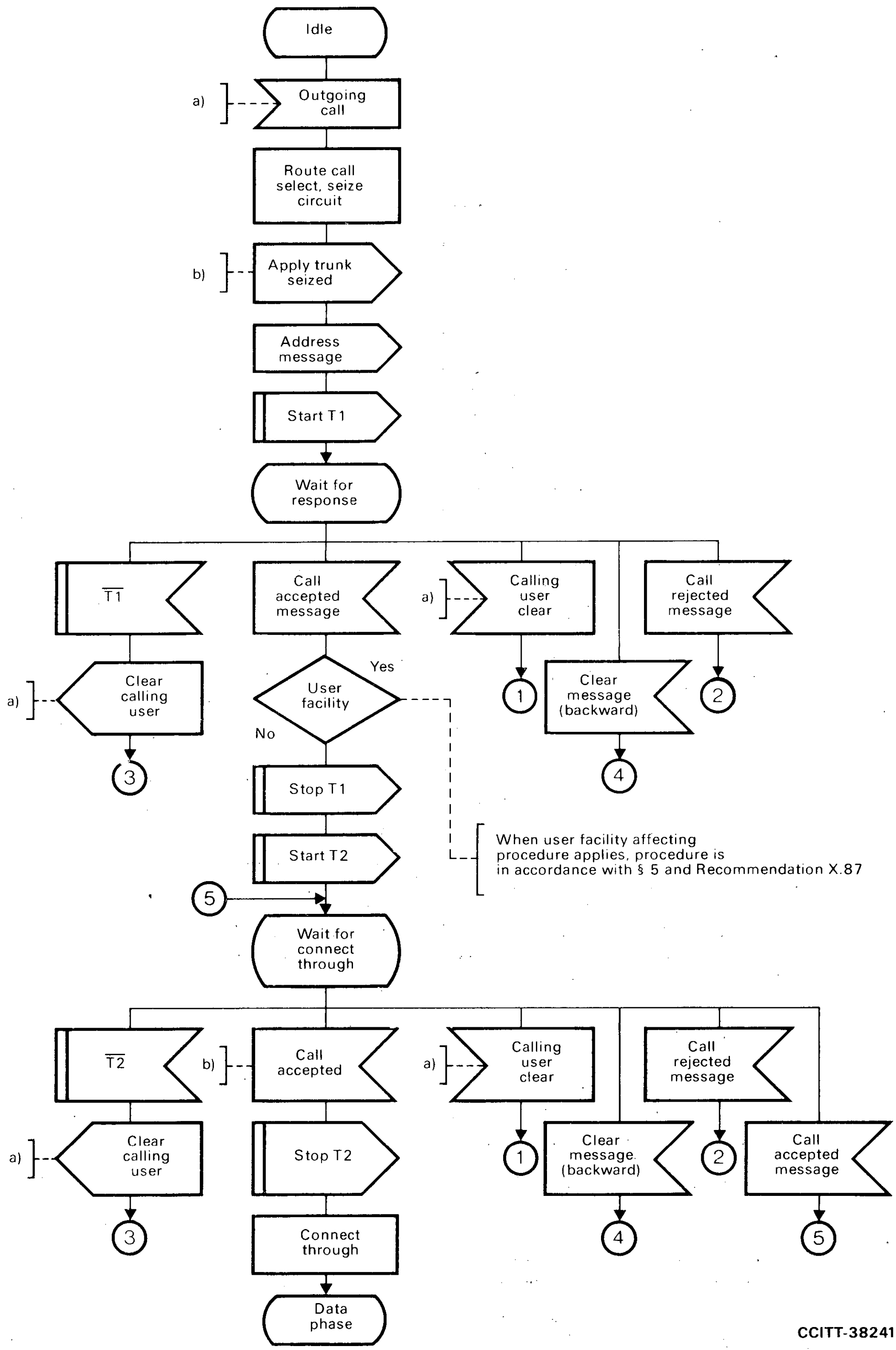
b) detection of *clear request* condition from the called user,

c) optionally, detection of a *clear request* condition from the calling user on the forward channel of the interexchange data circuit, or

d) receipt of a forward clear message.

After release of the connection:

- a call rejected message is sent to the preceding exchange in the case a),
- a clear message is sent to the preceding exchange in the cases b), c) or d),
- the called user is cleared in accordance with the applicable DTE/DCE interface protocol in the cases b), c) and d).

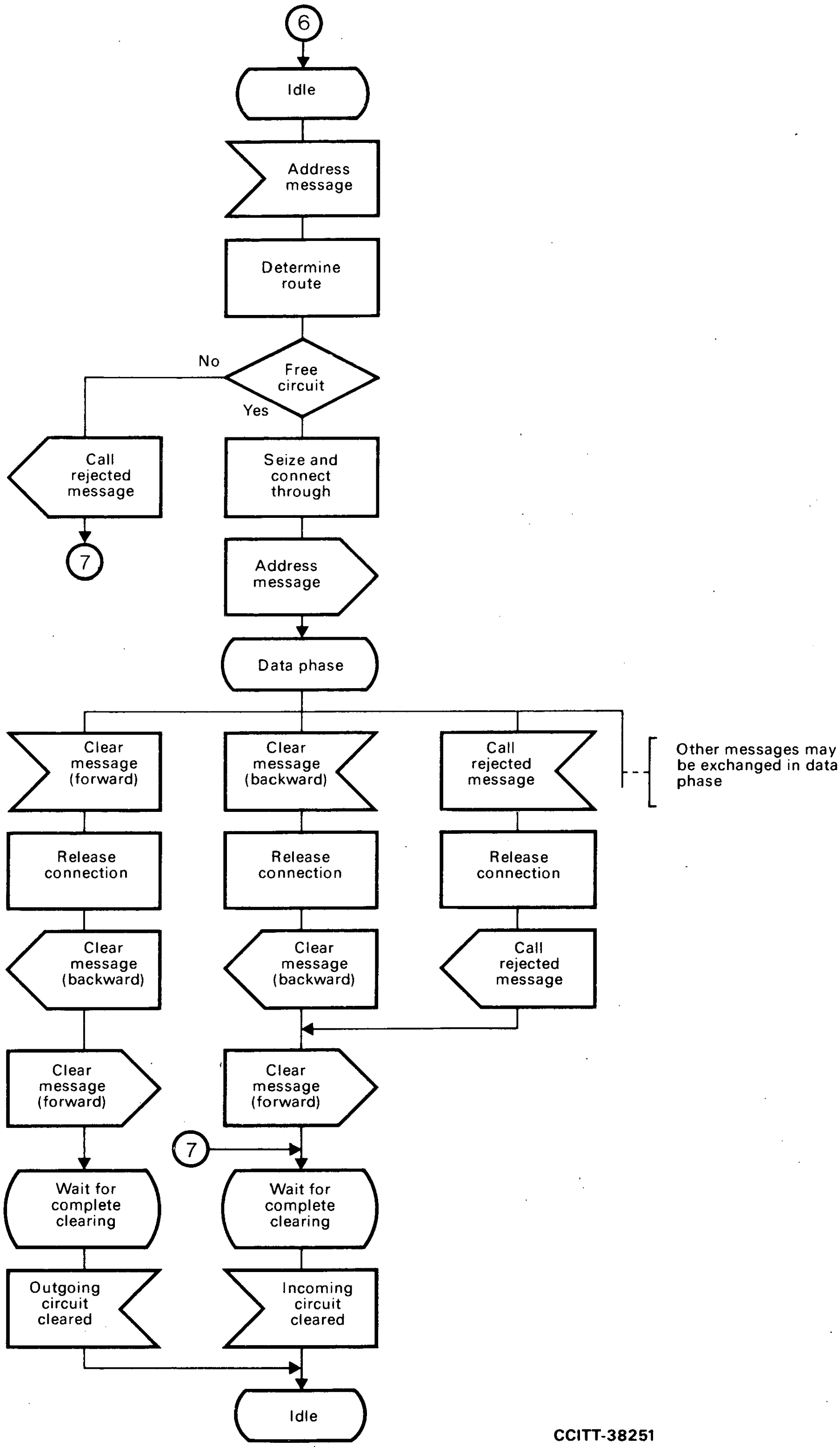


a) In accordance with the applicable DTE/DCE interface protocol.
b) In interexchange data channel.

Note – Connectors ① to ④ go to Figure 18/X.61 which also shows clearing in data phase. Time-outs T1 and T2 as in § 4.5.3.1.

FIGURE 15/X.61

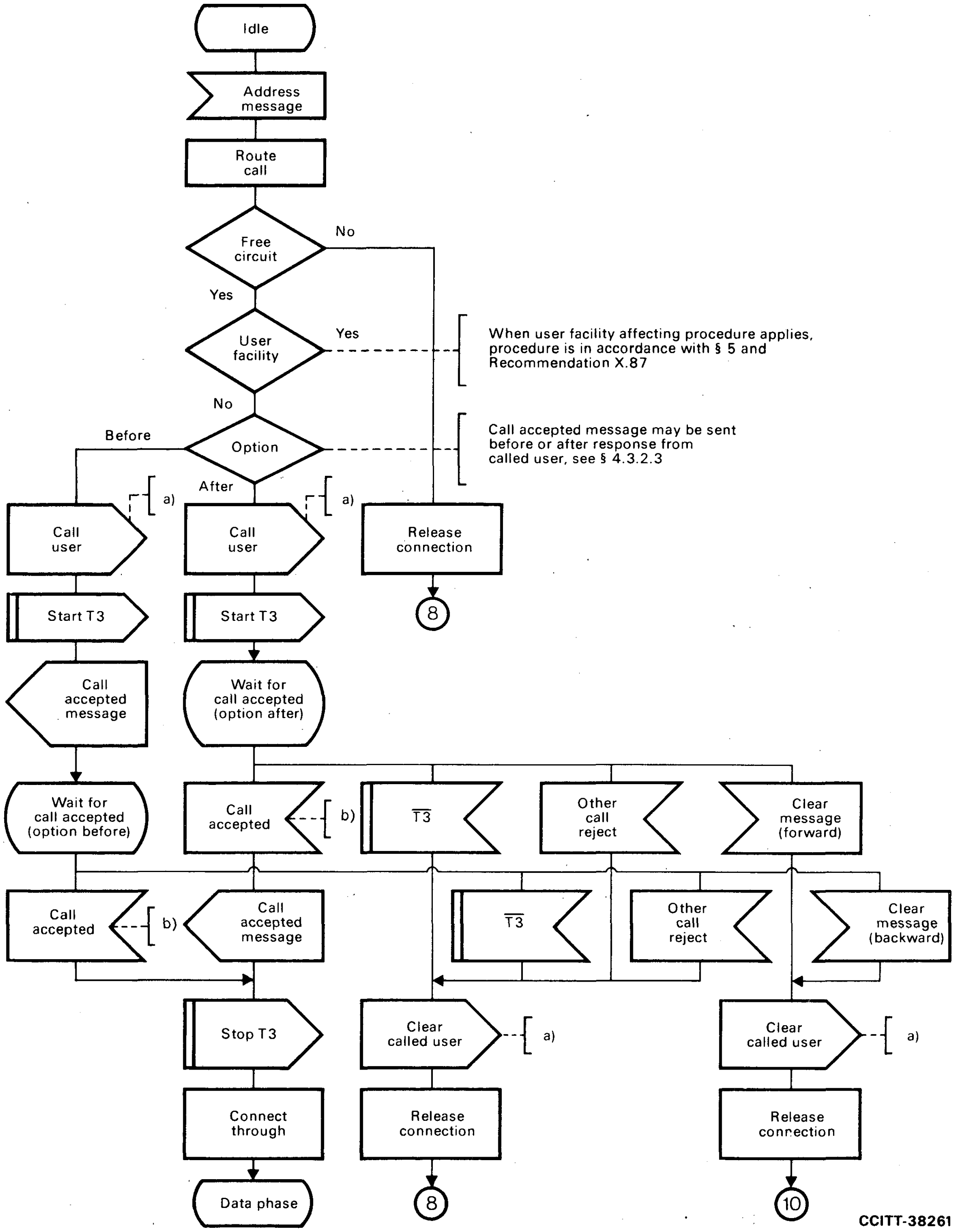
Call set-up at originating exchange



Note – Detailed clearing procedures are shown in Figure 18/X.61.

FIGURE 16/X.61

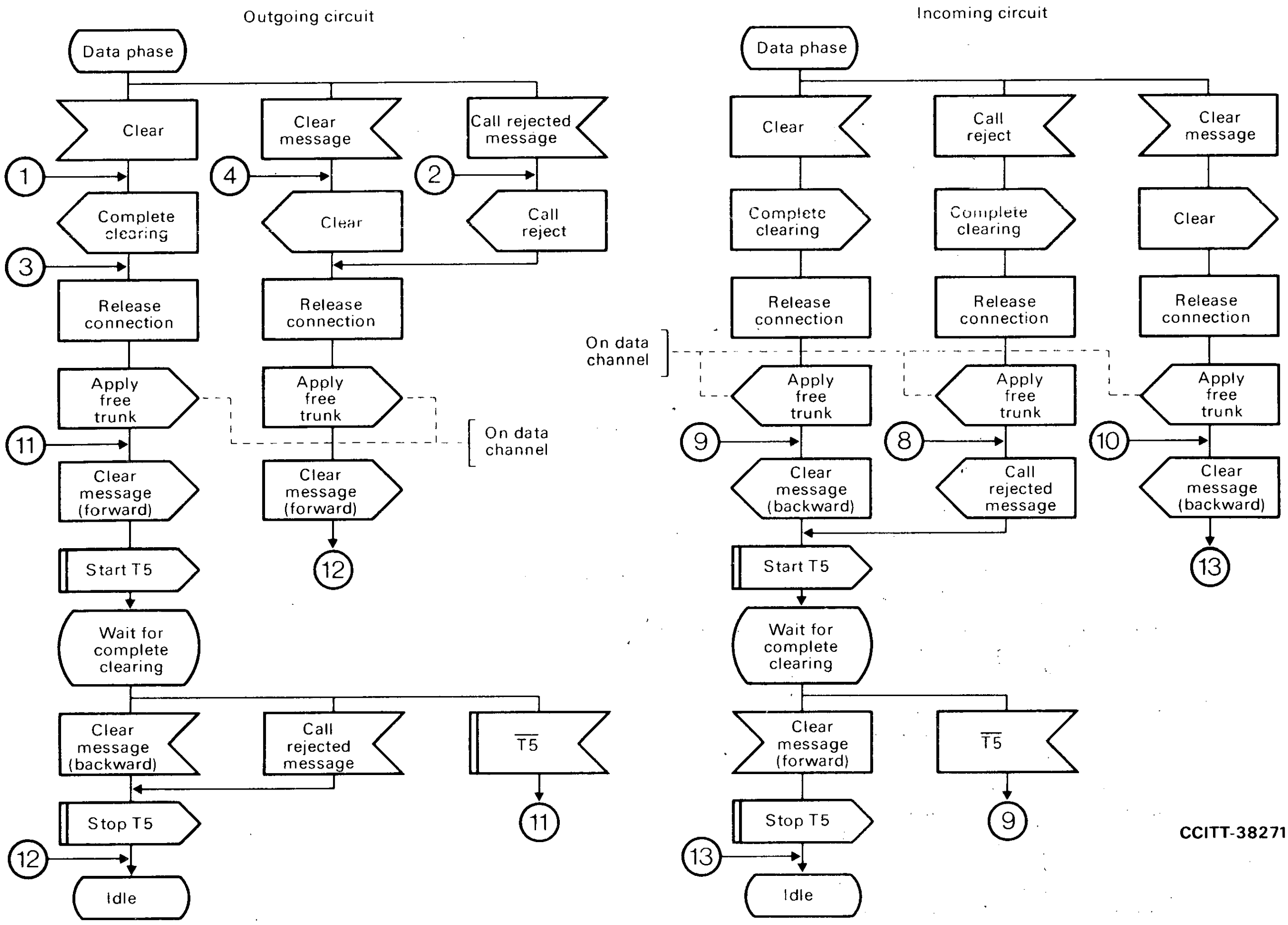
Call set-up at transit exchange



[a] In accordance with the applicable DTE/DCE interface protocol.
[b] Call accepted state, or corresponding, from called user.

Note – Connectors ⑧ to ⑩ go to Figure 18/X.61, which also shows clearing in data phase. Time-out T3 as in § 4.5.3.2.

FIGURE 17/X.61
Call set-up at destination exchange



Note – Connectors (1) to (4) from Figure 15/X.61 and (8) to (10) from Figure 17/X.61. Time-out T5 and delayed maintenance alarm in case of ineffective release as in § 4.5.3.4.

FIGURE 18/X.61

Clearing of interexchange data circuits

4.4 *Detailed signalling procedures under normal conditions*

The signalling information content of the different signalling message types is specified in § 3. The general function of the different signalling information components is defined in § 2. In the following, requirements are detailed for the signalling information components that are involved in normal basic calls. The requirements for sending the messages and for the principal actions at their reception are specified in § 4.2.

4.4.1 *Address message*

In the international network the *destination* address will be the complete international data number of the called user in accordance with Recommendation X.121, i.e. including the DCC/DNIC.

The *DCC/DNIC* indicator is provided to cater for discrimination in national networks between cases where the destination address does or does not include the DCC/DNIC component. Depending on the national numbering and routing plans,this indicator may be necessary or useful for interpretation of the destination address and to determine the routing of the call. It may, for example, be used to identify an outgoing international call.

The *national/international call* indicator is provided to cater for discrimination in national networks between national and international calls. Depending on the implementation of user facilities and network functions that imply different handling of national and international calls, this indication may be a necessary or useful means for such differentiation. It may, for example, be used to determine whether a called line identity sent from the destination exchange should include the DNIC.

The *user class* indicator provides information about the user class of the calling user. At a transit exchange the user class information is used for selection of an appropriate type of data circuit. At the destination exchange the user class information is used to verify that the calling and the called users have compatible user classes of service.

The *alternative routing* indicator is set in the case where alternative routing is performed. It may be used to prevent the call being subjected to alternative routing more than once.

Provision is made for transfer in a national network of the calling line identity as part of the basic procedures, e.g. for call management purposes.

An address message may also contain additional signalling information relating to user facilities and network utilities the procedures of which are covered in § 5 and Recommendation X.87.

4.4.2 *Call accepted message*

The *call accepted* signal is used at the time of connection of the call to a called user having automatic answer. In some cases when a user facility applies, or when the called DTE operates with manual answer, another signal is used in the first call accepted message. In such cases the *call accepted* signal is used in a second call accepted message when the call is completed by receipt of a *call accepted* (or corresponding) signal from the called user. At receipt of the *call accepted* signal the originating exchange prepares normal connect through.

In some situations of interworking with decentralized signalling the *transit through-connect* signal will be used as specified in Recommendation X.80. It will normally be followed by a second call accepted message. At receipt of the *transit through-connect* signal the originating exchange waits for a further call accepted message.

In some cases when the called user has a user facility, an alternative signal to the *call accepted* signal and/or additional signalling information will be used as covered in § 5 and Recommendation X.87. Depending on the facility involved this may result in an alternative connect through procedure at the destination exchange.

Provision is made for transfer in a national network of the called line identity as part of the basic procedures, e.g. for call management purposes.

4.4.3 *Call rejected message*

This message contains a signal indicating the cause for call rejection. The signal to be used in a particular case and the applicable translation at the originating exchange to a *DTE/DCE* call progress signal is as defined in § 2.3.

Receipt of a call rejected message will initiate clearing (see § 4.3.2). In international operation the network identity of the exchange originating the signal will be included in the message.

4.4.4 *Clear message*

A clear message containing a *circuit released* signal will be sent after release of the connection in the case when a clear message or a call rejected message has not been received for the same call and circuit. In the case where a clear message or a call rejected message has been received for the same call and circuit, the clear message sent will contain a *circuit released acknowledgement* signal. The signal sent will in both cases be coded as forward and backward respectively depending on the direction of the call at call set-up.

An interexchange data circuit is considered to be free for a new call when a clear message or a call rejected message has been sent, or received, subsequent to receipt, or sending, of those types of messages.

4.4.5 *Other messages*

Other types of messages are also provided for control of user facilities and network utilities as covered in § 5 and Recommendation X.87. Also, some message types are used in abnormal conditions as specified in § 4.5.

4.4.6 *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 interexchange data circuit at approximately the same time. Head-on collision is detected when after sending of an address message, an address message is received as the first "backward" message.

In international operation it may be necessary to employ preventive measures to reduce the probability of head-on collisions and to take actions to minimize their effects. The necessary field of application and the form of such arrangements are for further study. However, the following offers some tentative possibilities.

Examples of the rules for circuit selection to reduce the probability of head-on collisions are given in Recommendations X.71 and Q.724 [9].

A method for minimizing the effects of head-on collisions by means of assigning priority to one end for each circuit is given in Recommendation Q.724 [9].

4.5 *Call handling in abnormal conditions*

4.5.1 *Sending of a second backward message at call set-up*

As specified in § 4.3.1.3, the call accepted message can be sent before receipt of a *call accepted* (or corresponding) signal from the called user. If subsequently a condition occurs, e.g. *call collision*, that prevents the call from being completed, a call rejected message indicating this condition is sent. In these cases sending of the call rejected message will clear the call. At the originating exchange, receipt of the call rejected message will result in sending the applicable call progress signal to the calling user.

In some interworking situations and with some user facilities, sending of a second call accepted message may apply in the normal condition.

4.5.2 *Blocking and unblocking sequences*

Sending of a *blocking* signal will have the effect of prohibiting outgoing calls from the distant end of the relevant circuit, but will in itself not prohibit incoming calls to the exchange. Sending of the *unblocking* signal will have the effect of cancelling the blocked condition effected by the *blocking* signal. Acknowledgement sequences are always required for both the *blocking* and *unblocking acknowledgement* signals respectively. The acknowledgement is not sent until the relevant action, i.e. blocking or unblocking of the circuit, has been taken.

Removal (restoration) of a circuit from (to) traffic from both ends thus requires completion of a blocking and blocking acknowledgement (unblocking and unblocking acknowledgement) signal sequence relating to both directions.

Blocking of a circuit may be made during a call. In such a case the blocking sequence will be completed but the progress of the call will not be affected. However, after clearing of the call by means of the normal clearing signal sequence, the *blocked* condition will prevent the circuit from being seized by a new call. A *blocked* condition may in some situations be cancelled by a *reset circuit* signal (see § 4.5.6).

Blocking and unblocking sequences may be initiated by automatic or manual actions.

4.5.3 *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 user. The duration of such periods has to be controlled by appropriate time-outs. See also Figures 15/X.61 to 18/X.61. The operation of some of the time-outs will be affected by certain user facilities, see § 5. The values specified for the time-outs in the following are all provisional and subject to change following further study.

All time-outs related to call set-up are terminated in the case that clearing takes place before expiry of the time-out.

4.5.3.1 *Originating exchange*

The following time-outs are necessary at call set-up:

a) T1 = 10 - 20 s; the time between the sending of the address message and the receipt of a call accepted message. On expiry of the time-out T1 the originating exchange will send the *no connection* call progress signal to the calling user and clear the call.

b) T2 = 5 - 10 s; the time between the receipt of the first call accepted message and detection of the *call accepted* condition. On expiry of time-out T2 the originating exchange will send the *no connection* call progress signal to the calling user and clear the call.

Note – The operation of time-out T2 is modified when certain user facilities apply (see § 5).

4.5.3.2 *Destination exchange*

The following time-outs are necessary at call set-up:

a) T3: value as specified for the relevant DTE/DCE interface; the time between the sending of the *incoming call* (or corresponding) signal to the called user and the receipt of the *call accepted* (or corresponding) signal from the called user. On expiry of time-out T3, as specified for the applicable DTE/DCE interface protocol, the destination exchange will send a call rejected message containing a *network failure* signal and thus clear the call.

b) T4 = 5 - 10 s; the time between the sending of the call accepted message and receipt of a calling line identity message (when identification is requested). On expiry of time-out T4, the destination exchange will send a call rejected message containing a *network failure* signal and thus clear the call.

4.5.3.3 *Transit exchange*

Because a transit exchange is through-connected without waiting for an external event, no time-out supervision is required at call set-up.

4.5.3.4 *Circuit supervision*

The following time-outs are required in all exchanges:

a) T5 = 5 - 10 s; the time between sending of the clear message, containing a *circuit released* signal, or a call rejected message and the receipt of a clear message or a call rejected message (relating to the same interexchange data circuit and clearing action). On expiry of time-out T5, a new clear message containing a *circuit released* signal will be sent. Should clearing continue to be ineffective, a maintenance alarm will be activated after an appropriate time interval, and the circuit is kept busy. No time-out will apply following sending of the clear message containing a *circuit released acknowledgement* signal.

b) T6 = 5 - 10 s; the time between sending of a *blocking* or *unblocking* signal and receipt of a *blocking acknowledgement* or *unblocking acknowledgement* signal (respectively). On expiry of time-out T6, the *blocking* or *unblocking* signal will be repeated. Should blocking or unblocking continue to be ineffective, a maintenance alarm will be activated after an appropriate time interval.

4.5.4 *Call clear-down before completion of call set-up*

In some circumstances of call clear-down in abnormal conditions, signalling information relating to the call may subsequently be received. With the exception in § 4.5.6 such information will in all cases be discarded.

In the case where user clearing is detected or a clear message is received during the call set-up, the call set-up process is terminated and normal clear-down is performed. If the originating exchange has seized an interexchange data circuit, a clear message will not be sent unless an address message has already been sent.

In some cases it may be required to clear a call for management purposes. This can be achieved by initiating at any exchange the clearing procedures. See also § 4.5.5.

4.5.5 *Circuit resetting in abnormal situations*

In the case where the state of an interexchange data circuit becomes ambiguous, due to for example memory mutilation or processor disturbances at an exchange (X), the reset circuit may be used by that exchange to align the state of the circuit at both ends. The *reset circuit* signal is always acknowledged by a *circuit released acknowledgement* signal.

When receiving a *reset circuit* signal an exchange (Y) will:

a) respond with a *circuit released acknowledgement* signal in the case where the circuit is indicated as free;

b) release the circuit and respond with a *circuit released acknowledgement* signal in the case where the circuit is busy;

c) respond with a *blocking* signal followed by a *circuit released acknowledgement* signal in the case where the circuit is unconnected but indicated as being blocked at exchange X by exchange Y;

d) release the circuit and respond with a *blocking* signal followed by a *circuit released acknowledgement* signal in the case where the circuit is busy and indicated as being blocked at exchange X by exchange Y;

e) cancel a *blocked* condition (for outgoing calls) indicated as initiated by the distant end and act as in a)-d) above, as applicable, in the case where such a *blocked* condition exists at exchange Y in addition to one of the conditions a)-d).

Note – If the exchange (X) sending the *reset circuit* signal wants to preserve a *blocked* condition at the other end (Y), it (X) has to send a *blocking* signal subsequent to the *reset circuit* signal.

After sending a *reset circuit* signal, the exchange (X) will regard the circuit as unavailable for traffic until a response is received (from Y) at which time the exchange will:

i) return the circuit to the *idle* condition when a *circuit released acknowledgement* signal is received;

ii) regard it as operational but blocked by the distant end (Y) for outgoing calls when a *blocking* signal is received.

Appropriate means to cover situations in which no response to a *reset circuit* signal is received should be provided.

Note – The possible provision of means for resetting a group of circuits by a single action is for further study.

4.5.6 *Receipt of unreasonable signalling information*

The Message Transfer Part of the signalling system will avoid mis-sequencing of or double delivery of messages with a high reliability. However, undetected errors at the signalling link level and exchange malfunctions may produce unreasonable signalling information in messages that are either ambiguous or inappropriate.

In order to resolve some possible ambiguities in the state of a circuit when unreasonable signals are received, the following will apply:

a) If a *circuit released* signal is received relating to an idle circuit, it will be acknowledged with a *circuit released acknowledgement* signal.

b) If a *circuit released acknowledgement* signal is received relating to an idle interexchange data circuit, it will be discarded.

c) If a *circuit released acknowledgement* signal is received relating to a busy interexchange data circuit for which a circuit released signal has not been sent, the circuit will be released and a circuit released signal will be sent.

d) If a *blocking* signal is received for a blocked interexchange data circuit, a *blocking acknowledgement* signal will be sent.

e) If an *unblocking* signal is received for an unblocked interexchange data circuit, an *unblocking acknowledgement* signal will be sent.

Any other unreasonable signalling information received will be discarded (see, however, § 4.4.6). 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.

5 **Additional call control and signalling procedures**

5.1 *General*

§ 5 refers to the call control and signalling procedures that apply, in addition to the basic procedures specified in § 4, where user facilities and network utilities are involved.

The principles and procedures for realization of international user facilities and network utilities are defined in Recommendation X.87, which thus gives the basis for the common channel signalling procedures. Therefore, the following is limited to an outline of the implications for the common channel signalling procedures of such user facilities and network utilities.

The additional signalling information components particular to user facilities and network utilities are indicated in § 2. The corresponding formats and codes are specified in § 3.

5.2 *Closed user group facilities*

Depending on whether a closed user group is involved, the address message may include a *closed user group call* indication and an *interlock code.*

In certain cases of redirection of a closed user group call, that closed user group information included in the address message will also be returned back, within a call accepted message, to the exchange controlling redirection.

5.3 *Bilateral closed user group facilities*

The signalling system is capable of supporting automatic user controlled procedures for registration and cancellation of bilateral closed user groups. Three types of messages:

– facility registration/cancellation request message,

– facility registration/cancellation request accepted message, and

– facility registration/cancellation request rejected message,

which may include a number of signalling indications relating to bilateral closed user groups, are provided for those procedures.

At call set-up within a bilateral closed user group, the address message will contain a *bilateral closed user group call* indication.

Note – Subject to further study, it may be necessary to include further information relating to this facility in the address message, see Recommendation X.87.

5.4 *Calling line identification*

The signalling system provides for transfer of the calling line identity:

a) in the address message, systematically or selectively, or

b) in a calling line identity message, on request from the destination exchange as indicated in the call accepted message.

5.5 *Called line identification*

The called line identity is transferred in the call accepted message on request from the originating exchange as indicated in the address message.

The *national/international* indicator included in the address message may be used by the destination exchange to determine whether the called line identity should be the national or the complete international data number of the called user.

5.6 *Redirection of calls*

The signalling system provides a number of signals that cater for the *redirection of calls* facility.

In the case where the call is released back to a controlling exchange at redirection, the call accepted message will contain the *redirection request* signal, a *redirection address* indication and the *redirection address.* The original forward connection is cleared from the controlling exchange.

The address message sent for a call that during redirection is set up towards the new number (i.e. the *redirection address*) will contain a *redirected call* indication.

When a redirected call has been connected to the *redirection address,* the call accepted message sent towards the originating exchange will contain the *redirected call* signal. The *redirected call* signal is equivalent to the *call accepted* signal but has also the additional function of sending a *call progress* signal to the called user.

5.7 *Connect when free and waiting allowed*

The call accepted message sent from the destination exchange, when a call to a busy user having the *connect when free* facility is put in a queue, will contain the *connect when free* signal. At the originating exchange this signal will among other actions inhibit time-out T2.

When the waiting call is connected to the called user, a second call accepted message, now containing the *call accepted* signal, will be sent.

5.8 *Reverse charging and reverse charge acceptance*

When a reverse charging request from a calling user is allowed by the originating network, the address message will contain a *reverse charging request* indication. In the case where reverse charging is rejected because the called user does not have the *reverse charge acceptance* facility, the call rejected message will contain the *reverse charge acceptance not subscribed* signal. Otherwise the call is accepted or rejected as an ordinary call.

Note – The principles for accounting of reverse charging calls have not yet been determined; thus the possible implications of special accounting arrangements for the switching or interexchange signalling procedures have not yet been determined.

5.9 *Manual answer*

The call accepted message sent from the destination exchange at connection of a call to a user who employs *manual answer*, will contain the *terminal called* signal. At receipt of the *terminal called* signal at the originating exchange, through-connection will be prepared but time-out T2 will be lengthened to 2-4 minutes.

When the called user responds by a *call accepted* signal, a second call accepted message, now containing the *call accepted* signal, will be sent.

5.10 *RPOA selection*

In the case where a calling user selects a particular RPOA, an address message sent in the originating network will contain an *RPOA selection* indication and the applicable *RPOA transit network identity.* If such a call is rejected because the selected RPOA transit network cannot handle the call, the call rejected message sent will contain the *RPOA out-of-order* signal.

5.11 *Network identification utilities*

The capability for *originating network identification* on request from the destination network is mandatory for international calls. When this utility is employed the call accepted message will contain an *originating network identification request* indication. The identity of the originating network is then sent in a calling line identity message.

The signalling system also provides for transfer of the identity of the originating network within the address message.

Destination network identification and transit network identification by means of transfer of the network identities in the call accepted message are mandatory for international calls.

6 **Signalling performance and traffic characteristics in data applications**

6.1 *Signalling reliability*

6.1.1 *General*

Recommendation Q.706 [10] details the factors that influence the performance of the message transfer service provided by a signalling network that uses the Message Transfer Part of Signalling System No. 7. It also provides information that may be used to estimate that performance in particular applications.

6.1.2 *Unsuccessful calls due to signalling malfunctions*

Although the Message Transfer Part is designed to provide a high reliability for transfer of messages through a signalling network, certain irregularities in message transfer cannot be prevented in certain situations.

Loss of the message will in most cases result in an unsuccessful call. The proportion of lost messages will primarily depend on the reliability of equipment used to realize certain signalling functions. The requirements specified for such equipments in Recommendation Q.706 [10] will ensure that the proportion of lost calls in typical applications is 1 in 10^5 or better.

In certain extreme conditions, it is also possible that the message transfer function delivers faulty messages with reasonable information or delivers messages out-of-sequence. The probability of such malfunctions is, however, negligible from the circuit-switched data service point of view, see [10].

6.1.3 *Availability of signalling*

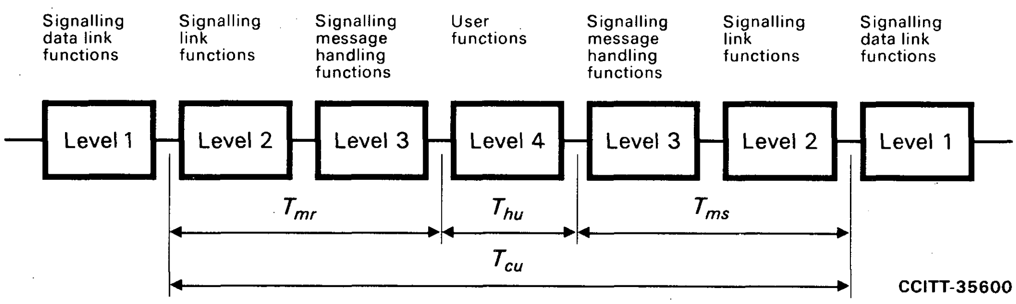
The availability of signalling primarily depends on the reliability of the equipment used to realize the signalling functions and the redundancy with which such equipment is provided.

No availability requirements for international signalling for the circuit-switched data service have yet been defined.

6.2 *Message transfer times*

6.2.1 *Functional reference points and signal transfer time components*

See Figure 19/X.61.



T_{cu} Cross-office transfer time

T_{hu} Data User Part handling time

T_{mr} Message Transfer Part receiving time

T_{ms} Message Transfer Part sending time

The definitions of these times are given in Recommendation Q.706 [10].

FIGURE 19/X.61
Functional diagram of the signal transfer time

6.2.2 *Definitions*

6.2.2.1 **cross-office transfer time T_{cu}**

T_{cu} is the period which starts when the last bit of the signal unit leaves the incoming signalling data link and ends when the last bit of the signal unit enters the outgoing signalling data link for the first time. It also includes the queueing delay in the absence of disturbances but not the additional queueing delay caused by retransmission.

6.2.2.2 **data User Part handling time, T_{hu}**

T_{hu} is the period which starts when the last bit of the message has entered the Data User Part and ends when the last bit of the derived message has left the Data User Part.

6.2.3 *Queueing delay*

An example of the queueing delays which may be expected in a particular case is shown in Appendix I to this Recommendation, see also § 6.3.

6.3 *Data signalling traffic models*

The characteristics of the signalling traffic generated for data call control will primarily depend on factors such as:

- the data traffic volume (call/s),
- the mix of different call types (international/national, successful/unsuccessful, etc.),
- the proportion of calls involving user facilities and network utilities and the mix of such facilities and utilities.

Appendix I contains two data signalling traffic models that indicate the mix of message types and lengths that result from particular sets of assumed conditions. The appendix also gives an example of the loading capacity of a signalling link for data call control signalling.

APPENDIX I

(to Recommendation X.61)

Examples of signalling traffic characteristics

I.1 *Signalling traffic models*

I.1.1 Tables I-1 and I-2/X.61 show two examples of mixes of data signalling message types and lengths. The models are simplified and do not fully reflect the possible variation of message lengths.

The following applies for both models:

- a mix of national and international calls is assumed with 8 and 12 digits in the data numbers respectively;
- the closed user group facility applies for 50% of the calls;
- the basic label specified in § 3.2.2.1 is used;
- the message length shown in the tables is the number of octets in the signalling information field of the corresponding signal unit; the overall length of the signal unit on the line is approximately 7 octets longer.

I.1.2 Table I-1/X.61 assumes that the calling line identity is always sent in the address message and that called line identification applies for 10% of the calls.

TABLE I-1/X.61

Example 1 of data signalling message mix

Message type	Messages/call	Message length (octets)
Address message	0.575	24
	0.425	18
Call accepted message	0.1	14
	0.9	8
Clear message	2	7

Message per call = 4
Average message length = 11 octets
Total amount of information per call = 576 bits

I.1.3 Table I-2/X.61 assumes that the calling line identity is sent on request for 10% of the calls.

TABLE I-2/X.61

Example 2 of data signalling message mix

Message type	Messages/call	Message length (octets)
Address message	0.575	18
	0.425	14
Call accepted message	1	8
Calling line identity message	0.1	14
Clear message	2	7

Messages per call = 4.1
Average message length = 9.7
Total amount of information per call = 548 bits

I.2 *Queueing delay and link loading*

Figure I-1/X.61 shows the mean value and standard deviation of message queueing delays for different signalling link loads.

The queueing delays shown in Figure I-1/X.61 assume:

– a message mix according to Table I-1/X.61,

– error-free operation of a signalling link using the basic error correction method.

The theoretical basis for calculation of the queueing delays and information about the performance of the signalling system under error conditions are included in Recommendation Q.706 [10].

The equivalent call rate shown in the figure assumes an even distribution of the calls in both directions of transmission.

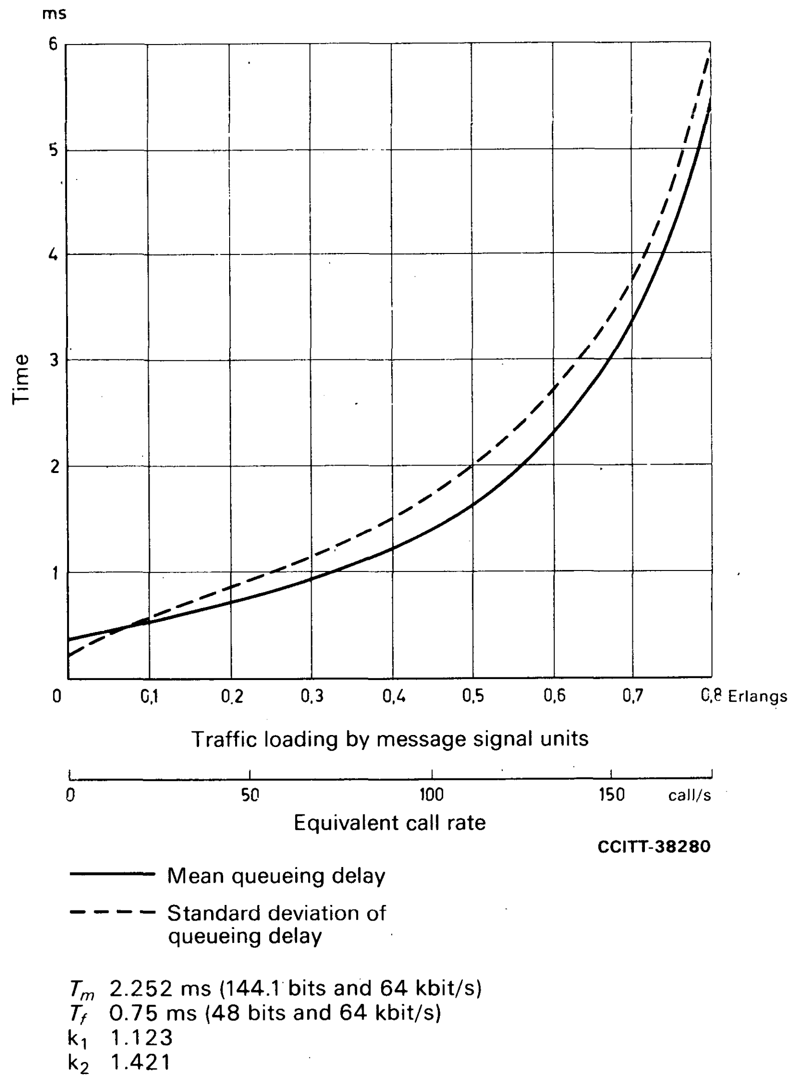


FIGURE I-1/X.61

Example of queueing delay as a function of link load

References

[1] CCITT Recommendation *Functional description of the signalling system (MTP)*, Vol. VI, Fascicle VI.6, Rec. Q.701.

[2] CCITT Recommendation *Signalling network functions and messages*, Vol. VI, Fascicle VI.6, Rec. Q.704.

[3] CCITT Recommendation *Signalling link*, Vol. VI, Fascicle VI.6, Rec. Q.703.

[4] CCITT Recommendation *Formats and codes*, Vol. VI, Fascicle VI.6, Rec. Q.723.

[5] CCITT Recommendation *Characteristics of 2048-kbit/s frame structure for use with digital exchanges*, Vol. III, Fascicle III.3, Rec. Q.734.

[6] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for synchronous operation on public data networks*, Vol. VIII, Fascicle VIII.2, Rec. X.21.

[7] CCITT Recommendation *General explanation of the specification and description language (SDL)*, Vol. VI, Fascicle VI.7, Rec. Z.101.

[8] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for start-stop transmission services on public data networks*, Vol. VIII, Fascicle III.2, Rec. X.20.

[9] CCITT Recommendation *Signalling procedures*, Vol. VI, Fascicle VI.6, Rec. Q.724.

[10] CCITT Recommendation *Message transfer part signalling performance*, Vol. VI, Fascicle VI.6, Rec. Q.706.

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 and 1980)

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 recommends

for interworking between anisochronous data networks the control signalling scheme given below should be used on international circuits.

Note 1 – The start-stop user classes of service are specified in Recommendation X.1 [1].

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.

Scope

This Recommendation defines a decentralized terminal and transit control signalling system for start-stop services on international circuits between anisochronous data networks.

1 General switching and signalling principles

1.1 The two classes, namely user class 1 and user class 2, which are considered applicable to anisochronous types of data network require a control signalling rate of 300 bit/s and 200 bit/s respectively.

Telex service based upon 50-baud trunks does not form part of this Recommendation [1].

1.2 Decentralized signalling will apply, the same channel being used for control signalling and data transmission.

[1] See Recommendation U.12 [2] for telex and similar telegraph services.

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 numbering scheme that will be applied to networks accessed by this signalling system is defined in Recommendation X.121 [3].

The data network identification code (DNIC) (see Recommendation X.121 [3]), and network or service identification signals will be transmitted on both transit and terminal calls. However, the data country code (DCC) portion of the DNIC may be suppressed in the *selection* signals and only the network or service digit forwarded on terminal calls if requested by the incoming network.

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. 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.

1.6 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 It is assumed that the gathering of information required for charging and accounting should normally be the responsibility of the originating Administration (see Recommendation D.10 [4]). Other arrangements for gathering information are for further study.

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.

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 § 2.

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 – For user class 1 the control signalling code (CSC) will employ 7-unit signalling characters with one parity bit, one start and two stop elements (see Table 8/X.70). The parity of the characters will be even and hence will be consistent with Recommendation X.4 [5]. The individual bits should be transmitted at the nominal modulation rate (300 bit/s) with the low order bit (i.e. b_1) first and completed by the parity bit (b_8).

The *end-of-selection* signal will be the International Alphabet No. 5 (IA5) character 2/11(+). The reception confirmation will use IA5 character 2/10 (*). All other signals will be characters chosen from column 3 of IA5 (see Table 1/X.70). This choice helps ensure that the end of selection and reception confirmation signals are uniquely separable from the other signalling characters.

For user class 2 the CSC will employ 4-unit signalling characters with one parity bit, one start and two stop elements (see Table 8/X.70). The parity of the characters will be even with regard to elements of Z polarity. The individual bit should be transmitted at the nominal modulation rate (200 bit/s) with the low order bit (i.e. b_1) first and completed by the parity bit (b_5).

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. 20 followed immediately by the *clearing* signal will be returned to the preceding centre after the *reception-confirmation* signal and the *network* or *service 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 characters the *reception-confirmation* signal or *reception-congestion* signal, should initiate the automatic *retest* 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. 20 followed immediately by the *clearing* signal, will be returned to the preceding centre after the *reception-confirmation* signal and the *network* or *service 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, 5/X.70 and 5a/X.70). The second part comprises the *address* signals (the called network terminal number which is preceded by the DNIC always in the case of a transit call and also for terminal calls unless the destination country requests omission of the data country code portion, see Tables 6/X.70 and 6a/X.70).

The *network selection* signals used in the forward direction (see also Appendix II) 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".

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 1/X.70

Decentralized signalling between anisochronous data networks

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 *selection* 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 character No. 14 (user class 2) or by IA5 character No. 2/10 (user class 1)	Stop polarity returned within three character periods after the end of receipt of the first class-of-traffic character. The return of CSC character No. 14 or IA5 character No. 2/10 shall be commenced 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 I), the digits of the DNIC of the called network, the digits of the called terminal number, and an *end-of-selection* signal		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 the appropriate data signalling rate for the user class-of-service concerned and at automatic speed in a single block which includes an *end-of-selection* signal. For user class 1 the *end-of-selection* signal will be IA5 character No. 2/11. For user class 2 the *end-of-selection* signal will be CSC character No. 11. The data country code (DCC) may be omitted on terminal calls at the request of the incoming country.
Network or service identification signals		CSC No. 12 followed by the data network identification code (DNIC) of the network	The character CSC No. 12 and DNIC follow 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. In all cases, the country or network identity shall consist of four decimal digits. The value of the fourth digit should, in the case when it is not explicitly defined by the numbering plan, be at the discretion of the country in question within the limits allowed by the numbering plan.

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 7d/X.70)	Examples would be *redirected call* or *terminal-called call progress* signal (for further details see Appendix III).
Call connected signal		One CSC character (see Table 7/X.70)	See § 2.14 of the text and for further details see Appendix III.
Start of transit through-connect signal (STTC)		CSC No. 15 (see Table 7/X.70)	This signal always precedes the *transit through-connect* signal.
Transit through-connect signal (TTC)		One CSC character (see Table 7b/X.70)	This signal will always be prefaced by the *start of transit through-connect* signal and will be returned preceding a *call progress* signal without clearing when this has to be sent. It will also be transmitted when the *calling* and/or *called line identification* is required (for further details see Appendix III).
Transit centres through-connected signal (TTD)	CSC No. 11 (see Table 6/X.70)		This signal will be transmitted within 40 to 120 ms after the receipt of the *transit through-connect* signal (TTC) when no calling line identification is required (for further details see Appendix III).
Called line identification (if applicable)		Combinations of the *called line identification* signals transmitted at automatic speed within 120 ms of the receipt of the TTD signal or the first character of the *calling line identification* signals	The *called line identification* signal consists of the data network or service identification code (DNIC) followed by the digits of the network terminal number and CSC No. 12. Where no identification is available, only CSC No. 12 is sent (for further details see Appendix III).
Calling line identification (if applicable)	Combinations of the *calling line identification* signals transmitted at automatic speed within 40 to 120 ms of receipt of the *transit through-connect* signal (TTC)		The *calling line identification* signal consists of the data network or service identification code (DNIC) followed by the digits of the network terminal number and CSC No. 12. Where no identification is available only the DNIC and CSC No. 12 is sent (for further details, see Appendix III).
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 III.

TABLE 1/X.70 *(concluded)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Call progress signals with clearing		CSC No. 11 followed by 2 digits (see Table 7d/X.70), followed by the *clearing* signal	
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	

Note – For the control signalling code (CSC) numbers mentioned, refer to Table 8/X.70.

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 for user class 2 only[c]
Z	Z	Z	A	Not allocated
Z	Z	Z	Z	Not allocated

a) CSC = control signalling code (see Table 8/X.70).

For user class 1 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 even parity over the character.

b) First class-of-traffic character.

c) For user class 2 only. The reception confirmation signal for user class 1 will be IA5 character No. 2/10.

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 [a]

Combination				Condition signalled from X to Y [b]
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	300 bit/s (user class 1)
	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 [c]

a) For user class 1 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 even parity over the character.

b) The user class character may be omitted if, for example, the information can be derived from the incoming line.

c) For future extension.

2.5.3 *Second and subsequent class-of-traffic characters* (see Tables 4/X.70 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.

TABLE 4/X.70

Second class-of-traffic character[a]

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 sequence follows
	Z			Closed user group sequence follows (see Table 5/X.70)
		A		Called line identification not required
		Z		Called line identification required
			A Z	} Reserved for national use[b]

[a] For user class 1 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 even parity over the character.

[b] On international circuits bit b_1 should be set to A polarity.

TABLE 4a/X.70

Third class-of-traffic character [a]

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 [b]
	A			Redirection not allowed [c]
	Z			Redirection allowed [c]
		A		Not multiple address call [c]
		Z		Multiple address call [c]
			A Z	Not allocated

a) For user class 1 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 even 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 Tables 5/X.70 and 5a/X.70)

These characters are only used in conjunction with the second and possibly subsequent class-of-traffic characters which may follow.

The start of closed user group (CVG) character would precede the closed user group number which would be coded into a number of hexadecimal characters up to a maximum of four (see Table 5/X.70).

TABLE 5/X.70

Start of closed user group character[a) b)]

Combination				Condition signalled from X to Y
b_4	b_3	b_2	b_1	
A				Without outgoing access
Z				With outgoing access
	A			No DNIC[c)] follows
	Z			DNIC[c)] follows
		A	A	1 — Number of hexadecimal CUG characters which follow
		A	Z	2 — Number of hexadecimal CUG characters which follow
		Z	A	3 — Number of hexadecimal CUG characters which follow
		Z	Z	4 — Number of hexadecimal CUG characters which follow

a) For user class 1 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 even parity over the character.

b) The start of closed user group character shall precede the DNIC of the representative user followed by the closed user group number which would be coded into a number of hexadecimal characters up to a maximum of four, as indicated. The closed user group number would be transmitted with the least significant bit of the least significant character first.

c) On international circuits bit b_3 should be set to Z polarity.

TABLE 5a/X.70

Closed user group characters[a)]

Combination				Condition signalled from X to Y
b_4	b_3	b_2	b_1	
A	A	A	A	0 — Hexadecimal closed user group character
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	A
Z	A	Z	Z	B
Z	Z	A	A	C
Z	Z	A	Z	D
Z	Z	Z	A	E
Z	Z	Z	Z	F

a) For user class 1 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 even parity over the character.

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 incoming country can adopt the option not to receive the data country code portion of the DNIC. The complete selection block is terminated by an *end-of-selection* signal which is different for user classes 1 and 2. They are shown in Tables 6/X.70 and 6a/X.70.

TABLE 6/X.70

Miscellaneous forward path signals [a)]

Combination				Condition signalled from X to Y	
b_4	b_3	b_2	b_1		
A	A	A	A	0	Digits for: – data network identification code (DNIC) – called network terminal 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 for user class 2 only [b)] Transit centres through connected signal (TTD)
Z	A	Z	Z		End-of-calling line identification signal [c)]
Z	Z	A	A		Not allocated
Z	Z	A	Z		
Z	Z	Z	A		
Z	Z	Z	Z		

a) For user class 1 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 even parity over the character.

b) For user class 2 only. The end-of-selection signal for user class 1 will be IA5-character No. 2/11.

c) This signal follows the DNIC when the calling line identification is not available. See § 2.13.

TABLE 6a/X.70

Other forward path signals

IA5-character	Condition signalled from X to Y
0/6	Originating through-connection
2/11	End-of-selection signal for user class 1

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 *call progress* signal No. 20 to the preceding centre, immediately followed by the *clearing* signal after the *reception-confirmation* signal and the *network* or *service identification* signals.

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 *call progress* signal No. 20 is returned to the preceding centre, immediately followed by the *clearing* signal after the *reception-confirmation* signal and the *network* or *service identification* signals.

2.7 The *address* signal may have a maximum number of 14 digits comprising the 4 digit data network identification code and a 10 digit maximum network terminal number. Alternatively the 14 digits can be considered as the 3 digit data country code followed by a national number of 11 digits maximum (see Recommendation X.121 [3]).

2.8 In the case of receipt of the *reception-congestion* signal at a transit centre, the *call progress* signal No. 61 should be returned to the preceding centre (after the *reception-confirmation* and *network* or *service identification* signals) and followed by the *clearing* signal.

2.9 The *network* or *service identification* signals shall be sent following the *reception-confirmation* signal in all cases. In all cases the country or network identity shall consist of four decimal digits. The value of the fourth digit should, in the case when it is not explicitly defined by the numbering plan, be at the discretion of the country in question within the limits allowed by the numbering plan.

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* or *service identification* signals within two seconds of the *reception-confirmation* signal, it will return to the preceding centre the *call progress* signal No. 20 (after the *reception-confirmation* and *network* or *service identification* signals), followed by the *clearing* signal.

The *network* or *service 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 the *network* or *service 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/X.70, 7a/X.70, 7b/X.70, 7c/X.70 and 7d/X.70.

TABLE 7/X.70

Miscellaneous backward path signal a)

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
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
				(0–9) Digits for: – network or service identification signals – called line identification signals – call progress signals
Z	A	Z	A	Start of call progress signal (see Table 7d/X.70)
Z	A	Z	Z	End-of-called line identification signal b) Start of network or service identification signal
Z	Z	A		Call connected signal
			A	Call metering
			Z	No call metering
Z	Z	Z	A	Start of transit through-connect signal (STTC)
Z	Z	Z	Z	Further backward path signal follows (see Table 7a/X.70)

a) For user class 1 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 even parity over the character.

b) This signal is also used alone when the called line identification is not available.

TABLE 7a/X.70

Further miscellaneous backward path signals [a) b)]

Combination				Condition signalled from Y to X
b_4	b_3	b_2	b_1	
A Z				Reserved for national use
	A A A A Z Z Z Z	A A Z Z A A Z Z	A Z A Z A Z A Z	Not allocated

a) For user class 1 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 even parity over the character.

b) These signals follow combination ZZZZ in Table 7/X.70.

TABLE 7b/X.70

Transit through-connect signals[a) b)]

Combination				Condition signalled from Y to X
b_4	b_3	b_2	b_1	
A	A	A	A	Not allocated
A	A	A	Z	
A	A	Z	A	
A	A	Z	Z	
A	Z	A	A	
A	Z	A	Z	
A	Z	Z	A	
A	Z	Z	Z	
Z	A	A	A	
Z	A	A	Z	
Z	A	Z	A	
Z	A	Z	Z	
Z	Z			Transit through-connect signal (TTC)
		A		Calling line identification not required
		Z		Calling line identification required
			A	Call metering
			Z	No call metering

a) For user class 1 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 even parity over the character.

b) These signals follow the start of transit through-connect signal (STTC) in Table 7/X.70.

TABLE 7c/X.70

Other backward path signals

IA5-character	Condition signalled from Y to X
2/10	Reception-confirmation for user class 1

TABLE 7d/X.70

Call progress signals [a)]

Numerical code first/second digit	Category	Significance
01	Without clearing	Terminal called
02		Redirected call
03		Connect when free
20	With clearing, due to subscriber – short term [b)]	Network failure [c)]
21		Number busy
22		d)
23		d)
41	With clearing, due to subscriber – long term [b)]	Access barred
42		Changed number
43		Not obtainable
44		Out of order
45		Controlled not ready
46		Uncontrolled not ready
47		DCE power off
48		d)
49		Network fault in local loop
51		Call information service
52		Incompatible user class service
61	With clearing, due to network – short term [b)]	Network congestion
71	With clearing, due to network – long term [b)]	Degradated service
72		e)
81	With clearing, due to DTE-network procedure	Registration/cancellation confirmed [f)]
82		d)
83		d)

a) For user class 1 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 even parity over the character.

b) "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.

c) At the originating exchange, this results in sending a call progress signal "no connection" to the calling customer and clearing the call.

d) These signals are normally only utilized between first centre and subscriber and are not signalled on inter-network links.

e) Only utilized within national networks.

f) Not yet included. To be studied in relation to Recommendation X.87 on network call-control procedures.

2.11 If any *call progress* signal or the *call connected* signal are not received within 30 seconds from the end of the selection, then the *call progress* signal No. 20 will be returned to the preceding centre (after the *reception-confirmation* and *network* or *service 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* signal should be delayed accordingly. This point is left for further study.

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 line identification* has been requested but is not available, the terminating centre in this connection should send only the *end-of-line identification* signal (CSC-character No. 12). If the *calling line identification* has been requested but is not available, the originating centre in this connection should send only the data network identification code (DNIC) signals followed by the *end-of-line identification* signal (CSC-character No. 12).

2.14 The *call connected* signal confirms that the call is accepted by the called subscriber and, if applicable, the *calling line identification* has been completely received by the terminating centre and passed to the called subscriber and, when applicable, that the *called line identification* has been completely transmitted to the originating centre (see Appendix III).

The originating *through-connection* signal confirms that the *call connected* signal has been received by the originating centre and, when applicable, that a *call progress* signal without clearing has been completely received by the originating centre and passed to the calling subscriber or, when applicable, that the *called line identification* has been completely received by the originating centre and passed to the calling subscriber (see Appendix III).

The *call connected* signal is sent on the backward path by the terminating centre. The originating *through-connection* signal is sent by the originating centre both to calling and called subscribers.

The connection must be switched through in the originating centre within 20 ms after transmission of the originating *through-connection* signal (see Appendix III). This limit follows from the condition given in Recommendation X.20 [6] for the beginning of data transmission.

The connection must be switched through in the terminating centre within 40 ms after transmission of the *call connected* signal (see Appendix III).

The connection must be switched through in the transit centres within 40 ms after transmission of the *call connected* or *transit through-connect* signal (see Appendix III).

If a transit centre has a character orientated switch, the connection may be switched through within 40 ms after transmission of the *call connected* signal for user class 2 service.

Complete network through-connection is assured when the originating *through-connection* signal is received by the data terminals.

2.15 If the terminating centre fails to receive the *transit centres through-connected* signal (TTD) or, if applicable, the first character of the *calling line identification* signals within 4 seconds after having sent the *transit through-connect* signal (TTC), it will return to the preceding centre the *call progress* signal No. 20 followed by 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 *retest* signal will be initiated as indicated in § 2.4.

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 retest 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 retests will be made at 30-minute intervals. An alarm will be given at an appropriate time. However, this retest procedure may be discontinued at any stage at the discretion of the outgoing Administration.

If, however, during the above sequence of retests, the *reception-confirmation* signal is received, a *clearing* signal will be transmitted in place of the *retest* 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 retest 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 retests do not overlap at both ends. In general, the intercontinental transit centre having the higher DNIC should take the longer interval (i.e. 1.2, 6 and 36 minutes). Nevertheless, when this requirement would entail considerable difficulty, alternative arrangements may be adopted by agreement between the two Administrations or RPOAs concerned.

Where an exchange has knowledge of a transmission system failure it is desirable that the *retest* 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 *retest* 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 retest permits the incoming centre to be informed about retests 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

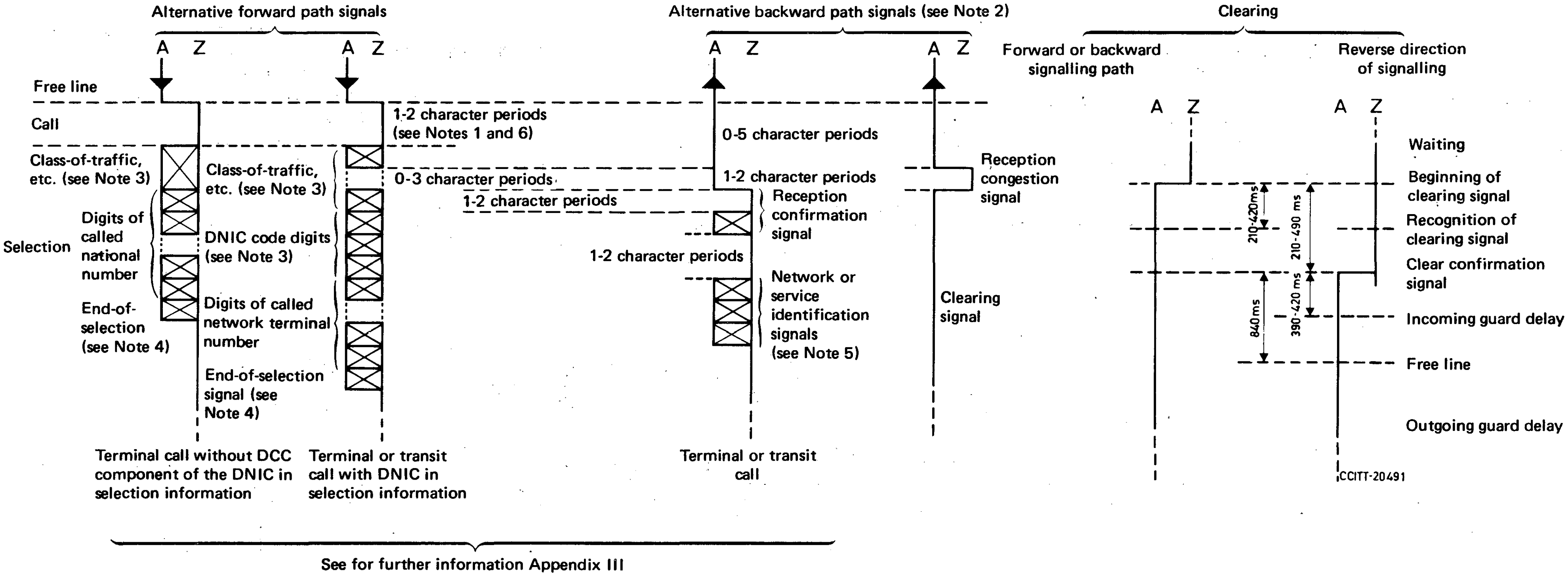
Control signalling code (CSC)

CSC character number	CSC character structure			
	b_4	b_3	b_2	b_1
1	A	A	A	A
2	A	A	A	Z
3	A	A	Z	A
4	A	A	Z	Z
5	A	Z	A	A
6	A	Z	A	Z
7	A	Z	Z	A
8	A	Z	Z	Z
9	Z	A	A	A
10	Z	A	A	Z
11	Z	A	Z	A
12	Z	A	Z	Z
13	Z	Z	A	A
14	Z	Z	A	Z
15	Z	Z	Z	A
16	Z	Z	Z	Z

Note 1 – The 7-unit code with one parity check bit, 1-unit start and 2-unit stop elements for user class 1 and the 4-unit code with 1 parity check bit, 1-unit start and 2-unit stop elements for user class 2 used in this control signalling system are listed in the table. As the bits b_5, b_6 and b_7 of the 7-unit code have a permanent pattern (1,1,0), only the bits b_1, b_2, b_3 and b_4 are shown.

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 of 200 bit/s (user class 2) and 300 bit/s (user class 1) with the low order bit (b_1) first and completed by the parity check bit (b_5 or b_8).

Note 3 – The transmitting part of the signalling device shall send the control character at the nominal modulation rate (300 bauds for user class 1 and 200 bauds for user class 2) of + 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%.



Note 1 – Timings shown as character periods refer to the complete control character of user class 1 (11 units at 300 bit/s) and user class 2 (8 units at 200 bit/s). Switching and propagation delays are not included.

Note 2 – *Forward path* signals may also appear in the backward path, indicating a head-on collision on both-way circuits.

Note 3 – *Network selection* signals (class-of-traffic, user class characters, etc.). See Tables 2-5/X.70. DNIC comprises 4 digits.

Note 4 – *Selection* signals will always be sent as a single block by the originating network with an *end-of-selection* signal in all cases.

Note 5 – The *network* or *service identification* signals comprise a distinctive character followed by the DNIC of the network concerned.

Note 6 – The minimum and consequently the maximum periods will be lengthened at the request of the incoming country Y.

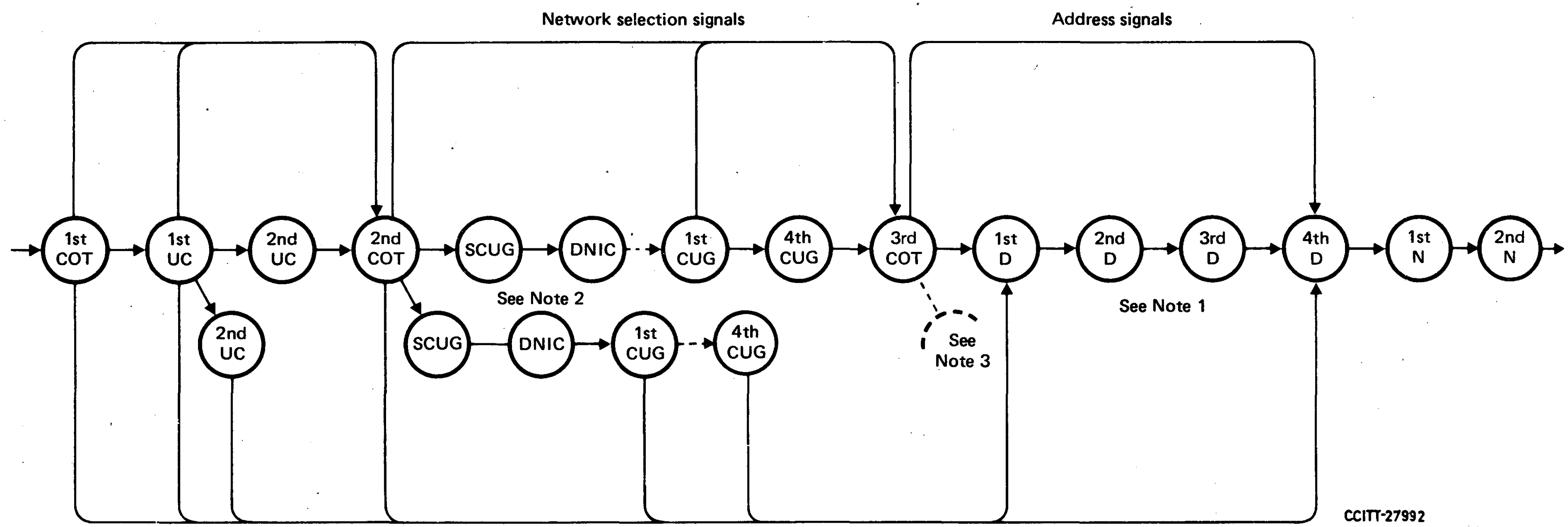
FIGURE 1/X.70

Decentralized signalling between data networks of anisochronous type

APPENDIX I

(to Recommendation X.70)

Possible sequences of network selection signals



COT	Class-of-traffic character
UC	User class character
SCUG	Start of closed user group character
DNIC	Data network identification code
CUG	Closed user group character
D	Data network (or service) identification code digit
N	Called number digit

Note 1 – The first three digits D_1, D_2 and D_3 form the data country code (DCC) component of the data network identification code (DNIC). The fourth digit (D_4) is the network or service digit of the DNIC.

Note 2 – The DNIC comprises four digits as defined in Note 1.

Note 3 – Reserved for future extension.

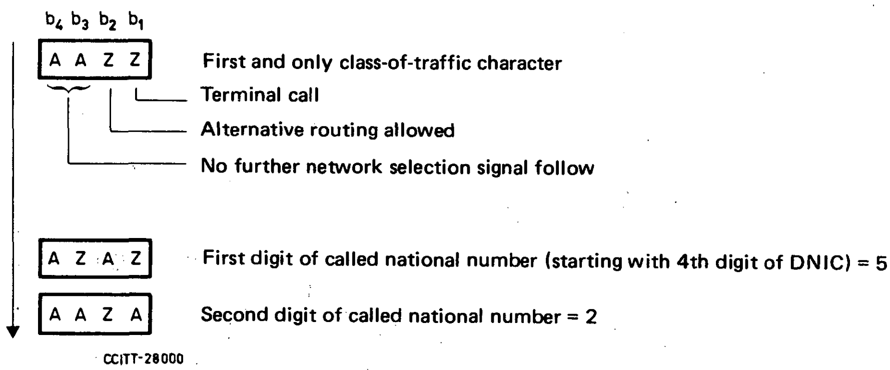
APPENDIX II

(to Recommendation X.70)

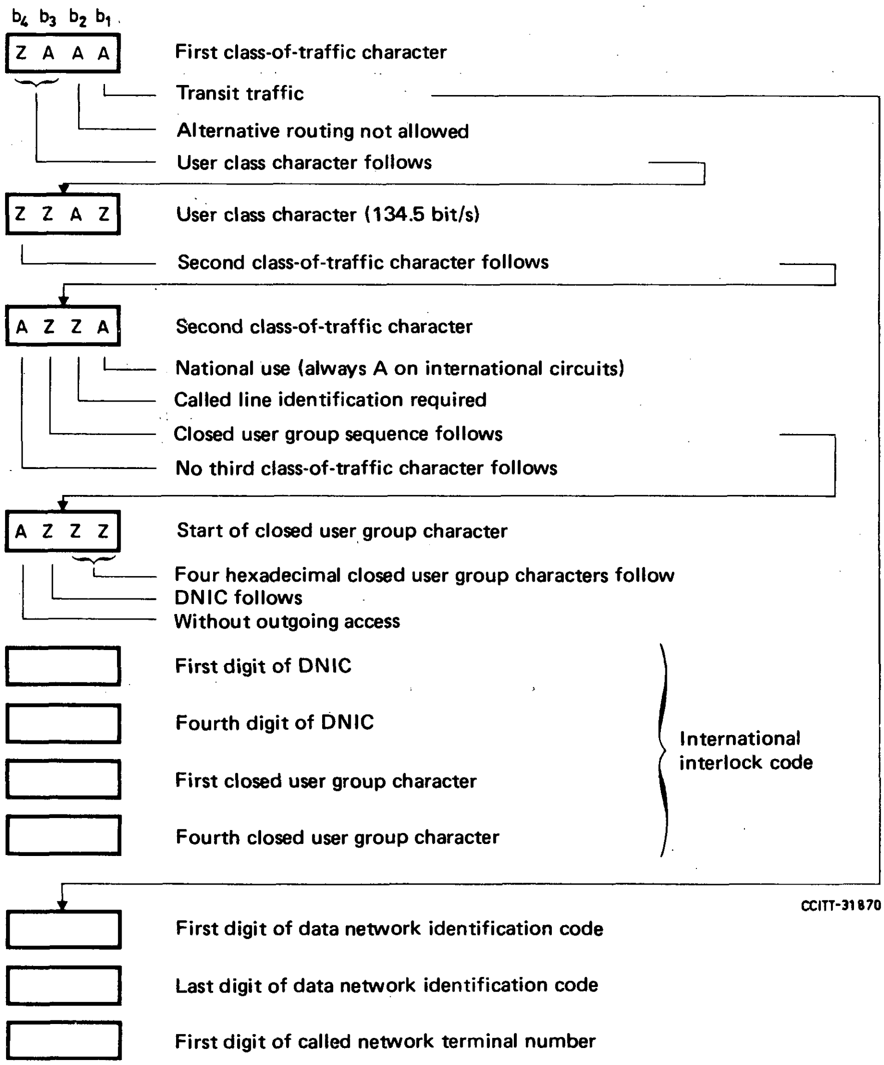
Examples of network selection signals

II.1 *First example* (minimum sequence of network selection signals)

This example shows a sequence of minimal length. The country of destination has indicated that it does not wish to receive the DCC component of the DNIC. (The preceding *calling* signal, start and stop elements, possible stuffing bits and the parity bit are not shown. The bits are shown in the order of b_4, b_3, b_2 and b_1).



II.2 *Second example* (a sequence of *network selection* signals including closed user group characters)

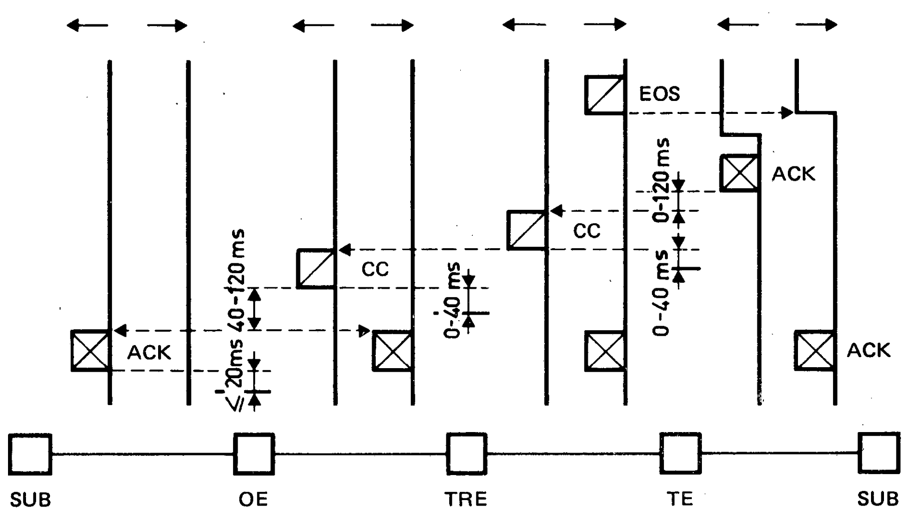


APPENDIX III (A)

(to Recommendation X.70)

Through-connection procedure

Called and calling line identification not required (no connect when free facility)



CCITT-28 021

- - - ➔	Correlation line
———	Through-connection
⧄	CSC or IA5-character
⊠	IA5-character

EOS	End-of-selection signal
CC	Call connected signal
SUB	Subscribers
OE	Originating exchange
TRE	Transit exchange
TE	Terminating exchange

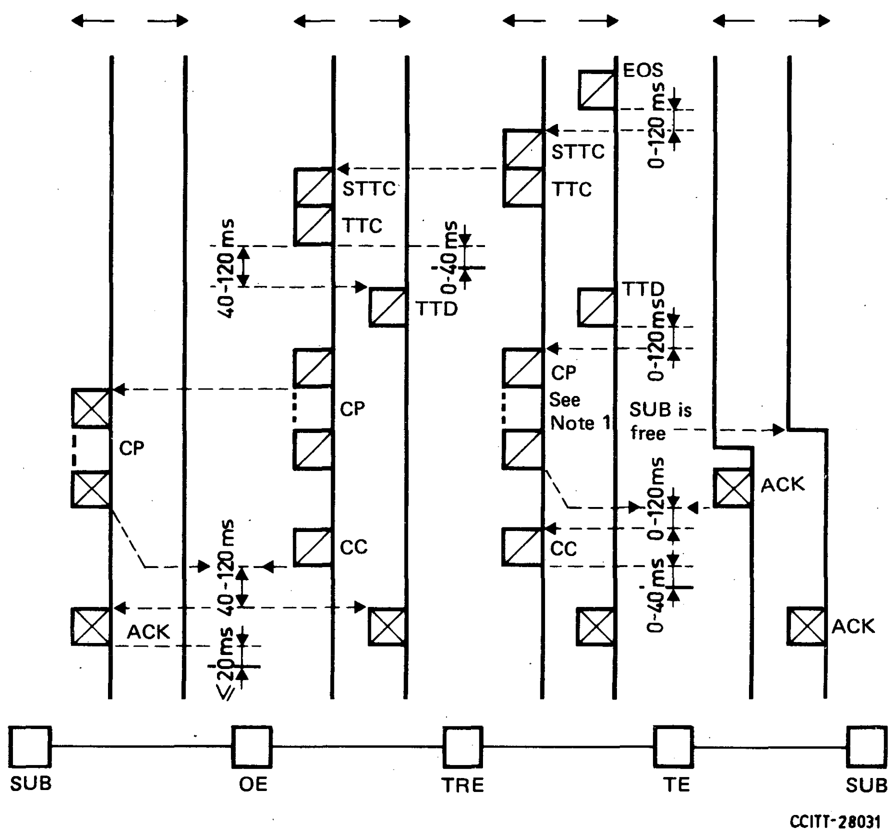
Note – Timings shown are worst case figures and design objectives should be to keep them as short as possible.

APPENDIX III (B)

(to Recommendation X.70)

Through-connection procedure

Called and calling line identification not required (subscriber is busy, connect when free facility)



- - - ▸	Correlation line	TTD	Transit centres through-connected signal
———	Through-connection	CP	Call progress signals (without clearing)
▨	CSC or IA5-character	CC	Call connected signal
☒	IA5-character	SUB	Subscribers
		OE	Originating exchange
EOS	End-of-selection signal	TRE	Transit exchange
STTC	Start-of-transit through-connect signal	TE	Terminating exchange
TTC	Transit through-connect signal		

Note 1 – *Call progress* signals comprise a distinctive character followed by a 2-digit number.

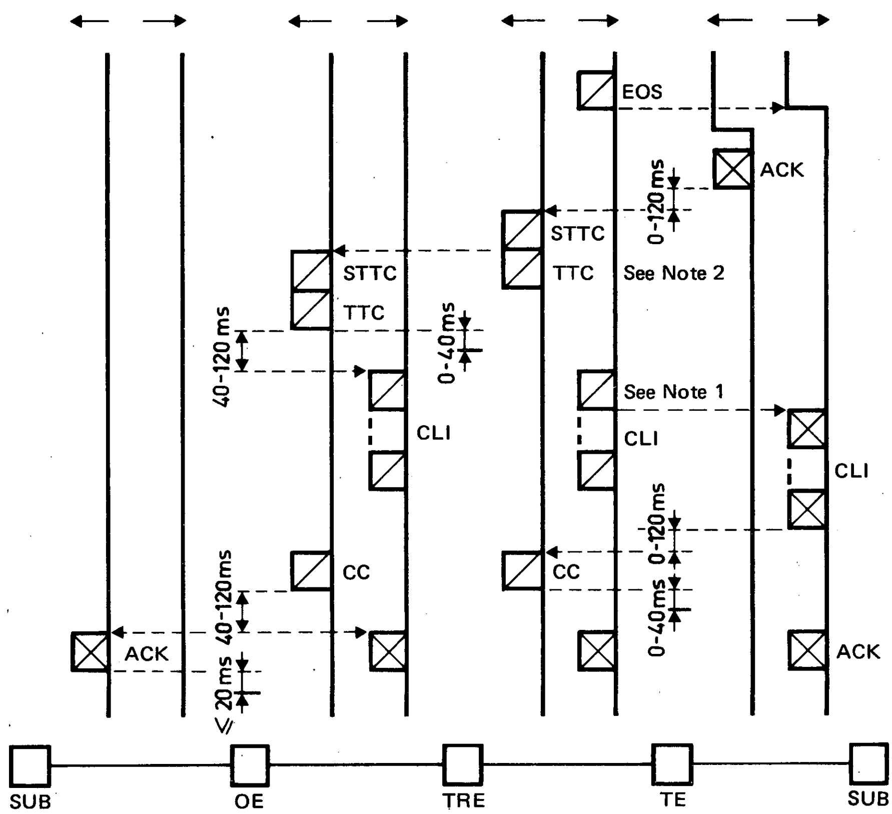
Note 2 – See Note in Appendix III (A).

APPENDIX III (C)

(to Recommendation X.70)

Through-connection procedure

Called line identification not required, calling line identification required (no connect when free facility)



CCITT-28042

– – – ▸	Correlation line	TTC	Transit through-connect signal
———	Through-connection	CLI	Calling line identification signals
	CSC or IA5-character	CC	Call connected signal
		SUB	Subscribers
	IA5-character	OE	Originating exchange
EOS	End-of-selection signal	TRE	Transit exchange
STTC	Start-of-transit through-connect signal	TE	Terminating exchange

Note 1 – The *calling line identification* signal consists of the DNIC followed by the digits of the subscriber number and CSC No. 12. Where no identification is available, only the DNIC followed by CSC No. 12 is sent.

Note 2 – In this example, it is assumed that the *STTC* signal is sent after the receipt of the *call accepted* signal (ACK). However, some countries may decide to return this signal following a positive subscriber check state (not busy), at the same time as the subscriber call set-up is initiated.

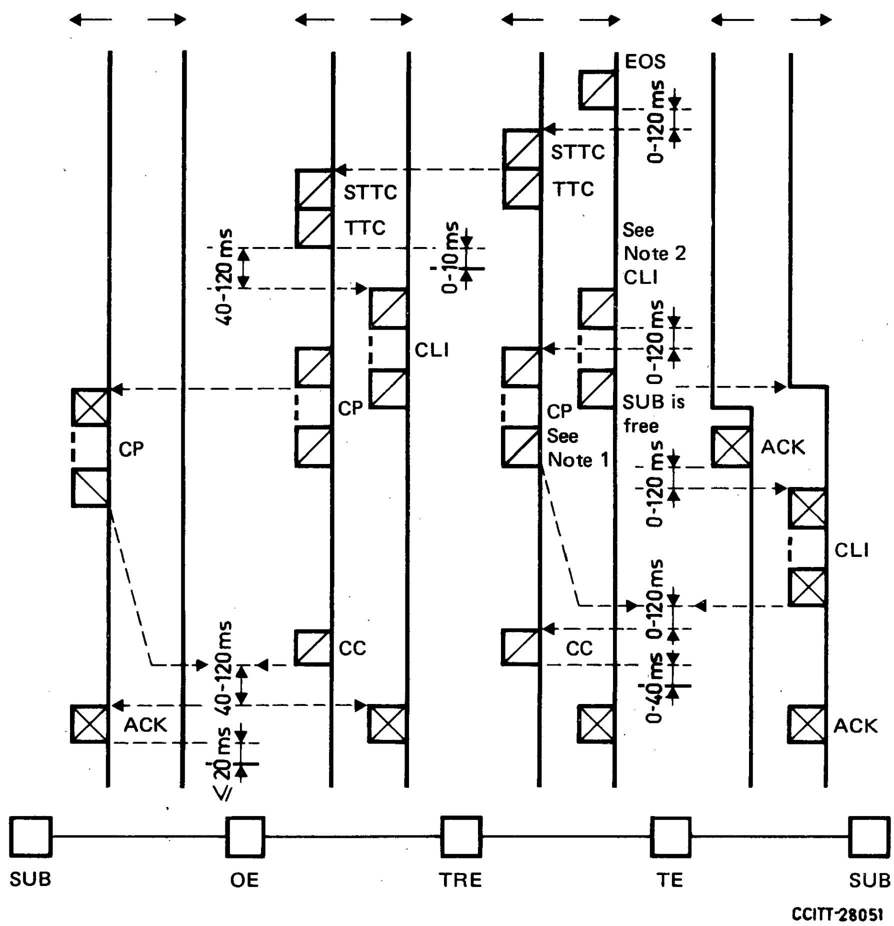
Note 3 – See Note in Appendix III (A).

APPENDIX III (D)

(to Recommendation X.70)

Through-connection procedure

Called line identification not required, calling line identification required (subscriber is busy, connect when free facility)



- - - →	Correlation line	EOS	End-of-selection signal
———	Through-connection	STTC	Start-of-transit through-connect signal
▨	CSC or IA5-character	TTC	Transit through-connect signal
☒	IA5-character	CLI	Calling line identification signals
		CP	Call progress signals
		CC	Call connected signal
		SUB	Subscribers
		OE	Originating exchange
		TRE	Transit exchange
		TE	Terminating exchange

Note 1 – *Call progress* signals comprise a distinctive character followed by a 2-digit number.

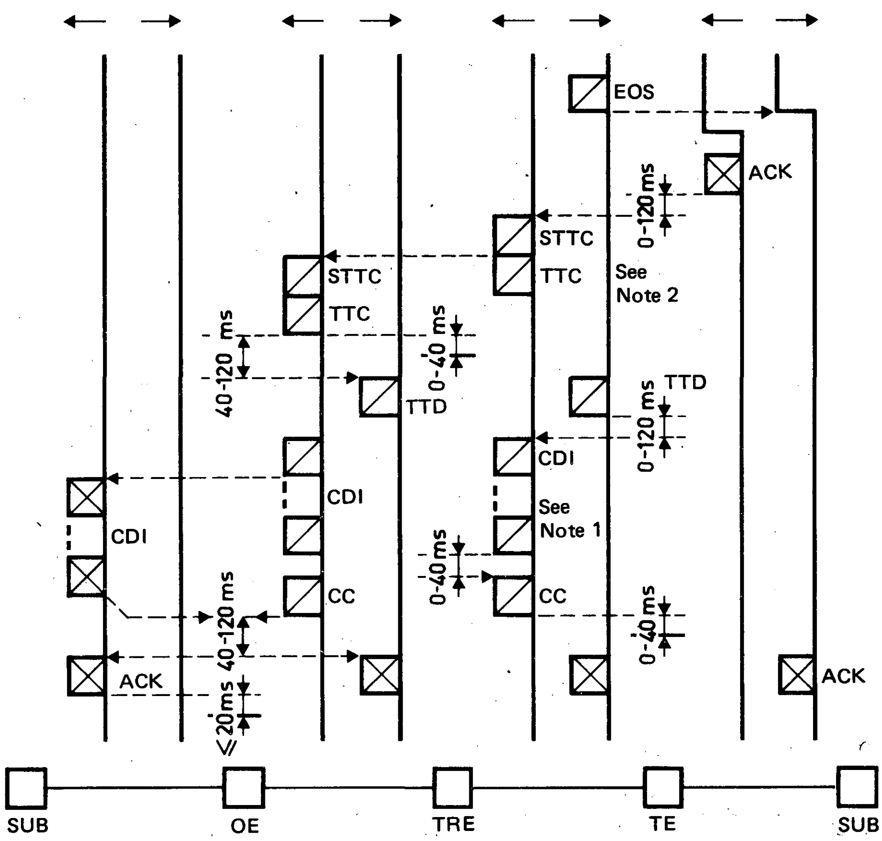
Note 2 – The *calling line identification* signal consists of the DNIC followed by the digits of the subscriber number and CSC No. 12. Where no identification is available, only the DNIC followed by CSC No. 12 is sent.

Note 3 – See Note in Appendix III (A).

(to Recommendation X.70)

Through-connection procedure

Called line identification required, calling line identification not required (no connect when free facility)



CCITT-28 061

- - - → Correlation line

——— Through-connection

▱ CSC or IA5-character

☒ IA5-character

EOS	End-of-selection signal
STTC	Start-of-transit through-connect signal
TTC	Transit through-connect signal
TTD	Transit centres through-connected signal
CDI	Called line identification signals
CC	Call connected signal
SUB	Subscribers
OE	Originating exchange
TRE	Transit exchange
TE	Terminating exchange

Note 1 – The *called line identification* signal consists of the DNIC followed by the digits of the subscriber number and CSC No. 12. Where no identification is available, only CSC No. 12 is sent.

Note 2 – In this example, it is assumed that the *STTC* signal is sent after the receipt of the *call accepted* signal (ACK). However, some countries may decide to return this signal following a positive subscriber check state (not busy), at the same time as the subscriber call set-up is initiated.

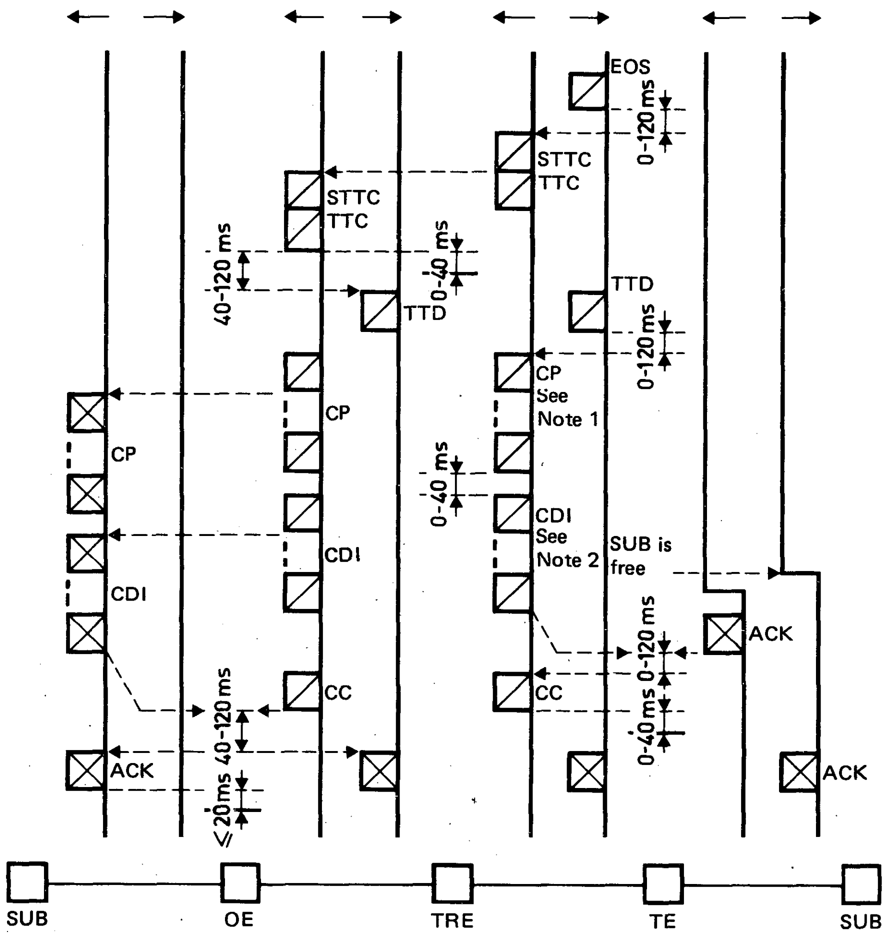
Note 3 – See Note in Appendix III (A).

APPENDIX III (F)

(to Recommendation X.70)

Through-connection procedure

Called line identification required, calling line identification not required (subscriber is busy, connect when free facility)



CCITT-28071

- - - →	Correlation line	TTD	Transit centres through-connected signal
———	Through-connection	CP	Call progress signals
⧄	CSC or IA5-character	CDI	Called line identification signals
		CC	Call connected signal
⊠	IA5-character	SUB	Subscribers
EOS	End-of-selection signal	OE	Originating exchange
STTC	Start-of-transit through-connect signal	TRE	Transit exchange
TTC	Transit through-connect signal	TE	Terminating exchange

Note 1 – *Call progress* signals comprise a distinctive character followed by a 2-digit number.

Note 2 – The *called line identification* signal consists of the DNIC followed by the digits of the subscriber number and CSC No. 12. Where no identification is available, only CSC No. 12 is sent.

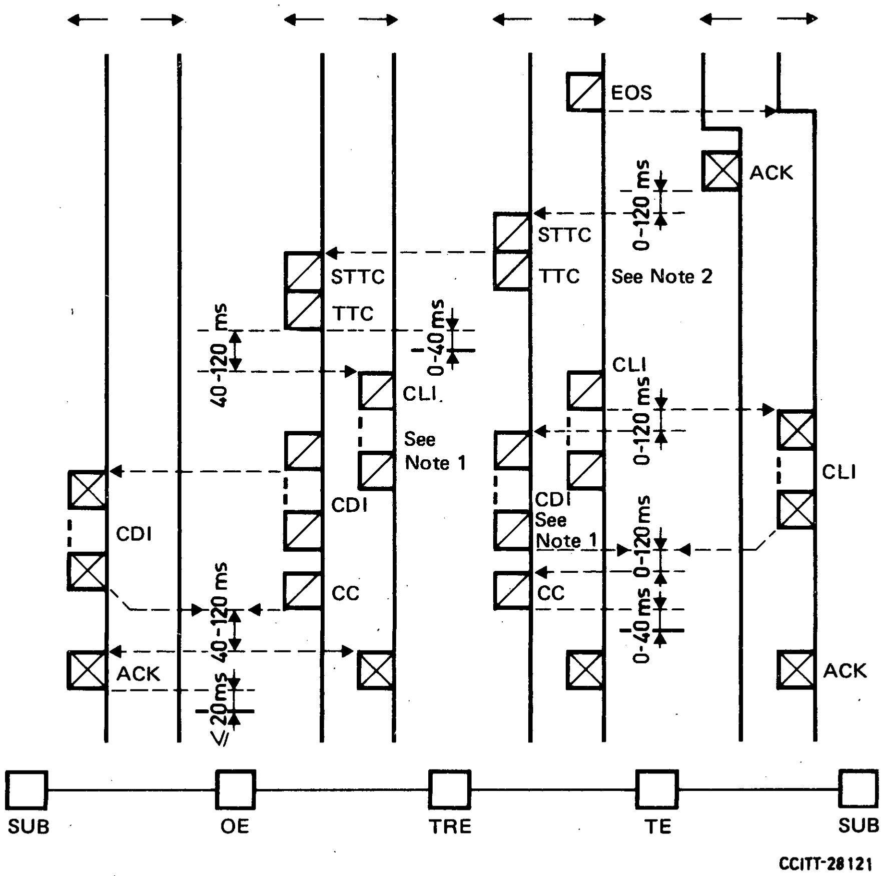
Note 3 – See Note in Appendix III (A).

APPENDIX III (G)

(to Recommendation X.70)

Through-connection procedure

Called and calling line identification required (no connect when free facility)



- - - ➔ Correlation line

——— Through-connection

⍁ CSC or IA5-character

⌧ IA5-character

EOS	End-of-selection signal
STTC	Start-of-transit through-connect signal
TTC	Transit through-connect signal
CLI	Calling line identification signals
CDI	Called line identification signals
CC	Call connected signal
SUB	Subscribers
OE	Originating exchange
TRE	Transit exchange
TE	Terminating exchange

Note 1 – The *called line identification* signal consists of the DNIC followed by the digits of the subscriber number and CSC No. 12. Where no called line identification is available, only CSC No. 12 is sent.

The *calling line identification* signal consists of the DNIC followed by the digits of the subscriber number and CSC No. 12. Where no calling line identification is available, only the DNIC followed by CSC No. 12 is sent.

Note 2 – In this example, it is assumed that the *STTC* signal is sent after the receipt of the call accepted signal (ACK). However, some countries may decide to return this signal following a positive subscriber check state (not busy), at the same time as the subscriber call set-up is initiated.

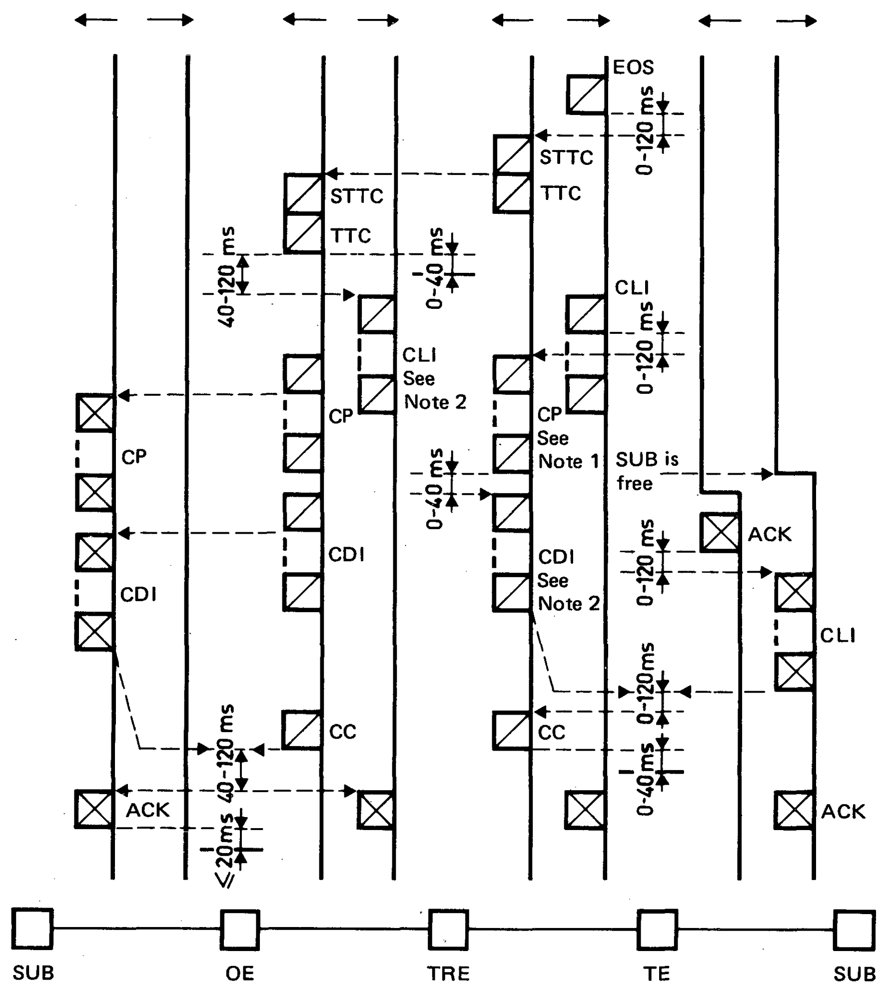
Note 3 – See Note in Appendix III (A).

APPENDIX III (H)

(to Recommendation X.70)

Through-connection procedure

Called and calling line identification required (subscriber is busy, connect when free facility)



CCITT-28 131

- - - →	Correlation line	CLI	Calling line identification signals
———	Through-connection	CP	Call progress signals
⧄	CSC or IA5-character	CDI	Called line identification signals
⊠	IA5-character	CC	Call connected signal
		SUB	Subscribers
		OE	Originating exchange
EOS	End-of-selection signal	TRE	Transit exchange
STTC	Start-of-transit through-connect signal	TE	Terminating exchange
TTC	Transit through-connect signal		

Note 1 – *Call progress* signals comprise a distinctive character followed by a 2-digit number.

Note 2 – The *called line identification* signal consists of the DNIC followed by the digits of the subscriber number and CSC No. 12. Where no called line identification is available, only CSC No. 12 is sent.

The *calling line identification* signal consists of the DNIC followed by the digits of the subscriber number and CSC No. 12. Where no calling line identification is available, only the DNIC followed by CSC No. 12 is sent.

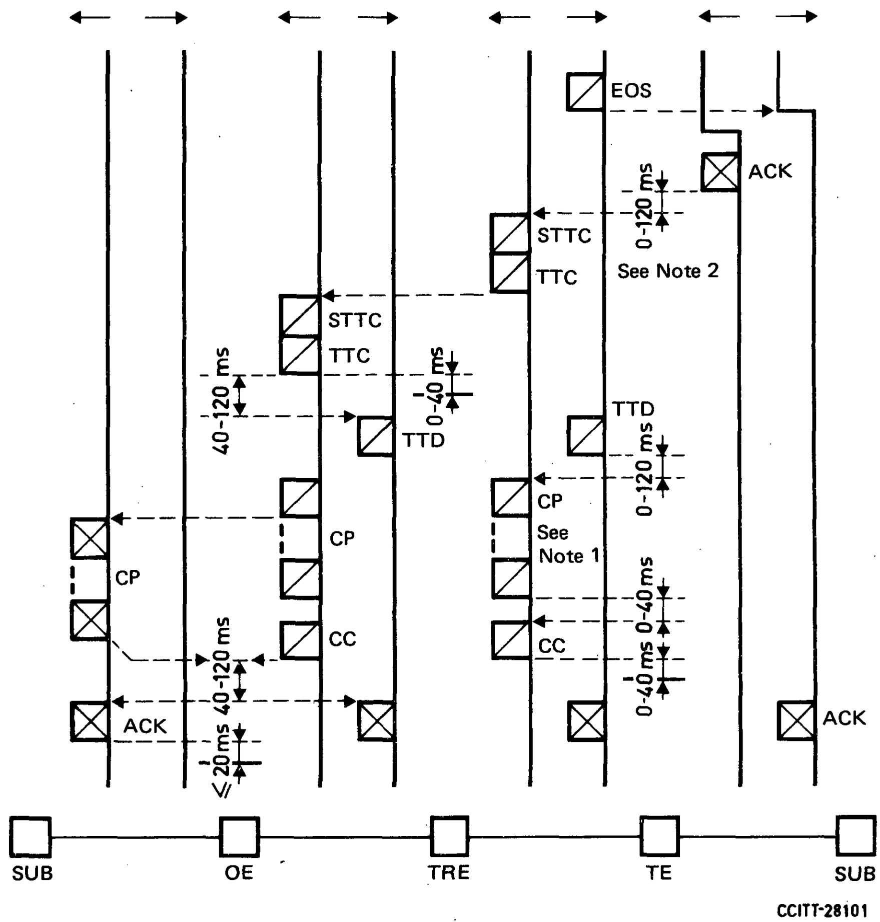
Note 3 – See Note in Appendix III (A).

APPENDIX III (I)

(to Recommendation X.70)

Through-connection procedure

Called and calling line identification not required (call progress signal without clearing, e.g. redirected call)



- - - -➔	Correlation line	TTD	Transit centres through-connected signal
———	Through-connection	CP	Call progress signal
▨	CSC or IA5-character	CC	Call connected signal
☒	IA5-character	SUB	Subscribers
		OE	Originating exchange
EOS	End-of-selection signal	TRE	Transit exchange
STTC	Start-of-transit through-connect signal	TE	Terminating exchange
TTC	Transit through-connect signal		

Note 1 – *Call progress* signals comprise a distinctive character followed by a 2-digit number.

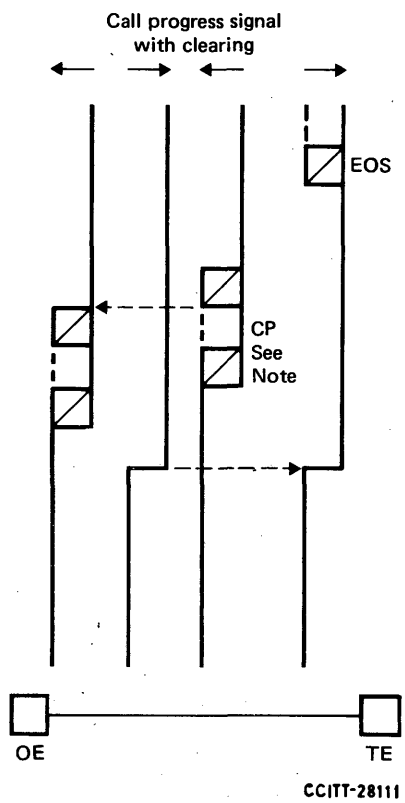
Note 2 – In this example, it is assumed that the *STTC* signal is sent after the receipt of the *call accepted* signal (ACK). However, some countries may decide to return this signal following a positive subscriber check state (not busy), at the same time as the subscriber call set-up is initiated.

Note 3 – See Note in Appendix III (A).

APPENDIX IV

(to Recommendation X.70)

Unsuccessful call



- - - → Correlation line

⧄ CSC or IA5-character

EOS	End-of-selection signal
OE	Originating exchange
TE	Terminating exchange
CP	Call progress signal

Note – *Call progress* signals comprise a distinctive character followed by a 2-digit number.

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.1.

[2] CCITT Recommendation *Terminal and transit control signalling system for telex and similar services on international circuits (Type D signalling)*, Vol. VII, Fascicle VII.4, Rec. U.12.

[3] CCITT Recommendation *International numbering plan for public data networks*, Vol. VIII, Fascicle VIII.7, Rec. X.121.

[4] CCITT Recommendation *General tariff principles for data transmission on public networks dedicated to this type of transmission*, Vol. II, Fascicle II.1, Rec. D.10.

[5] CCITT Recommendation *General structure of signals of International Alphabet No. 5 code for data transmission over public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.4.

[6] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for start-stop transmission services on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.20.

Recommendation X.71

DECENTRALIZED TERMINAL AND TRANSIT CONTROL SIGNALLING SYSTEM ON INTERNATIONAL CIRCUITS BETWEEN SYNCHRONOUS DATA NETWORKS

(Geneva, 1976, amended at Geneva, 1980)

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 recommends

for interworking between synchronous data networks utilizing decentralized control signalling techniques the scheme given below should be used on international circuits.

Note 1 – The synchronous user classes of service are as specified in Recommendation X.1 [1].

Note 2 – The signalling on links between synchronous and anisochronous networks is the subject of further study.

Note 3 – The interworking between common channel and decentralized signalling is the subject of Recommendation X.80.

Scope

This Recommendation defines a decentralized control signalling system for use in setting up terminal and transit calls on international circuits between synchronous data networks.

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, telex, etc., will be assembled and transmitted in accordance with Recommendation X.52.

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.

The data network identification code (DNIC) (see Recommendation X.121 [2]), and *network* or *service identification* signals will be transmitted on both transit and terminal calls. However, the data country code (DCC) portion of the DNIC may be suppressed and only the network or service digit forwarded on terminal calls if requested by the incoming network.

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 The numbering scheme that will be applied to networks accessed by this signalling system is defined in Recommendation X.121 [2].

1.6 Alternative routing will be permitted. The principle of high-usagecircuits will be adopted, with overflow onto adequately provided routes between centres.

Overflow onto 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 of 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 It is assumed that the gathering of information required for charging and accounting should normally be the responsibility of the calling Administration (see Recommendation D.10 [3]). Other arrangements for gathering information are for further study.

1.9 The grade of service to apply for the provision of circuits for links between public data networks of the synchronous type which carry traffic overflowing from other routes, or from which overflow was not permitted, would be not worse than one call lost 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.

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 [1)] and 1s.

During the control signalling stage, the status bits are 0s. Upon the final through-connection in the originating exchange, 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 [4] for links and connections using end-to-end synchronous operation, and with Recommendation X.21 [5]. 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 abovementioned 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 V. In the Recommendation X.51 multiplex structure, the signalling characters will be aligned with the 8 + 2 envelope.

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. 20 is returned to the preceding centre within a sequence of signals ordered as follows: *call confirmation* or *proceed-to-select*, *network* or *service identification*, the *call progress* signal and *clearing*.

[1)] The impact of the all zeros pattern is left for further study.

TABLE 1/X.71

Decentralized signalling between synchronous data networks

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 exchange 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 2 SYN characters (1/6)	Returned within 10 ms or 16 information bits of receipt of the *calling* signal, whichever is the greater in time. The *call confirmation* signal shall be followed by the *network* or *service identification* signal within 50 ms of receipt of the first class-of-traffic character, followed by the *waiting* signal if no other 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.
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 2 SYN characters (1/6)	Returned within 3 seconds from the start of the received *calling* signal. The *proceed-to-select* signal shall be followed by the *network* or *service identification* signal within 50 ms of receipt of the first class-of-traffic character, 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.

TABLE 1/X.71 *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
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 I), the digits of the DNIC 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 data country code (DCC) may be omitted on terminal calls at the request of the incoming country. 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 or service identification signals		S = 0, IA5 character 3/11 followed by the DNIC of the network followed by the *waiting* signal if no other signalling characters follow contiguously	The character 3/11 and DNIC 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.
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 7d/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* signals, 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 III. This signal is preceded by at least two SYN characters (1/6) if it follows a *waiting* signal.

TABLE 1/X.71 *(continued)*

Signal or function	Forward path (Y towards X)	Backward path (Y towards X)	Remarks
Start-of-transit through-connect signal (STTC)		S = 0, one IA5 character 3/14 according to Table 7/X.71	This signal always precedes the *transit through-connect* signal.
Transit through-connect signal (TTC)		S = 0, one IA5 character, 3/12-15, according to Table 7b/X.71, followed by the *waiting* signal if no other signalling characters follow contiguously	This signal will always be prefaced by the *start-of-transit through-connect* signal and will be returned preceding a *call progress* signal without clearing when this has to be sent. It will also be transmitted when the calling and/or called line identification is required (for further details see Appendix III. The signal is returned at the same time as the subscriber call set-up procedure is initiated following a positive subscribers state check, e.g. not busy, no loss of synchronization, or when the subscriber is busy and connect when free facility is provided (see Appendix III(B) for example).
Transit centres through-connected signal (TTD)	S = 0, one IA5 character, 3/10 according to Table 6/X.71		This signal is returned by the originating exchange 30-50 ms following receipt of the *transit through-connect* signal. The signal is omitted and replaced by the calling line identity if it is requested.
Called line identification signal (if applicable)		S = 0, *called line identification* signal transmitted between 0 and 30 ms after the *transit centres through-connected* signal or the first character of the calling line identification is received	The *called line identification* signal consists of the DNIC followed by the digits of the network terminal number and then the end-of-identification character (3/11) (see § 2.12 of the text and Appendix III). If the called line identification is requested and is not available within the network receiving the request, a dummy identification consisting of the end-of-identification character (3/11) only is transmitted. This signal is preceded by at least two SYN characters (1/6) when it follows a *waiting* signal.
Calling line identification signal (if applicable)	S = 0, *calling line identification* signal transmitted between 30 and 50 ms after the *transit through-connect* signal is received		The *calling line identification* signal consists of the DNIC followed by the digits of the network terminal number and then the end-of-identification character (3/11). If the calling line identification is requested and is not available within the network receiving the request, the DNIC followed by character 3/11 shall be transmitted. See Appendix III.
Terminating through-connection signal		Continuous repetitions of 1s (S = 1) from the called DTE received by the originating centre	This signal confirms through-connection in both directions of transmission in the destination centre (see § 2.13 of the text and Appendix III).

TABLE 1/X.71 *(concluded)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Originating through-connection signal	Continuous repetitions of 1s (S = 1) received by the called DTE from the calling DTE		This signal confirms through-connection in both directions of transmission in the originating centre (see § 2.13 of the text and Appendix III).
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 7d/X.71) 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 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.
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	

a) The duration of the *calling* signal and return of the *call confirmation* signal is for further study in the light of experience.

Note 1 – The status bit may be OFF (= 0) or ON (= 1).

Note 2 – For call confirmation (CC) protocol and proceed-to-select (PTS) protocol see § 2.1.

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 *retest* signal on the circuit concerned.

The need for an automatic *retest* signal may not be so great in a digital environment, its purpose being met by alternative methods. If an automatic *retest* signal is used, however, it will conform to § 2.16.

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. 20 is returned to the preceding centre within a sequence of signals ordered as follows: *call confirmation* or *proceed-to-select*, *network* or *service identification*, the *call progress* signal and *clearing*.

2.5 *Selection* signals can be divided into two 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, 5/X.71 and 5a/X.71). The second part comprises the *address* signals (the called national terminal number which is preceded by the DNIC always in the case of a transit call and also for terminal calls unless the incoming destination country requests omission of the data country code portion, see Tables 6/X.71 and 6a/X.71).

The *network selection* signals used in the forward direction (see also Appendix II 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 chosen so that no further characters would be 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.

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.

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 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 (Table 4/X.71)
1	0			User class character follows (Table 3/X.71)
		0		Alternative routing not allowed
		1		Alternative routing allowed
			0	Transit traffic
			1	Terminal traffic
1 1 1 1	1 1 1 1	0 0 1 1	0 1 0 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.

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 (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 (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	
1	0	1	0	
1	0	1	1	
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.

b) The user class character(s) may be omitted if, for example, the information can be derived from the incoming line.

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 (Table 4a/X.71)
	0			No closed user group sequence follows
	1			Closed user group sequence follows (Table 5/X.71)
		0		Called line identification not required
		1		Called line identification required
			0 1	Reserved for national use[b]

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 c)
	0			Redirection not allowed d)
	1			Redirection allowed d)
		0		Not multiple address call d)
		1		Multiple address call d)
			0 1	} Not allocated b)

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) On international circuits bit b_1 should be set to zero.

c) Reserved for future needs.

d) The international use of this signal requires further study.

2.5.4 *Closed user group characters* (see Tables 5/X.70 and 5a/X.71)

These characters are only used in conjunction with the second and possibly subsequent class-of-traffic characters which may follow.

The start of closed user group character shall precede the closed user group number which should be coded into a number of hexadecimal characters up to a maximum of four (see Table 5/X.71).

2.5.5 The numerical characters used for the second part of the *selection* signals are shown in Tables 6/X.71 and 6a/X.71. When the first class-of-traffic character indicates a terminal call, the incoming country can adopt the option not to receive the data country code portion of the DNIC.

TABLE 5/X.71

Start of closed user group character [a) b)]

Combination				Condition signalled from X to Y
b_4	b_3	b_2	b_1	
0				Without outgoing access
1				With outgoing access
	0			No DNIC follows
	1			DNIC follows [c)]
		0	0	1 — Number of hexadecimal closed user group characters which follow
		0	1	2 — Number of hexadecimal closed user group characters which follow
		1	0	3 — Number of hexadecimal closed user group characters which follow
		1	1	4 — Number of hexadecimal closed user group characters which follow

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 start of closed user group character shall precede the DNIC of the representative user, followed by the closed user group number which should be coded into a number of hexadecimal characters up to a maximum of four, as indicated. The closed user group number shall be transmitted with the least significant bit of the least significant character first.

c) On international circuits bit b_3 should be set to 1.

TABLE 5a/X.71

Closed user group characters [a)]

Combination				Condition signalled from X to Y	
b_4	b_3	b_2	b_1		
0	0	0	0	0	Hexadecimal closed user group character
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	A	
1	0	1	1	B	
1	1	0	0	C	
1	1	0	1	D	
1	1	1	0	E	
1	1	1	1	F	

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.

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
1	0	1	0	Transit centres through-connected (TTD)
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

Digits 0–9: Digits for:
- data network identification code (DNIC)
- called network terminal number
- calling line identification signal

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 follows the DNIC when the calling line identification is not available (see § 2.12).

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

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.

In the case of receipt of a spurious signal as indicated by a parity error or by a character other than a *selection* signal (with the possible exception of SYN characters), the incoming equipment should return the *call progress* signal No. 20 to the preceding centre immediately followed by the *clearing* signal after the *call confirmation* or *proceed-to-select* signal and the *network* or *service identification* signals.

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 *call progress* signal No. 20 is returned to the preceding centre immediately followed by the *clearing* signal after the *call confirmation* or *proceed-to-select* signal and the *network* or *service identification* signals.

2.7 The *address* signal may have a maximum number of 14 digits comprising the 4 digit data network identification code and a 10 digit maximum network terminal number. Alternatively the 14 digits can be considered as the 3 digit data country code followed by a national number of 11 digits maximum. (See Recommendation X.121 [2]).

2.8 In the case of receipt of the *reception congestion* signal at a transit centre, the *call progress* signal No. 61 should be returned to the preceding centre (after the *call confirmation* or *proceed-to-select* signal, *network* or *service identification* signal) followed by the *clearing* signal.

2.9 The *network* or *service identification* signals shall be sent following the *call confirmation* or *proceed-to-select* signal in all cases. In all cases the country or network identity shall consist of four decimal digits. The value of the fourth digit should, in the case when it is not specifically defined by the numbering plan, be at the discretion of the country in question within the limits allowed by the numbering plan.

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* or *service identification* signals, within two seconds of the *call confirmation* signal, it will return to the preceding centre, the *call progress* signal No. 20 (after the *call confirmation* or *proceed-to-select* signal and the *network* or *service identification* signal followed by the *clearing* signal).

The *network* or *service 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* or *service 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/X.71, 7a/X.71, 7b/X.71, 7c/X.71 and 7d/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. 20 will be returned to the preceding centre (after the *call confirmation* or *proceed-to-select* signal, *network* or *service 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 or called subscribers respectively. These identifications may be exchanged within the network as an optional subscribers' feature.

If the called line identification has been requested but is not available, the terminating centre in the connection should send only the *end-of-line identification* signal (3/11).

If the calling line identification has been requested but is not available, the originating centre should send only the DNIC followed by the *end-of-line identification* signal (3/11).

2.13 The *call-connected* signal confirms that the call is accepted by the called subscriber and, if applicable, the calling line identification has been completely received by the terminating centre and passed to the called subscriber, and when applicable that the called line identification has been completely transmitted to the originating centre (see Appendix III).

The *terminating through-connection* signal confirms (by change of status bit from 0 to 1) that through-connection in both directions of transmission has been effected at the terminating exchange (see Appendix III).

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 (see Appendix III).

The *call connected* signal is sent on the backward path by the terminating centre. The originating through-connection signal (change of status bit from 0 to 1) is sent by the originating centre both to the calling and called subscribers.

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
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4 Digits for: – network or service identification signals – called line identification signal – call progress signal
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 7d/X.71)
1	0	1	1	End-of-called-line identification signal[b)] Start of network or service identification signal
1	1	0		Call connected signal
			0	Call metering
			1	No call metering
1	1	1	0	Start of transit through-connect signal (STTC)[c)]
1	1	1	1	Further backward path signal follows (see Table 7a/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) This signal is also used alone when the called line identification is not available.

c) This signal always precedes the *transit through-connect* signals detailed in Table 7b/X. 71.

TABLE 7a/X.71

Further miscellaneous backward path signals[a) b)]

First four bits of character				Condition signalled from Y to X
b_4	b_3	b_2	b_1	
0				Reserved for national use
1				Reserved for national use
	0	0	0	Not allocated
	0	0	1	
	0	1	0	
	0	1	1	
	1	0	0	
	1	0	1	
	1	1	0	
	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.

b) These signals follow combination 1111 in Table 7/X.71.

TABLE 7b/X.71

Transit through-connect signal[a) b)]

First four bits of character				Condition signalled from Y to X
b_4	b_3	b_2	b_1	
0	0	0	0	No allocated
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	
1	0	1	0	
1	0	1	1	
1	1			Transit through-connect signal (TTC)
		0		Calling line identification not required
		1		Calling line identification required
			0	Call metering
			1	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) These signals follow the start of *transit through-connect* signal in Table 7/X.71.

TABLE 7c/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 7d/X.71

Call progress signals [a)]

Numerical code first/second digit	Category	Significance
01	Without clearing	Terminal called
02		Redirected call
03		Connect when free
20	With clearing, due to short term condition [b)]	Network failure [f)]
21		Number busy
22		c)
23		c)
41	With clearing, due to long term condition [b)]	Access barred
42		Changed number
43		Not obtainable
44		Out of order
45		Controlled not ready
46		Uncontrolled not ready
47		DCE power off
48		c)
49		Network fault in local loop
51		Call information service
52		Incompatible user class of service
61	With clearing, due to network short term conditions [b)]	Network congestion
71	With clearing, due to network long term conditions [b)]	Degraded service
72		e)
81	With clearing, due to DTE-network procedure	Registration/cancellation confirmed [d)]
82		c)
83		c)

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) "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.

c) These signals are only utilized between the first exchange and the subscriber and are not signalled on inter-network links.

d) Not yet included. To be studied in relation to Recommendation X.87 on network call control procedures.

e) Only utilized within national networks.

f) At the originating exchange, this results in sending a *call progress* signal "no connection" to the calling customer, and clearing the call.

2.14 If the terminating centre fails to receive the *transit centres through-connected* signal (TTD) or, if applicable, the first character of the *calling line identification* signals within 4 seconds after having sent the *transit through-connect* signal (TTC), it will return to the preceding centre the *call progress* signal No. 20 followed by the *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 centres are able to distinguish between the different clearing conditions, shorter periods may be introduced accordingly.

2.16 The automatic *retest* signal will be initiated, as indicated in § 2.4.

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 retest 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 retests will be made at 30-minute intervals. An alarm will be given at an appropriate time. However, this retest procedure may be discontinued at any stage at the discretion of the outgoing Administration.

If, however, during the above sequence of retests, the *call confirmation* or *proceed-to-select* signal is received, a *clearing* signal will be transmitted in place of the *retest* 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.

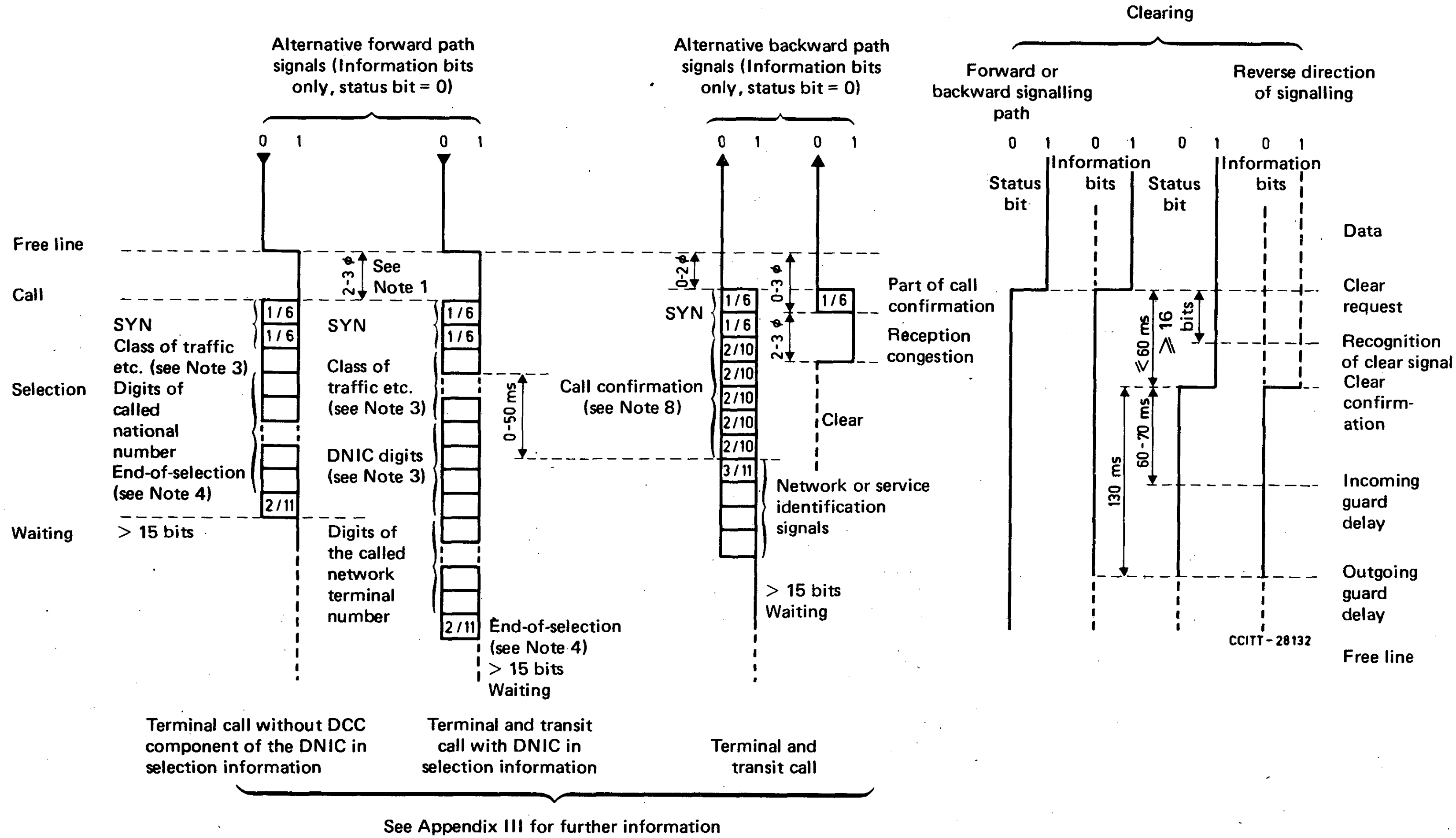
In order to cater for the possibility that a faulty circuit may be seized at both ends, the automatic retest equipment should be arranged to allow an incoming call to be received during continuous repetitions of 0s (S = 0). Administrations may, however, ignore such calls which occur during the incoming 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 retests do not overlap at both ends. In general, the intercontinental transit centre having the higher DNIC should take the longer interval (i.e. 1.2, 6 and 36 minutes). Nevertheless, when this requirement would entail considerable difficulty, alternative arrangements may be adopted by agreement between the two Administrations or RPOAs concerned.

Where an exchange has knowledge of a transmission system failure, it is desirable that the *retest* 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 *retest* 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.



Note 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.

Note 2 – *Forward path* signals may also appear on the backward path, indicating a head-on collision on both-way circuits.

Note 3 – *Network selection* signals (class-of-traffic, user class characters, etc.) see Tables 2-5/X.71. DNIC comprises 4 digits.

Note 4 – *Selection* signals will be sent by the originating network in a single block always with an *end-of-selection* signal.

Note 5 – The *network identification* signal comprises character 3/11 followed by the DNIC of the network concerned.

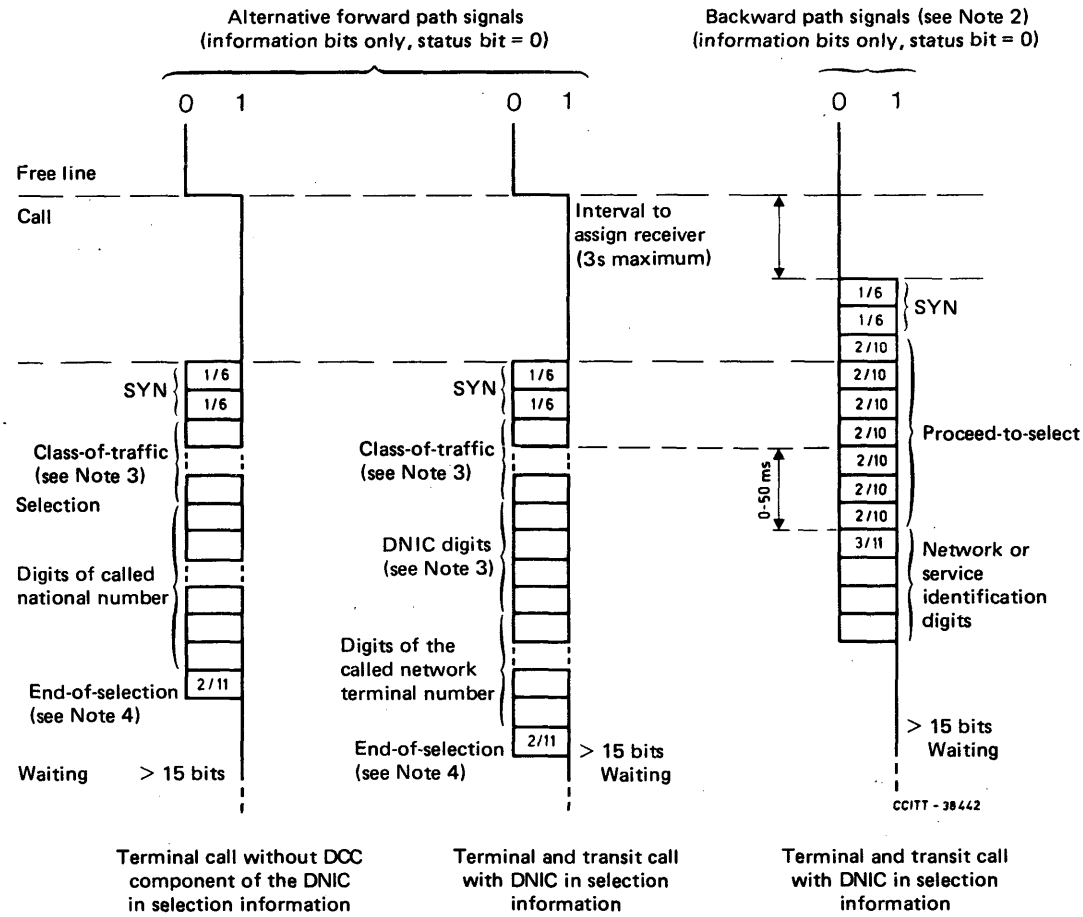
Note 6 – For further details on *call-connected* and *through-connection* signals and their timings see § 2.13 and Appendix III.

Note 7 – All characters shown are from the International Alphabet No. 5.

Note 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.

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

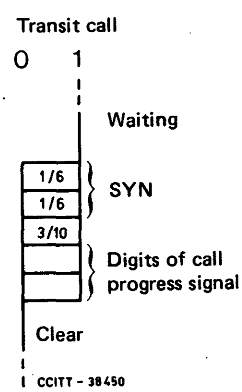


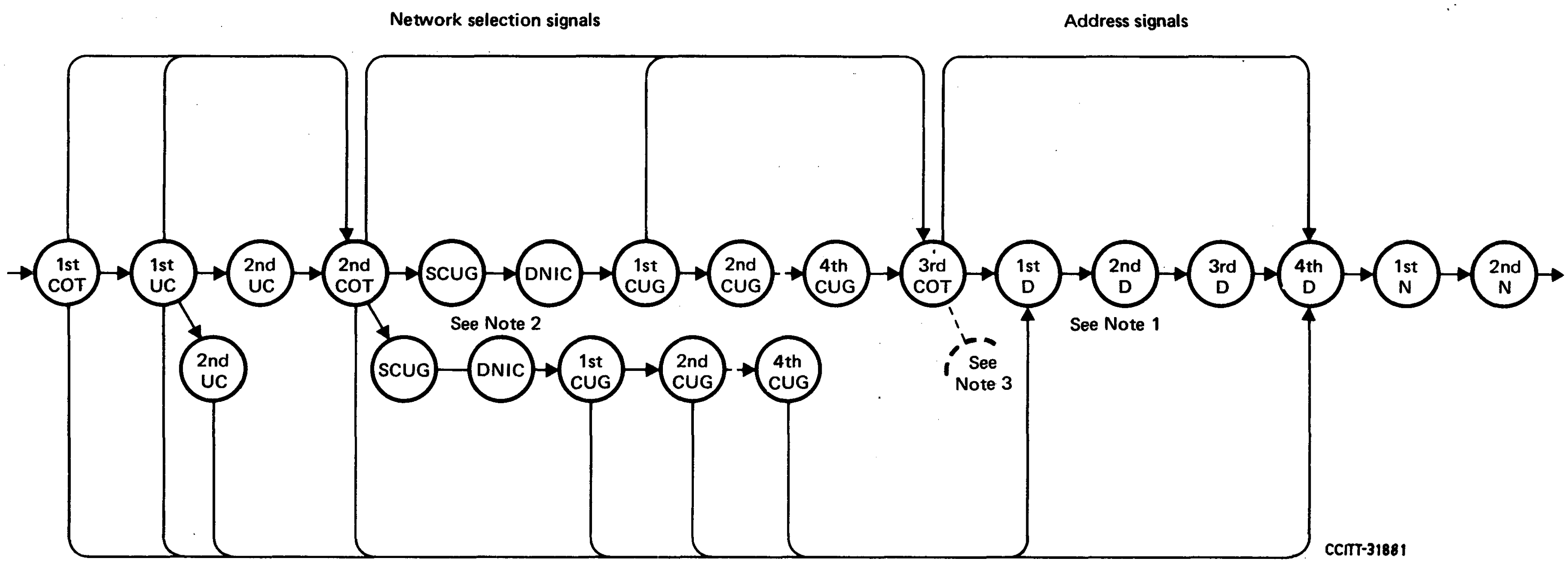
FIGURE 2/X.71

Call progress signal for a transit call

APPENDIX I

(to Recommendation X.71)

Possible sequences of network selection signals



COT	Class-of-traffic character
UC	User class character
CUG	Closed user group
D	Data network (or service) identification code digit
N	Called number digit
SCUG	Start of closed user group character
DNIC	Data network identification code

Note 1 – The first three D digits form the data country code (DCC) component of the data network identification code (DNIC). The fourth D digit is the network or service digit of the DNIC.

Note 2 – The DNIC comprises four digits as defined in Note 1.

Note 3 – Reserved for future extension.

APPENDIX II

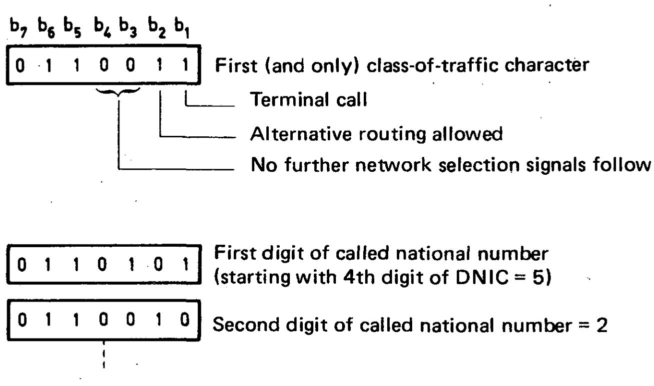
(to Recommendation X.71)

Examples of network selection signals

II.1 *First example* (minimum sequence of network selection signals)

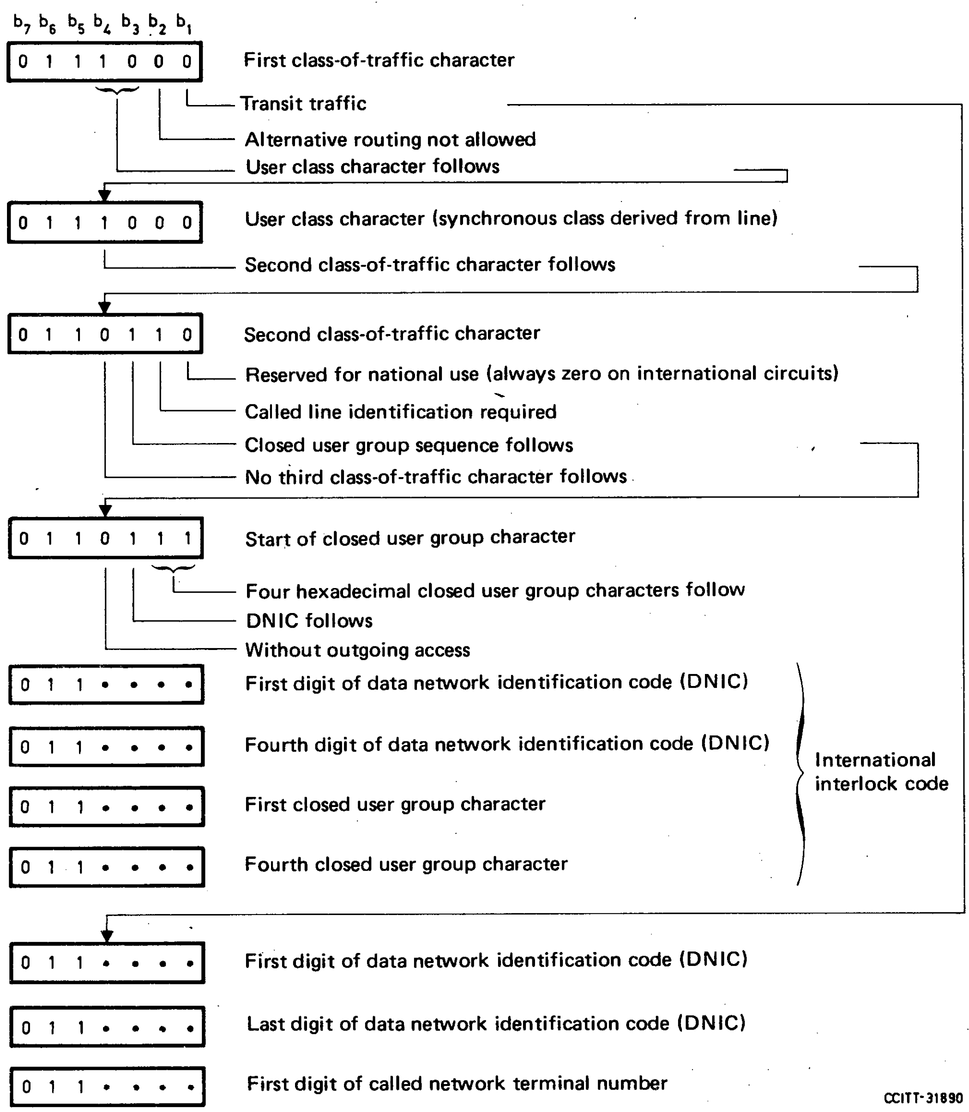
This example shows a sequence of minimal length. (The remaining bits in each complete envelope and the preceding calling signal are not shown. The bits are shown in the order of b_7, b_6, b_5, b_4, b_3, b_2, b_1.)

In this example the country of destination has indicated that it does not wish to receive the DCC component of the DNIC.



CCITT-28160

II.2 *Second example* (a sequence of network selection including closed user group characters)

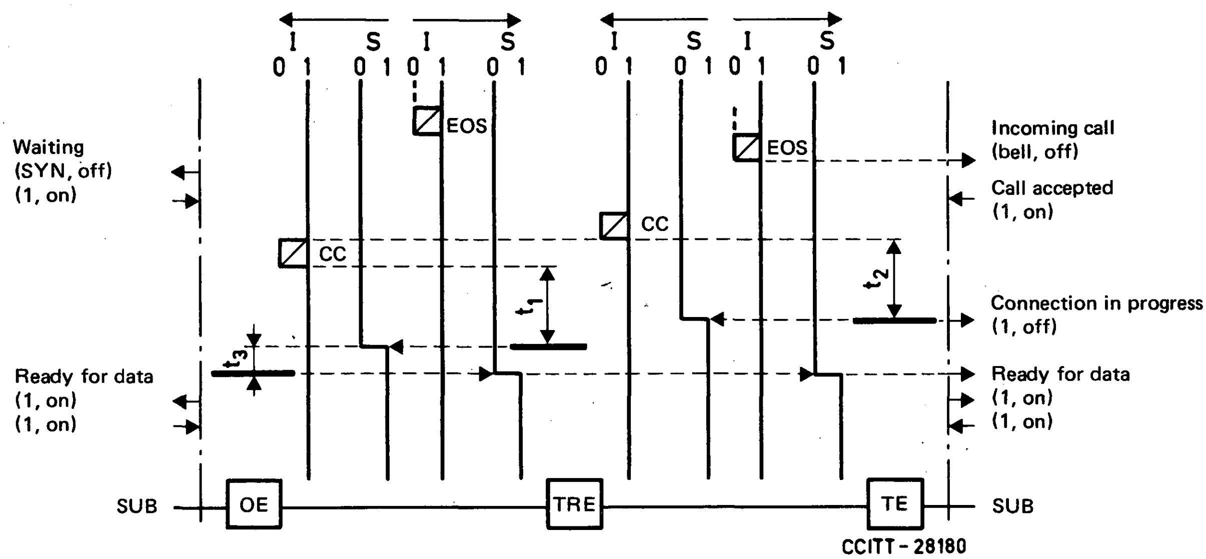


APPENDIX III (A)

(to Recommendation X.71)

Through-connection procedure

Called and calling line identification not required (No connect-when-free facility)



S	Status bit	CC	Call connected signal
– – – –	Correlation line	SUB	Subscriber
———	Through-connection	OE	Originating exchange
		TRE	Transit exchange
⧄	IA5-character	TE	Terminating exchange
		I	Information bit
EOS	End-of-selection signal		

Note 1 – Where groups of characters are not contiguous, the waiting signal (S = 0, repetitions of 1s for a period of at least 15 information bits) must be sent during the interim period.

Note 2 – t_1 = 0-30 ms, t_2 = 0-40 ms, t_3 = 0-40 ms.

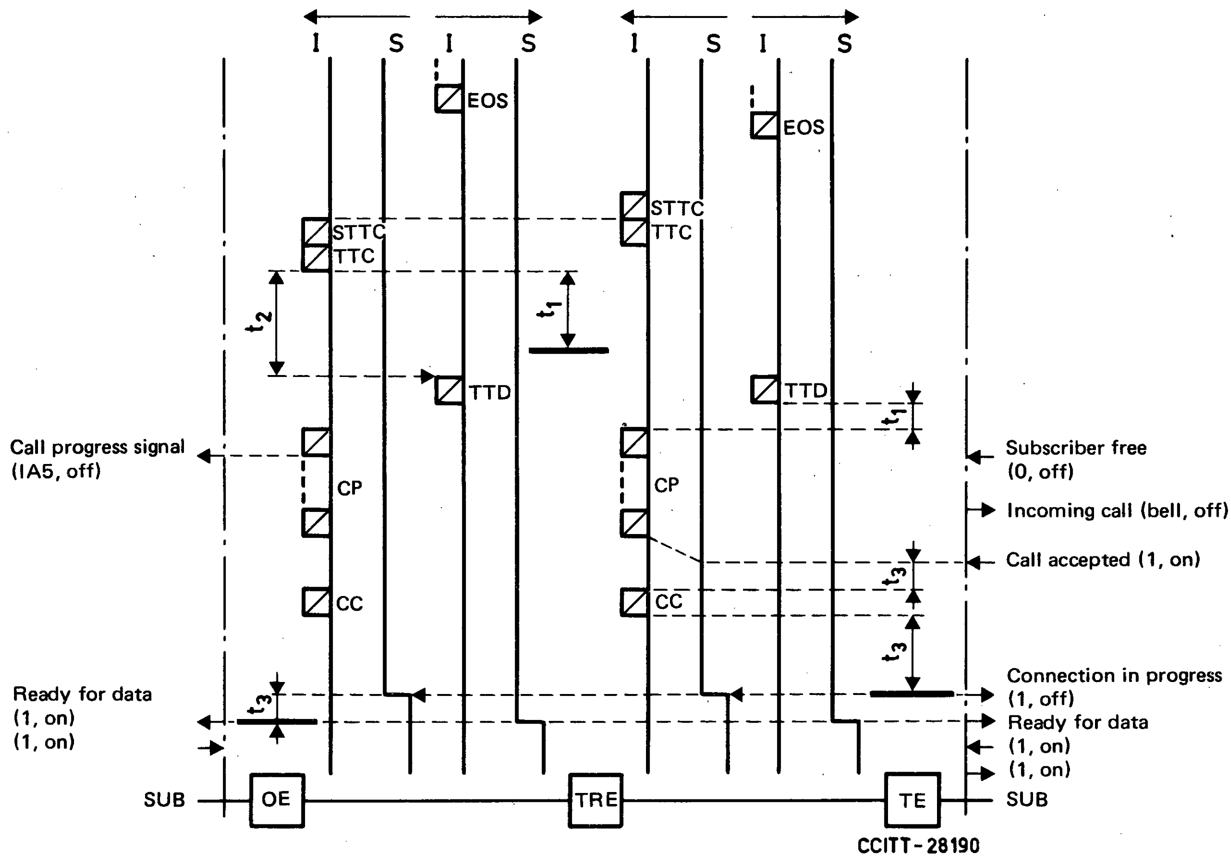
Note 3 – The timings given in Note 2 cover worst case conditions and exchange design should aim to keep them as short as possible.

APPENDIX III (B)

(to Recommendation X.71)

Through-connection procedure

Called and calling line identification not required (Connect-when-free facility, subscriber is busy)



S	Status bit	TTC	Transit through-connect signal
I	Information bit	TTD	Transit centres through-connected signal
– – – –	Correlation line	CP	Call progress signal
———	Through-connection	CC	Call connected signal
⧄	IA5-character	SUB	Subscriber
		OE	Originating exchange
EOS	End-of-selection signal	TRE	Transit exchange
STTC	Start-of-transit through-connect signal	TE	Terminating exchange

Note 1 – Where groups of signalling characters are not contiguous, the *waiting* signal (S = 0, repetitions of 1s for a period of at least 15 information bits) must be sent during the interim period.

Note 2 – t_1 = 0-30 ms, t_2 = 30-50 ms, t_3 = 0-40 ms.

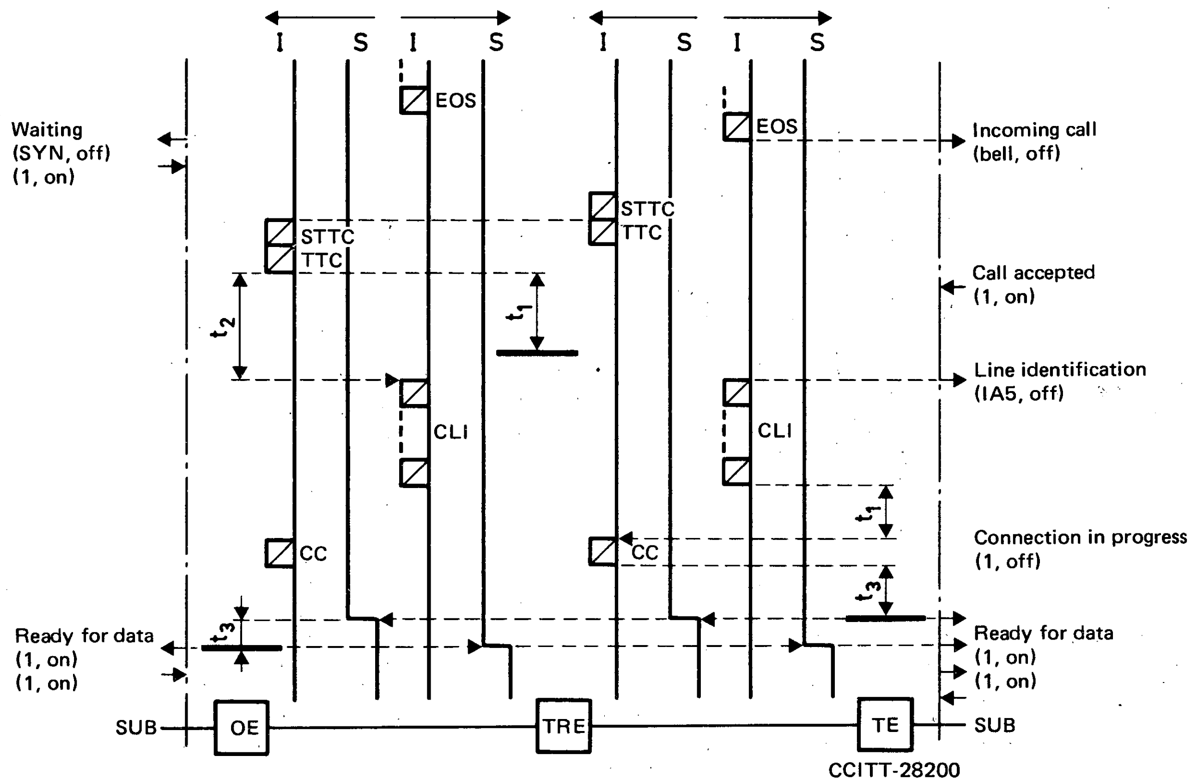
Note 3 – The timings given in Note 2 cover worst case conditions and exchange design should aim to keep them as short as possible.

APPENDIX III (C)

(to Recommendation X.71)

Through-connection procedure

Called line identification not required, calling line identification required (No connect-when-free facility)



S	Status bit	CLI	Calling line identification signals
– – – –	Correlation line	CC	Call connected signal
———	Through-connection	SUB	Subscriber
☒	IA5-character	OE	Originating exchange
		TRE	Transit exchange
EOS	End-of-selection signal	TE	Terminating exchange
STTC	Start-of-transit through-connect signal	I	Information bit
TTC	Transit through-connect signal		

Note 1 – Where groups of signalling characters are not contiguous, the *waiting* signal (S = 0, repetitions of 1s for a period of at least 15 information bits) must be sent during the interim period.

Note 2 – t_1 = 0-30 ms, t_2 = 30-50 ms, t_3 = 0-40 ms.

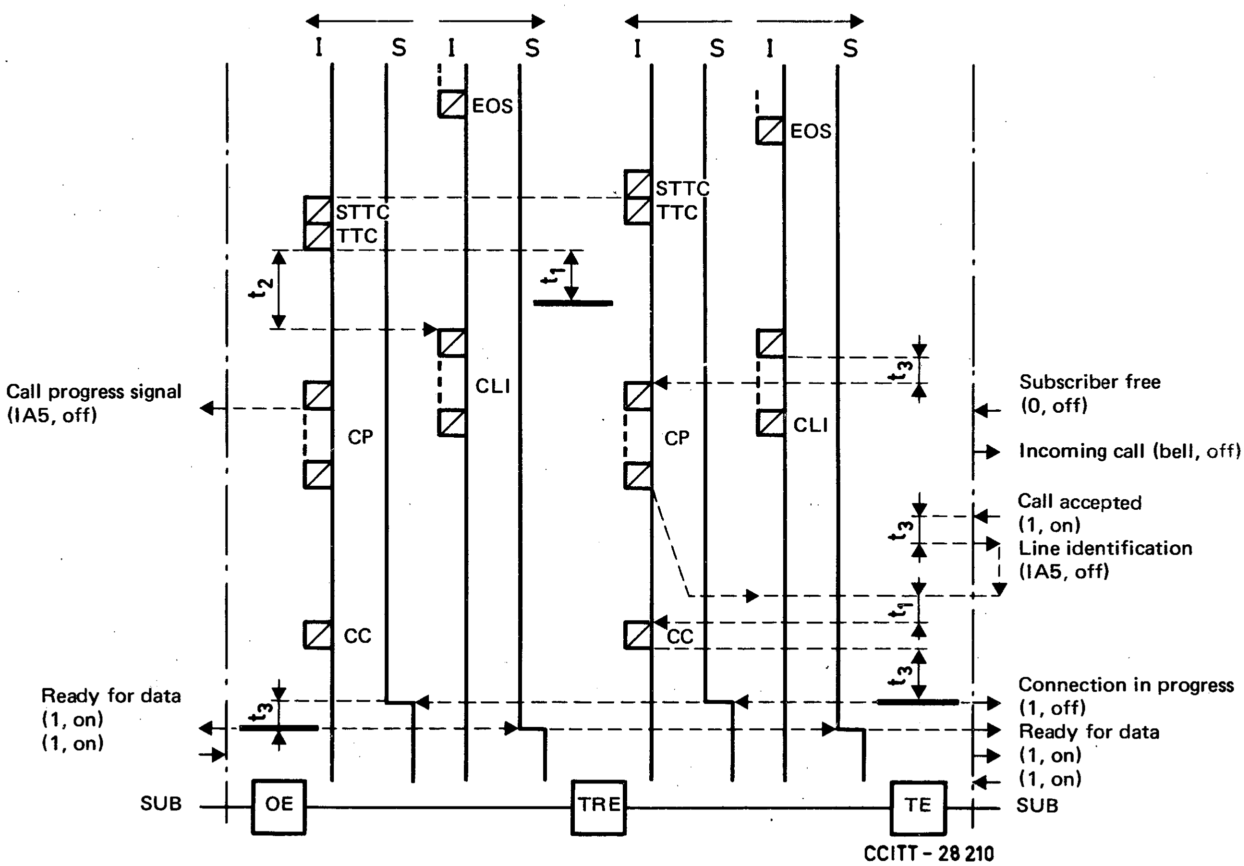
Note 3 – The timings given in Note 2 cover worst case conditions and exchange design should aim to keep them as short as possible.

APPENDIX III (D)

(to Recommendation X.71)

Through-connection procedure

Called line identification not required, calling line identification required (Connect-when-free facility, subscriber is busy)



S	Status bit	CLI	Calling line identification signals
– – – –	Correlation line	CP	Call progress signal
———	Through-connection	CC	Call connected signal
		SUB	Subscriber
☒	IA5-character	OE	Originating exchange
EOS	End-of-selection signal	TRE	Transit exchange
STTC	Start-of-transit through-connect signal	DE	Destination exchange
TTC	Transit through-connect signal	I	Information bit

Note 1 – Where groups of signalling characters are not contiguous, the *waiting* signal (S = 0, repetitions of 1s for a period of at least 15 information bits) must be sent during the interim period.

Note 2 – t_1 = 0-30 ms, t_2 = 30-50 ms, t_3 = 0-40 ms.

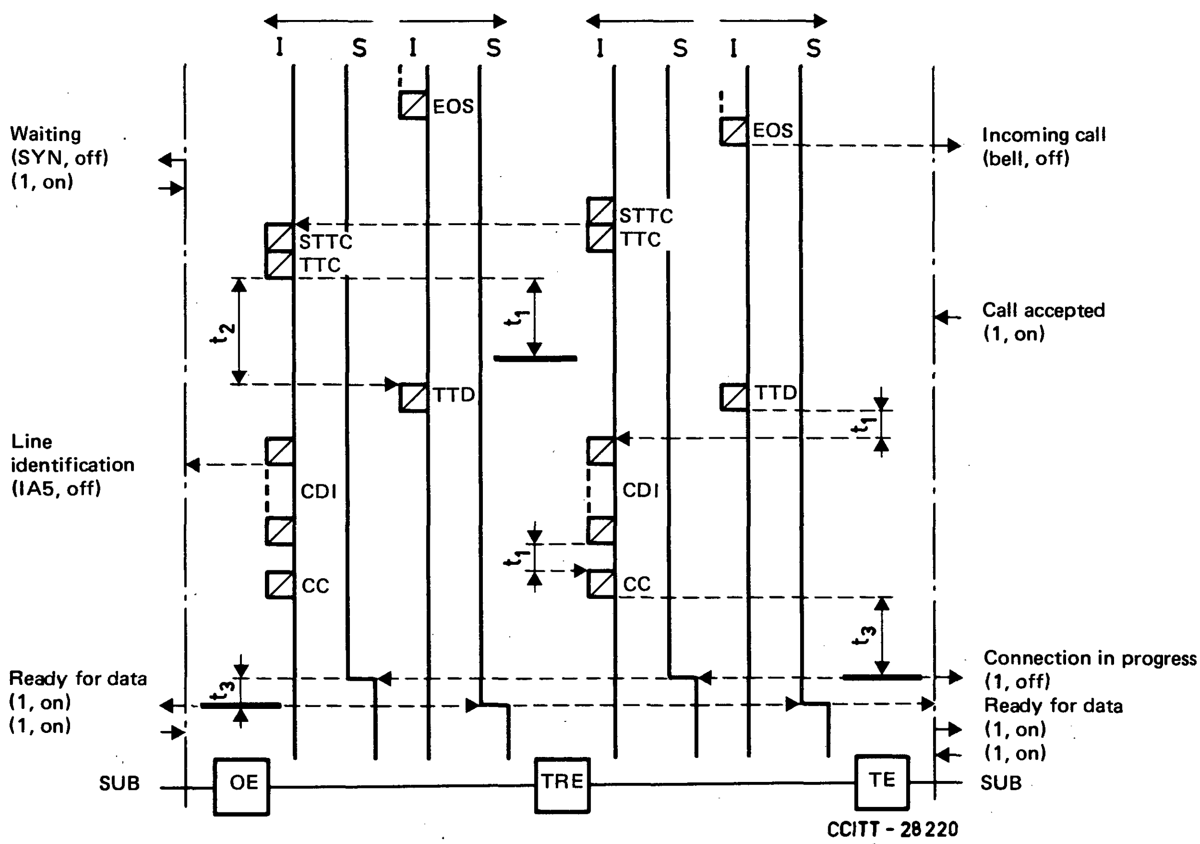
Note 3 – The timings given in Note 2 cover worst case conditions and exchange design should aim to keep them as short as possible.

APPENDIX III (E)

(to Recommendation X.71)

Through-connection procedure

Called line identification required, calling line identification not required (No connect-when-free facility)



S	Status bit	CDI	Called line identification signals
– – – –	Correlation line	CC	Call connected signal
———	Through-connection	SUB	Subscriber
⍁	IA5-character	OE	Originating exchange
		TRE	Transit exchange
EOS	End-of-selection signal	TE	Terminating exchange
STTC	Start-of-transit through-connect signal	I	Information bit
TTC	Transit through-connect signal		
TTD	Transit centres through-connected signal		

Note 1 – Where groups of signalling characters are not contiguous, the *waiting* signal (S = 0, repetitions of 1s for a period of at least 15 information bits) must be sent during the interim period.

Note 2 – t_1 = 0-30 ms, t_2 = 30-50 ms, t_3 = 0-40 ms.

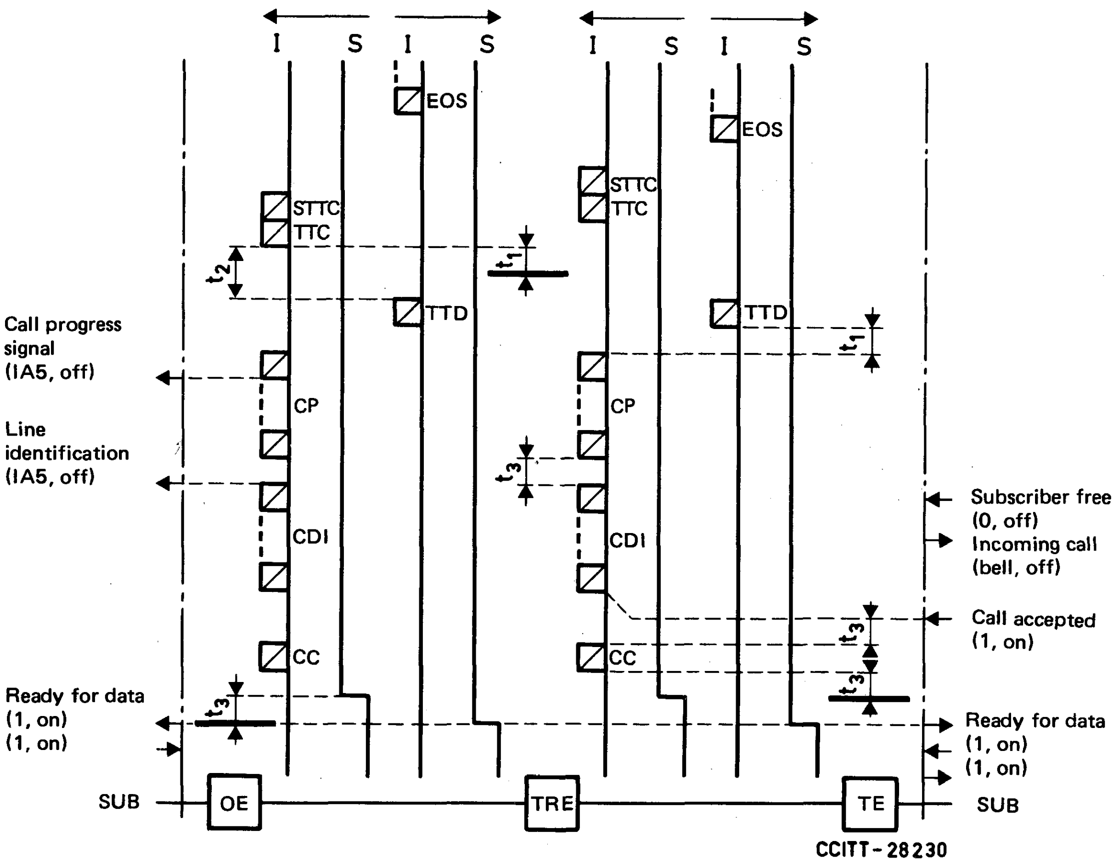
Note 3 – The timings given in Note 2 cover worst case conditions and exchange design should aim to keep them as short as possible.

APPENDIX III (F)

(to Recommendation X.71)

Through-connection procedure

Called line identification required, calling line identification not required (Connect-when-free facility, subscriber is busy)



S	Status bit	TTD	Transit centres through-connected signal
– – – –	Correlation line	CP	Call progress signal
———	Through-connection	CC	Call connected signal
☒	IA5-character	SUB	Subscriber
		OE	Originating exchange
EOS	End-of-selection signal	TRE	Transit exchange
STTC	Start-of-transit through-connect signal	TE	Terminating exchange
TTC	Transit through-connect signal	I	Information bit

Note 1 – Where groups of signalling characters are not contiguous, the *waiting* signal (S = 0, repetitions of 1s for a period of at least 15 information bits) must be sent during the interim period.

Note 2 – t_1 = 0-30 ms, t_2 = 30-50 ms, t_3 = 0-40 ms.

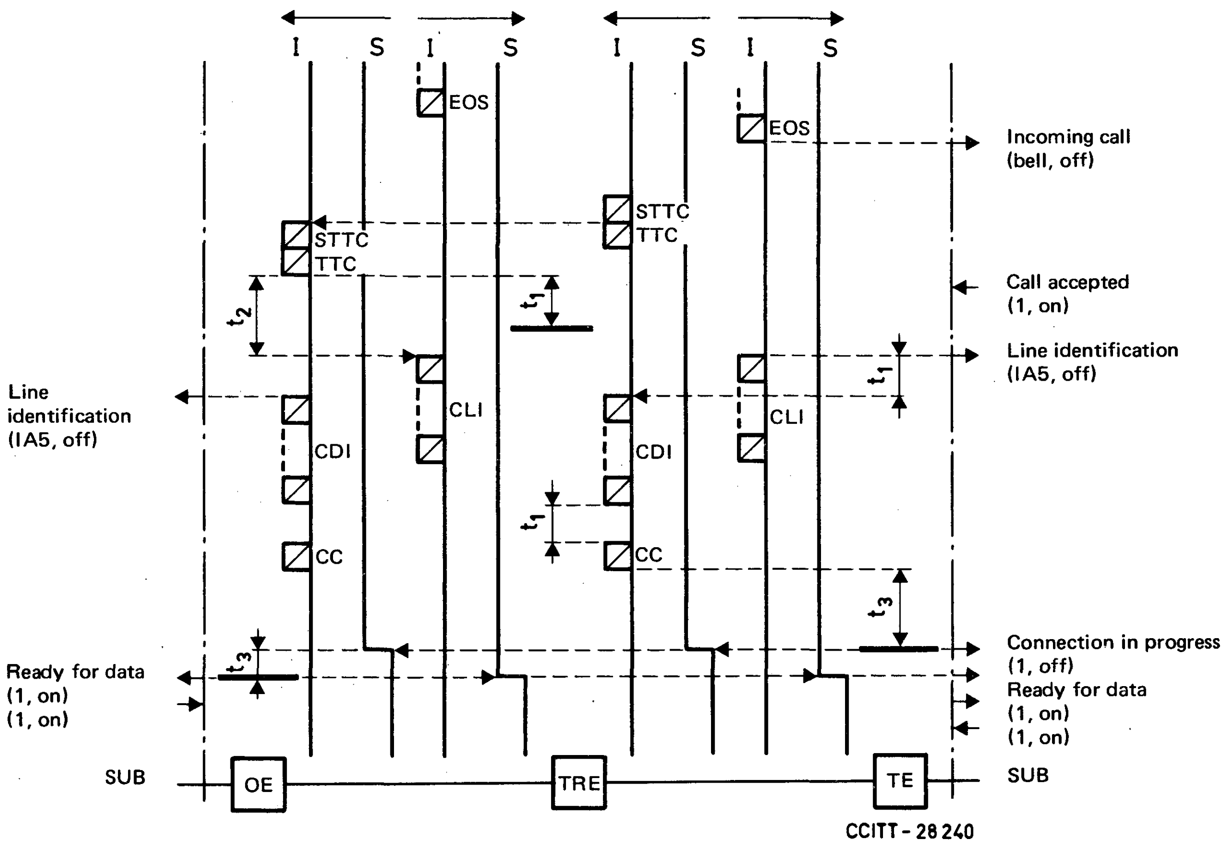
Note 3 – The timings given in Note 2 cover worst case conditions and exchange design should aim to keep them as short as possible.

APPENDIX III (G)

(to Recommendation X.71)

Through-connection procedure

Called and calling line identification required (No connect-when-free facility)



S	Status bit	CDI	Called line identification signals
– – – –	Correlation line	CLI	Calling line identification signal
———	Through-connection	CC	Call connected signal
⍁	IA5-character	SUB	Subscriber
		OE	Originating exchange
EOS	End-of-selection signal	TRE	Transit exchange
STTC	Start-of-transit through-connect signal	TE	Terminating exchange
TTC	Transit through-connect signal	I	Information bit

Note 1 – Where groups of signalling characters are not contiguous, the *waiting* signal (S = 0, repetitions of 1s for a period of at least 15 information bits) must be sent during the interim period.

Note 2 – t_1 = 0-30 ms, t_2 = 30-50 ms, t_3 = 0-40 ms.

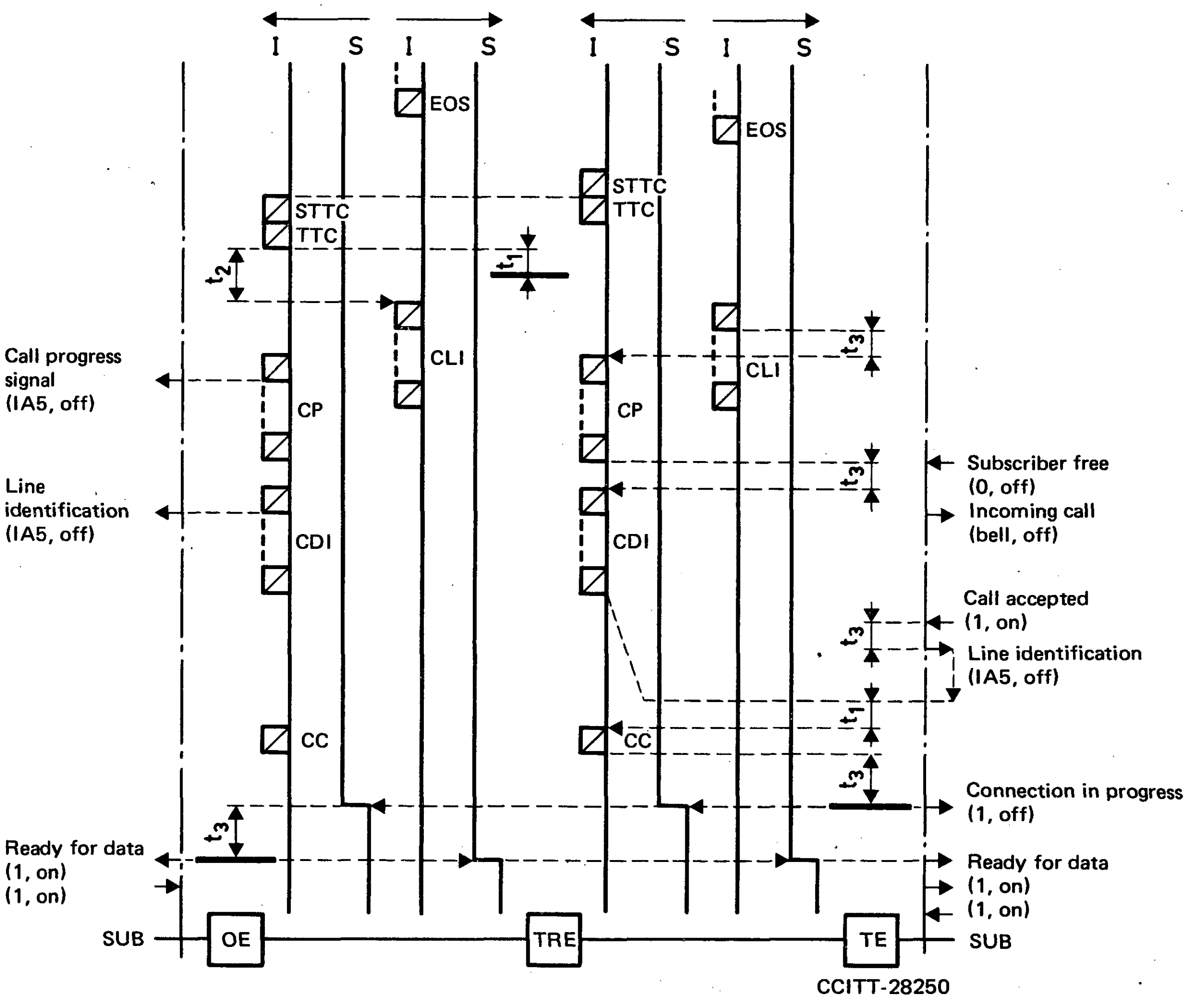
Note 3 – The timings given in Note 2 cover worst case conditions and exchange design should aim to keep them as short as possible.

APPENDIX III (H)

(to Recommendation X.71)

Through-connection procedure

Called and calling line identification required (Connect-when-free facility, subscriber is busy)



S	Status bit	CP	Call progress signal
– – – –	Correlation line	CDI	Called line identification signal
———	Through-connection	CC	Call connected signal
☒	IA5-character	SUB	Subscriber
		OE	Originating exchange
EOS	End-of-selection signal	TRE	Transit exchange
STTC	Start-of-transit through-connect signal	TE	Terminating exchange
TTC	Transit through-connect signal	I	Information bit
CLI	Calling line identification		

Note 1 – Where groups of signalling characters are not contiguous, the *waiting* signal (S = 0, repetitions of 1s for a period of at least 15 information bits) must be sent during the interim period.

Note 2 – t_1 = 0-30 ms, t_2 = 30-50 ms, t_3 = 0-40 ms.

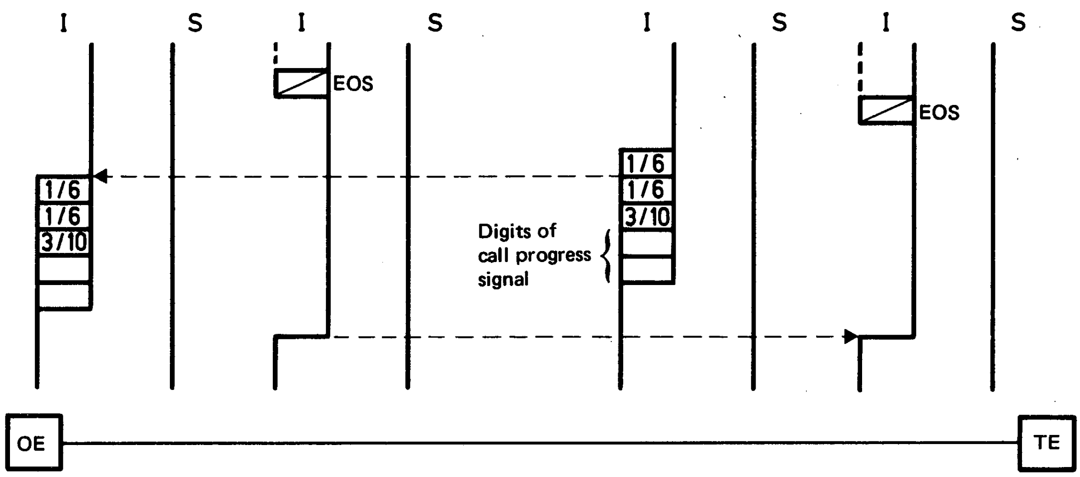
Note 3 – The timings given in Note 2 cover worst case conditions and exchange design should aim to keep them as short as possible.

APPENDIX IV

(to Recommendation X.71)

Unsuccessful call

Call progress signal with clearing



CCITT - 28260

S	Status bit
I	Information bit
– – – –	Correlation line
(IA5 symbol)	IA5-character
EOS	End-of-selection signal
OE	Originating exchange
TE	Terminating exchange

Note – *Call progress* signals without clearing may be included to indicate such facilities as call redirection.

APPENDIX V

(to Recommendation X.71)

Format of signalling characters within the Recommendation X.50

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.

$a_1 \dots a_8$ is a signalling character

$b_1 \dots b_8$ is a signalling character

$c_1 \dots c_8$ 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.

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.1.

[2] CCITT Recommendation *International numbering plan for public data networks*, Vol. VIII, Fascicle VIII.7, Rec. X.121.

[3] CCITT Recommendation *General tariff principles for data transmission on public networks dedicated to this type of transmission*, Vol II, Fascicle II.1, Rec. D.10.

[4] CCITT Recommendation *General structure of signals of International Alphabet No. 5 code for data transmission over public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.4.

[5] CCITT Recommendation *General purpose interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for synchronous on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.21.

TERMINAL AND TRANSIT CALL CONTROL PROCEDURES AND DATA TRANSFER SYSTEM ON INTERNATIONAL CIRCUITS BETWEEN PACKET-SWITCHED DATA NETWORKS

(provisional, Geneva, 1978; amended at Geneva, 1980)

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

The CCITT,

considering

(a) that Recommendation X.1 [1] includes specific user classes of service for data terminal equipments operating in the packet mode, Recommendation X.2 [2] defines user facilities, Recommendations X.25 [3] and X.29 [4] define DTE/DCE interface characteristics and Recommendation X.96 [5] defines *call progress* signals;

(b) that the logical links A1 and G1 in an international connection are defined in Recommendation X.92 [6] for packet-switched data transmission services;

(c) the desirability of being able to use links A1 and G1 for all user facilities;

(d) the urgent need to standardize an international signalling Recommendation to allow interworking between gateway/transit data switching exchanges as defined in Recommendation X.92 [6];

(e) that the necessary elements of the signalling terminal (STE) interface Recommendation at the gateway/transit data switching exchange should be defined independently as:

Physical level – the mechanical, electrical, functional and procedural characteristics to activate, maintain and deactivate the physical link at the signalling terminal interface;

Link level – the packet transfer procedures for data interchange across the interface between the signalling terminals;

Packet level – the packet format and signalling procedures for the exchange of packets containing control information and user data at the signalling terminal interface;

unanimously declares the view

(1) that the basic system structure of the signalling and data transfer procedures in terms of elements, should be as specified in the Introduction, *Basic system structure*;

(2) that the mechanical, electrical, functional and procedural characteristics to activate, maintain and deactivate the physical link at the signalling terminal interface should be as specified in § 1 below, *Physical level – Characteristics of the signalling terminal/physical circuit interface*;

(3) that the packet transfer procedures which operate over the physical circuits and provide a mechanism for reliable transport of packets at the signalling terminal interface should be as specified in § 2 below, *Link level – Packet transfer procedures between signalling terminals*;

(4) that the packet signalling procedures for the exchange of call information and user data at the signalling terminal interface should be as specified in § 3 below, *Packet level – Packet signalling procedures between signalling terminals*;

(5) that the packet format for packets exchanged at the signalling terminal interface should be as specified in § 4 below, *Packet formats for virtual calls*;

(6) that the procedure and formats for user facilities and network utilities at the signalling terminal interface should be as spcified in § 5 below, *Procedure and formats for user facilities and network utilities.*

INDEX TO RECOMMENDATION X.75

Introduction

General

This Recommendation defines the characteristics and operation of an interexchange signalling system for international packet-switched data transmission services.

The signalling system defined in this Recommendation is intended to be used for the transfer of information between two signalling terminals each within a packet-mode data network and directly connected by an international link.

Each Signalling Terminal (STE) will be located at a network node and be associated with, or part of, an exchange or exchange function at that node. The nodes may be part of separate packet-mode data networks.

The information transferred will consist of call control and network control information and user traffic.

The link connecting the two signalling terminals will comprise one or a number of circuits.

Elements

The system is made up of communicating elements which function independently and are therefore defined separately. These elements are:

a) the physical circuits which comprise links A1 or G1, and a set of mechanical, electrical, functional and procedural interface characteristics between the transmission media and the signalling terminals and which provide a mechanism for information transfer between two signalling terminals;

b) the packet transfer procedures which operate over the physical circuits and provide a mechanism for reliable transport of packets between the two signalling terminals independently of the particular types of physical circuit in use;

c) the packet signalling procedures which use the packet transfer procedures and provide a mechanism for the exchange of call control information and user traffic between the two signalling terminals.

Basic system structure

The basic system structure of the signalling and data transfer procedures, in terms of the elements, is shown in Figure 1/X.75.

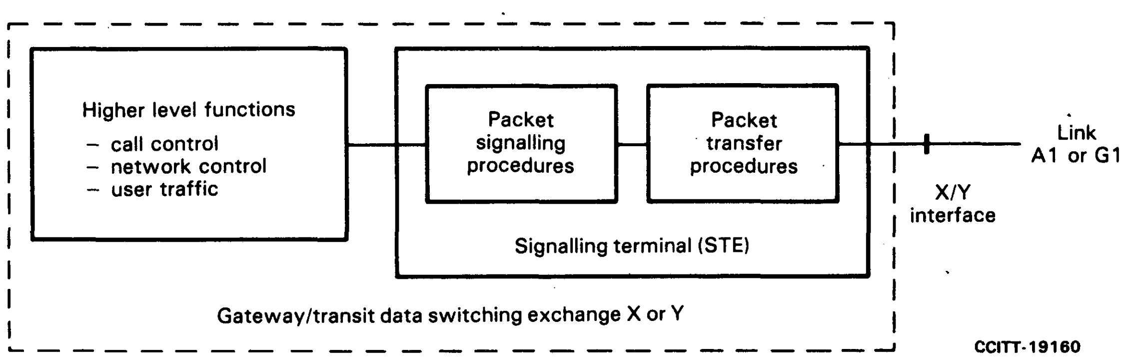


FIGURE 1/X.75

Basic system structure of signalling and data transfer procedures

Note – Applicable to this Recommendation:

a) STE-X denotes the STE of the international exchange under consideration on the international link concerned;

b) STE-Y denotes the STE of the other international exchange under consideration on the international link;

c) the STE-X/STE-Y interface is abbreviated to the X/Y interface.

1 Physical level – Characteristics of the signalling terminal/physical circuit interface

The characteristics of the signalling terminal/physical circuit interface, defined as the physical level element, shall be in accordance with Recommendation G.703 [7], for physical circuits having a bearer rate of 64 kbit/s. Optionally Administrations may adopt, for digital circuits, a data transfer rate of 48 kbit/s or any other internationally recognized rate by bilateral agreement.

However, for an interim period by bilateral agreement, any other internationally recognized rates could be used for analogue circuits, in which case the characteristics of the signalling terminal/physical circuit interface shall be in accordance with the appropriate V-Series Recommendations.

The international link should be capable of supporting duplex operation.

The international link is assumed to be data link A1 and/or data link G1 in terms of the hypothetical reference connections defined in Recommendation X.92 [6].

2 Link level – Packet transfer procedures between signalling terminals

2.1 *Scope and field of application*

2.1.1 In order to provide a mechanism for the reliable transport of packets between two signalling terminals, it is necessary to define a procedure which can accept and deliver packets to the packet level when either single or multiple physical circuits are employed. A multiplicity of physical circuits is required if the effects of circuit failures are not to disrupt the packet level operation.

2.1.2 The Single Link Procedure (SLP) described in §§ 2.2 to 2.4 is used for data interchange over a single physical circuit, conforming to the description given in § 1, between two STEs. When multiple physical circuits are employed in parallel this single link procedure is used independently on each circuit and the Multilink Procedure (MLP) described in §§ 2.4 and 2.5 is used for data interchange over these multiple parallel links. In addition, when only a single physical circuit is employed, Administrations may agree bilaterally to use this multilink procedure over the one link.

2.1.3 Each transmission facility is duplex.

2.1.4 The single link procedure is based upon the Link Access Procedure (LAPB) described in § 2 of Recommendation X.25 [3]. The procedure uses the principle and terminology of the High Level Data Link Control (HDLC) procedure specified by the International Organization for Standardization (ISO).

The multilink procedure is based on the principle and terminology of the multilink procedure to be specified by ISO.

2.1.5 For each SLP employed, either extended mode (modulo 128) or non-extended mode (modulo 8) may be used. The choice of the mode employed for such link procedures is independent of all others and of the choice of mode for the corresponding packet level procedures. All choices are matters for bilateral agreement.

2.2 *Frame structure*

2.2.1 All transmissions are in frames conforming to one of the formats of Tables 1/X.75 and 2/X.75. The flag preceding the address field is defined as the opening flag.

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 or two octets. The content of this field is described in § 2.3.2 below.

2.2.5 *Information field*

The information field of a frame is unrestricted with respect to code or grouping of bits except for the packet formats specified in § 4 below. However, when the multilink procedure (MLP) is used, the coding of the first sixteen bits transmitted is determined according to the provision of § 2.5.3.

See §§ 2.3.4.7 and 2.4.7.3 with regard to the maximum information field length.

TABLE 1/X.75

Frame formats (modulo 8)

Bit order of transmission	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 to 8	16 to 1	1 2 3 4 5 6 7 8
	Flag	Address	Control	FCS	Flag
	F 0 1 1 1 1 1 1 0	A 8-bits	C 8-bits	FCS 16-bits	F 0 1 1 1 1 1 1 0

FCS frame checking sequence

Bit order of transmission	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 to 8		16 to 1	1 2 3 4 5 6 7 8
	Flag	Address	Control	Information	FCS	Flag
	F 0 1 1 1 1 1 1 0	A 8-bits	C 8-bits	I N-bits	FCS 16-bits	F 0 1 1 1 1 1 1 0

FCS frame checking sequence

$0 \leqslant N \leqslant N1 - 32$

TABLE 2/X.75

Frame formats (modulo 128)

Bit order of transmission	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 to 16	16 to 1	1 2 3 4 5 6 7 8
	Flag	Address	Control	FCS	Flag
	F 0 1 1 1 1 1 1 0	A 8-bits	C 16-bits	FCS 16-bits	F 0 1 1 1 1 1 1 0

FCS frame checking sequence

Bit order of transmission	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 to 16		16 to 1	1 2 3 4 5 6 7 8
	Flag	Address	Control	Information	FCS	Flag
	F 0 1 1 1 1 1 1 0	A 8-bits	C 16-bits	I N-bits	FCS 16-bits	F 0 1 1 1 1 1 1 0

FCS frame checking sequence

$0 \leqslant N \leqslant N1 - 40$

2.2.6 *Transparency*

The STE, when transmitting, shall examine the frame content between the two flag sequences including the address, control, information and FCS sequences and shall insert a 0 bit after all sequences of five contiguous 1 bits (including the last five bits of the FCS) to ensure that a flag sequence is not simulated. The STE, when receiving, shall examine the frame content and shall discard any 0 bit which directly follows five 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 1s and is then modified by division by the generator polynomial (as described above) on the address, control and information fields; the 1s complement of the resulting remainder is transmitted as the 16-bit FCS sequence.

At the receiver, the initial remainder is preset to all 1s, 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. 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 3/X.75, 4/X.75, 5/X.75, 6/X.75, 7/X.75 and 8/X.75.

2.2.9 *Invalid frames*

A frame not properly bounded by two flags, or having fewer than 32 bits (modulo 8) or 40 bits (modulo 128) between flags, is an invalid frame.

2.2.10 *Frame abortion*

Aborting a frame is performed by transmitting at least seven contiguous 1s (with no inserted 0s).

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 STE 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 1s state is detected that persists for at least 15 bits times.

Note 1 – The action to be taken upon detection of the idle channel state is a subject for further study.

Note 2 – 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 frames.

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 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 Tables 3/X.75 and 4/X.75) are used to perform numbered information transfer (I frames), numbered supervisory functions (S frames) and unnumbered control functions (U frames).

TABLE 3/X.75

Control field formats (modulo 8)

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	S	P/F		N(R)	
U frame	1	1	M	M	P/F	M	M	M

N(S) Transmitter send sequence number (bit 2 = low order bit)
N(R) Transmitter receive sequence number (bit 6 = low order bit)
S Supervisory function bit
M Modifier function bit
P/F Poll bit when issued as a command, final bit when issued as a response

Note – Distinction between command and response, and therefore distinction between P bit and F bit, are made by the addressing rules.

TABLE 4/X.75

Control field formats (modulo 128)

Control field bits	1st Octet								2nd Octet							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I frame	0	N(S)							P/F	N(R)						
S frame	1	0	S	S	X	X	X	X	P/F	N(R)						
U frame	1	1	M	M	U	M	M	M	P/F	X	X	X	X	X	X	X

N(S) Transmitter send sequence number (bit 2 = low order bit)
N(R) Transmitter receive sequence number (bit 10 = low order bit)
S Supervisory function bit
M Modifier function bit
X Reserved and set to 0
U Unspecified
P/F Poll bit when issued as a command, final bit when issued as a response

Note – Distinction between command and response, and therefore distinction between P bit and F bit, are made by the addressing rules.

2.3.2.1.1 *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), an N(R) which may or may not acknowledge additional I frames received by the STE, and a P/F bit.

2.3.2.1.2 *Supervisory format – S*

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

2.3.2.1.3 *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 and responses is as defined in Tables 5/X.75 and 6/X.75.

2.3.2.2 *Control field parameters*

The various parameters associated with the control field formats are described below.

2.3.2.3 *Modulus*

Each I frame is sequentially numbered and may have the value 0 through modulus – 1 (where modulus is the modulus of the sequence numbers). The modulus equals 8 or 128 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 I frame to be transmitted. The send state variable can take on the value 0 through modulus – 1. The value of the send state variable is incremented by 1 with each successive I frame transmission, but cannot exceed N(R) of the last received I or S frame by more than the maximum number of outstanding I 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 I frames contain N(S), the send sequence number of transmitted frames. Prior to transmission of an in-sequence I 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 I frame to be received. This receive state variable can take on the values 0 through modulus – 1. The value of the receive state variable is incremented by the receipt of an error free, in-sequence I frame whose send sequence number N(S) equals the receive state variable.

2.3.2.4.4 *Receive sequence number N(R)*

All I frames and S frames contain N(R), the expected sequence number of the next received I 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 STE transmitting the N(R) has correctly received all I frames numbered up to and including 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 the STE and are represented in Tables 5/X.75 and 6/X.75.

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) command and response*

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

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

2) acknowledge previously received I frames numbered up to and including N(R) – 1.

RR may be used to clear a busy condition that was initiated by the transmission of RNR. The RR command with the P bit set to 1 may be used by the STE to ask for the status of the other STE.

2.3.4.3 *Reject (REJ) command and response*

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

TABLE 5/X.75

Commands and responses (modulo 8)

Format	Command	Response	Encoding 1	2	3	4	5	6	7	8
Information transfer	I (information)		0	N(S)			P	N(R)		
Supervisory	RR (receive ready)	RR (receive ready)	1	0	0	0	P/F	N(R)		
	RNR (receive not ready)	RNR (receive not ready)	1	0	1	0	P/F	N(R)		
	REJ (reject)	REJ (reject)	1	0	0	1	P/F	N(R)		
Unnumbered	SABM (set asynchronous balanced mode)		1	1	1	1	P	1	0	0
	DISC (disconnect)		1	1	0	0	P	0	1	0
		FRMR (frame reject)	1	1	1	0	F	0	0	1
		UA (unnumbered acknowledgement)	1	1	0	0	F	1	1	0
		DM (disconnected mode)	1	1	1	1	F	0	0	0

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

TABLE 6/X.75

Commands and responses (modulo 128)

Format	Command	Response	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Information transfer	I (information)		0	N(S)							P	N(R)						
Supervisory	RR (receive ready)	RR (receive ready)	1	0	0	0	0	0	0	0	P/F	N(R)						
	RNR (receive not ready)	RNR (receive not ready)	1	0	1	0	0	0	0	0	P/F	N(R)						
	REJ (reject)	REJ (reject)	1	0	0	1	0	0	0	0	P/F	N(R)						
Unnumbered	SABME (set asynchronous balanced mode extended)		1	1	1	1	U	1	1	0	P	0	0	0	0	0	0	0
	DISC (disconnect)		1	1	0	0	U	0	1	0	P	0	0	0	0	0	0	0
		FRMR (frame reject)	1	1	1	0	U	0	0	1	F	0	0	0	0	0	0	0
		UA (unnumbered acknowledgement)	1	1	0	0	U	1	1	0	F	0	0	0	0	0	0	0
		DM (disconnected mode)	1	1	1	1	U	0	0	0	F	0	0	0	0	0	0	0

Note 1 – Bit 5 of unnumbered frames is unspecified.

Note 2 – The need for, and use of, additional commands and responses are for further study.

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) equal to the N(R) of the REJ.

The REJ command with the P bit set to 1 may be used by an STE to ask for the status of the other STE.

2.3.4.4 *Receive not ready (RNR) command and response*

The receive not ready (RNR) supervisory frame is used by the STE to indicate a busy condition; i.e., temporary inability to accept additional incoming I frames. I frames numbered up to and including N(R) − 1 are acknowledged. I frame N(R) and any subsequent I frames received, if any, are not acknowledged; the acceptance status of these I frames will be indicated in subsequent frames.

An indication that the busy condition has cleared and I frames will now be accepted is communicated by the transmission of a valid UA, RR, REJ, or SABM/SABME (modulo 8/modulo 128: SABM for modulo 8 and SABME for modulo 128).

The RNR command with the P bit set to 1 may be used by the STE to ask for the status of the other STE.

2.3.4.5 *Set asynchronous balanced mode (SABM) command and set asynchronous balanced mode extended (SABME) command*

The SABM unnumbered command is used to place the addressed STE in the asynchronous balanced mode (ABM) information transfer phase, where all command/response control fields will be one octet in length.

The SABME unnumbered command is used to place the addressed STE in the asynchronous balanced mode information transfer phase, where all command/response control fields will be two octets in length.

No information field is permitted with the SABM and SABME command. The STE confirms acceptance of SABM/SABME (modulo 8/modulo 128) by the transmission at the first opportunity of a UA response. Upon acceptance of this command both the send state variable and the receive state variable are set to 0.

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

2.3.4.6 *Disconnect (DISC) command*

The DISC unnumbered command is used to terminate the mode previously set. No information field is permitted with the DISC command. Prior to actioning the DISC command, the addressed STE confirms the acceptance of DISC by the transmission of a UA response. The STE sending the DISC enters the disconnected phase when it receives the acknowledging UA response.

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

2.3.4.7 *Frame reject (FRMR) response*

The FRMR unnumbered response is used by the STE to report an error condition not recoverable by transmission of the identical frame, i.e., one of the following conditions resulted from the receipt of a frame without FCS error:

1) the receipt of a command or a response 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);

4) the receipt of a supervisory or unnumbered frame with an information field which is not permitted or has an incorrect length;

5) the receipt of a supervisory frame with the F bit set to 1, except during a timer recovery condition as described in § 2.4.4.9 or except as a reply to a command sent with the P bit set to 1;

6) the receipt of an unexpected UA or DM response;

7) the receipt of an invalid N(S).

An invalid N(R) is defined as one 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 invalid N(S) is defined as an N(S) which is equal to the last transmitted N(R) + k and is equal to the received state variable V(R), where k is the maximum number of outstanding information frames (see § 2.4.7.4 below).

An invalid/not implemented command or response is defined as a frame with a control field that is unknown to the receiver of this frame.

An information field which immediately follows the control field, and consists of 3 octets (modulo 8) or 5 octets (modulo 128), is returned with this response and provides the reason for the FRMR response. This format is given in Tables 7/X.75 and 8/X.75.

For condition 4) listed above, bit W and Y should be set to 1.

For conditions 5), 6) and 7) listed above, bit W should be set to 1.

In all cases, the STE receiving the FRMR should examine the contents of the rejected frame control field for further clarification of the cause of the error before recording this error.

2.3.4.8 *Unnumbered acknowledge (UA) response*

The UA unnumbered response is used by the STE 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.

2.3.4.9 *Disconnected mode (DM) response*

The DM unnumbered response is used to report a status where the STE is logically disconnected from the link, and is in the disconnected phase. The DM response is sent in this phase in response to the reception of a set mode command, to inform the STE that the STE is still in disconnected phase and cannot action a set mode command. No information field is permitted with the DM response.

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 are described below. Exception conditions described are those situations which may occur as the result of transmission errors, STE malfunction or operational situations.

2.3.5.1 *Busy condition*

The busy condition results when an STE is temporarily unable to continue to receive I frames due to internal constraints, e.g., receive buffering limitations. In this case an RNR frame is transmitted from the busy STE. I frames pending transmission may be transmitted from the busy STE prior to or following the RNR. Clearing of the busy condition is indicated as described in § 2.3.4.4 above.

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

An STE 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 and the P bit to perform link control functions; e.g., to receive acknowledgement of previously transmitted I frames. Therefore, the retransmitted frame may contain an N(R) and a P bit that are updated from, and therefore different from, the ones contained in the originally transmitted I frame.

TABLE 7/X.75

FRMR information field format (modulo 8)

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 frame control field								0	V(S)			C/R	V(R)			W	X	Y	Z	0	0	0	0

Rejected frame control field is the control field of the received frame which caused the frame reject.

V(S) is the current send state variable value at the STE reporting the rejection condition (bit 10 = low order bit).

C/R set to 1 indicates the rejected frame was a response.

C/R set to 0 indicates the rejected frame was a command.

V(R) is the current receive state variable value at the STE reporting the rejection condition (bit 14 = low order bit).

W set to 1 indicates that the control field received and returned in bits 1 through 8 was invalid or not implemented.

X set to 1 indicates that 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 that the information field received exceeded the maximum established capacity.

Z set to 1 indicates the control field received and returned in bits 1 through 8 contained an invalid N(R).

Bits 9 and 21 through 24 shall be set to 0.

TABLE 8/X.75

FRMR information field format (modulo 8)

Information field bits

1 to 16	17	18 to 24	25	26 to 32	33	34	35	36	37	38	39	40
Rejected frame control field	0	V(S)	C/R	V(R)	W	X	Y	Z	0	0	0	0

Rejected frame control field is the control field of the received frame which caused the frame reject.

V(S) is the current send state variable value at the STE reporting the rejection condition (bit 18 = low order bit).

C/R set to 1 indicates the rejected frame was a response.

C/R set to 0 indicates the rejected frame was a command.

V(R) is the current receive state variable value at the STE reporting the rejection condition (bit 26 = low order bit).

W set to 1 indicates that the control field received and returned in bits 1 through 16 was invalid or not implemented.

X set to 1 indicates that the control field received and returned in bits 1 through 16 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 that the information field received exceeded the maximum established capacity.

Z set to 1 indicates the control field received and returned in bits 1 through 16 contained an invalid N(R).

Bits 17 and 37 through 40 shall be set to 0.

2.3.5.3 *REJ recovery*

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

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

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

2.3.5.4 *Time-out recovery*

If an STE, due to a tranmission 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 condition and therefore will not transmit an REJ. The STE which transmitted the unacknowledged I frame(s) shall, following the completion of a system specified time-out period (see §§ 2.4.4.9 and 2.4.7.1 below), take appropriate recovery action to determine at which I frame retransmission must begin.

2.3.5.5 *Invalid frame and FCS error*

Any invalid frame (see § 2.2.9 above) or any frame received with an FCS error will be discarded and no action is taken as the result of that frame.

2.3.5.6 *Frame rejection condition*

A frame rejection condition is established upon the receipt of an error-free frame with one of the conditions listed in § 2.3.4.7 above.

This exception is reported by sending an FRMR.

Once an STE has established a frame rejection condition, no additional I or S frames are accepted, except for examination of the P bit.

2.4 *Description of the procedure*

Note – In § 2.4.7.5 (N3), § 2.4.7.6 (T3) and § 2.4.7.7 (T4), other mechanisms can be envisaged to achieve the same functions.

2.4.1 *Procedure for addressing*

Commands are sent with the remote STE address and responses are sent with the local STE address.

In order to allow differentiation between single link operation and multilink operation for diagnostic and/or maintenance reasons, different address pair encodings shall be assigned to links operating with the multilink procedure (MLP) compared to links operating with the single link procedure (SLP). These STE addresses are coded as follows:

	Address	1 2 3 4 5 6 7 8
Single link operation	A	1 1 0 0 0 0 0 0
	B	1 0 0 0 0 0 0 0
Multilink operation	C	1 1 1 1 0 0 0 0
	D	1 1 1 0 0 0 0 0

A and B, or C and D, are assigned by bilateral agreement between the Administrations.

2.4.2 *Procedure for the use of the P/F bit*

The next response frame returned by the STE to an SABM/SABME or DISC command with P bit set to 1 will be a UA or DM response with the F bit set to 1. The next response frame returned to an I frame with the P bit set to 1, received during the information transfer phase, will be an RR, REJ or RNR response in supervisory format with the F bit set to 1.

The next response frame returned to a supervisory command frame with the P bit set to 1, received during the information transfer phase, will be an RR, REJ or RNR response with the F bit set to 1.

The response frame returned to an S or I frame with the P bit set to 1, received in the disconnected phase, will be a DM with F bit set to 1.

The P bit is used by the STE in conjunction with the time-out recovery condition (see § 2.4.4.9 below).

When not used the P/F bit is set to 0.

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

2.4.3 *Procedures for link set-up and disconnection*

2.4.3.1 *Link set-up*

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

Either STE may initialize the link by sending SABM/SABME (modulo 8/modulo 128) and starting Timer T1. The opposite STE, upon receiving SABM/SABME correctly, sends UA and resets both its state variables to 0. If UA is received correctly, then the link is set up and the initiating STE resets both its state variables to 0 and stops Timer T1.

If, upon receipt of SABM/SABME correctly, the STE determines that it cannot enter the indicated phase, it sends the DM response.

When receiving the DM response, the STE which has transmitted an SABM/SABME stops its Timer T1 and does not enter the information transfer phase.

The STE sending SABM/SABME will ignore and discard any frames except SABM/SABME, DISC, UA and DM from the other STE.

Frames other than UA and DM in response to a received SABM/SABME will be sent only after the link is set up and if no outstanding SABM/SABME exists.

If an SABM/SABME or DISC command, UA or DM response is not received correctly, the result will be that the Timer T1 will run out in the STE which originally sent the SABM/SABME and that the STE may re-send SABM/SABME and restart Timer T1.

After transmission of SABM/SABME N2 times by the STE, 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 setting up the link, in this phase the STE will accept and transmit I and S frames according to the procedures described in § 2.4.4 below.

When receiving an SABM/SABME (modulo 8/modulo 128) command while in the information transfer phase, the STE will conform to the resetting procedure described in § 2.4.6 below.

2.4.3.3 *Link disconnection*

During the information transfer phase either STE shall indicate a request for disconnecting the link by transmitting a DISC command and it shall start Timer T1 (see § 2.4.7 below).

The STE, on correctly receiving a DISC command, will send a UA response and enter the disconnected phase. The STE, on receiving a UA or DM response to a sent DISC command, stops its timer, and enters the disconnected phase. If a UA or DM response is not received correctly, this will result in the expiration of the Timer T1 in the STE which originally sent the DISC command. If Timer T1 runs out, this STE will retransmit a DISC command and restart Timer T1. This action will continue until a UA response or a DM response is correctly received or until recovery takes place at a higher level after transmission of DISC N2 times. The value of N2 is defined in § 2.4.7.2 below.

2.4.3.4 *Procedures in a disconnected phase*

2.4.3.4.1 The STE in the disconnected phase will monitor received commands and will react to the receipt of an SABM/SABME (modulo 8/modulo 128) as described in § 2.4.3.1 above and will transmit a DM response in answer to a received DISC command.

When receiving any other command frame with the P bit set to 1, the STE will transmit a DM response with the F bit set to 1. Other frames in the disconnected phase will be ignored.

2.4.3.4.2 After recovery from an internal malfunction, the STE may either initiate a resetting procedure (see § 2.4.6.2 below) or disconnect the link (see § 2.4.3.3 above) prior to a link set-up procedure (see § 2.4.3.1 above).

2.4.3.5 *Collision of unnumbered commands*

Collision situations shall be resolved in the following way:

2.4.3.5.1 If the sent and received U commands are the same, each STE shall send the UA response at the earliest possible opportunity. Each STE shall enter the indicated phase after receiving a UA response.

2.4.3.5.2 If the sent and received U commands are different, each STE shall enter the disconnected phase and issue a DM response at the earliest possible opportunity. However, the actions to be taken by each STE on collision of an SABM and SABME command are for further study.

2.4.4 *Procedures for information transfer*

The procedures which apply to the transmission of I frames in each direction during the information transfer phase are described below.

In the following, "number 1 higher" is in reference to a continuously repeated sequence series, i.e. 7 is 1 higher than 6 and 0 is 1 higher than 7 for modulo 8 series, and 127 is 1 higher than 126 and 0 is 1 higher than 127 for modulo 128 series.

2.4.4.1 *Sending I frames*

When the STE has an I frame to transmit (i.e., an I frame not already transmitted, or having to be retransmitted as described in § 2.4.4.6 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 I frame, it will increment its send state variable V(S) by 1.

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

Note – It is for further study to determine whether Timer T1 will be restarted or not influenced if it is running at the instant of transmission of an I frame.

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 I frames – see § 2.4.7.4) the STE will not transmit any new I frames, but may retransmit an I frame as described in § 2.4.4.6 or § 2.4.4.9 below.

When the STE is in a busy condition, it may still transmit I frames provided that the other STE is not busy itself. When in the frame rejection condition, the STE will stop transmitting I frames.

2.4.4.2 *Receiving an I frame*

2.4.4.2.1 When the STE is not in a busy condition and receives, with correct FCS, an I frame whose send sequence number is equal to the STE receive state variable V(R), the STE will accept the information field of this frame, increment by 1 its receive state variable V(R), and act as follows:

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

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

2.4.4.2.2 When the STE is in a busy condition, it may ignore N(S) and the information field contained in any received I frame.

2.4.4.3 *Reception of out of sequence frames*

When the STE receives with correct FCS an I frame whose send sequence number is incorrect, i.e. not equal to the current STE receive state variable V(R), it will discard the information field of the frame and transmit an REJ response with the N(R) set to 1 higher than the N(S) of the last correctly received I frame. The STE will then discard the information field of all frames until the expected frame is correctly received. When receiving the expected frame, the STE will then acknowledge the frame as described in § 2.4.4.2 above. The STE will use the N(R) and P bit indications in the discarded I frames.

2.4.4.4 *Reception of incorrect frames*

When the STE receives a frame with incorrect FCS, an invalid frame (see § 2.2.9 above) or a frame with an address other than A or B (for single link operation), other than C or D (for multilink operation), this frame will be discarded.

2.4.4.5 *Receiving acknowledgement*

When correctly receiving an I or S frame (RR, RNR or REJ), except in the frame rejection condition, the STE will consider the N(R) contained in this frame as an acknowledgement for all I frames it has transmitted with an N(S) up to and including the received N(R) − 1. The STE will reset Timer T1 when it correctly receives an I or S frame with the N(R) higher than the last received N(R) (actually acknowledging some I frames).

If the timer has been reset and if there are outstanding I frames still unacknowledged, Timer T1 will restart. If the timer then runs out, the STE will follow the retransmission procedure (in § 2.4.4.9 below) with respect to the unacknowledged frames.

2.4.4.6 *Receiving reject*

When receiving an REJ, the STE will set its send state variable V(S) to the N(R) received in the REJ control field. It will transmit the corresponding I frame as soon as it is available or retransmit it. (Re)transmission will conform to the following procedure:

i) If the STE 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 I frame.

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

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

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

If the REJ frame was received from the other STE as a command with the P bit set to 1, the STE will transmit an RR, RNR or REJ response with the F bit set to 1 before transmitting or retransmitting the corresponding I frame.

2.4.4.7 *Receiving RNR*

After receiving an RNR, the STE may transmit or retransmit the I frame with the send sequence number equal to the N(R) indicated in the RNR. If Timer T1 runs out after the reception of RNR, the STE will follow the procedure described in § 2.4.4.9 below. In any case the STE will not transmit any other I frames before receiving an RR or REJ, or the completion of a resetting procedure.

2.4.4.8 *STE busy condition*

When the STE enters a busy condition, it will transmit an RNR response at the earliest opportunity. While in the busy condition, the STE will accept and process supervisory frames and return an RNR response with the F bit set to 1 if it receives an S frame or an I frame with the P bit set to 1. To clear the busy condition, the STE will transmit either an REJ response or an RR response with N(R) set to the current receive state variable V(R) depending on whether or not it discarded information fields of correctly received I frames.

2.4.4.9 *Waiting acknowledgement*

The STE maintains an internal retransmission count variable which is set to 0 when the STE receives a UA or RNR or sends a UA response, or when the STE correctly receives an I or S frame with the N(R) higher than the last received N(R) (actually acknowledging some outstanding frames).

If Timer T1 runs out, the STE 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 STE will restart Timer T1, set its send state variable to the last N(R) received from the opposite STE and retransmit the corresponding I frame with the P bit set to 1, or transmit an appropriate supervisory frame with the P bit set to 1.

If, while in the timer recovery condition, the STE correctly receives an S frame with the F bit set to 1 and with an N(R) within the range from its current send state variable to x included, it will clear the timer recovery condition and set its send state variable to the received N(R).

If, while in the timer recovery condition, the STE correctly receives a frame with the F bit set to 0 and with an N(R) within the range from its current send state variable to x included, it will not clear the timer recovery condition. The received N(R) may be used to update the send state variable. However, the STE may decide to keep the last transmitted I frame in store (even if it is acknowledged), in order to be able to retransmit it with the P bit set to 1 when Timer T1 runs out at a later time.

If Timer T1 runs out in the timer recovery condition, the STE will add one to its retransmission count variable.

If the retransmission count variable is equal to N2, the STE initiates a resetting procedure for both directions of transmission as described in § 2.4.6.2 below. N2 is a system parameter (see § 2.4.7.2 below).

2.4.5 *Frame rejection conditions*

2.4.5.1 Frame rejection conditions are established when receiving, during the information transfer phase, a frame with correct FCS and with one of the conditions listed in § 2.3.4.7 above.

Under these conditions, the STE will ask the other STE to reset the link by transmitting an FRMR response as described in § 2.4.6.3 below.

2.4.6 *Procedures for resetting*

2.4.6.1 The resetting procedures are used to initialize both directions of information transmission. The procedures only apply during the information transfer phase.

2.4.6.2 The STE shall indicate a resetting of both directions of transmission by sending an SABM/SABME (modulo 8/modulo 128) command and starting Timer T1. After receiving an SABM/SABME command, the STE will return, at the earliest opportunity, a UA response and reset its send and receive state variable V(S) and V(R) to 0 and stop Timer T1 unless it has sent an SABM/SABME or DISC itself. If the UA is received correctly by the initial STE, it resets its send and receive state variables to 0 and stops Timer T1.

This also clears one and/or both STEs busy condition if present.

If a DM response is received, the STE will enter the disconnected phase and stop its Timer T1. If Timer T1 runs out before a UA or DM response is received, the SABM/SABME command will be retransmitted and Timer T1 will be started. After Timer T1 runs out N2 times, appropriate recovery action will be initiated and the STE will enter the disconnected phase. The value of N2 is defined in § 2.4.7.2 below.

The reaction of an STE in the case of collision of SABM, SABME or DISC commands is described in § 2.4.3.5 above.

Other commands or responses received by the STE before completion of the reset procedure will be discarded.

2.4.6.3 Under certain rejection conditions listed in § 2.3.4.7 above, one STE may ask the other STE to reset the link by transmitting an FRMR response.

Upon reception of an FRMR response (even during a frame rejection condition) the STE will initiate a resetting procedure by transmitting an SABM/SABME command.

After transmitting an FRMR response, the STE will enter the frame rejection condition. The frame rejection condition is cleared when the STE receives or transmits an SABM/SABME (modulo 8/modulo 128) or DISC command. Any other frame received while in the frame rejection condition will cause the STE to retransmit the FRMR response with the same information field as originally transmitted.

In the frame rejection condition additional I frames will not be transmitted and received I frames and S frames will be discarded by the STE.

The F bit in an FRMR frame has no significance and therefore it will not be checked by the receiving STE.

Note – Timer T1 may be started on transmission of the FRMR response and the STE may then, when Timer T1 runs out, retransmit the FRMR response and restart Timer T1. After Timer T1 has run out N2 times, the link will be reset as described in § 2.4.6.2 above. When an additional FRMR response is transmitted while Timer T1 is running, Timer 1 will not be restarted.

2.4.7 *List of system parameters*

The system parameters are as follows:

2.4.7.1 *Timer T1*

The period of Timer T1, at the end of which transmission of a frame may be initiated, is a system parameter agreed for a period of time between the Administrations.

The period of Timer T1 will take into account whether the timer is started at the beginning or end of transmission of the frame in the STE.

The proper operation of the procedure requires that Timer T1 be greater than the maximum time between transmission of a command frame and reception of the corresponding frame returned as an answer to this frame.

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 a system parameter agreed for a period of time between Administrations.

2.4.7.3 *Maximum number of bits in an I frame N1*

The maximum number of bits in an I frame (excluding flags and 0 bits inserted for transparency) is a system parameter which depends upon the maximum length of the information fields transferred across the X/Y interface.

Note – When multilink procedures are used, N1 shall allow for the multilink control field (MLC). See § 2.5.2 below.

2.4.7.4 *Maximum number of outstanding I frames k*

The maximum number (k) of sequentially numbered I frames that the STE may have outstanding (i.e., unacknowledged) at any given time is a system parameter which can never exceed 7/127 (modulo 8/ modulo 128). It shall be agreed for a period of time between Administrations and shall have the same value for both the STEs.

2.4.7.5 *Retransmission attempts N3 (multilink)*

N3 has a value between zero and the smallest N2 over all SLPs inclusive. If a multilink frame is to be retransmitted at the SLP level, N3 retries indicates when action may be taken at the MLP level.

2.4.7.6 *Lost-frame timer T3 (multilink)*

Timer T3 is used at a receiving STE to provide a means to identify during low traffic periods that the multilink frame with MN(S) equal to MV(R) is lost.

2.4.7.7 *Group busy timer T4 (multilink)*

Timer T4 is provided at a receiving STE to identify a "blocked" multilink frame condition (e.g., a buffer exhaust situation) that occurs before required resequencing can be accomplished. T4 is started when all SLPs are busy and there are multilink frames awaiting resequencing. If T4 expires before the "blocked" multilink frame [MV(R)] is received, the "blocked" multilink frame(s) is (are) declared lost. MV(R) is incremented to the value of the next in-sequence multilink frame to be received, and any intervening multilink frames are transferred to the packet level.

Note – T4 may be set to infinity; e.g., when the receiving STE always has sufficient storage capacity.

2.5 *Multilink procedure (MLP)*

A multilink procedure (MLP) must perform the functions of distributing across the available SLPs, packets which are to be transported to the other STE and of resequencing packets transported from the other STE for delivery to the packet level.

Note – In §§ 2.5.4.3.2 (last paragraph: T3 expiry) and 2.5.4.4 (retransmission), other mechanisms can be envisaged to achieve the same functions.

2.5.1 *Field of application*

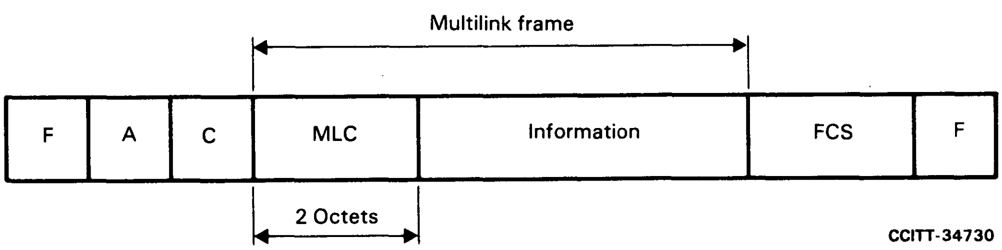
The multilink procedure (MLP) described below is used for data interchange over one or more SLPs, each conforming to the description in §§ 2.2 to 2.4, in parallel between two STEs.

2.5.2 *Multilink frame structure*

All transfers over a link are in multilink frames conforming to the format shown in Table 9/X.75.

TABLE 9/X.75

Format showing multilink frame



The multilink control field (MLC) consists of two octets and its contents are described in § 2.5.3.

The multilink frame's information field is unrestricted with respect to code and grouping of bits.

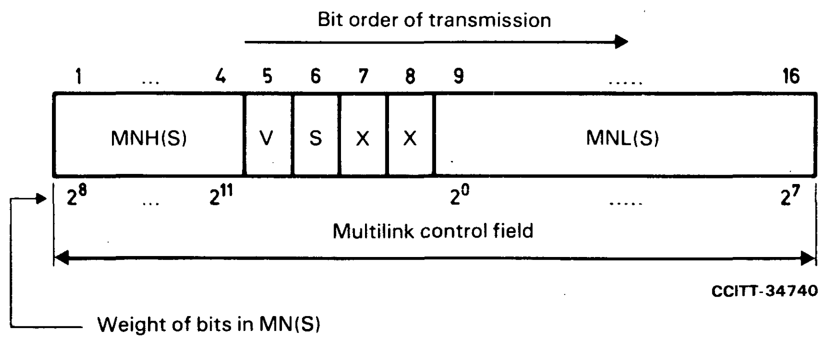
2.5.3 *Multilink control field format and parameters*

2.5.3.1 *Multilink control field format*

The relationship shown in Table 10/X.75 exists between the order of bit transmission on the line and the coding of the fields in the multilink control field.

TABLE 10/X.75

Multilink control field format



MNH(S) Bits 9-12 of 12 bit multilink send sequence number MN(S)
MNL(S) Bits 1-8 of 12 bit multilink send sequence number MN(S)
V Void sequencing bit
S Sequence check option bit
X Reserved

2.5.3.2 *Multilink control field parameters*

The various parameters associated with the multilink control field format are described below. See Table 11/X.75.

The bits labelled "X" are reserved and shall be set to 0. Reserved bits will not be examined by the receiving STE.

2.5.3.2.1 *Void sequencing bit V*

The void sequencing bit indicates if a received multilink frame shall be subjected to sequencing constraints. V set to 1 means sequencing shall not be required. V set to 0 means sequencing shall be required.

2.5.3.2.2 *Sequence check option bit S*

The sequence check option bit is only significant when V is set to 1 (indicating that sequencing of received multilink frames shall not be required). S set to 1 shall mean no MN(S) number has been assigned. S set to 0 shall mean an MN(S) number has been assigned so that, although sequencing shall not be required, a duplicate multilink frame check may be made.

2.5.3.2.3 *Multilink send state variable MV(S)*

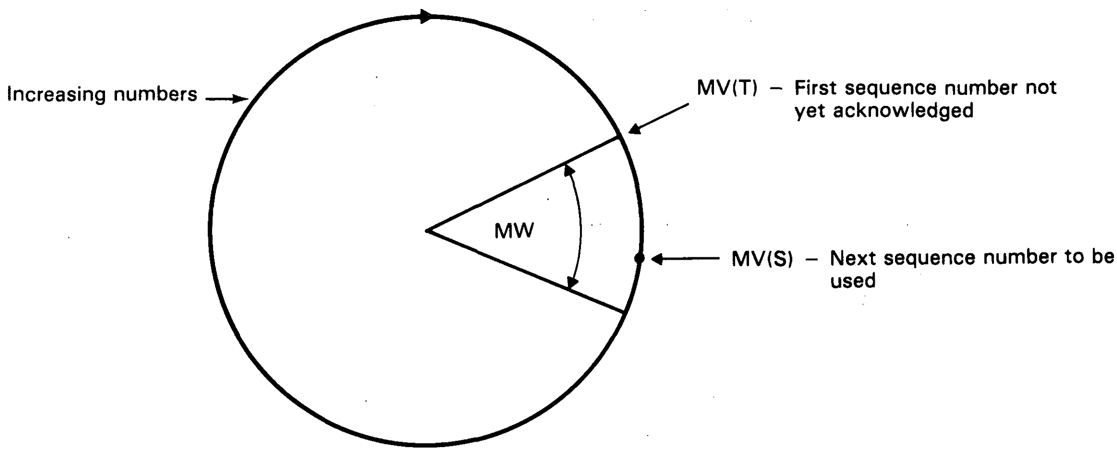
The multilink send state variable MV(S) denotes the sequence number of the next in-sequence multilink frame to be assigned to an SLP. The variable can take on the value 0 through 4095 (modulus 4096). The value of MV(S) is incremented by 1 with each successive multilink frame assignment.

2.5.3.2.4 *Multilink sequence number MN(S)*

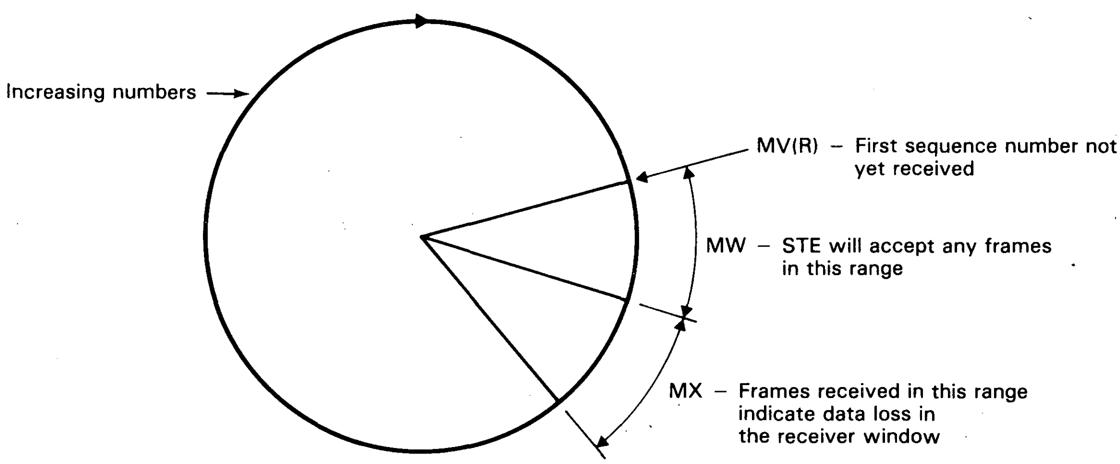
Multilink frames contain the multilink sequence number MN(S). Prior to the assignment of an in-sequence multilink frame, the value of MN(S) is updated to equal the value of the multilink send state variable MV(S).

TABLE 11/X.75

Parameters



Transmitter's window



Receiver's window

CCITT-34750

2.5.3.2.5 *Transmitted multilink frame acknowledged variable MV(T)*

MV(T) is the state variable at the transmitting STE denoting the oldest multilink frame which is awaiting an indication that a local SLP has received an acknowledgement from its remote SLP. Some multilink frames with sequence numbers higher than MV(T) may already have been acknowledged.

2.5.3.2.6 *Multilink receive state variable MV(R)*

The multilink receive state variable MV(R) denotes the sequence number at the receiving STE of the next in-sequence multilink frame to be received and transferred to the packet level. The value of MV(R) is updated as described in § 2.5.4.3.2 below. Multilink frames with higher sequence numbers in the MLP receive window may already have been received.

This multilink receive state variable MV(R) takes on the values 0 through 4095 (modulus 4096).

2.5.3.2.7 *Multilink window size MW*

MW is the maximum number of sequentially numbered multilink frames that the STE may transmit beyond the lowest numbered multilink frame which has not as yet been acknowledged. MW is a system parameter which can never exceed (4095 – MX).

The value of MW shall be agreed for a period of time between Administrations and shall have the same value for both STEs for a given direction of transmission.

Note – Factors which will affect the value of parameter MW include, but are not limited to, link transmission and propagation delays, single link parameters N2, T1, and k, the number of links and the range of multilink frame lengths.

2.5.3.2.7.1 *MLP transmit window*

The MLP transmit window contains the sequence numbers MV(T) to MV(T) + MW – 1 inclusive.

2.5.3.2.7.2 *MLP receive window*

The MLP receive window contains the sequence numbers MV(R) to MV(R) + MW – 1 inclusive. Any multilink frame received within this window shall be passed to the packet level when its MN(S) is the same as MV(R).

2.5.3.2.8 *Receive MLP window guard MX*

MX is a system parameter which defines a range of sequence numbers beginning at MV(R) + MW. A multilink frame with sequence number MN(S) received in this range indicates that any missing multilink frame(s) in the range MV(R) to MN(S) – MW has (have) been lost. MV(R) is set to MN(S) – MW + 1.

Note – In a system where the transmitting STE assigns *h* multilink frames at a time, on a rotation basis to each SLP, MX shall be at least h (L – 1) + 1, where L is the number of single links in the multilink group.

MX may be larger, e.g., the range of MX is the lesser of i) and ii) below:

i) MW.

ii) Large enough to accommodate all very short multilink frames transmitted during a period equal to the time required to transmit a multilink frame on the slowest link N3 times. This allows for the case where loss occurs and the first multilink frame with MN(S) in the range MX takes a long time to transmit across the group.

Additional methods of selecting MX values are for further study.

2.5.4 *Description of multilink procedure (MLP)*

2.5.4.1 *Procedure for initialization*

The STE will perform a MLP initialization by first resetting MV(S), MV(T) and MV(R) to 0 and then initializing each of the SLPs. Upon successful initialization of at least one of the SLPs, the STE may interchange multilink frames.

A SLP initialization is performed according to § 2.4.3.1 of this Recommendation.

Note – A single link that cannot be initialized should be declared out of service and appropriate recovery action should be taken.

2.5.4.2 *Procedure for resetting*

The MLP shall be reset by requesting all SLPs to perform a link disconnection over each link. When all SLPs are in the disconnected phase at the same time, the STE will initialize the MLP as described in § 2.5.4.1.

SLPs are determined to be in the disconnected phase upon either the successful execution of the disconnect procedure at the link level (see § 2.4.3.3) or the indication of a disconnection of the communications facility detected by the physical level or the link level. If any remote SLP attempts to re-establish a link during this procedure, the SLP shall respond DM to an SABM in order to remain in the disconnected phase.

Note – The methods of detecting the disconnection of the communications facility by the physical level are for further study.

2.5.4.3 *Procedures for interchange of multilink frames*

The arithmetic is performed modulo 4096.

2.5.4.3.1 *Transferring multilink frames*

When the transmitting MLP accepts a packet from the packet level, it shall place the packet in a multilink frame, and shall set the MN(S) equal to MV(S), set V and S to 0 and MV(S) shall then be incremented by 1.

Note – The use of V and/or S set to 1 is for further study.

If the MN(S) is less than MV(T) + MW, and the remote STE has not indicated a busy condition on all available links, the transmitting MLP may then assign the new multilink frame to an available link. The transmitting MLP shall always assign the lowest MN(S) unassigned multilink frame first. Also, the transmitting MLP may assign a multilink frame to more than one link.

When the SLP successfully completes the transmission of (a) multilink frame(s) by receiving an acknowledgement from the remote SLP, it shall indicate this to the transmitting MLP. The transmitting MLP may then discard the acknowledged multilink frame(s).

As the transmitting STE receives new indications of acknowledgements from the SLPs, MV(T) shall be advanced to denote the lowest numbered multilink frame not yet acknowledged.

Note – If an MLP implementation is such that a multilink frame is transmitted on more than one link (e.g., to increase the probability of successful delivery) there is a possibility that one of these multilink frames (i.e., a duplicate) may be delivered to the remote STE after an earlier one has been acknowledged [resulting in the receiving STE incrementing its MV(R) and the transmitting STE incrementing its MV(T)].

In this case, the transmitting STE design must ensure that an old duplicate multilink frame is not mistaken for a new frame by the receiving STE. It is required that the transmitting STE never send a new multilink frame with MN(S) equal to MN(S)′ – MW – MX, where MN(S)′ is associated with a duplicate multilink frame being retransmitted on any single link.

Alternatively, if transmission is attempted over more than one link, MV(T) is not incremented until all SLPs have either successfully transferred the multilink frame or attempted N2 tries.

These and other alternatives are for further study.

In the event of a circuit failure, receipt of a single link RNR, single link reset or single link disconnection, all multilink frames unacknowledged on that link shall be retransmitted on an operational link(s) which is (are) not in the busy condition.

Note – The following is for further study:

Whenever a busy condition is indicated by one or more SLPs, the transmitting STE will send the multilink frame with MN(S) equal to MV(T) on one or more of the remaining links without a busy condition.

When the value of MV(S) – MV(T) = MW, the transmitting STE is not allowed to assign any new multilink frames to the single links.

Note 1 – The action to be taken on the receipt of an RNR by the single link whose unacknowledged multilink frames have been removed is for further study.

Note 2 – The means of detecting transmitting STE malfunctions (e.g., sending more than MW multilink frames) and the actions to be taken are for further study.

2.5.4.3.2 *Receiving multilink frames*

Any multilink frame less than two octets in length shall be discarded by the receiving STE.

Note – The procedures to be followed by the receiving STE when V and/or S is equal to 1 are for further study.

When the STE receives multilink frames from one of the SLPs, the STE will compare the multilink sequence number MN(S) of the received multilink frame to its multilink receive state variable MV(R), and act on the frame as follows:

a) If the received MN(S) is equal to the current value of MV(R), i.e., is the next expected in-sequence multilink frame, the MLP delivers the packet to the packet level.

b) If the MN(S) is greater than the current value of MV(R) but less than MV(R) + MW + MX, the MLP keeps the received multilink frame until condition a) is met, or discards it if it is a duplicate.

c) If the MN(S) is other than that in a) and b) above, the multilink frame is discarded.

On receipt of a multilink frame, MV(R) is incremented in the following way:

i) If MN(S) is equal to the current value of MV(R), the MV(R) is incremented by the number of consecutive in-sequence multilink frames received. If additional multilink frames are awaiting delivery pending receipt of a multilink frame with MN(S) equal to MV(R), then Timer T3 is restarted; otherwise T3 is reset.

ii) If MN(S) is greater than the current value of MV(R) but less than MV(R) + MW, MV(R) remains unchanged. Timer T3 is started, if not already running.

iii) If MN(S) is $\geq$ MV(R) + MW but $<$ MV(R) + MW + MX, MV(R) is incremented to MN(S) – MW + 1 and then the higher level may be informed of the packet loss. As MV(R) is being incremented, if the multilink frame with MN(S) = MV(R) has not yet been received, the higher level may be informed of the packet loss; if the multilink frame with MN(S) = MV(R) has been received, it is delivered to the higher level.

After MV(R) reaches MN(S) – MW + 1, it may then be incremented further until the first unacknowledged MN(S) is encountered.

iv) If the MN(S) is other than that in i), ii) and iii) above, MV(R) remains unchanged.

If Timer T3 runs out, MV(R) is incremented to MN(S) of the next multilink frame awaiting delivery to the packet level and then the packet level may be informed of packet loss. The procedure follows i) and a) above as long as there are consecutive in-sequence multilink frames which have been received.

2.5.4.4 *Retransmission of multilink frames*

If an SLP has retransmitted a multilink frame N3 times, the STE will then assign the multilink frame to the same or one or more other links, unless the MN(S) has been acknowledged on some previous link. The STE shall always reassign the lowest MN(S) frame first. The first SLP transmits the frame N2 times, regardless of the value of N3.

Note – The procedures associated with the reassigning of multilink frames from a link of poor quality (e.g., before N2 transmissions) to other links are for further study.

2.5.4.5 *Taking an SLP out of service*

An SLP is taken out of service by disconnecting at the physical level or the link level. Any outstanding multilink frames will be treated as in § 2.5.4.4. The usual procedure would be to flow control this link by an RNR, and then logically disconnect (see § 2.4.3.3 above).

A link may be taken out of service for maintenance, traffic, or performance considerations.

If Timer T1 has run out N2 times and the SLP reset is unsuccessful, then the SLP will enter the disconnected phase, taking the SLP out of service (see §§ 2.4.4.9 and 2.4.6.2 above).

3 Packet level – Packet signalling procedures between signalling terminals

General Principles

Paragraph 3 of this Recommendation relates to the transfer of packets at the STE-X/STE-Y (X/Y) interface. The procedures apply to packets which are successfully transferred across the X/Y interface.

Each packet to be transferred across the X/Y interface shall be contained in the information field of an I frame in the link access procedure. The number of packets contained in the information field of an I frame is to be decided and until this study is completed only one packet is contained in the information field of an I frame.

To enable simultaneous virtual calls, a logical channel group number (in the range 0 to 15 inclusive) and a logical channel number (in a range 0 to 255 inclusive) are assigned to the virtual call during the call set-up phase. The range of logical channels and logical channel groups that are available for assignment to virtual calls is agreed bilaterally for a period of time.

The combination of logical channel number 0 and logical channel group number 0 will not be used for virtual calls.

During the existence of a particular virtual call, each packet related to that call uses the STEs selected at call set-up.

It is assumed that the gathering of information required for charging and accounting should normally be the responsibility of the calling Administration (see Recommendation D.10 [8]). Other arrangements for gathering information are for further study.

The following text together with Annexes A, B, C and D specifies for each logical channel the states, received packets and consequent actions in an STE. Packet formats are defined and explained in § 4 of this Recommendation.

Note – The need for any procedures, particularly for permanent virtual circuits, other than the virtual call procedures specified is for further study.

3.1 *Procedure for virtual call set-up and clearing*

Virtual calls will be set up and cleared according to the procedures described hereunder. The procedures for call set-up and clearing are only applicable when a logical channel is in the *packet level ready* state (r1). In all other *r* states these procedures are not applicable.

3.1.1 *Ready state*

If there is no call or call attempt in existence and if call set-up is possible, the logical channel is in the *ready* state (p1), within the *packet level ready* state (r1).

3.1.2 *Call request packet*

An STE indicates a call request by transferring a *call request* packet which specifies a logical channel in the *ready* state (p1) across the X/Y interface. The logical channel selected by the calling STE is then in the STE *call request* state (p2/3). If this state persists for more than T31 minutes, the calling STE will clear the call. The value of T31 is for further study.

If an STE receives a *call request* packet with a call user data field longer than 16 octets, the STE should clear the virtual call indicating the cause *network congestion* (see Note 1).

Note 1 – If the called STE supports the *fast select* optional user facility, the called STE should be able to receive a *call request* packet with a call user data field up to 128 octets.

Note 2 – In the *call request* packet, bit 7 of the general format identifier (see § 4.1.1) may be used in conjunction with the delivery confirmation procedure (see § 3.3.4). This bit 7 is conveyed transparently through an STE.

3.1.3 *Call connected packet*

The called STE will indicate acceptance of the call by the called DTE by transferring across the X/Y interface a *call connected* packet specifying the same logical channel as that of the *call request* packet. This places the specified logical channel in the *flow control ready* state (d1) within the *data transfer* state (p4). The procedure applying to the *data transfer* state is specified in § 3.3 below.

Note – In the *call connected* packet, bit 7 of the general format identifier (see § 4.1.1) may be used in conjunction with the delivery confirmation procedure (see § 3.3.4). This bit 7 is conveyed transparently through an STE.

3.1.4 *Call collision*

Call collision occurs if STE-X receives a *call request* packet when the logical channel specified is in state *p2* or if the STE-Y receives a *call request* packet when the logical channel specified is in state *p3*. In these cases, both calls shall be cleared. The clearing cause field shall be coded *network congestion*.

In order to reduce the occurrence of this situation, inverse order testing of logical channels will be used. The *call request* packet of one STE will use the logical channel in the *ready* state with the lowest number; the *call request* packet of the other STE will use the logical channel in the *ready* state with the highest number. Which STE will use the lowest number and which the highest number will be agreed bilaterally.

3.1.5 *Clear request packet*

An STE may request clearing of a logical channel in any state by transferring across the X/Y interface a *clear request* packet specifying the logical channel. If the *STE clear request* state persists for more than T33, the STE may again request clearing. This may be continued and indicated by an alarm at an appropriate time. This procedure may be discontinued at any stage. The value of T33 is 3 minutes.

The clearing cause field will be coded according to the reason for clearing. Each STE shall be capable of generating the distinct codes for all of the call progress signals specified in Recommendation X.96 [5] for the packet-switched data transmission service.

Note – When *network congestion* occurs, it may be necessary to signal additional network-related information across the X/Y interface as to why the call is being cleared. The manner in which this is done is for further study.

3.1.6 *Clear confirmation packet*

When an STE-X or STE-Y (STE X/Y) has received a *clear request* packet, it will free the logical channel, whatever the state of the logical channel except the *STE X/Y clear request* state (p6 or p7 respectively), and transfer across the X/Y interface a *clear confirmation* packet specifying the same logical channel. The logical channel is placed in the *ready* state (p1) within the *packet level ready* state (r1). The receipt of a *clear confirmation* packet cannot be interpreted as an indication of the remote DTE being cleared.

3.1.7 *Clear collision*

If a logical channel is in the *STE X/Y clear request* state (p6 or p7 respectively) and the STE X/Y receives a *clear request* packet specifying the same logical channel, this STE will consider the clearing completed and will not transmit a *clear confirmation* packet. This logical channel is now in the *ready* state (p1) within the *packet level ready* state (r1).

3.2 *Procedure for permanent virtual circuits*

This procedure remains for further study.

3.3 *Procedure for data and interrupt transfer*

The data transfer procedure described below applies independently to each logical channel existing at the X/Y interface.

Normal network operation dictates that user data in *data* packets and interrupt data are all passed tranparently, unaltered through the network. The order of bits within these packets is preserved. A packet sequence received by an STE is always delivered as a complete packet sequence. Diagnostic codes are treated as described in §§ 4.2.3, 4.4.3 and 4.5.1 below.

3.3.1 *States for data transfer in virtual calls*

Data, interrupt, flow control and *reset* packets may be transmitted and received by an STE in the *data transfer* state (p4) of the *packet level ready* state (r1) of a logical channel at the X/Y interface. Only in this state, do the flow control and reset procedures described in § 3.4 below apply to data transmission on that logical channel to and from the STE. In all other *r* or *p* states the data and interrupt transfer, flow control, and reset procedures are not applicable.

3.3.2 *Numbering of data packets*

Each *data* packet transmitted at the X/Y interface for each direction of transmission in a virtual call is sequentially numbered. This sequential numbering is performed regardless of the level of data [value of the qualifier (Q) bit].

The sequence numbering scheme of the packets is performed modulo 8 or 128. This modulo is common to all logical channels at the X/Y interface. The packet sequence numbers cycle through the entire range 0 to 7 or 0 to 127 respectively. The selection of modulo 8 or 128 is done by bilateral agreement.

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

After the virtual call has been established or reset, the first *data* packet to be transmitted across the X/Y interface for a given direction of data transmission has a packet send sequence number equal to 0.

If an STE receives the first *data* packet with a packet send sequence number not equal to 0 after the virtual call has been established or reset, it will reset the virtual call indicating the cause *network congestion.*

3.3.3 *Data field length of data packets*

The standard maximum data field length is 128 octets (1024 bits) and is provided by all Administrations. In addition, optional maximum data field lengths may be provided on a per call basis by bilateral agreement between Administrations in conjunction with an optional network utility defined in § 5.3.5 of the text. (See Note).

The data field length may contain any number of bits from 0 up to the maximum data field length.

If an STE receives a *data* packet having a data field exceeding the maximum data field length, it will reset the virtual call indicating the cause *network congestion.*

Note – One or a set of optional maximum data field lengths may be selected from the following list: 16, 32, 64, 256, 512 and 1024 octets.

3.3.4 *Delivery confirmation, more data and qualifier bits*

The setting of the *Delivery confirmation* bit (or D bit) is used to indicate whether or not an end-to-end acknowledgement of delivery is required for data being transmitted, this information being provided by means of the packet receive sequence number P(R) (see § 3.4.1.2).

A packet sequencing method is provided to enable coherent transmission of data longer than the maximum data field length of *data* packets.

Each complete packet sequence consists of any number (including 0) of full *data* packets (full means that the data field contains the bit number of the maximum data field length) with M = 1 and D = 0, followed by one other packet of any length up to (and including) the maximum with either M = 0 and D = 0 or 1, or M = 1 and D = 1. If an STE receives a packet which is not full, and which has the D bit set to 0 but the M bit set to 1, it may reset the virtual circuit; the resetting cause shall be *network congestion.*

A complete packet sequence may be one of two levels as indicated by the *Qualifier* bit (or Q bit).

The value of the Q bit should not change within a complete packet sequence. If an STE detects that the value of this bit has changed within a packet sequence, it may reset the virtual circuit; the resetting cause shall be *network congestion.*

Note – The value of the Q bit in a *data* packet, which follows a *data* packet with either M = 0 or both the M and D bits set to 1, may be set independently of the value of the Q bit in the previous packet.

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 between STEs (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.

If an STE receives an *interrupt* packet with a user data field longer than 1 octet, the STE should reset the virtual call.

An STE conveys an interrupt by transferring across the X/Y interface an *interrupt* packet. The other STE will convey the interrupt confirmation by transferring an *interrupt confirmation* packet.

The receipt of an *interrupt confirmation* packet indicates that the interrupt has been confirmed by the remote DTE by means of a *DTE interrupt confirmation* packet.

An *interrupt* packet is conveyed across the X/Y interface at or before the point in the stream of *data* packets at which it was generated by the DTE.

An STE receiving a further *interrupt* packet in the time between receiving one *interrupt* packet and transferring the interrupt confirmation, may either discard this *interrupt* packet or reset the virtual circuit.

3.4 *Procedure for flow control and for reset*

The procedures for flow control of *data* packets and for reset only apply to the *data transfer* state (p4) and are specified below.

3.4.1 *Procedure for flow control*

At the X/Y interface of each logical channel used for a virtual call, 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 X/Y interface of each logical channel used for a virtual call, a window is defined for each direction of data transmission as the ordered set of W consecutive packet send sequence numbers 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 at the X/Y interface has just been established or reset, 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).

The maximum value of the window size for each direction of transmission at the X/Y interface is unique to all the logical channels and is agreed for a period of time bilaterally. This value does not exceed 7 or 127 (modulo 8 or 128).

For a particular virtual call two window sizes may be selected, one for each direction of transmission. These window sizes may be less than or equal to the above-mentioned maximum. The two sizes are selected by reference to a utility (see § 5.3.4) in the network utility field of the *call requested* packet and the *call connected* packet, and, in some cases, by reference also to a correspondence table relating window size to throughput class. This table is agreed for a period of time between Administrations.

3.4.1.2 *Flow control principles*

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

When the sequence number P(S) of the next *data* packet to be transmitted by the STE is within the window, the STE is authorized to transmit this *data* packet to the other STE, which may then accept it. When the sequence number P(S) of the next *data* packet to be transmitted by the STE is outside the window, the STE shall not transmit a *data* packet to the other STE. Otherwise, the other STE will consider the receipt of this *data* packet as a procedure error and will reset the virtual call.

The packet receive sequence number, P(R), is conveyed in *data*, *receive ready* (RR) and *receive not ready* (RNR) packets, and implies that the STE transmitting the P(R) has accepted at least all *data* packets numbered up to and including $P(R) - 1$.

The value of a P(R) received by the STE must be within the range starting from the last P(R) received by the STE up to and including the packet send sequence number of the next *data* packet to be transmitted by the STE. Otherwise, the STE will consider the receipt of this P(R) as a procedure error and will reset the virtual call.

When the D bit is set to 0 in a *data* packet [$P(S) = p$], the significance of the P(R) [i.e., $P(R) \geq p + 1$] corresponding to that *data* packet is a local updating of the window across the packet level interface.

When the D bit is set to 1 in a *data* packet [P(S) = p], the significance of the P(R) received corresponding to the *data* packet [i.e., P(R) $\geqslant$ p + 1] is an indication that a P(R) has been received from the remote DTE for all data bits in the *data* packet in which the D bit had originally been set to 1 [i.e., P(S) = p].

Note 1 – The STE is required to send a P(R) corresponding to a *data* packet with the D bit set to 1 as soon as possible after it receives the P(R) from the remote DTE. An *RNR* packet may be used in this case if necessary.

Note 2 – In the case where a P(R) for a *data* packet with the D bit set to 1 is outstanding, local updating of the window will be deferred for subsequent *data* packets with the D bit set to 0. Some STEs may also defer updating of the window for previous *data* packets (within the window) with the D bit set to 0.

3.4.1.3 *STE receive ready (RR) packet*

RR packets are used by the STE 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 *STE receive not ready (RNR) packet*

RNR packets are used by the STE to indicate a temporary inability to accept additional *data* packets for a given virtual call. An STE receiving an *RNR* packet shall stop transmitting *data* packets on the indicated logical channel but the window is updated by the P(R) indicated in the *RNR* packet.

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.

The transmission of an *RR* after an *RNR* at the packet level is not to be taken as a demand for retransmission of packets which have already been transmitted.

3.4.2 *Procedure for reset*

The reset procedure is used to reinitialize the virtual call. The reset procedure only applies in the *data transfer* state (p4) of the X/Y interface. In any other state of the interface the reset procedure is not applicable.

There are three states within the *data transfer* state (p4). They are *flow control ready* (d1), *STE-X reset request* (d2) and *STE-Y reset request* (d3). When entering state p4, the logical channel is placed in state d1.

When a virtual call at the X/Y 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 X/Y interface for each direction of data transmission shall start from 0.

Note – When *network congestion* occurs, it may be necessary to signal additional network-related information across the X/Y interface as to why the call is being reset. The manner in which this is done is for further study.

3.4.2.1 *Reset request packet*

The STE shall indicate a request for reset by transmitting a *reset request* packet specifying the logical channel. This places the logical channel in the *Reset request* state (d2 or d3).

In this state, the STE will discard *data, interrupt, RR* and *RNR* packets.

3.4.2.2 *Reset collision*

Reset collision occurs when both STEs simultaneously transfer a *reset request* packet. In this case both STEs shall consider that resetting is complete and shall not transfer a *reset confirmation* packet. The logical channel is then in the *flow control ready* state (d1).

3.4.2.3 *Reset confirmation packet*

When the logical channel is in the *reset request* state, the requested STE will confirm reset by transmitting to the requesting STE a *reset confirmation* packet. This places the logical channel in the *flow control ready* state (d1).

The *reset confirmation* packet can only be interpreted universally as having local significance; however within some Administrations' networks, reset confirmation may have end-to-end significance. In all cases, the time spent in the *reset request* state (d2 or d3) will not exceed a network dependent limit. The limit will be lower than T32 minutes. The value of T32 is for further study.

3.4.2.4 *Effect of reset procedure on data and interrupt packets*

Data and *interrupt* packets, transmitted by an STE before a reset procedure is initiated at its X/Y interface, will either be delivered before the corresponding reset procedure is initiated at the remote DTE/DCE interface, or discarded.

The first *data* and *interrupt* packets transmitted by an STE after a reset procedure is completed at its interface will be the first packets delivered after the corresponding reset procedure is completed at the remote DTE/DCE interface.

Data and *interrupt* packets transmitted by an STE after a reset procedure has been initiated by the other STE will be discarded by the latter STE until the reset procedure has been completed at the X/Y interface.

3.5 *Procedure for restart*

The restart procedure is used to clear simultaneously all the virtual calls at the X/Y interface.

There are three states of the X/Y interface concerned with the restart procedure. They are *packet level ready* (r1), *STE-X restart request* (r2) and *STE-Y restart request* (r3), when entering state r1, all logical channels are placed in state p1.

3.5.1 *Restart by the STE*

The STE may at any time request a restart by transferring across the X/Y interface a *restart request* packet. The interface for each logical channel is then in the *restart request* state (r2 or r3).

In this state of the X/Y interface, the STE will discard all packet types except *restart request* and *restart confirmation* packets.

On receipt of a *restart request* packet, an STE shall clear all virtual calls and shall place all assigned logical channels in the *ready* state (p1) within the *packet level ready* state (r1). The STE shall return a *restart confirmation* packet unless a collision has occurred.

The *restart confirmation* packet can only be interpreted universally as having local significance. The time spent in the *restart request* state (r2 or r3) will not exceed a network dependent limit. The limit will be lower than T30 minutes. The value of T30 is for further study.

3.5.2 *Restart collision*

Restart collision can occur when both STEs simultaneously transfer *restart request* packets. Under this circumstances, both STEs will consider that the restart is completed and will not expect a *restart confirmation* packet, neither will they transfer a *restart confirmation* packet.

3.6 *Relationship between levels*

Changes of operational states of the physical and link level of the X/Y interface do not implicitly change the state of each logical channel at the packet level. Such changes, when they occur, are explicitly indicated at the packet level by the use of restart, clear or reset procedures as appropriate.

However, in some cases of trouble at the link level, it may be appropriate to initiate the restart procedure, and accept no more new calls.

4 Packet formats for virtual calls

4.1 *General*

The formats of X.75 packets are based on the general structure of packets in Recommendation X.25 [3]. It is anticipated that modification in X.25 control packet formats will also be adopted in X.75.

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 12/X.75).

TABLE 12/X.75

General format identifier

General format identifier		Octet 1 Bits 8	7	6	5
Data packets	Sequencing numbering scheme modulo 8	X	X	0	1
	Sequencing numbering scheme modulo 128	X	X	1	0
Call set-up packets	Sequencing numbering scheme modulo 8	0	X	0	1
	Sequencing numbering scheme modulo 128	0	X	1	0
Clearing, flow control, interrupt, reset and restart packets	Sequencing numbering scheme modulo 8	0	0	0	1
	Sequencing numbering scheme modulo 128	0	0	1	0
General format identifier extension		U	U	1	1

Note – A bit which is indicated as X may be set to either 0 or 1 as specified in the text and in Figures 2/X.75, 3/X.75, 6/X.75 and 7/X.75. A bit which is indicated as U is unspecified.

Bit 8 of the general format identifier is used for the qualifier (Q) in *data* packets and is set to 0 in all other packet types.

Bit 7 of the general format identifier is used in *data* and *in call set-up* packets in conjunction with the *delivery confirmation* (D) procedure, and is set to 0 in all other packet types.

Bits 5 and 6 are encoded for four possible indications. Two of the codes are used to distinguish packets using modulo 8 sequence numbering scheme from packets using modulo 128 sequence numbering scheme. The third code is used to indicate an extension to an extended family of general format identifier codes and extended formats which are a subject for further study. The fourth code is unassigned.

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.

For each logical channel, this number has local significance at the X/Y interface.

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.

For each logical channel, this number has local significance at the X/Y interface.

4.1.4 *Packet type identifier*

Each packet shall be identified in octet 3 of the packet according to Table 13/X.75.

TABLE 13/X.75

Packet type identifier

Packet type	Octet 3 Bits 8	7	6	5	4	3	2	1
Call set-up and clearing								
Call request	0	0	0	0	1	0	1	1
Call connected	0	0	0	0	1	1	1	1
Clear request	0	0	0	1	0	0	1	1
Clear confirmation	0	0	0	1	0	1	1	1
Data and interrupt								
Data	X	X	X	X	X	X	X	0
Interrupt	0	0	1	0	0	0	1	1
Interrupt confirmation	0	0	1	0	0	1	1	1
Flow control and reset								
Receive ready (modulo 128)	0	0	0	0	0	0	0	1
Receive ready (modulo 8)	X	X	X	0	0	0	0	1
Receive not ready (modulo 128)	0	0	0	0	0	1	0	1
Receive not ready (modulo 8)	X	X	X	0	0	1	0	1
Reset request	0	0	0	1	1	0	1	1
Reset confirmation	0	0	0	1	1	1	1	1
Restart								
Restart request	1	1	1	1	1	0	1	1
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 as specified in the text and in Figures 2/X.75 to 17/X.75.

4.2 *Call set-up and clearing packets*

4.2.1 *Call request packet*

Figure 2/X.75 illustrates the format of a *call request* packet. In this figure the user facility length field, user facilities field, and call user data field are as defined in Recommendation X.25 [3].

4.2.1.1 *General format identifier*

Bit 7 can be set to either 0 or 1.

4.2.1.2 *Address length 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.

Number of octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				Logical channel group number			
1	Logical channel number							
1	Packet type identifier 0	0	0	0	1	0	1	1
1	Calling DTE address length				Called DTE address length			
15 (max.)	Called and calling DTEs addresses							
1	0	0	Network utility length					
63 (max.)	Network utilities							
1	0	0	User facility length					
63 (max.)	User facilities							
16 (max.) or 128 (max.)	Call user data (see Note 2)							

Note 1 – Coded 0D01 (modulo 8) or 0D10 (modulo 128). D is the delivery confirmation bit.

Note 2 – More than 16 octets of call user data will only be present under the following conditions:

i) both STEs support the *fast select* optional user facility; and

ii) the *fast select* optional user facility is requested.

FIGURE 2/X.75

Call request packet format

4.2.1.3 *Address field*

Octet 5 and the following octets consist of the called DTE international data number followed by the calling DTE international data number.

The international data number is as defined in Recommendation X.121 [9].

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 0s in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

4.2.1.4 *Network utility length field*

Bits 6 through 1 of the octet following the address field indicate the length of the network utility field in octets.

The network utility length field indicator is binary coded and bit 1 is the low order bit.

Bits 8 and 7 of this octet are unassigned and set to 0.

4.2.1.5 *Network utility field*

The network utility field contains an integral number of octets. The length of this field depends on the utilities present. The maximum length of this field is 63 octets.

The coding of the network utility field is defined in § 5 below.

4.2.1.6 *User facility length field*

Bits 6 through 1 of the octet following the network utility field indicate the length of the user facility field in octets. The user facility length indicator is binary coded and bit 1 is the low order bit.

Bits 8 and 7 of this octet are set to 0.

4.2.1.7 *User facility field*

The user facility field contains an integral number of octets. The length of this field depends on the facilities present. The maximum length of this field is 63 octets. The coding of the user facility field is dependent on the facility being requested as defined in Recommendation X.25 [3].

4.2.1.8 *Call user data field*

Following the user facility field, user data may be present. In the absence of the *fast select* optional user facility, the call user data field may contain any number of bits from 0 up to 128 (16 octets). When the *fast select* optional user facility is requested, the call user data may contain any number of bits from 0 up to 1024 (128 octets). The contents of the field are passed unchanged.

4.2.2 *Call connected packet*

Figure 3/X.75 illustrates the format of a *call connected* packet. Similarly to the *call request* packet, the *call connected* packet contains:

- an address length field,
- an address field,
- a network utility length field,
- a network utility field,
- a user facility length field,
- a user facility field, and
- a called user data field.

The coding of these fields is the same as that in the *call request* packet (see § 4.2.1 above). The address field may be empty. Bit 7 of the General Format Identifier can be set to either 0 or 1.

The called user data field may only be included for calls in which the *fast select* optional user facility has been requested and may contain any number of bits from 0 up to 1024 (128 octets). The contents of the field are passed unchanged.

4.2.3 *Clear request packet*

Figure 4/X.75 illustrates the format of a *clear request* packet.

4.2.3.1 *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 a *clear request* packet is given in Table 14/X.75.

Bits

Number of octets	8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				Logical channel group number			
1	Logical channel number							
1	Packet type identifier							
	0	0	0	0	1	1	1	1
1	Calling DTE address length				Called DTE address length			
15 (max.)	Called and calling DTEs addresses							
1	0	0	Network utility length					
63 (max.)	Network utilities							
1	0	0	User facility length					
63 (max.)	User facilities							
128 (max.)	Called user data (see Note 2)							

Note 1 – Coded 0D01 (modulo 8) or 0D10 (modulo 128). D is the delivery confirmation bit.

Note 2 – This field will only be included where the called user data is returned in response to a *call request* packet in which the fast select optional user facility has been requested.

FIGURE 3/X.75

Call connected packet format

Number of octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				Logical channel group number			
1	Logical channel number							
1	Packet type identifier: 0	0	0	1	0	0	1	1
1	Clearing cause							
1	Diagnostic code							
1	Calling DTE address length				Called DTE address length			
15 (max.)	Called and calling DTEs addresses							
1	0	0	Network utility length					
63 (max.)	Network utilities							
1	0	0	User facility length					
63 (max.)	User facilities							
128 (max.)	Clear user data (see Note 2)							

Note 1 – Coded 0001 (modulo 8) or 0010 (modulo 128).

Note 2 – This field will only be included where the clear user data is returned in response to a *call request* packet in which the *fast select* optional user facility has been requested.

FIGURE 4/X.75

Clear request packet format

TABLE 14/X.75

Coding of clearing cause field in a clear request packet

Clearing cause	Octet 4 Bits							
	8	7	6	5	4	3	2	1
DTE originated	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
Reverse charging acceptance not subscribed	0	0	0	1	1	0	0	1
Incompatible destination	0	0	1	0	0	0	0	1
Fast select acceptance not subscribed	0	0	1	0	1	0	0	1
Invalid facility request	0	0	0	0	0	0	1	1
Access barred	0	0	0	0	1	0	1	1
Network congestion	0	0	0	0	0	1	0	1
Not obtainable	0	0	0	0	1	1	0	1

4.2.3.2 *Diagnostic code field*

Octet 5 is the diagnostic code field and may contain additional information on the reason for the clearing of the call.

The contents of this field are passed unchanged. However, when the clear request is locally generated by an STE, the coding of the diagnostic code field and its further conveyance by the receiving STE is for further study.

4.2.3.3 *Other fields*

The following fields may follow the diagnostic code field:

– an address length field,
– an address field,
– a network utility length field,
– a network utility field,
– a user facility length field,
– a user facility field, and
– a clear user data field.

4.2.3.3.1 *Address length field*

This single octet field 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.

Note – This field is coded with all 0s. Other codings are for further study.

4.2.3.3.2 *Address field*

Note – Pending further study as indicated above, this field is not present.

4.2.3.3.3 *Network utility length field*

Bits 6 through 1 of the octet following the address field indicate the length of the network utility field in octets.

The network utility length field is binary coded and bit 1 is the low order bit.

Bits 8 and 7 of this octet are unassigned and set to 0.

4.2.3.3.4 *Network utility field*

The network utility field contains an integral number of octets. The length of this field depends on the utilities present. The maximum length of the field is 63 octets.

The coding of the network utility field is defined in § 5 below.

4.2.3.3.5 *User facility length field*

Bits 6, 5, 4, 3, 2, and 1 of the octet following the network utility field indicate the length of the user facility field in octets. The user 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.

Note – This field is coded with all 0s. Other codings are for further study.

4.2.3.3.6 *User facility field*

Note – Pending further study indicated above, this field is not present.

4.2.3.3.7 *Clear user data field*

For calls in which the *fast select* optional user facility has been requested, clear user data may be present, following the user facility field. The clear user data field may contain any number of bits from 0 up to 1024 (128 octets). The contents of the field are passed unchanged.

4.2.4 *Clear confirmation packet*

Figure 5/X.75 illustrates the format of the *clear confirmation* packet.

Octets \ Bits	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	1	0	1	1	1

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 5/X.75

Clear confirmation packet format

4.3 *Data and interrupt packets*

4.3.1 *Data packet*

Figures 6/X.75 and 7/X.75 illustrate the format of the *data* packets in the case of modulo 8 and modulo 128 respectively.

Octets \ Bits	8	7	6	5	4	3	2	1
	General format identifier							
1	Q	D	0	1	Logical channel group number			
2	Logical channel number							
3	P(R)			M	P(S)			0
4	User data							

D Delivery confirmation
M More data indication
Q Qualifier

FIGURE 6/X.75

Data packet format (modulo 8)

Octets \ Bits	8	7	6	5	4	3	2	1
	General format identifier							
1	Q	D	1	0	Logical channel group number			
2	Logical channel number							
3	P(S)							0
4	P(R)							M
	User data							

D Delivery confirmation bit
M More data bit
Q Qualifier bit

FIGURE 7/X.75

Data packet format (modulo 128)

4.3.1.1 *Qualifier (Q) bit*

Bit 8 in octet 1 is used for the *qualifier* (Q) bit.

4.3.1.2 *Delivery confirmation (D) bit*

Bit 7 in octet 1 is the *delivery confirmation* (D) bit.

4.3.1.3 *Packet receive sequence number*

In Figure 6/X.75 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. In Figure 7/X.75 bits 2 through 8 of octet 4 are used for the packet receive sequence number and bit 2 is the low order bit.

4.3.1.4 *More data indication*

In Figure 6/X.75, bit 5 in octet 3 is used for the *more data* indication. In Figure 7/X.75, bit 1 in octet 4 is used for the *more data* indication (0 for no more data and 1 for more data).

4.3.1.5 *Packet send sequence number*

In Figure 6/X.75, 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. In Figure 7/X.75, bits 2 through 8 of octet 3 are used for the packet send sequence number and bit 2 is the low order bit.

4.3.1.6 *User data field*

The bits following octet 3 (modulo 8) or octet 4 (modulo 128) contain user data.

4.3.2 *Interrupt packet*

Figure 8/X.75 illustrates the format of the *interrupt* packet.

Octets \ Bits	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	1	0	0	0	1	1
4	Interrupt user data							

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 8/X.75

Interrupt packet format

4.3.2.1 *Interrupt user data field*

Octet 4 contains interrupt user data.

4.3.3 *Interrupt confirmation packet*

Figure 9/X.75 illustrates the format of the *interrupt confirmation* packet.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	1	0	0	1	1	1

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 9/X.75

Interrupt confirmation packet format

4.4 *Flow control and reset packets*

4.4.1 *Receive ready (RR) packet*

Figures 10/X.75 and 11/X.75 illustrate the format of *receive ready* packets in the case of modulo 8 and modulo 128 respectively.

Octets	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)			Packet type identifier 0	0	0	0	1

FIGURE 10/X.75

RR packet format (modulo 8)

4.4.1.1 *Packet receive sequence number*

In Figure 10/X.75, 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. In Figure 11/X.75, bits 2 through 8 of octet 4 are used for the packet receive sequence number and bit 2 is the low order bit.

4.4.2 *Receive not ready (RNR) packet*

Figures 12/X.75 and 13/X.75 illustrate the format of *receive not ready* packets in the case of modulo 8 and modulo 128 respectively.

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier 0	0	1	0	Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	0	0	0	0	1
4	P(R)							0

FIGURE 11/X.75

RR packet format (modulo 128)

Bits

Octets	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)			Packet type identifier 0	0	1	0	1

FIGURE 12/X.75

RNR packet format (modulo 8)

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier 0	0	1	0	Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	0	0	1	0	1
4	P(R)							0

FIGURE 13/X.75

RNR packet format (modulo 128)

4.4.2.1 *Packet receive sequence number*

In Figure 12/X.75, 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. In Figure 13/X.75, bits 2 through 8 of octet 4 are used for the packet receive sequence number and bit 2 is the low order bit.

4.4.3 *Reset request packet*

Figure 14/X.75 illustrates the format of the *reset request* packet.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				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							

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 14/X.75

Reset request packet format

4.4.3.1 *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 request* packet is given in Table 15/X.75.

TABLE 15/X.75

Coding of resetting cause field in reset request packet

Resetting cause	Octet 4 Bits 8	7	6	5	4	3	2	1
DTE originated	0	0	0	0	0	0	0	0
Out of order (see Note)	0	0	0	0	0	0	0	1
Remote procedure error	0	0	0	0	0	0	1	1
Network congestion	0	0	0	0	0	1	1	1
Remote DTE operational (see Note)	0	0	0	0	1	0	0	1
Network operational	0	0	0	0	1	1	1	1
Incompatible destination	0	0	1	0	0	0	0	1

Note – Applicability is for further study.

4.4.3.2 *Diagnostic code field*

Octet 5 is the diagnostic code field and may contain additional information on the reason for the reset.

The contents of this field are passed unchanged. However, when the reset request is locally generated by an STE the coding of the diagnostic code field and its further conveyance by the receiving STE is for further study.

4.4.4 *Reset confirmation packet*

Figure 15/X.75 illustrates the format of the *reset confirmation* packet.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	0	1	1	1	1	1

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 15/X.75

Reset confirmation packet format

4.5 *Restart packets*

4.5.1 *Restart request packet*

Figure 16/X.75 illustrates the format of the *restart request* packet. Bits 4, 3, 2 and 1 of the first octet and all bits of the second octet are set to 0.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				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							
5	Diagnostic code							

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 16/X.75

Restart request packet format

4.5.1.1 *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 request* packets is given in Table 16/X.75.

TABLE 16/X.75

Coding of restarting cause field in restart request packet

Restarting cause	Octet 4 Bits							
	8	7	6	5	4	3	2	1
Network congestion	0	0	0	0	0	0	1	1
Network operational	0	0	0	0	0	1	1	1

4.5.1.2 *Diagnostic code field*

Octet 5 is the diagnostic code field and may contain additional information on the reason for the restart.

The bits of the diagnostic code field are all set to 0 when no specific reason for the restart is supplied. Other values are not specified at this time.

4.5.2 *Restart confirmation packet*

Figure 17/X.75 illustrates the format of the *restart confirmation* packet. Bits 4, 3, 2 and 1 of the first octet and all bits of the second octet are set to 0.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				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

Note – Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 17/X.75

Restart confirmation packet format

5 Procedures and formats for user facilities and network utilities

5.1 *Description of optional user facilities*

User facilities signalled in the user facility field are described in the Recommendation cited in [10]. User facilities are conveyed through an STE which may examine and store them.

5.2 *Formats for optional user facilities*

The formats for optional user facilities are described in the Recommendation cited in [11].

5.3 *Procedures for network utilities*

The network utility field is a network administrative signalling mechanism in the *call request, call connected* and *clear request* packets. The network utility field complements the user facility field and serves to separate user service signalling from network administrative signalling. The request for a service through an optional user facility may, in certain instances, require the use of a network utility.

5.3.1 *Transit network identification*

The *transit network identification* is a network utility used to name a transit network controlling a portion of the (perhaps partially established) irtual circuit. A transit network is identified by the first four digits of the international data number.

A *transit network identification* is always present in the *call request* packet for each transit network controlling the virtual circuit up to this point of call set-up. When more than one transit network is identified, the order of identification in the network utility field is identical to the order of traversal of transit networks following the path being established from the calling DTE to the destination network.

A *transit network identification* is always present for each transit network in the *call connected* packet, or the *clear request* packet issued as a direct response to the *call request* packet by the called DTE. When there is more than one transit network, the identification order in the network utility field is identical to the order of traversal of transit networks following the path established from the calling to called DTE.

Note – In the event of clearing by the network(s) or STE(s), the presence of this utility in the *clear request* packet is for further study.

5.3.2 *Call identifier*

The *call identifier* is a network utility which is always present in the *call request* packet. The *call identifier* parameter is established by the originating network and is an identifying name for each virtual circuit established. The *call identifier* when used in conjunction with the calling DTE address, uniquely identifies the virtual call. The uniqueness is only guaranteed over a period of time. The duration of this time period is for further study.

The use of the *call identifier* in the *call connected* and in the *clear request* packets is for further study.

5.3.3 *Throughput class indication*

The *throughput class indication* is a network utility that can be used by any STE for specifying the throughput classes applying to that call.

5.3.3.1 The STE associated with the virtual call originating network may request in the *throughput class indication* utility of the *call request* packet the throughput class values selected at the calling DTE/DCE interface (however, see also § 5.3.3.2).

Any transit STE may also request throughput class values in the *throughput class indication* utility of the *call request* packet.

If particular throughput classes are not explicitly requested, the STE is assumed to request the default throughput class values agreed between both Administrations.

5.3.3.2 Any STE, including the STEs associated with the virtual call originating and destination networks, may reduce the throughput class values requested for the call.

Thus, the STE associated with the virtual call destination network will be indicated by the throughput classes from which the negotiation may start with the called DTE.

If reducing the throughput class values, different criteria can be envisaged by the STE. The STE should consider the packet sizes, the window sizes and the throughput classes that it can support at a given time. The STE may also consider the STE resources available and the throughput classes requested for that call. The STEs associated with the virtual call originating and destination networks may also consider the flow control parameters used at the DTE/DCE interface.

5.3.3.3 When the called DTE has accepted the call, the STE associated with the virtual call destination network may confirm in the *throughput class indication* utility of the *call connected* packet the throughput class values that finally apply to the virtual call following the negotiation with the called DTE.

Any transit STE may also confirm throughput class values in the *throughput class indication* utility of the *call connected* packet.

If particular throughput classes are not explicitly confirmed, STE-Y is assumed to confirm the default throughput class values agreed between both Administrations.

If an STE detects that a throughput class value finally applying to the call is higher than the one requested, it should clear the call with an indication of *network congestion.*

The STE should not alter the throughput class values received in a *call connected* packet.

5.3.3.4 The *throughput class indication* utility should not be present in the *clear request* packet.

No indication of *throughput classes* should be present in the user facility field of the *call request, call connected* and *clear request* packets.

5.3.4 *Window size indication*

The *window size indication* is a network utility that can be used by any STE for negotiating the window sizes on a specified logical channel at the STE X/Y interface for each direction of transmission.

5.3.4.1 When using the *window size indication* utility in the *call request* packet, STE-X requests particular window sizes to be used at the STE X/Y interface for that call.

If particular window sizes are not explicitly requested, STE-X is assumed to request the default values for that call, that is either the standard value of 2 or other values agreed between both Administrations.

5.3.4.2 When using the *window size indication* utility in the *call connected* packet, STE-Y confirms the window sizes finally applying at the STE X/Y interface to that call.

If particular window sizes are not explicitly confirmed, STE-Y is assumed to confirm the default values as finally applying to that call.

Each finally applying value should be in the range from the value requested by STE-X or assumed as a default value to the standard 2 value (both inclusive). If an STE detects that a value finally applying to that call is out of this range, it should clear the call with an indication of *network congestion.*

If altering the window size values, different criteria can be envisaged by the STE. The STE should consider the packet sizes, window sizes and the throughput classes that it can support at a given time. The STE may also consider the STE resources available and the throughput classes requested for that call. The STEs associated with the virtual call originating and destination networks may also consider the flow control parameters used at the DTE/DCE interface.

5.3.4.3 The *window size indication* utility should not be present in the *clear request* packet.

No indication of *window sizes* should be present in the user facility field of the *call request, call connected,* and *clear request* packets.

5.3.5 *Packet size indication*

The *packet size indication* is a network utility that can be used by any STE for negotiating the maximum data field length of *data* packets on a specified logical channel at the STE X/Y interface for each direction of data transmission.

5.3.5.1 When using the *packet size indication* utility in the *call request* packet, STE-X requests the maximum data field lengths to be used at the STE X/Y interface for that call.

If particular data field lengths are not explicitly requested, STE-X is assumed to request default values for that call, that is either the standard value of 128 octets or other values agreed between both Administrations.

5.3.5.2 When using the *packet size indication* utility in the *call connected* packet, STE-Y confirms the data field lengths finally applying at the STE X/Y interface for that call.

If particular data field lengths are not explicitly confirmed, STE-Y is assumed to confirm the default values as finally applying to that call.

Each finally applying value should be in the range from the value requested by STE-X to the standard 128 value (both inclusive). If an STE detects that a value finally applying to that call is out of this range, it should clear the call with an indication of *network congestion.*

5.3.5.3 If altering the data field length values, different criteria can be envisaged by the STE. The STE should consider the packet sizes, the window sizes and the throughput classes that it can support at a given time. The STE may also consider the STE resources available and the throughput classes requested for that call. The STEs associated with the virtual call originating and destination networks may also consider the flow control parameters used at the DTE/DCE interface.

5.3.5.4 The *packet size indication* utility should not be present in the *clear request* packet.

No indication of packet sizes should be present in the user facility field of the *call request, call connected* and *clear request* packets.

5.3.6 *Fast select indication*

The *fast select indication* is a network utility used for indicating that the *fast select* user facility applies to that call. The use of this network utility at the STE X/Y interface is subject to a bilateral agreement between Administrations.

Note – The presence or absence of this utility at an STE X/Y interface implies that transit networks may need to take account of the presence of the *fast select* utility when choosing an ongoing route during the establishment of a virtual call.

When using the *fast select indication* utility in the *call request* packet, the STE indicates that the *fast select* facility applies to that call, with the corresponding packet formats as described in § 4.

When restriction on response is indicated in such a *call request* packet, the corresponding STE is permitted to issue as a direct response to this packet a *clear request* packet with a clear user data field of up to 128 octets, and is not authorized to send a *call connected* packet.

When no restriction on response is indicated in such a *call request* packet, the corresponding STE is permitted to issue as a direct response to this packet a *call connected* packet with a called user data field of up to 128 octets or a *clear request* packet with a clear user data field of up to 128 octets.

No indication of *fast select* should be present in the user facility field of the *call request, call connected* and *clear request* packets.

Note – The *fast select indication* utility should not be present in the *call connected* and *clear request* packets.

5.3.7 *Closed user group indication*

The *closed user group indication* is a network utility used for enabling the establishment of virtual calls by DTEs which are members of international closed user groups. The use of this network utility at the STE X/Y interface is subject to a bilateral agreement between Administrations.

When using the *closed user group indication* utility in the *call request* packet, the STE indicates that the international virtual call is requested on the basis of valid international closed user group membership. The network of the calling DTE supplies the relevant international interlock code.

The STE should not alter the *closed user group indication* received in a *call request* packet.

Only one of the *closed user group indication* and the *closed user group with outgoing access indication* utilities may be present in a *call request* packet.

No indication of *closed user group* should be present in the user facility field of the *call request, call connected* and *clear request* packets.

Note – The *closed user group indication* utility should not be present in the *call connected* and *clear request* packets.

5.3.8 *Closed user group with outgoing access indication*

The *closed user group with outgoing access indication* is a network utility used for enabling the establishment of virtual calls by DTEs which are members of international closed user groups. The use of this network utility at the STE X/Y interface is subject to a bilateral agreement between Administrations.

When using the *closed user group with outgoing access indication* utility in the *call request* packet, the STE indicates that the international virtual call is requested on the basis of valid international closed user group membership. In addition the STE signals an associated outgoing access capability. The network of the calling DTE supplies the relevant international interlock code.

The STE should not alter the *closed user group with outgoing access indication* received in a *call request* packet.

Only one of the *closed user group indication* and the *closed user group with outgoing access indication* utilities may be present in a *call request* packet.

No indication of *closed user group with outgoing access* should be present in the user facility field of the *call request, call connected* and *clear request* packets.

Note – The *closed user group with outgoing access* utility should not be present in the *call connected* and *clear request* packets.

5.3.9 *Reverse charging indication*

The *reverse charging indication* is a network utility used for enabling virtual calls to be established internationally, when the *reverse charging* facility applies. The use of this network utility at the STE X/Y interface is subject to a bilateral agreement between Administrations.

When using the *reverse charging indication* utility in the *call request* packet, STE-X indicates a request for reverse charging to apply to the call.

In the absence of the *reverse charging indication* utility, STE-X is assumed not to request reverse charging for that call.

The *reverse charging indication* utility should not be present in the *call connected* and the *clear request* packets.

No indication of *reverse charging* should be present in the user facility field of the *call request, call connected* and *clear request* packets.

5.3.10 *Traffic class indication* (for further study)

The *traffic class* utility indicates a service category for the virtual circuit being established. The *traffic class* signals service information (e.g., terminal, facsimile, maintenance) necessary for administering the call. Though their use is beyond the scope of this Recommendation, *traffic class* may have routing, tariff and other implications. The need for and definition of traffic classes are for further study.

5.3.11 *Estimated transit delay* (for further study)

The *estimated transit delay* is a network utility that signals the transit delay of the virtual circuit. Packet delays occur at all points along the path of a virtual circuit. Some networks, such as those with a single node, will have small transit delays while others will have delays comparable to those of satellite channels. The use of satellite channels between STEs and their use internally by some networks will cause additional delays to the virtual circuit. Thus, in order to determine expected performance, all sources of delay must be measured.

The procedures and use of the estimated transit delay are for further study.

5.3.12 *Tariffs* (for further study)

5.3.13 *Utility marker*

The *utility marker*, consisting of a single octet pair, is used to separate X.75 utilities, as defined under § 5 here, from non-X.75 utilities that may be agreed bilaterally by the Administrations. The use of this *utility marker* at the STE X/Y interface is subject to a bilateral agreement between Administrations.

5.4 *Formats for network utilities*

5.4.1 *General*

The network utility field is present in all *call request* and *call connected* packets, and may be present in *clear request* packets, exchanged between STEs.

The utility field contains a number of utility elements. Each utility element consists of a utility code followed by a utility parameter.

If multiple instances of a utility parameter are required in the utility field, such as the transit network identification, this information will be presented in multiple utility elements with an identical utility code.

The utility codes are divided into four classes, by the use of bits 7 and 8, in order to specify utility parameters consisting of 1, 2, 3 or a variable number of octets. The general class coding is shown in Table 17/X.75.

TABLE 17/X.75

General class coding for network utility field

	Utility code field Bits 8	7	6	5	4	3	2	1	
Class A	0	0	X	X	X	X	X	X	for single octet parameter field
Class B	0	1	X	X	X	X	X	X	for double octet parameter field
Class C	1	0	X	X	X	X	X	X	for triple octet parameter field
Class D	1	1	X	X	X	X	X	X	for variable length parameter field

Note – A bit which is indicated as X may be set to either 0 or 1 as discussed in the text.

For class D, the octet following the utility code indicates the length, in octets, of the utility parameter. The utility parameter length is binary encoded and bit 1 is the low order bit. The maximum length of utility parameter field for class D cannot exceed 61 octets due to the maximum length of the network utility field.

The utility coded field is binary coded and, without extension, provides for a maximum of 64 utility codes for classes A, B and C and 63 utility codes for class D giving a total of 255 utility codes (see Figure 18/X.75).

Utility code 11111111 is reserved for extension of the utility code. The octet following this octet indicates an extended utility code having the format A, B, C or D as defined in Figure 18/X.75. Repetition of utility code 11111111 is permitted and thus additional extensions result.

The specific coding of the utility parameter field is dependent on the utility being requested.

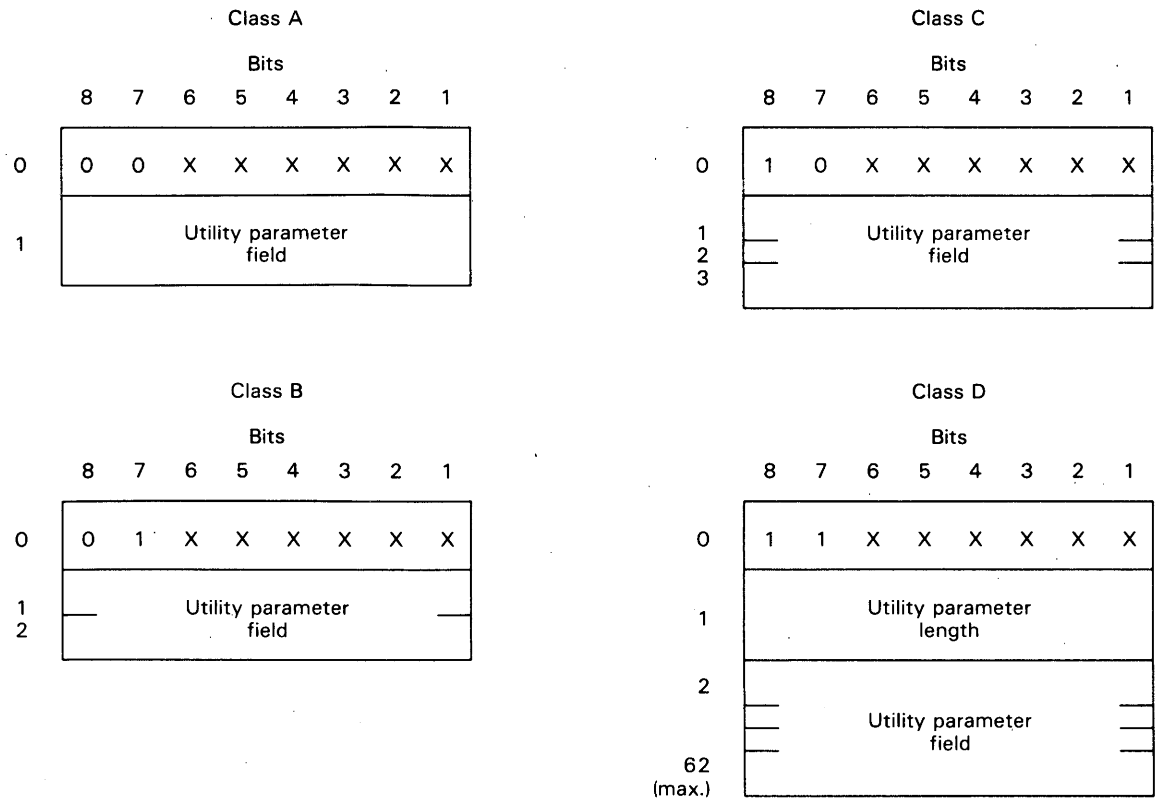


FIGURE 18/X.75

Utility code general formats

5.4.2 *Coding of utility code field*

The coding of the utility code field is given in Table 18/X.75.

Utility codings are the same for *call request*, *call connected* and *clear request* packets.

5.4.3 *Coding of utility parameter field*

5.4.3.1 *Coding of transit network identification utility parameter*

Each digit of the first four digits of the international data number is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low order bit of the digit. The high order digit is coded into bits 8 to 5 of the first octet of the parameter.

5.4.3.2 *Coding of the call identifier utility parameter*

The call identifier consists of 24 bits of binary data.

5.4.3.3 *Coding of throughput class indication utility parameter*

The throughput class for transmission from the calling STE is indicated in bits 4, 3, 2 and 1. The throughput class for transmission from the called STE is indicated in bits 8, 7, 6 and 5.

The four bits indicating each throughput class are binary coded and correspond to throughput classes as indicated.

TABLE 18/X.75

Coding of the utility code field

Utility code	Bits 8	7	6	5	4	3	2	1
Transit network identification	0	1	0	0	0	0	0	1
Call identifier	1	0	0	0	0	0	0	1
Throughput class indication	0	0	0	0	0	0	1	0
Window size indication	0	1	0	0	0	0	1	1
Packet size indication	0	1	0	0	0	0	1	0
Fast select and/or Reverse charging indication	0	0	0	0	0	0	0	1
Closed user group indication	1	1	0	0	0	0	1	1
Closed user group with outgoing access indication	1	1	0	0	0	1	1	1
Traffic class indication	0	0	0	0	0	0	1	1
Estimated transit delay	(see Note)							
Tariffs	(see Note)							
Utility marker	0	0	0	0	0	0	0	0

Note – The coding is for further study.

TABLE 19/X.75

Bit: 4 or Bit: 8	3 / 7	2 / 6	1 / 5	Throughput class (bit/s)
0	0	0	0	Reserved
0	0	0	1	Reserved
0	0	1	0	Reserved
0	0	1	1	75
0	1	0	0	150
0	1	0	1	300
0	1	1	0	600
0	1	1	1	1 200
1	0	0	0	2 400
1	0	0	1	4 800
1	0	1	0	9 600
1	0	1	1	19 200
1	1	0	0	48 000
1	1	0	1	Reserved
1	1	1	0	Reserved
1	1	1	1	Reserved

5.4.3.4 *Coding of window size indication utility parameter*

The window size for the direction of transmission from the called STE is indicated in bits 7 to 1 of the first octet. The window size for the direction of transmission from the calling STE is indicated in bits 7 to 1 of the second octet. Bit 1 is the least significant bit. Bit 8 of each octet is unassigned and set to 0. Each window size value is binary encoded.

The range of window size values allowed at the STE X/Y interface is subject to a bilateral agreement between Administrations. Window sizes of 8 to 127 are only valid for calls which employ extended numbering.

5.4.3.5 *Coding of packet size indication utility parameter*

The maximum user data field length for the direction of transmission from the called STE is indicated in bits 4 to 1 of the first octet. The maximum user data field length for the direction of transmission from the calling STE is indicated in bits 4 to 1 of the second octet. Bits 8 to 5 of both octets are unassigned and set to 0.

The four bits indicating each maximum user data field length are binary encoded and express the logarithm to base 2 of the maximum number of octets of the data field of data packets. Bit 1 is the least significant bit.

The maximum user data field length values allowed at the STE X/Y interface are subject to a bilateral agreement between Administrations; however all Administrations will allow 128 octets.

5.4.3.6 *Coding of fast select and/or reverse charging indication utility parameter*

Bit: 8 7 6 5 4 3 2 1

Code: X Y U U U U U Z

U = Unassigned and set to 0,

X = 0 and Y = 0 or 1 for *fast select* not requested,

X = 1 and Y = 0 for *fast select* requested with no restriction on response,

X = 1 and Y = 1 for *fast select* requested with restriction on response,

Z = 0 for *reverse charging* not requested, and

Z = 1 for *reverse charging* requested.

5.4.3.7 *Coding of closed user group code and closed user group code with outgoing access: utility parameter length and utility parameter*

5.4.3.7.1 *Utility parameter length*

Bit: 8 7 6 5 4 3 2 1

Code: 0 0 0 0 0 1 0 0

5.4.3.7.2 *Utility parameter*

The international interlock code is contained in the utility parameter field and consists of four octets.

The first two octets consist of the four DNIC digits contained in the international interlock code. Each digit is coded in a semi-octet in binary coded decimal with bit 5 or 1 being the low order bit of the digit. The high order digit is coded into bits 8 to 5 of the first octet of the parameter.

The remaining two octets contain the remaining 16 bits of the international interlock code, encoded with bit 8 of the third parameter octet as the high order bit.

5.4.3.8 *Coding of traffic class indication utility parameter*

The coding of the traffic class parameter is for further study.

5.4.3.9 *Coding of estimated transit delay utility parameter*

The coding of the estimated transit delay utility is for further study.

5.4.3.10 *Coding of the tariffs utility parameter*

The coding of the tariffs utility is for further study.

5.4.3.11 *Coding of the utility marker utility parameter*

Bit: 8 7 6 5 4 3 2 1

Code: 0 0 0 0 0 0 0 0

ANNEX A

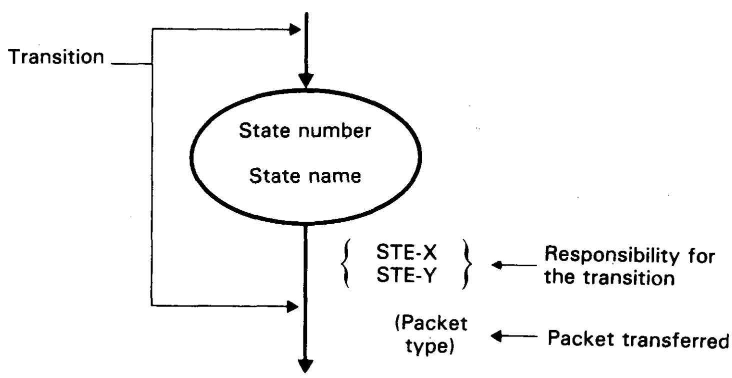
(to Recommendation X.75)

Definition of symbols for Annexes B, C and D

A.1 *General*

This Annex contains the definitions for the symbols to be used in Annexes B, C and D. Annex B defines the states of the X/Y interface and the transitions between states in the normal case, while Annex C contains the full definition of actions, if any, to be taken on the receipt of packets by an STE. Annex D describes the actions taken by the STE on time-outs, if any, in the packet level.

A.2 *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 (STE-X or STE-Y) and the packet that has been transferred are indicated beside that arrow.

FIGURE A-1/X.75

Symbol definition of the state diagrams

A.3 *Order definition of the state diagrams*

For the sake of clarity, the normal procedure at the interface is described in a number of small state diagrams. In order to describe the normalprocedure fully it is necessary to allocate a priority to the different figures and to relate a higher order diagram with a lower one. This has been done by the following means:

- The figures are arranged in order of priority with Figure A-2/X.75 *(restart)* having the highest priority and subsequent figures having lower priority. Priority means that when a packet belonging to a higher order diagram is transferred, that diagram is applicable and the lower order one is not.
- The relation with a state in a lower order diagram is given by including that state inside an ellipse in the higher order diagram.

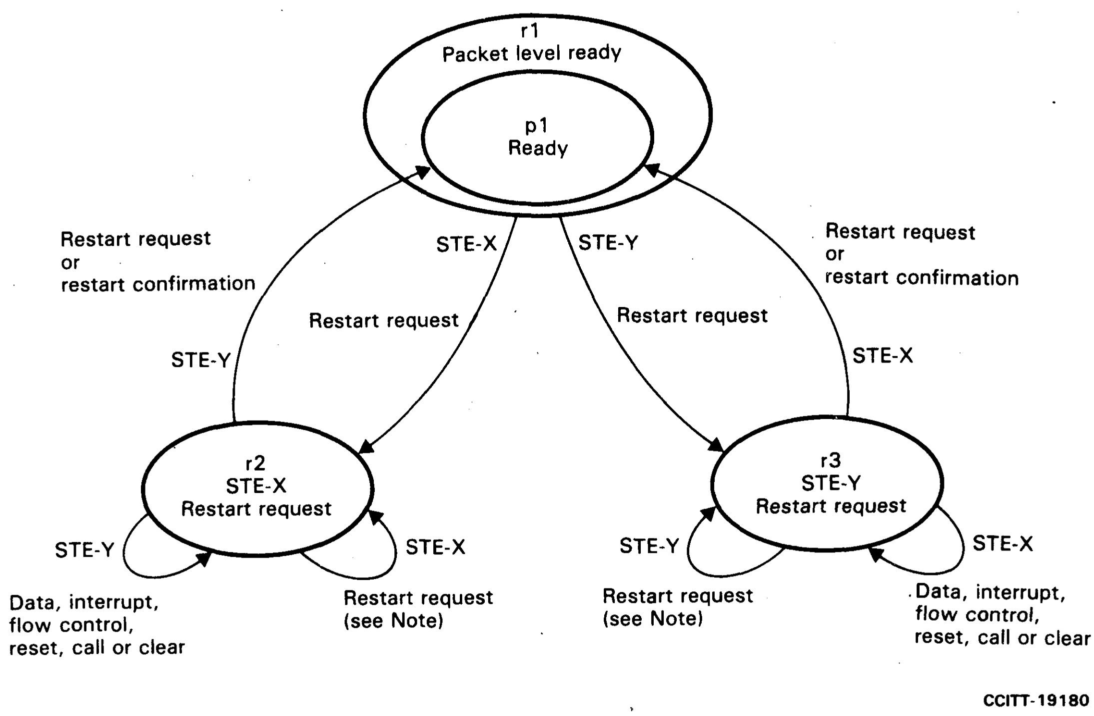
A.4 *Symbol definition of the action tables*

The entries given in Tables C-1/X.75 to C-5/X.75 and D-1/X.75 (see Annexes C and D) indicate the action, if any, to be taken by an STE on receipt of any kind of packet, and the state the STE enters, which is given in parenthesis, following the action taken.

ANNEX B

(to Recommendation X.75)

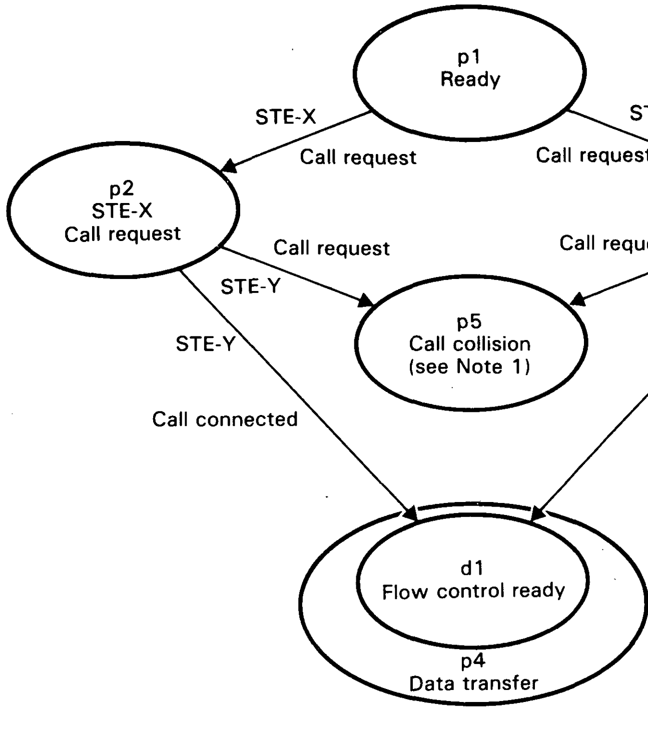
State diagrams for the packet level interface for a logical channel between STEs



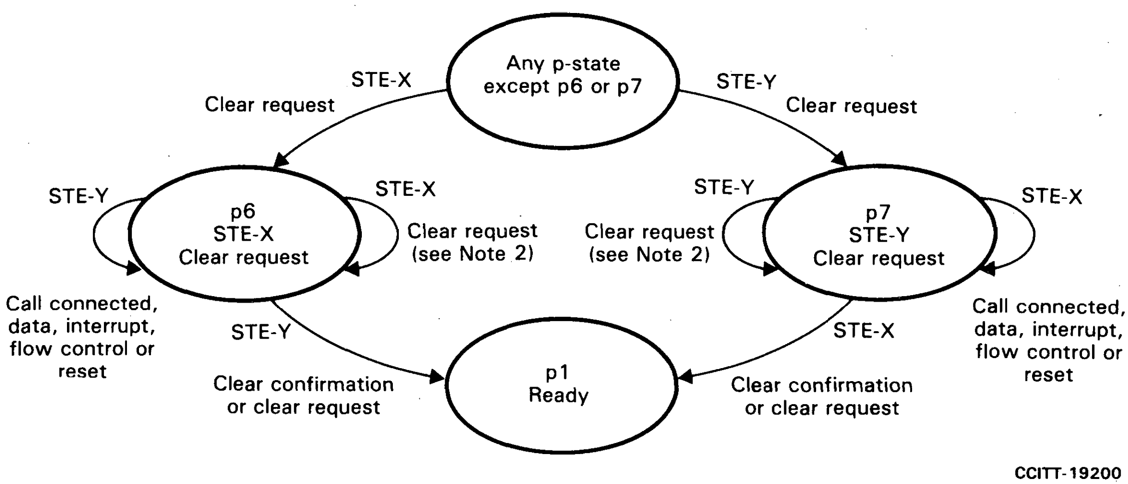
Note – This transition may take place after time-out T30.

FIGURE B-1/X.75

Diagram of states for the transfer of restart packets



a) *Transfer of call establishment packets*



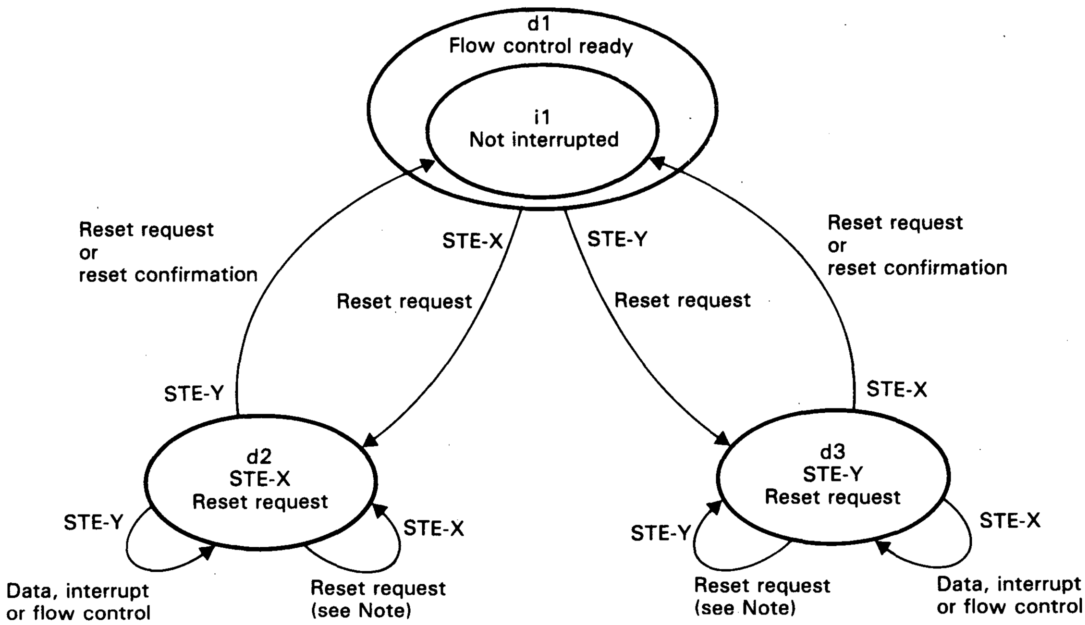
b) *Transfer of call clearing packets*

Note 1 – STE-X/Y shall issue a *clear request* packet and proceed to states p6/p7.

Note 2 – This transition may take place after time-out T33.

FIGURE B-2/X.75

State diagrams for the transfer of call establishment and call clearing packets within the packet level ready (r1) state



Note – This transition may take place after time-out T32.

FIGURE B-3/X.75

Diagram of states for the transfer of reset packets within the data transfer (p4) state

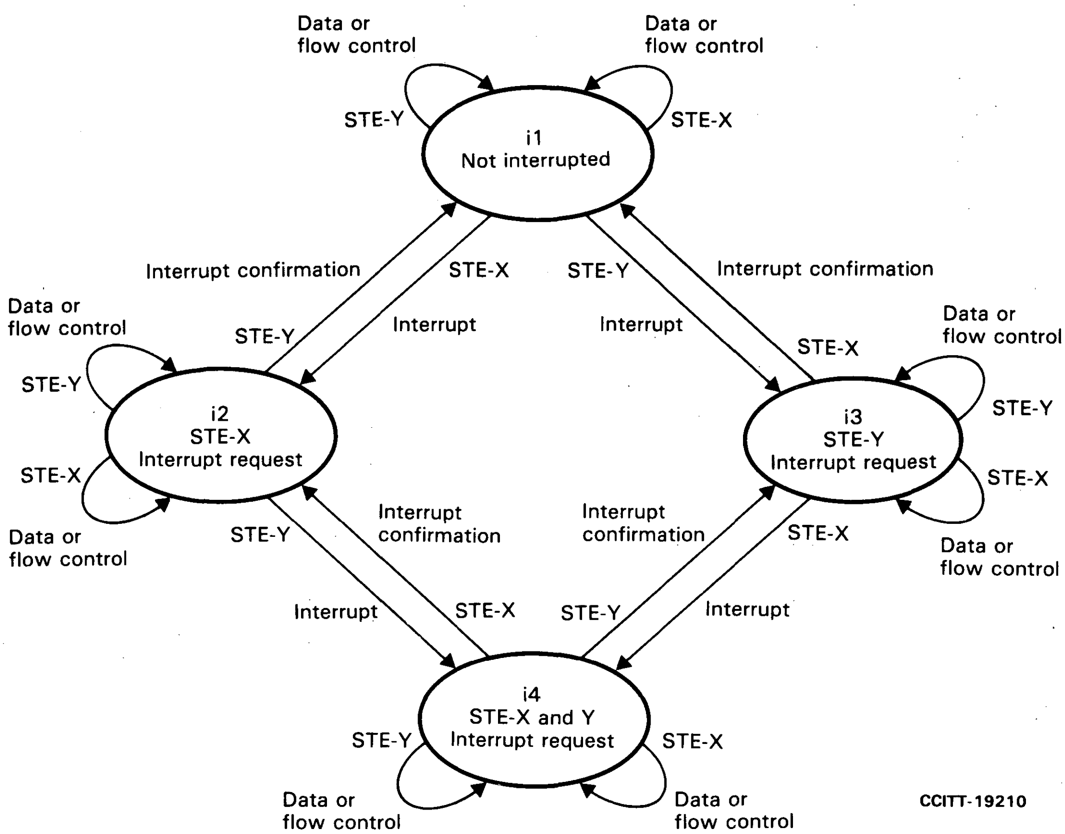


FIGURE B-4/X.75

Diagram of states for the transfer of data, flow control and interrupt packets within the flow control ready (d1) state

ANNEX C

(to Recommendation X.75)

Actions taken by the STE on receipt of packets in a given state of the packet level X/Y interface

Note – Actions are specified for STE-Y only. STE-X should follow the same procedure.

TABLE C-1/X.75

Action taken by STE-Y en receipt of packets

Packet received by STE-Y \ State of the interface as perceived by STE-Y	Any state
Any packet with unassigned logical channel	DISCARD
Any packet with less than 2 octets	DISCARD
Any packet with an incorrect general format identifier	DISCARD
Any packet with correct general format identifier and assigned logical channel	(see Table C-2/X.75)

DISCARD: STE-Y discards the received packet and takes no subsequent action.

TABLE C-2/X.75

Action taken by STE-Y on receipt of packets in a given state: restart

State of the interface as perceived by STE-Y / Packet received by STE-Y	Packet level ready r1	STE-X restart request r2	STE-Y restart request r3
Restart request	NORMAL (r2)	DISCARD (r2)	NORMAL (r1)
Restart confirmation	ERROR (r3)	ERROR (r3) (see Note 1)	NORMAL (r1)
Data, interrupt, flow control, reset, call set-up or clear	(see Table C-3/X.75)	ERROR (r3) (see Note 1)	DISCARD (r3)
Restart request or confirmation with bit 1 to 4 of octet 1 or bit 1 to 8 of octet 2 ≠ 0			
Packet having a packet type identifier which is shorter than 1 octet or is incompatible with the ones defined in § 4 of the text			

NORMAL: The action taken by STE-Y follows the normal procedures as defined in § 3 of the text (see Note 2).

DISCARD: STE-Y discards the received packet and takes no subsequent action.

ERROR: STE-Y discards the received packet and indicates restarting with *network congestion* cause.

Note 1 – If STE-Y issues a *restart request* packet as a result of an error condition in state r2, it should eventually consider the interface to be in the *packet level ready* state (r1).

Note 2 – If the received packet exceeds the maximum permitted length, the ERROR procedure is invoked.

TABLE C-3/X.75

Action taken by STE-Y on receipt of packets specifying an assigned logical channel in a given state: call establishment and clearing

State of the interface as perceived by STE-Y / Packet received by STE-Y	Packet level ready r1					
	Ready p1	STE-X call request p2	STE-Y call request p3	Data transfer p4	STE-X clear request p6	STE-Y clear request p7
Call request	NORMAL (p2)	ERROR (p7)	ERROR (p7)	ERROR (p7)	ERROR (p7) (see Note 1)	ERROR (p7)
Call connected	ERROR (p7)	ERROR (p7)	NORMAL (p4) (see Note 2)	ERROR (p7)	ERROR (p7) (see Note 1)	DISCARD (p7)
Clear request	NORMAL (p6)	NORMAL (p6)	NORMAL (p6)	NORMAL (p6)	DISCARD (p6)	NORMAL (p1)
Clear confirmation	DISCARD (p1)	ERROR (p7)	ERROR (p7)	ERROR (p7)	ERROR (p7) (see Note 1)	NORMAL (p1)
Data, interrupt, flow control or reset	ERROR (p7)			(see Table C-4/X.75)	ERROR (p7) (see Note 1)	DISCARD (p7)
Restart request or confirmation with bit 1 to 4 of octet 1 or bit 1 to 8 of octet 2 ≠ 0						
Packet having a packet type identifier which is shorter than 1 octet or is incompatible with the ones defined in § 4 of the text						

NORMAL: The action taken by STE-Y follows the normal procedures as defined in § 3 of the text (see Note 3).

DISCARD: STE-Y discards the received packet and takes no subsequent action.

ERROR: STE-Y discards the received packet and indicates clearing with *network congestion* cause.

Note 1 – If STE-Y issues a *clear request* packet as a result of an error condition in state p6, it should eventually consider the interface to be in the *ready* state (p1).

Note 2 – The ERROR (p7) procedure is invoked if STE-Y receives a *call connected* packet in response to a *call request* packet from STE-Y requesting the *fast select* facility with restriction on response.

Note 3 – If the received packet exceeds the maximum permitted length, the ERROR procedure is invoked.

TABLE C-4/X.75

Action taken by STE-Y on receipt of packets specifying an assigned logical channel in a given state: reset

Packet received by STE-Y \ State of the interface as perceived by STE-Y	Data transfer p4		
	Flow control ready d1	STE-X reset request d2	STE-Y reset request d3
Reset request	NORMAL (d2)	DISCARD (d2)	NORMAL (d1)
Reset confirmation	ERROR (d3)	ERROR (d3)	NORMAL (d1)
Data, interrupt or flow control	(see Table C-5/X.75)	ERROR (d3)	DISCARD (d3)
Restart request or confirmation with bit 1 to 4 of octet 1 or bit 1 to 8 of octet 2 $\neq 0$	ERROR (d3)	ERROR (d3) (see Note 1)	DISCARD (d3)
Packet having a packet type identifier which is shorter than 1 octet or is incompatible with the ones defined in § 4 of the text			

NORMAL: The action taken by STE-Y follows the normal procedures as defined in § 3 of the text (see Note 2).

DISCARD: STE-Y discards the received packet and takes no subsequent action.

ERROR: STE-Y discards the received packet and indicates resetting with *network congestion* cause.

Note 1 – If STE-Y issues a *reset request* packet as a result of an error condition in state d2, it should eventually consider the interface to be in the *flow control ready* state (d1).

Note 2 – If the received packet exceeds the maximum permitted length, the ERROR procedure is invoked.

TABLE C-5/X.75

Action taken by STE-Y on receipt of packets specifying an assigned logical channel in a given state: data, interrupt or flow control

Packet received by STE-Y / State of the interface as perceived by STE-Y	Flow control ready d1			
	Not interrupted i1	STE-X interrupt request i2	STE-Y interrupt request i3	STE-X and Y interrupt request i4
Interrupt	NORMAL (i2)	DISCARD (i2) or ERROR (d3) (see Note 1)	NORMAL (i4)	DISCARD (i4) or ERROR (d3) (see Note 1)
Interrupt confirmation	DISCARD (i1)	DISCARD (i2)	NORMAL (i1)	NORMAL (i2)
Data with M or Q bit violation, out of sequence P(S), or P(S) outside of window	ERROR (d3)	ERROR (d3)	ERROR (d3)	ERROR (d3)
Data or flow control with invalid P(R)				
A first data packet after entering state d1 with P(S) $\neq$ 0				
When modulo 128 numbering is used, a flow control or data packet with octet 4 shorter than 1 octet				
Valid data or flow control	NORMAL (i1)	NORMAL (i2)	NORMAL (i3)	NORMAL (i4)

NORMAL: The action taken by STE-Y follows the normal procedures as defined in § 3 of the text (see Note 2).

DISCARD: STE-Y discards the received packet and takes no subsequent action.

ERROR: STE-Y discards the received packet and indicates reset with *network congestion* cause.

Note 1 – According to § 3.3.5 of the text an STE receiving a further *interrupt* packet in the time between receiving one *interrupt* packet and transferring the *interrupt confirmation* may either discard this *interrupt* packet or reset the virtual circuit.

Note 2 – If the received packet exceeds the maximum permitted length, the ERROR procedure is invoked.

ANNEX D

(to Recommendation X.75)

Actions taken by the STE on time-outs in the packet level

Under certain circumstances, the STE Y/X is required to respond to a packet from the STE X/Y within a stated maximum time. If any of these maximum times are exceeded, a time-out in the STE X/Y will initiate the actions summarized in Table D-1/X.75. Therefore, it must be taken into account in the STE design.

TABLE D-1/X.75

STE X/Y time-outs

Time-out number	Time-out value	State of the logical channel	Started when	Normally terminated when	Actions to be taken when the time-out expires	
					Toward STE Y/X	Toward network
T30	(see Note 1)	r2/r3	STE X/Y issues a *restart request* packet	STE X/Y leaves the r2/r3 state (i.e., a *restart confirmation* or *restart request* packet is received)	STE X/Y waits indefinitely for a *restart confirmation* or *restart request* packet, or STE X/Y (re)transmits a *restart request* packet (*network congestion*) (see Note 2)	
T31	(see Note 1)	p2/p3	STE X/Y issues a *call request* packet	STE X/Y leaves the p2/p3 state (e.g., a *call connected*, *clear request* or *call request* packet is received)	STE X/Y enters the p6/p7 state signalling a *clear request* packet (*network congestion*)	STE X/Y signals a *clear request* packet (*network congestion*)
T32	(see Note 1)	d2/d3	STE X/Y issues a *reset request* packet	STE X/Y leaves the d2/d3 state (e.g., a *reset confirmation* or *reset request* packet is received)	STE X/Y enters the p6/p7 state signalling a *clear request packet* (*network congestion*), or STE X/Y (re)transmits a *reset request packet* (*network congestion*) (see Note 2)	STE X/Y signals a *clear request* packet (*network congestion*), or STE X/Y signals a *reset request* packet (*network congestion*)
T33	3 min	p6/p7	STE X/Y issues a *clear request* packet	STE X/Y leaves the p6/p7 state (e.g., a *clear confirmation* or *clear request packet is received*)	STE X/Y waits indefinitely for a *clear confirmation* or *clear request* packet, or STE X/Y (re)transmits a *clear request* packet (*network congestion*) (see Note 2)	

Note 1 – The value is for further study.

Note 2 – After unsuccessful retry, decisions must be taken at higher levels.

References

[1] CCITT Recommendation *International user classes of services in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.1.

[2] CCITT Recommendation *International user services and facilities in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.2.

[3] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for terminals operating in the packet mode on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.25.

[4] CCITT Recommendation *Procedures for the exchange of control information and user data between a packet assembly/disassembly facility (PAD) and a packet mode DTE or another PAD*, Vol. VIII, Fascicle VIII.5, Rec. X.29.

[5] CCITT Recommendation *Call progress signals in public data networks*, Vol. VIII, Fascicle VIII.7, Rec. X.96.

[6] CCITT Recommendation *Hypothetical reference connections for public synchronous data networks*, Vol. VIII, Fascicle VIII.7, Rec. X.92.

[7] CCITT Recommendation *General aspects of interfaces*, Vol. III, Fascicle III.5, Rec. G.703.

[8] CCITT Recommendation *General tariff principles for data transmission on public networks dedicated to this type of transmission*, Vol. II, Fascicle II.5, Rec. D.10.

[9] CCITT Recommendation *International numbering plan for public data networks*, Vol. VIII, Fascicle VIII.7, Rec. X.121.

[10] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for terminals operating in the packet mode on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.25, §§ 7.1, 7.2.

[11] *Ibid.*, § 7.4.

Recommendation X.80

INTERWORKING OF INTEREXCHANGE SIGNALLING SYSTEMS FOR CIRCUIT SWITCHED DATA SERVICES

(Geneva, 1980)

The CCITT,

considering

(a) that Recommendations X.60 and X.71 define two different signalling systems which are intended for use on international circuits between synchronous data networks;

(b) that Recommendation X.70 defines a signalling system which is intended for use on international circuits between anisochronous data networks;

(c) that Administrations and RPOAs have expressed interest in implementing Recommendations X.60, X.70 or X.71 as national signalling systems between national data switching exchanges;

(d) that Recommendations X.60, X.70 and X.71 have been defined to include the necessary signals to allow interworking between any combination of these signalling systems;

(e) that there is a need to define the specific interworking requirements between these signalling systems;

unanimously declares the view

that interworking between any combination of signalling systems conforming to Recommendations X.60, X.70 and X.71 should be as defined in this Recommendation.

1 General

1.1 *Principles*

This Recommendation provides a set of interworking specifications for CCITT circuit-switched data signalling systems. Interworking is defined as the controlled transfer of signalling information across an interface between different signalling systems where the significance of the transferred information is identical, or where significance is translated in a defined manner, and includes the performance of the appropriate interworking procedures in association with the transfer. These interworking procedures will be performed by an interworking function at a boundary between the two interworking signalling systems.

Interworking commences at call set-up when a link is established between two circuits using different signalling systems and continues throughout the call until release of the connection occurs. Interworking ceases with the release of the connection, whether the release is initiated by the reception of a clear condition from either of the signalling systems involved or by the interworking function itself in response to some abnormal condition.

1.2 *Presentation*

The specifications are basically represented by flow charts consistent with the CCITT Specifications and Descriptions Language (SDL), described in Recommendations Z.101 to Z.103 [1], [2], [3]; and are used to describe the logical requirements of the interworking function. In addition, two tables are included to show the signalling sequences required for a typical interworking situation. Narrative description has been reduced to a minimum.

SDL provides an implementation independent and comprehensive method of presentation ensuring that all interworking conditions can be covered in a systematic manner. The logic of each signalling system is covered in the relevant signalling Recommendations X.60, X.70 or X.71.

2 Interworking procedures between Recommendations X.60 and X.71

Paragraph 2 details the specific requirements for interworking between an X.60 and an X.71 signalling system.

Table 1/X.80 illustrates the relationship between the signals on the X.60 side of the interworking function and the corresponding signals on the X.71 side. It illustrates the simple case of a basic call which originates in an "X.60 network" and terminates in an "X.71 network", and which does not invoke any additional facilities, and it assumes that the call is successful. The call clear-down is initiated by the customer in the X.60 network.

There are, however, several combinations of facilities which could be required on a particular call which complicate the interworking procedures, in particular the instant of connect through. In Table 1/X.80 the reception of the *Call Connected (CC)* signal from the Recommendation X.71 signalling system defines the conclusion of the call set-up sequence at the interworking point and hence the instant of connect through. If the call involves additional facilities the reception of the *Transit Through Connect* (TTC) signal from the Recommendation X.71 signalling system initiates the additional protocols necessary to setting up the call successfully. Table 2/X.80 illustrates an example involving these additional protocols for a call requiring both calling and called line identities and including a positive call progress indication.

Appendix I to this Recommendation illustrates further examples of interworking situations which can occur for the X.60 to X.71 case. The appendix illustrates examples of interworking situations where two "X.71 networks" transit an "X.60 network" or two "X.60 networks" transit an "X.71 network".

TABLE 1/X.80

X.60 to X.71 interworking situation—simple case, customer in X.60 network initiates clear

Originating network	Inter-network data circuit →	Inter-network data circuit ←	X.60 →	X.60 ←	Transit exchange interworking unit functions	X.71 →	X.71 ←	Destination network
Seize free trunk	TF →	← TF						
Send trunk seized	TS →							
Send address message			AM →		Address message received			
					Seize free trunk Send calling signal	CS →		
					Send selection signals	SS →		Selection signals received
							← C.CONF	Send call confirmation signal
					Call connected received		← CC	Call connected sent Connect through
Call accepted message received Connect through		← CA		← CAM 1	Call accepted message sent Connect through	TS →	← CA	Call accepted signal sent by customer
Ready for data sent by customer	RD →					RD →		
Data phase	DATA →	← DATA				DATA →	← DATA	Data phase
Customer clears Disconnect call	CLEAR[a] →	← TF			Clear recognized (optionally)	CLEAR →		Clear recognized
Clear request message sent				CM →	Clear message received Call disconnected	CLEAR →		Call disconnected
					Maintain clear signal			
				← CM	Clear message sent			

X.60 signals + messages
TF Trunk free
TS Trunk seized
AM Address message
CAM 1 Call accepted (CC) message
CM Clear message

X.71 signals
CS Calling signal
SS Selection signals
C.CONF Call confirmation
CC Call connected
CLEAR

Customer signals
RD Ready for data
CA Call accepted
DATA
Clear request

[a] Customer clear signal same as trunk free.

TABLE 2/X.80

X.60 to X.71 interworking situation — complex case, call set-up only, no internetwork data circuits shown for X.60 network

Originating network	X.60 →	X.60 ←	Transit exchange interworking unit functions	X.71 →	X.71 ←	Destination network
Seize free trunk Send trunk seized Send address message (includes a request for called line identity)	AM (CDIR) →		Address message received			
			Seize free trunk			
			Send calling signal	CS →		
			Send selection signals (including request for called line identity)	SS →		Selection signals received
					← C.CONF	Call confirmation signal sent
			TTC signal received		← TTC	Transit through-connect (including request for calling line identity)
Call accepted message (TTC) received		← CAM 2	Call accepted message (TTC) sent (including request for calling line identity)			
Calling line identity message sent	CLIM →		Calling line identity message received			
			Calling line identity sent	CLI →		Calling line identity received
						Called line identity sent
		← CAM 1	Called line identity, call progress and call connected signals received		← CDI/CP+	Call progress signal sent
					← CC	Call connected signal sent
Call accepted message received			Call accepted message sent including called line identity and call progress signal			
Connect through			Connect through			Connect through

X.60 messages

AM	Address message
CAM 2	Call accepted (TTC)
CAM 1	Call accepted (CC)
CLIM	Calling line identity

X.71 signals

CS	Calling signal	TTC	Transit through-connected
SS	Selection	CLI	Calling line identification
C.CONF	Call confirmation	CDI	Called line identification
CC	Call connected	CP+	Positive call progress

2.1 *Interworking from Recommendation X.60 to X.71*

Figure 1/X.80 shows the transit exchange interworking functions required to enable an X.60 to X.71 call to be connected.

In response to the selection information sent to the X.71 network, one of two signals may be received: *CC* or *TTC* as described above.

The consequent *Call Accepted* Message(s) (CAM) which are transmitted on the X.60 side of the interworking unit function can contain:

a) The *call accepted* signal when a *CC* signal was received on the X.71 side. Note that this type of CAM (designated CAM 1) can also contain the *called line identity* and/or a *positive call progress* signal for calls which have initiated the additional protocols and are now ready to connect through. [See (c) below.]

b) The *transit through connect* signal when a *TTC* signal was received on the X.71 side. The *TTC* signal may or may not *request the calling line identity*. The consequent *call accepted* message (designated CAM 2) can therefore contain:

   i) a request for the *calling line identity* if it was requested and it is not available;

   ii) no request if the calling line identity is already available as part of the *originating address* message;

   iii) no request if the *calling line identity* was not requested.

   In i) a *calling line identity* message is received from the X.60 side in response to the CAM 2. Then the *calling line identity* can be transmitted on the X.71 side.

   In ii) the *calling line identity* can be transmitted on the X.71 side.

   In iii) a Transit centres Through-Connected (TTD) signal is transmitted on the X.71 side.

c) A *positive call progress* signal and/or the *called line identity* when they were received on the X.71 side preceding the *call connected (CC)* signal. This information can be included in the CAM 1 sent on the X.60 side to complete the through-connection.

2.2 *Interworking from Recommendation X.71 to X.60*

Figure 2/X.80 shows the transit exchange interworking functions required to enable an X.71 to X.60 call to be connected.

The signals that can be transmitted on the X.71 side of the interworking unit function in response to a CAM 1 or CAM 2 message are as follows:

a) The *call connected (CC)* signal either directly or after the transmission of *called* and/or *calling line identification* and/or *a positive call progress* signal.

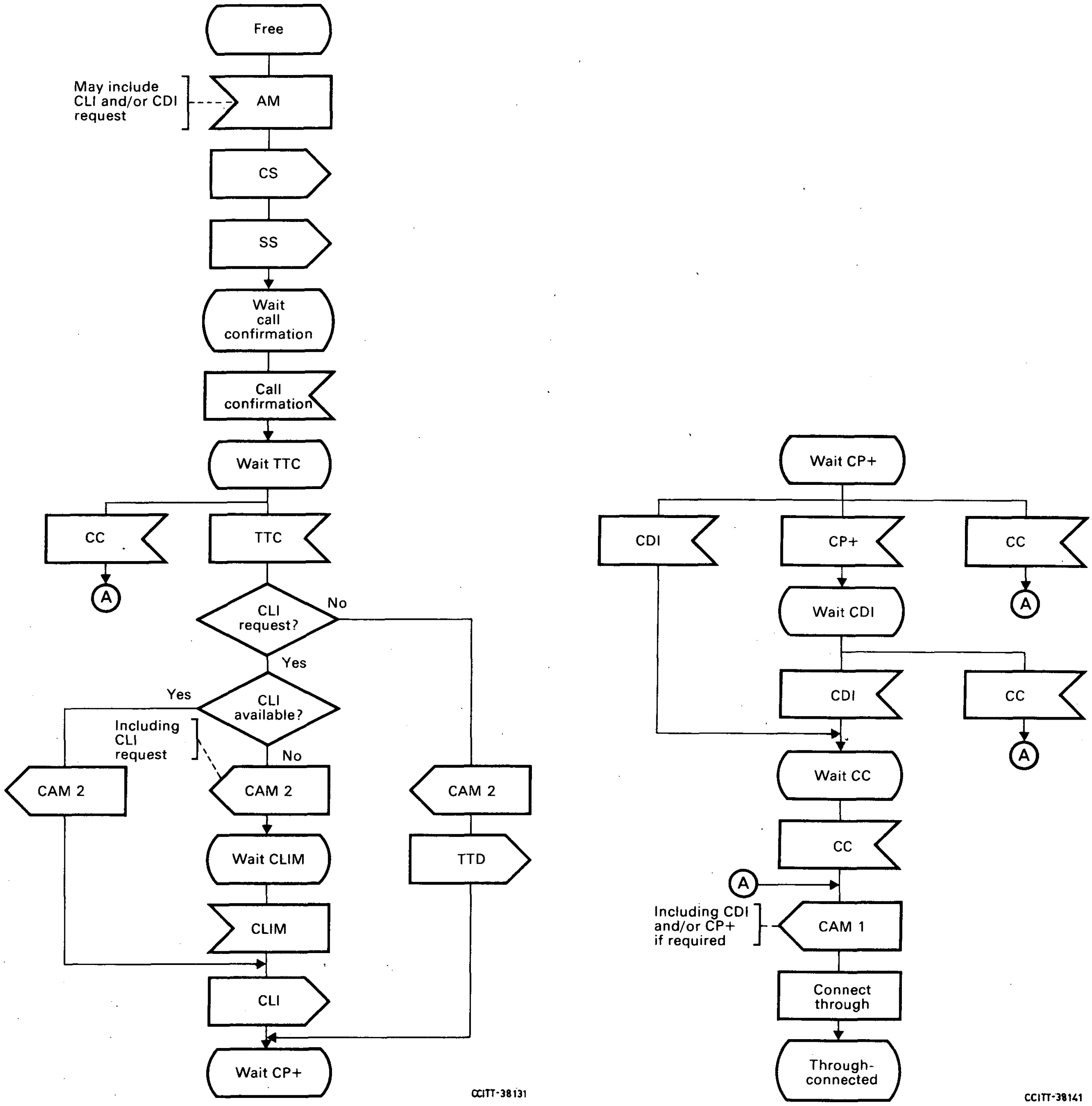
b) If the CAM 1 or CAM 2 contains a *request for calling line identity*, a TTC signal is transmitted with a *request for calling line identification* on the X.71 side. In response, the *calling line identity* is received from the X.71 side and a *calling line identity message* transmitted on the X.60 side.

   Note – If the *calling line identity* is sent as a result of a CAM 2 request, a subsequent CAM 1, which may contain the *called line identity*, must be sent on the X.60 side in order to complete the call set-up.

c) Where *calling line identity* is not required by a CAM 2, a *TTC* signal is sent on the X.71 side. A *TTD* signal will be received in response and this may be received before or after a CAM 1, which may contain the *called line identity*, has been received from the X.60 side in order to complete the call.

d) In b) and c) a *positive call progress* signal and/or the *called line identity* can be sent on the X.71 side before the *CC* signal.

e) Where a CAM 1 is received without a *request for calling line identity* but including the *called line identity* or a *positive call progress* signal, a *TTC* signal is sent on the X.71 side. When a *TTD* signal has been received in response, the *called line identity* and/or the *positive call progress* signal may be sent before the *CC* signal.



AM Address message
CAM 1 Call accepted message, containing call accepted signal
CAM 2 Call accepted message, containing TTC signal
CLIM Calling line identity message
CS Calling signal

SS Selection signals; can include request for CDI
CC Call connected signal
TTC Transit through-connect; can include request for CLI
CLI Calling line identity
CDI Called line identity
CP+ Positive call progress signal

FIGURE 1/X.80

Transit exchange functions for interworking from X.60 network to X.71 network

2.3 *Call clear-down*

A *call clear-down* signal can originate in either the X.60 or X.71 network. The interworking function must therefore be capable of detecting *clear* signals and messages, which can occur at any time during the call set-up or data phase of a call, and take the appropriate action as detailed below:

a) *A* clear request *signal received from the X.71 network*

This will initiate disconnection of the call at the interworking function, the transmission of a *clear confirmation* signal to the X.71 network and a *clear* message to the X.60 network. At this point interworking ceases and each network clears down according to the normal X.60 or X.71 procedures.

b) *A* clear message *received from the X.60 network*

This will initiate disconnection of the call at the interworking function, the transmission of a *clear* message to the X.60 network and a *clear request* signal to the X.71 network. At this point interworking ceases and each network clears down according to the normal X.60 or X.71 procedures.

Note – The interworking function may optionally detect the internetwork data circuit *clear request* signal initiated by the user in the X.60 network. This will cause the disconnection of the call at the interworking function and initiate the same procedures as described above.

2.4 *Further study*

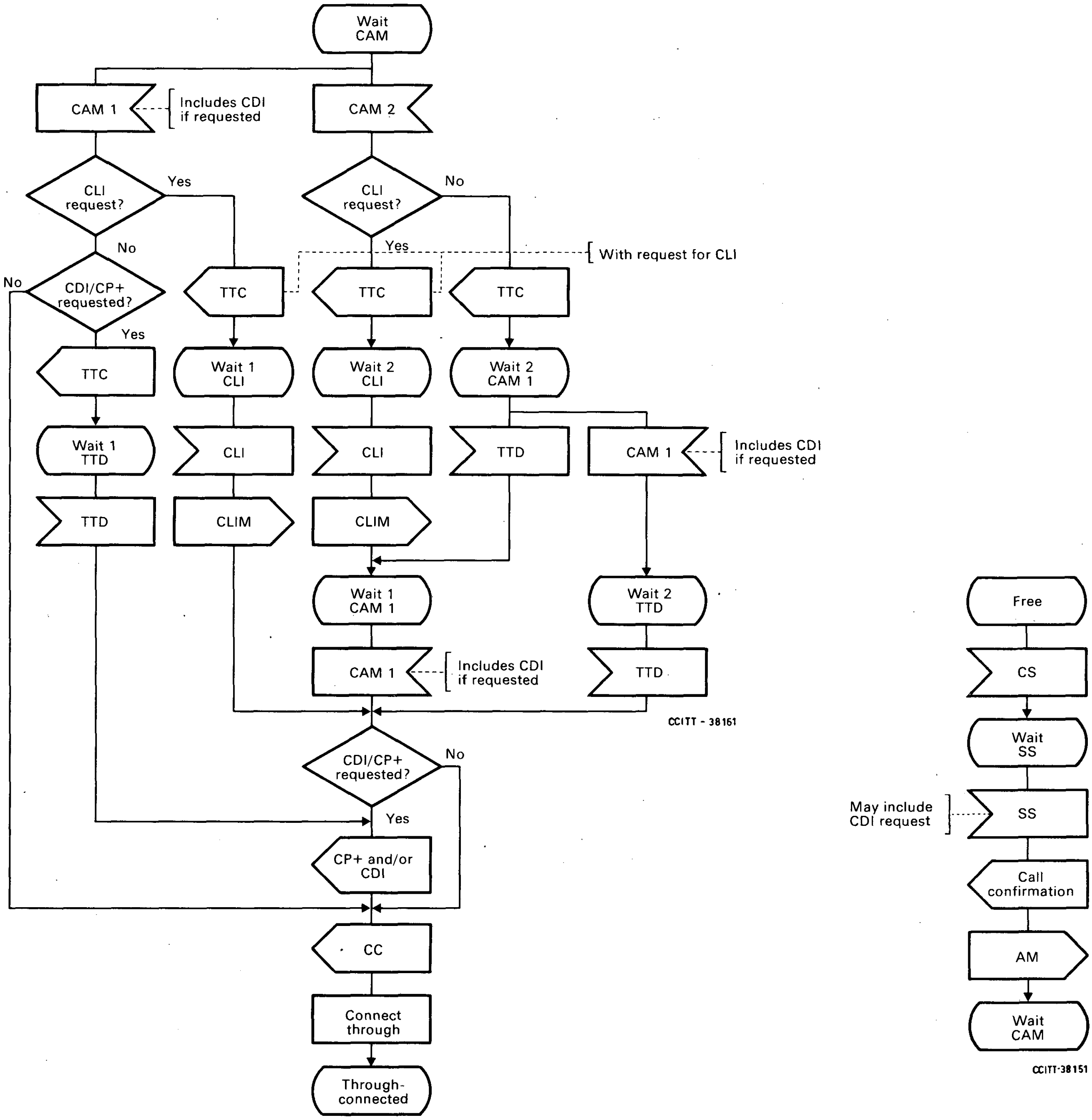
Further study will be needed to detail the interworking procedures applicable to call failure conditions during call set-up and to identify the need for time-out supervision at the interworking function.

3 Interworking procedures between Recommendations X.70 and X.71

Since the proposals for Recommendations X.70 and X.71 are closely related, interworking between an X.70 and an X.71 network should be straightforward; however the interworking procedures required are for further study.

4 Interworking procedures between Recommendations X.60 and X.70

The required interworking procedures should be similar to the Recommendation X.60/71 case; however they are for further study.



AM	Address message
CAM 1	Call accepted message, containing call accepted signal
CAM 2	Call accepted message, containing TTC signal
CLIM	Calling line identity message
CS	Calling signal
SS	Selection signals; can include request for CDI
CC	Call connected signal
TTC	Transit through-connect; can include request for CLI
CLI	Calling line identity
CDI	Called line identity
CP+	Positive call progress signal

FIGURE 2/X.80

Transit exchange functions for interworking from X.71 network to X.60 network

APPENDIX I

(to Recommendation X.80)

Interworking cases, Recommendations X.60/X.71

The following sequence charts illustrate examples of complex transit interworking situations.

Key to sequence charts

O – Originating network

T – Transit network

D – Destination network

X – Data path through-connect

Recommendation X.60

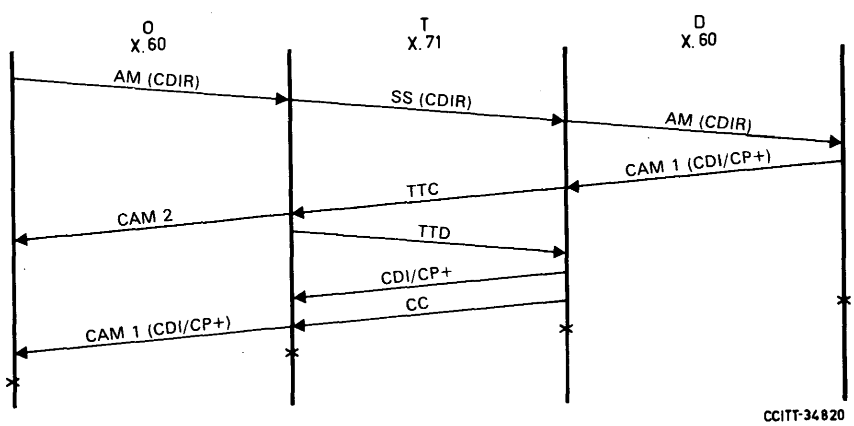
AM	–	Address message
AM (CLI)	–	Address message with calling line identity (CLI).
AM (CDIR)	–	Address message with request for called line identity (CDI).
AM (CLI + CDIR)	–	Address message with CLI and request for CDI.
CAM 1	–	Call accepted message contains call accepted signal; can contain CDI, CLI request and/or positive call progress signal
CAM 2	–	Call accepted message; TTC signal can contain CLI request
CLIM	–	Calling line identity message.

Recommendation X.71

CS	–	Calling signal
SS	–	Selection signals; can include request for called line identity
C.CONF	–	Call confirmation signal
CC	–	Call connected signal
TTC	–	Transit through-connect signal can include request for Calling Line Identity
TTD	–	Transit centres through-connected signal
CLI	–	Calling line identity
CDI	–	Called line identity
CP+	–	Positive call progress signal

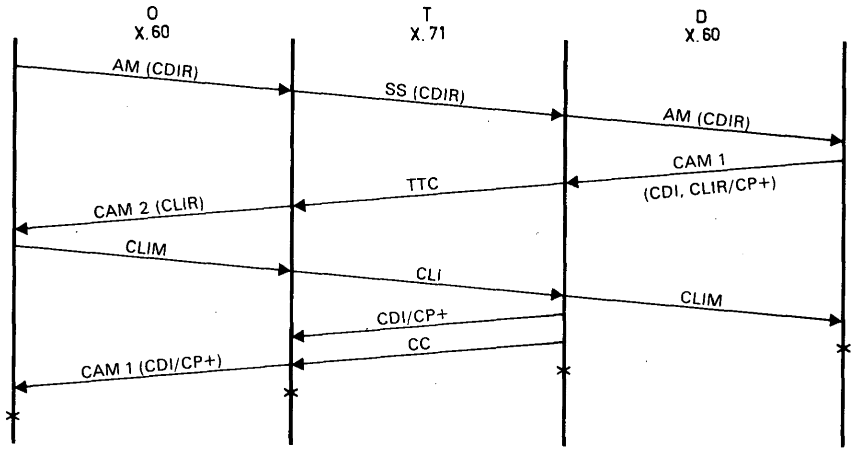
I.1 *Interworking, Recommendations X.60/X.71/X.60*

a) *Called line identity and/or positive call progress signal required, calling line identity not required*



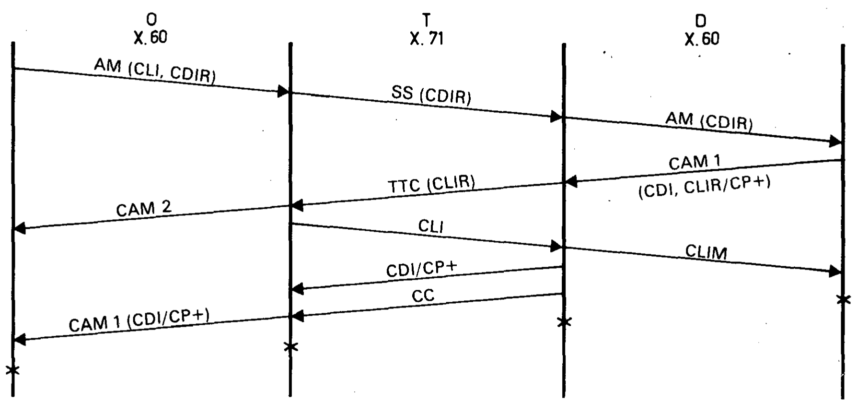
b) *Both called and calling line identity required and/or positive call progress signal*

First case



CCITT-34830

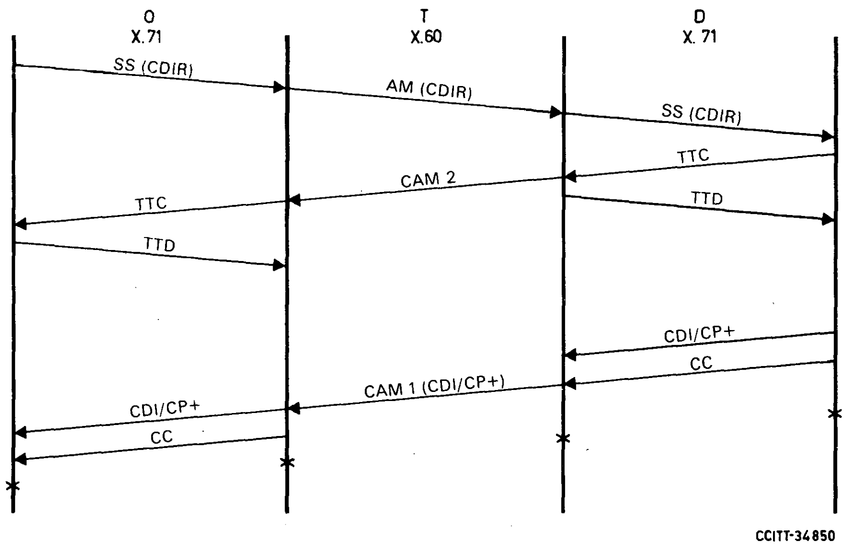
Second case



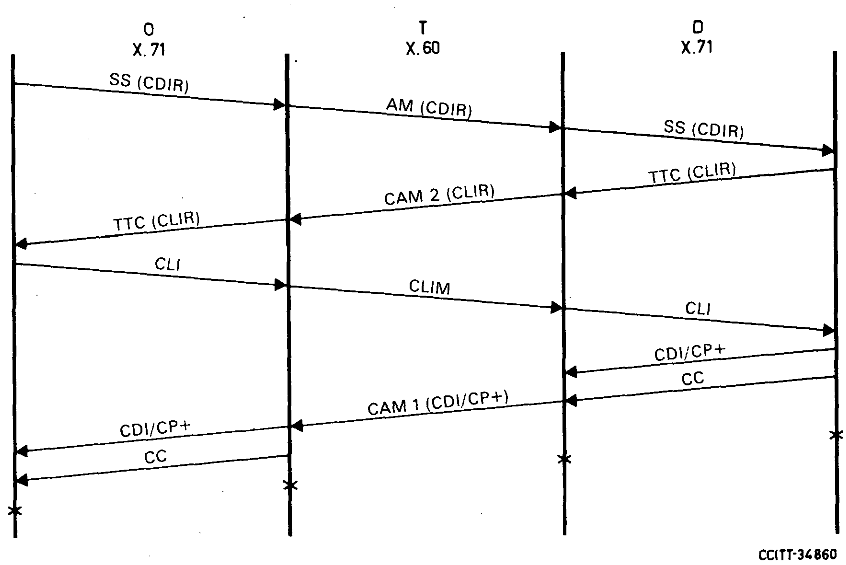
CCITT-34840

I.2 *Interworking, Recommendations X.71/X.60/X.71*

a) *Called line identity and/or positive call progress signal, calling identity not required*



b) *Calling Line identity and called line identity and/or positive call progress signal required*



References

[1] CCITT Recommendation *General explanation of the specification and description language (SDL)*, Vol. VI, Fascicle VI.8, Rec. Z.101.

[2] CCITT Recommendation *Symbols and rules*, Vol. VI, Fascicle VI.8, Rec. Z.102.

[3] CCITT Recommendation *Optional use of pictorial elements within state symbols*, Vol. VI, Fascicle VI.8, Rec. Z.103.

Recommendation X.87

PRINCIPLES AND PROCEDURES FOR REALIZATION OF INTERNATIONAL USER FACILITIES AND NETWORK UTILITIES IN PUBLIC DATA NETWORKS

(Geneva, 1980)

CONTENTS

The CCITT,

considering

(a) that Recommendation X.2 [1] standardizes international user facilities in public data networks;

(b) that Recommendation X.96 [2] defines call progress signals including those used in conjunction with international user facilities;

(c) that Recommendations X.20 [3], X.21 [4], X.25 [5], X.28 [6] and X.29 [7] specify the detailed procedures applicable to user facilities for different types of data terminal equipment interfaces;

(d) the need for certain internationally defined network utilities for international operation of public data networks;

(e) that Recommendations X.61, X.70, X.71 and X.75 specify the detailed procedures applicable for operation of international user facilities and network utilities for different types of control signalling for the circuit and packet switched services;

(f) the need for compatibility and the desire for uniformity in the principles for realization of international user facilities and network utilities in public data networks;

(g) the need for certain user facilities and network utilities for communication through the national networks between the internationally defined data terminal equipment interface protocols and international interexchange control and signalling procedures;

unanimously declares the view

that the necessary elements for realization of international user facilities and network utilities in public data networks be in accordance with the principles and procedures specified in this Recommendation.

Note 1 – The applicability of the principles and procedures specified in this Recommendation to the datagram service is for further study.

Note 2 – The applicability of the principles and procedures specified in this Recommendation to data transmission services provided in Integrated Services Digital Networks (ISDNs) is for further study.

Introduction

The rapid evolution of data transmission services has resulted in a large number of international standards in this field. The increasing complexity of the totality of these standards creates a need to rationalize common aspects in order to achieve a coherent relationship between these standards.

The scope of this Recommendation is:

- to define the principles for realization of international user facilities and network utilities for data transmission services, and
- to specify, in a general network context, the necessary interaction between elements of customer interfaces, interexchange signalling systems and other network functions that are specifically related to the provision and use of international user facilities and network utilities.

The scope of the Recommendation is to define how an international user facility or network utility should be realized where provided. If and where a user facility should be provided is covered by Recommendation X.2 [1]. In addition, this Recommendation does not cover contractual or administrative aspects of the provision and operation of international user facilities and network utilities.

This first version of the Recommendation is limited to a number of facilities and utilities. Inclusion of other facilities and utilities is for further study.

In the case where a combination of two or more facilities or utilities applies for a call, the requirements of each facility or utility individually must be fulfilled unless special requirements are specified for the particular facility or utility combination.

In this Recommendation *ordinary call* refers to a call that does not involve the facility under consideration.

Note – In the context of the datagram service, due to its special characteristics, the term *call* should be interpreted as *datagram*, *calling* as *source*, *called* as *destination* and *cleared* as *not delivered*.

1 Closed user group

1.1 *General*

The Closed User Group (CUG) facilities enable users to form groups with different combinations of restrictions for access from or to users having one or more of these facilities. The following CUG facilities are standardized for the circuit-switched and packet-switched, virtual call and datagram, services. They are all optional user facilities that are assigned to the user for an agreed contracted period (see Note 1):

a) *Closed user group* – this is the basic facility that enables a user to belong to one or more CUGs;

b) *Closed user group with outgoing access* – this is an extension to a) which also enables the user to make outgoing calls to the open part of the network, and to DTEs having the incoming access capability [see c) below];

c) *Closed user group with incoming access* – this is a variant of a) which also enables the user to receive incoming calls from the open part of the network, and from DTE's having the outgoing access capability (see b) above);

d) *Incoming calls barred within the closed user group* – this is a supplementary facility to a), b) or c) which, when used, applies per user per CUG;

e) *Outgoing calls barred within the closed user group* – this is a supplementary facility to a), b) or c) which, when used, applies per user per CUG.

A user may belong to one or more CUGs. In the case where a user belongs to more than one CUG, one of these is nominated as the preferential CUG of that user. Each user belonging to at least one CUG has either the *closed user group* facility or one or both of the *closed user group with outgoing access* and the *closed user group with incoming access* facilities. For each CUG to which a user belongs, either or none of the *incoming calls barred within the closed user group* or *outgoing calls barred within the closed user group* facilities may apply for that user. Different combinations of CUG facilities may apply for different users belonging to the same CUG.

The realization of the CUG facilities is done by the provision of interlock codes and is based on various validation checks at call set-up, determining whether or not a requested call to or from a user having a CUG facility is allowed. In particular, a validation check is performed by verification that both the calling and called users belong to the same CUG as indicated by interlock codes.

Facility registration including registration of interlock codes is controlled by the Administration or operating agency and cannot be controlled by the user.

The international interlock code of an international CUG is as specified in § 1.3. The international interlock code expresses the *international CUG number* assigned to the CUG in accordance with the administrative rules defined in Recommendation X.180 [8].

The originating network identification utility specified in § 10 may be used for international CUG calls under control of the gateway exchange of the destination network (see § 1.2.2).

Note 1 – Outgoing access and/or incoming access applies to an individual user and not to a specific closed user group.

Note 2 – The requirements in § 1.2 include cases which do not necessarily exist in a particular network, either because the Administration (or RPOA) has chosen not to offer the full range of CUG facility combinations or because some combinations are not meaningful from the user's point of view.

Note 3 – A network should, also in the case where the *closed user group with outgoing access* facility is not provided, be capable of supporting the signalling necessary to complete incoming calls from users in another network providing that facility.

1.2 *Call set-up procedure*

1.2.1 *Originating exchange*

The DTE/DCE interface protocol and the actions at the originating exchange at call set-up from a user belonging to a CUG depends on whether the user belongs to one or more CUGs and on the combination of CUG facilities that applies. See also Figure 1/X.87.

1.2.1.1 *CUG selection*

For each CUG that a user belongs to, the interlock code assigned to the CUG is stored, associated to the user at the local exchange. In the case where a user belongs to more than one CUG, a selection of the CUG concerned, and thus of the corresponding interlock code, is required at call set-up. This selection is made on the following criteria.

In the case where the calling user makes a facility request including an index identifying a particular CUG, this CUG is selected by the originating exchange.

In the case where the calling user makes no facility request identifying a particular CUG, the originating exchange selects the preferential (or only) CUG.

Thus in the case where the calling user belongs to a CUG, no facility request concerning CUG facilities is made in the case:

a) where the user belongs to one CUG only,

b) where a user who belongs to more than one CUG (with or without outgoing access) makes a call within the preferential CUG,

c) where a user having the *closed user group with outgoing access* facility makes an outgoing access call.

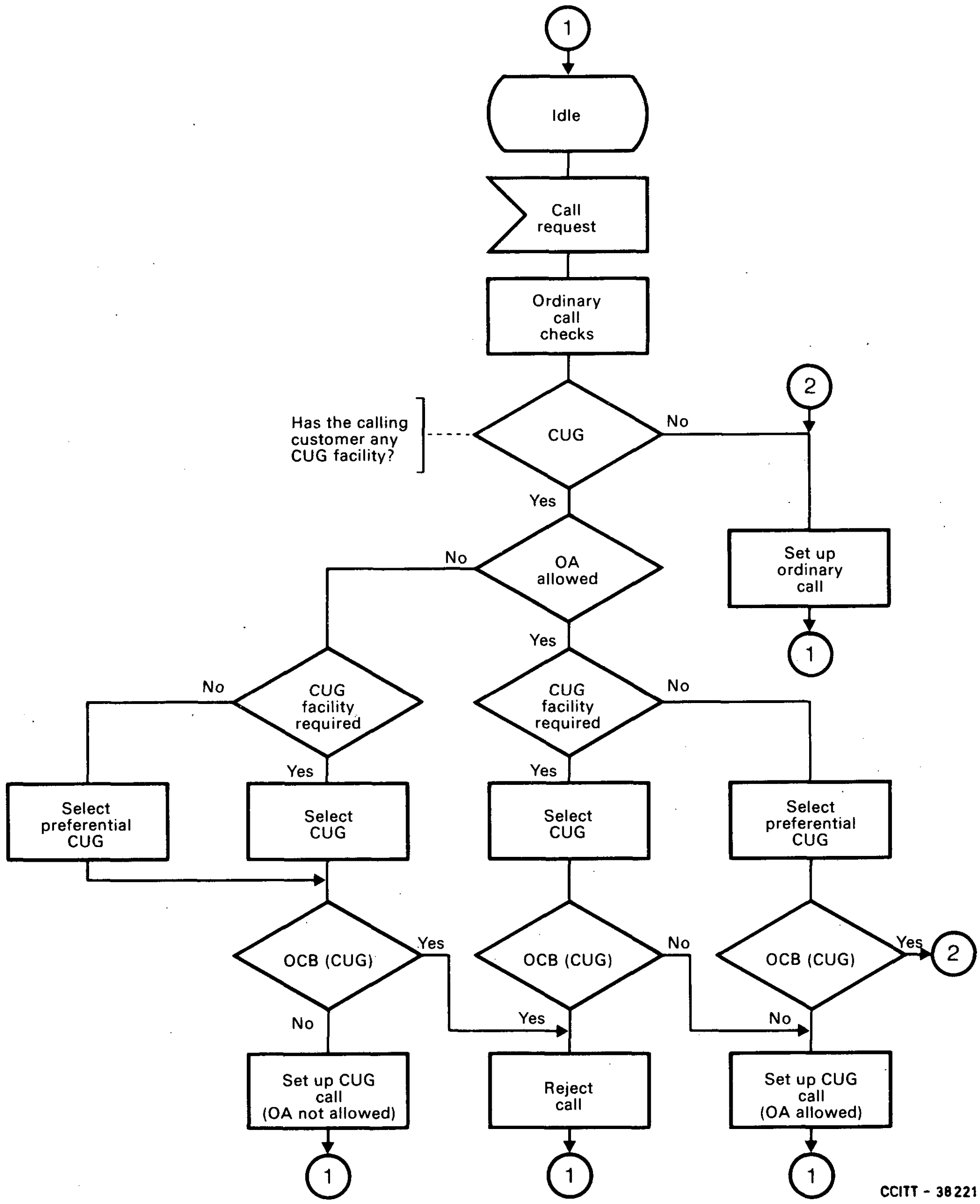
A facility request is always required for a call within any CUG other than the preferential CUG.

1.2.1.2 *Call set-up from a user having the closed user group or the closed user group with incoming access facility*

The case where a user has both the *closed user group with incoming access* and *closed user group with outgoing access* facilities is handled in accordance with § 1.2.1.3.

In this case CUG selection is performed in accordance with § 1.2.1.1.

In the case where the *outgoing calls barred within the closed user group* facility does not apply for the selected CUG, the call is set up at the originating exchange. The call control information forwarded to the next exchange then includes the interlock code of the selected CUG together with an indication that the call is a CUG call.



OA Outgoing access
OCB (CUG) Outgoing calls barred within the CUG

Note – The diagram is not a specification of a particular sequence of actions [9].

FIGURE 1/X.87

Closed user group facilities: call set-up conditions at originating exchange

In the case where the *outgoing calls barred within the closed user group* facility applies for the selected CUG, the call is rejected and the *access barred* call progress signal is returned to the calling user.

1.2.1.3 *Call set-up from a user having the closed user group with outgoing access facility*

In this case the call is regarded as either an outgoing access call or a call within the preferential (or only) CUG, unless the calling user makes a facility request identifying a particular CUG for the call.

In the case where the *outgoing calls barred within the closed user group* facility does not apply for the preferential (or only) CUG, the call is set up at the originating exchange. The call control information forwarded to the next exchange then includes the interlock code of the preferential (or only) CUG together with an indication that the call is a CUG call for which outgoing access is allowed.

Note – With the above procedure it is not necessary to distinguish at the originating exchange between a call within a CUG and an outgoing access call.

In the case where the *outgoing calls barred within the closed user group* facility applies for the preferential (or only) CUG, the call is regarded as an outgoing access call. In this case the call is set up at the originating exchange and no interlock code or CUG call indication is included in the call control information forwarded to the next exchange.

1.2.2 *Transit exchange*

With the possible exception of some gateway exchanges, each transit exchange sets up a CUG call as an ordinary call. The information related to the CUG facilities received from the preceding exchange, i.e. an interlock code, a CUG call indication and possibly an indication that outgoing access is allowed, is forwarded to the succeeding exchange.

In the case of an international CUG call, no special functions are required at the gateway exchange provided that the international interlock code assigned to the international CUG concerned is used in the national network. However, in the case where a national interlock code other than the applicable international interlock code is used within a national network, interlock code conversion is required at the gateway (or corresponding) exchange.

In the case where a destination network has a requirement for identification of the originating network for CUG calls, the *originating network identification* utility specified in § 10 may be employed.

1.2.3 *Destination exchange*

At the destination exchange a validation check of the acceptability of a call is made where either the calling user (as indicated by a CUG call indication in the control information received) or the called user belongs to a CUG. The call is connected only in cases where the information received checks with the information stored at the destination exchange, associated to the called user, as specified in the following. In cases where a call is rejected because of incompatible CUG information an *access barred* signal is sent towards the calling user.

The conditions for acceptance or rejection of calls because of the CUG facilities are illustrated in Figure 2/X.87.

Note – A call may be rejected for other reasons than those related to the CUG facilities.

1.2.3.1 *Calls to a user having the closed user group or the closed user group with outgoing access facility*

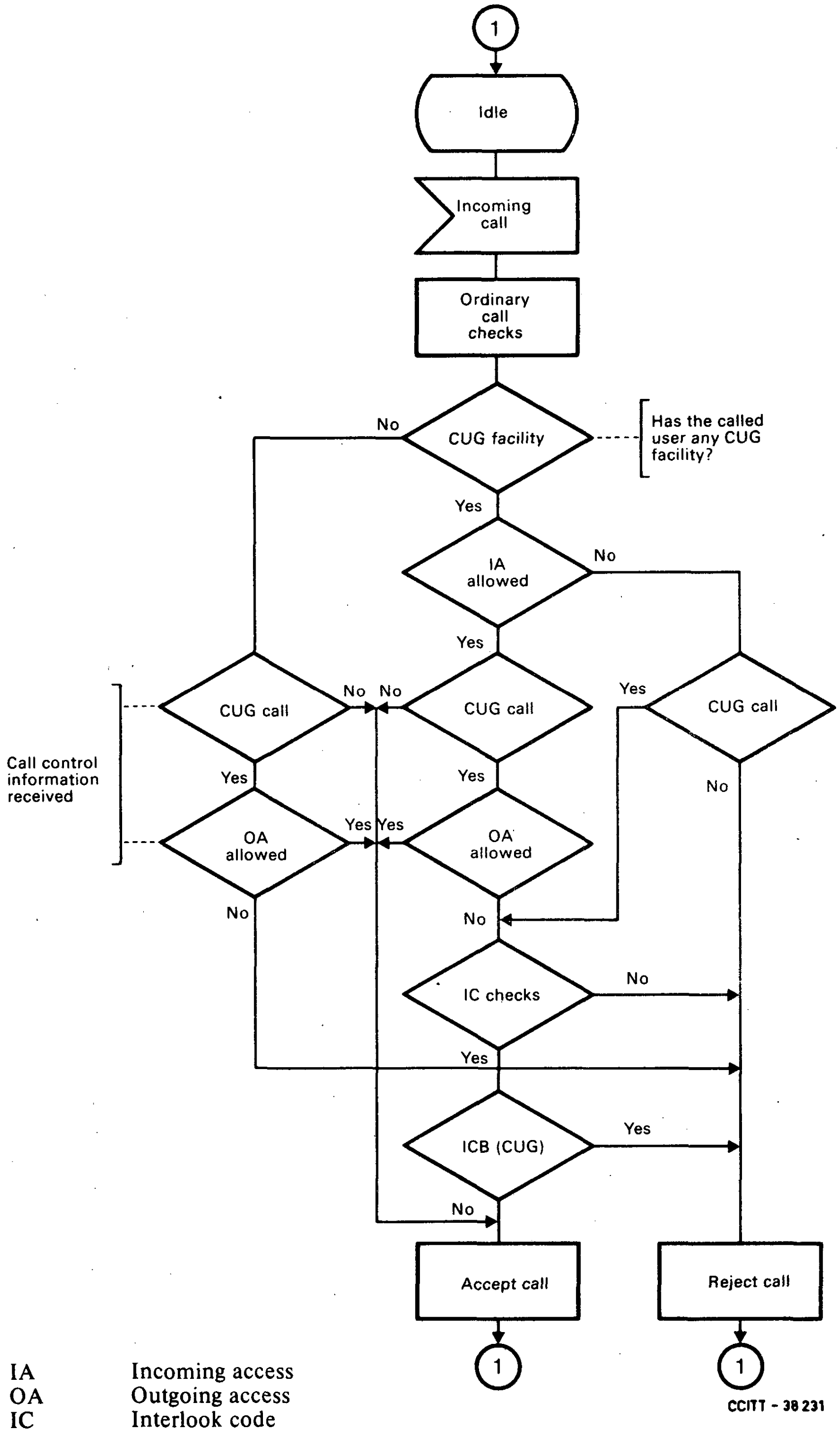
In this case an incoming call is accepted only when:

a) it is a CUG call, including the case where outgoing access is allowed, and

b) correspondence is found between the interlock code received and an interlock code associated with the called user, and

c) the *incoming calls barred within the closed user group* facility does not apply for the CUG identified by the interlock code received.

If all the above conditions are not met, the call is rejected.



IA Incoming access
OA Outgoing access
IC Interlook code
ICB (CUG) Incoming calls barred within the CUG

Note – The diagram is not a specification of a particular sequence of actions [9].

FIGURE 2/X.87
Closed user group facilities: call set-up conditions at destination exchange

1.2.3.2 *Calls to a user having the closed user group with incoming access facility*

In the case where the incoming call is:

a) an ordinary call, it is accepted;

b) a CUG call for which outgoing access is not allowed, it is accepted if both conditions specified in § 1.2.3.1 b) and c) are met, otherwise it is rejected;

c) a CUG call for which outgoing access is allowed, it is accepted, otherwise it is rejected.

1.2.3.3 *CUG calls to a user not belonging to any CUG*

In the case where the incoming call is:

a) a CUG call for which outgoing access is allowed, it is accepted;

b) a CUG call for which outgoing access is not allowed, it is rejected.

1.3 *International interlock code*

Each international CUG is assigned a unique *International CUG Number* (ICN) according to the administrative rules defined in Recommendation X.180 [8].

Each international interlock code includes:

a) four binary coded decimal digits expressing the DCC plus one digit, or DNIC, of the country or network of the coordinating Administration (or Recognized Private Operating Agency), i.e. the decimal number A of the international CUG number;

b) a 16-bit code expressing in pure binary representation the value of the decimal number B of the international CUG number.

The interlock code is transferred, DNIC/DCC portion first, in accordance with the procedures specified by the relevant Recommendations X.60, X.70, X.71 or X.75.

Note – In some cases of signalling, all, some or none of the leading zeros are transmitted, see Recommendations X.70 and X.71. The binary code should then have the same meaning regardless of the number of the leading zeros.

2 Bilateral closed user group

2.1 *General*

The *Bilateral Closed User Group* (BCUG) facility is a user facility that enables pairs of users to form bilateral relations allowing access between each other while excluding access to or from other users with which such a relation has not been formed. A user may belong to more than one BCUG.

The *Bilateral Closed User Group with Outgoing access* (BCUGO) facility is a user facility that enables a user to form BCUGs as with the *bilateral closed user group* facility, but at the same time allows the user to access by outgoing calls open users not having the *bilateral closed user group* or *bilateral closed user group with outgoing access* facilities.

A user may at the same time have the *bilateral closed user group* or *bilateral closed user group with outgoing access* facility and one or more of the *closed user group* (CUG) facilities. In such a case a call within a CUG is handled separately from the *bilateral closed user group* facility and is not regarded as an outgoing access call in relation to the *bilateral closed user group* facility.

Bilateral closed user group and *bilateral closed user group with outgoing access* are optional user facilities assigned to the user for an agreed contractual period. They are standardized for the circuit-switched and packet-switched, virtual call and datagram, services.

Registration and cancellation of a BCUG of two users to the *bilateral closed user group* or *bilateral closed user group with outgoing access* facilities are controlled by the users concerned by means of automatic registration and cancellation procedures.

Note 1 – Standardization of an alternative facility registration and cancellation procedure is for further study (see Annex to Question 12/VII) [10].

Note 2 – The means for the facility registration and cancellation procedure specified below are not provided by Recommendation X.25 as currently specified [5].

The *bilateral closed user group* and *bilateral closed user group with outgoing access* facilities, including automatic user controlled facility registration and cancellation, can be supported by common channel signalling (Recommendation X.60) for the circuit switched service and by the control procedures (Recommendation X.75) for the packet-switched, virtual call or datagram, service. Decentralized signalling (Recommendations X.70 and X.71) for the circuit switched service cannot support the facilities.

The procedures for the *bilateral closed user group* facility are based on the mutual registration method. This method makes use of the features of *abbreviated address calling*. Thus, a user having the *bilateral closed user group* facility uses a local index (i.e. an abbreviated address) for each remote user with which a BCUG is formed. In the exchange to which the user is connected a table associated to that user is available. The local index used to address a remote user corresponds to a position in the table containing the data number (address) of the remote user, the local index used by that remote user to address the local user and an indication (association bit) about the status of the BCUG.

2.2 *Registration procedure*

2.2.1 When requesting registration of a BCUG the user (*A*) makes a facility request including the data number (*B*) of the remote user and the local index (*x*) used for that user. The originating exchange checks whether a data number has been registered or not in the position corresponding to the local index *x* received, in the local user *A* table.

a) In the case where a data number has not yet been registered in position *x* in the user *A* table, the originating exchange registers data number *B* in that position. The originating exchange then sends a BCUG registration request to the destination exchange, including a data number *B* as a destination address, data number *A* as a source address and the local index *x*.

b) In the case where data number *B* for the remote user has already been registered in position *x* in the user *A* table and its association bit has not yet been set, indicating that registration has not yet been completed, the originating exchange sends a BCUG registration request to the destination exchange, including the same information as described in a) above.

c) In the case where data number *B* for the remote user has already been registered in position *x* in the user *A* table and its association bit has already been set, the originating exchange sends *the registration/cancellation confirmed* call progress signal to user *A*.

d) In the case where the data number registered in that position is different from the data number *B* received, the originating exchange sends the *local procedure error* call progress signal to user *A*.

2.2.2 When receiving the BCUG registration request, the destination exchange checks the addressed user *B* table.

a) In the case where user *B* has already registered user *A* in a position *y*, where *y* is the local index used by user *B* for user *A*, and its association bit has not yet been set, indicating that registration has not yet been completed, the destination exchange sets the association bit and registers local index *x* in that position. The destination exchange then responds to the originating exchange with a *registration completed* signal together with the local index *y*.

b) In the case where user *B* has already registered user *A* in position *y* and its association bit has already been set, the destination exchange checks the local index registered in that position. In the case when that local index is equal to the local index received, the destination exchange responds to the originating exchange as under item a) above.

c) In the case where user *B* has not registered data number *A* in any position, the destination exchange responds to the originating exchange with a *registration accepted* signal.

d) In the case where user *B* does not subscribe to the BCUG facility, the destination exchange responds to the originating exchange with an *access barred* signal.

e) In the case where user *B* is not accessible by user *A* for any other reason, the destination exchange responds to the originating exchange with the appropriate call progress signal.

2.2.3 When receiving the response to a BCUG registration request from the destination exchange; the action at the originating exchange depends on the signal received.

a) In the case where a *registration completed* signal is received, the originating exchange sets the association bit and registers the local index *y* in position *x* in the user *A* table and sends the *registration/cancellation confirmed* call progress signal confirming registration to user *A*.

b) In the case where a *registration-accepted* signal is received, no further registration is made at the originating exchange and the *registration/cancellation confirmed* call progress signal is sent to user *A*.

c) In the case where a signal is received indicating that BCUG registration has been rejected by the destination exchange, the originating exchange clears all the information in position *x* in the user *A* table and sends the corresponding call progress signal to user *A*.

2.2.4 With the above procedures, registration of a BCUG is completed when both users concerned have requested registration of each other and have received positive responses.

2.3 *Cancellation procedure*

2.3.1 When requesting cancellation of a BCUG, user *A* makes a facility request, including local index *x*. The originating exchange checks the status of position *x* in the user *A* table.

a) In the case where a data number is registered in position *x*, the originating exchange sends a BCUG cancellation request with data number *B* as address and including remote local index *y* and the calling user number *A*. Also, the originating exchange resets the association bit if it was set.

b) In the case where no data number is registered in position *x*, the originating exchange returns the *registration/cancellation confirmed* call progress signal to user *A*.

2.3.2 When receiving the BCUG cancellation request the destination exchange checks the addressed user *B* table.

a) In the case where the data number in position *y* in the user *B* table is equal to the data number *A* received, the destination exchange clears all information in position *y*.

b) In all other cases, and in particular in the case where the data number stored in position *y* is different from the data number *A* received, the destination exchange does not alter any information stored in the user *B* table.

In cases a) and b) the destination exchange sends a *cancellation completed* signal to the originating exchange.

2.3.3 When receiving the *cancellation completed* signal in response to a BCUG cancellation request, the originating exchange clears all the information in position *x* in the user *A* table and sends the *registration/cancellation confirmed* call progress signal to user *A*.

2.3.4 With the above procedure, a BCUG is cancelled when either of the two users concerned has requested cancellation and has received the *registration/cancellation confirmed* call progress signal.

2.3.5 Possible implications of abnormal conditions at cancellation may require further study.

2.4 *Time-out supervision in registration/cancellation procedure*

At the originating exchange in the facility registration/cancellation procedure, it is necessary to wait for receipt of the response from the destination exchange after sending a BCUG registration/cancellation request. The duration of such periods has to be controlled by appropriate time-outs.

The following time-outs are necessary:

T1 – The time between the sending of the BCUG registration request and receipt of a response in accordance with § 2.2.

T2 – The time between the sending of the BCUG cancellation request and receipt of a *cancellation completed* signal.

On expiry of a time-out *T1* or *T2*, the originating exchange sends the *network congestion* call progress signal to user *A* thus indicating that the requested registration or cancellation has failed. User *A* then has to repeat the request for registration or cancellation.

The value of *T1* and *T2* should (provisionally) be 5-10 seconds.

2.5 *Call set-up procedure*

2.5.1 *Originating exchange*

2.5.1.1 When making a call within a BCUG, the calling user *A* uses the local index *x* as address for the called user (in accordance with the procedure for the *abbreviated address calling* facility). The originating exchange checks the position corresponding to the local index *x* registered in the calling user *A* table.

a) In the case where the association bit is set, indicating that the BCUG is registered by both the calling and called users, the originating exchange sets up the call towards the destination exchange, using the called user data number *B* stored in the calling user *A* table. The call control information forwarded by the originating exchange includes an indication that the call is a BCUG call.

b) In the case where the association bit is not set, indicating that the BCUG is not completely registered, the originating exchange rejects the call and sends the *access barred* call progress signal to the calling user.

2.5.1.2 In the case where a user having the *bilateral closed user group* facility makes a call with an ordinary data number or an abbreviated address not registered as a BCUG, the originating exchange rejects the call and sends the *access barred* call progress signal to the calling user.

Note – In the case where the user also belongs to a closed user group (CUG), calls within a CUG are handled independently and are not rejected because of the *bilateral closed user group* facility.

2.5.1.3 In the case where a user having the *bilateral closed user group with outgoing access* facility makes a call with an ordinary data number or an abbreviated address not registered as a BCUG, the call is handled as an outgoing access call and is set up by the originating exchange in accordance with ordinary call set-up procedures.

2.5.1.4 The possibility of transfer of the local index *x* (in the forward direction) and local index *y* (in the backward direction) and the possibility of additional verification checks at the destination exchange are for further study.

2.5.2 *Transit exchange*

A transit exchange handles a BCUG call as an ordinary call.

2.5.3 *Destination exchange*

2.5.3.1 When receiving a BCUG call the destination exchange may accept the call without checking whether the called user has the *bilateral closed user group* facility.

2.5.3.2 When receiving an ordinary call (i.e. not a BCUG call) to a user having the *bilateral closed user group* facility, the destination exchange rejects the call and responds with the *access barred* signal to the originating exchange.

2.5.3.3 The call may be rejected for other reasons not related to the *bilateral closed user group* facility. Closed user group calls can be accepted regardless of the above conditions, provided that the requirements of that facility (see § 1) are met.

2.5.4 *Combination of BCUG and line or terminal identification facilities*

The possible arrangements for combinations of the *bilateral closed user group* or *bilateral closed user group with outgoing access* facilities and the *calling line identification* and/or *called line identification* facilities and the form of calling or called DTE identification of BCUG calls are for further study.

3 Calling line identification

3.1 *General*

Calling line identification is a user facility that enables a user to be informed at incoming calls of the identity of the calling user. When provided the facility applies to all incoming calls.

It is an optional user facility assigned to the user for an agreed contractual period. It is standardized for the circuit-switched service.

In the packet-switched service, the identity of the calling subscriber is transferred in the calling DTE address signalled to the called DTE. The data number is always either inserted or checked by the network.

The calling line identity is the data number of the calling user. For international calls the identity is the complete international data number including the DNIC or DCC component as applicable.

Note – The implications of a possible combination of *calling line identification* and the *bilateral closed user group* facility are for further study.

Information indicating that a user has the *calling line identification* facility is stored at the exchange to which the user is connected. The identity sent to the called user is originated under control of the exchange to which the calling user is connected.

Facility registration is controlled by the Administration or Recognized Private Operating Agency.

3.2 *Call set-up procedure*

The procedure for a call to a user having the *calling line identification* facility varies depending on whether the calling line identity is included in the initial call control information received by the destination exchange at call set-up.

a) In the case where the calling line identity is included in the call control information received by the destination exchange, it sends this identity to the called user in accordance with the applicable DTE/DCE interface protocol.

b) In the case where the calling line identity is not included in the call control information received by the destination exchange, it sends a request for identification towards the originating exchange.

   i) In the case where the originating network provides the *calling line identification* facility, the originating exchange responds with the calling line identity which is forwarded by the destination exchange to the called user in accordance with the applicable DTE/DCE interface protocol.

   ii) In the case where the originating network does not provide the *calling line identification* facility, it responds with the originating network identity (see § 10). In this case the identification sent by the destination exchange to the called user is in accordance with the applicable DTE/DCE interface protocol.

The destination exchange must not connect through until the identity has been completely sent to the called user. Also, in the case where decentralized signalling is used, transit exchanges have to delay through-connection in certain situations until a possible identification has been completed in accordance with the applicable interexchange signalling procedures (see Recommendations X.70 and X.71).

4 Called line identification

4.1 *General*

Called line identification is a user facility that enables a user to be informed at outgoing calls of the identity of the user to which the call has been connected. When provided, the facility applies to all outgoing calls.

It is an optional user facility assigned to the user for an agreed contractual period. It is standardized for the circuit-switched service.

In the packet-switched service, the identity of the called subscriber may be transferred in the called DTE address signalled to the originating network. When transferred, the data number is either inserted or checked by the destination network.

The called line identity is the data number of the user to which the call has been connected. For international calls the identity is the complete international data number including the DNIC or DCC component as applicable.

Information indicating that a user has the *called line identification* facility is stored at the exchange to which the user is connected. The identity sent to the calling user is originated under control of the exchange to which the called user is connected.

4.2 *Call set-up procedure*

In the case of a call from a user having the *called line identification* facility, the call control information forwarded by the originating exchange at call set-up includes a request for called line identification. The procedure then depends on whether or not the destination network provides the facility.

a) In the case where the destination network provides the *called line identification* facility, the destination exchange responds with the called line identity which is returned by the originating exchange to the calling user in accordance with the applicable DTE/DCE interface protocol.

b) In the case where the destination network does not provide the *called line identification* facility, it responds, depending on what type of signalling is used, with the destination network identity (Recommendation X.60) or with a "dummy" identification Recommendation X.70 or X.71. The information sent by the originating exchange to the calling user is in accordance with the applicable DTE/DCE interface protocol.

For circuit-switched calls the originating exchange must not connect through until the identity has been completely sent to the called user. Also, in the case where decentralized signalling is used, transit exchanges have to delay through-connection in certain situations until a possible identification has been completed in accordance with the applicable interexchange signalling procedures (Recommendations X.70 and X.71).

5 Redirection of calls

5.1 *General*

Redirection of calls is an optional user facility assigned to the user for an agreed contractual period. It is standardized for the circuit-switched service.

The *redirection of calls* facility enables a user to have calls to a data number, for which the facility is subscribed, to be redirected to another predetermined data number during periods when the facility is activated.

Facility registration including registration of the redirection address (i.e. the data number to which calls are to be redirected) is controlled by the Administration or Recognized Private Operating Agency.

Depending on the possibilities offered by the Administration or Recognized Private Operating Agency facility, activation and deactivation may be made:

a) by the user by means of user controlled activation and deactivation procedures;

b) by the network at predetermined times;

c) by the Administration or Recognized Private Operating Agency on request of the user.

User controlled procedures for inquiry of the status of the facility (i.e. whether the facility is activated or deactivated) may also be provided.

For international calls redirection may only be made within the destination country. A call may only be redirected once. Redirected calls are subject to the same restrictions as other calls where a closed user group is involved. Bilateral closed user group calls may not be redirected.

5.2 *Call set-up procedure*

5.2.1 *Calls not involving other facilities affecting the procedure*

Information that a user has the *redirection of calls* facility activated is stored, together with the redirection address, at the exchange to which the user is connected. When such a user is called, the call is set up to the redirection address in accordance with the following.

5.2.1.1 *The redirection address is at the same exchange*

In this case the destination exchange connects the call to the redirection address and returns the *redirected call* signal unless the call is rejected for one of the reasons indicated below. When receiving the *redirected call* signal, the originating exchange sends the corresponding call progress signal to inform the calling user that the call has been redirected.

In the case where the user at the redirection address also has the *redirection of calls* facility activated, the destination exchange rejects the call and returns the *access barred* call progress signal. The call may also be rejected for other reasons (e.g. number busy) in accordance with the ordinary procedures.

5.2.1.2 *The redirection address is at another exchange*

5.2.1.2.1 In this case the call is set up to the redirection address in accordance with one of the following procedures depending on the arrangements in the destination network.

5.2.1.2.2 The following procedure is based on the principle that the call is released back within the destination network and then set up to the new destination exchange. In the case of an international call it is released back to the incoming gateway exchange. In the case of a national call it is released back to the originating exchange. This procedure can be supported by common channel signalling (Recommendation X.60). The means necessary to support this procedure are not defined in Recommendations X.70 and X.71, as currently specified.

i) The first destination exchange returns the *redirection request* signal together with the redirection address towards the controlling exchange (i.e. the incoming gateway or originating exchange).

ii) In the case of an international call the incoming gateway exchange, upon receipt of the *redirection request* signal, sets up a new forward connection to the redirection address. The call control information forwarded includes a *redirected call* indication. The forward connection to the first direction exchange is released.

iii) In the case of a national call the originating exchange acts in accordance with ii).

iv) Upon receipt of the redirected call the new destination exchange connects the call or rejects the call in accordance with § 5.2.1.1. The forward *redirected call* indication received by the new destination exchange is used to prevent a further redirection.

v) In the case where the call is connected to the redirection address the originating exchange will receive the *redirected call* signal. It then sends the *redirected call* call progress signal to inform the calling user that the call has been redirected.

5.2.1.2.3 The following procedure is based on the principle that the connection is extended forward from the first destination exchange to the new destination exchange. This procedure can be supported by common channel signalling and decentralized signalling in accordance with Recommendations X.60, X.70 and X.71.

i) The first destination exchange sets up the forward connection to the redirection address. The call control information forwarded will include a *redirected call* indicator.

ii) Upon receipt of the redirected call the new destination exchange connects or rejects the call in accordance with § 5.2.1.1. The forward *redirected call* indication received is used to prevent a further redirection.

iii) In the case where the call is connected to the redirection address the originating exchange will receive a *redirected call* signal. It then sends the *redirected call* call progress signal to inform the calling user that the call has been redirected.

5.2.2 *Calls involving a closed user group facility*

Redirected calls are subject to the restrictions applying for the closed user group (CUG) facilities.

a) In the case where the call is a CUG call, or the originally called user has a CUG facility, the call is rejected before redirection unless the validation check requirements applying for the CUG facility(ies) concerned are satisfied.

b) In the case where the call is a CUG call, or the user at the redirection address has a CUG facility, the call is rejected unless the validation check requirements applying for the CUG facility(ies) concerned are satisfied.

c) In the case where:

i) the call is a CUG call, and

ii) the redirection address is at an exchange other than the first destination exchange, and

iii) the procedure for setting up the call to the redirection address is in accordance with § 5.2.1.2.2 (i.e. the call is released back), the first destination exchange has to send the CUG information received (e.g. the CUG call indication, and the interlock code) back to the controlling exchange together with the *redirected call* signal and the redirection address to enable the controlling exchange to include this CUG information in the call control information sent on the new forward connection.

5.2.3 *The calling user has the called line identification facility*

In the case where a call from a user that has the *called line identification* facility is redirected, the called line identity sent to the calling user is the data number of the redirection address.

6 Connect when free and waiting allowed

6.1 *General*

Connect when free and *waiting allowed* are optional user facilities assigned to the user for an agreed contractual period. They are standardized for the circuit-switched service.

A user subscribing to the *connect when free* facility is assigned a number of waiting positions at his local exchange at which incoming calls received can wait when the access line(s) to the user is busy. The *waiting allowed* facility enables a user calling a busy user having the *connect when free* facility to wait for completion of the call when the called user becomes free. During waiting the connection is maintained.

The two facilities thus provide an opportunity for users having certain data traffic characteristics to make more efficient use of the network than in the ordinary case when a call to a busy user is rejected.

Facility registration is controlled by the Administration or Recognized Private Operating Agency.

6.2 *Call set-up procedure*

6.2.1 When receiving a call to a busy user (i.e. at least one access line to the called user is occupied by a call in progress) having the *connect when free* facility, the destination exchange checks the waiting positions at the called user.

a) In the case where a free waiting position exists the call is placed in the queue and the *connect when free* signal is sent towards the originating exchange.

b) In the case where all waiting positions are occupied the call is rejected and the *number busy* signal is sent towards the originating exchange.

The call may be rejected for other reasons not related to the *connect when free* facility.

6.2.2 The action at the originating exchange depends on whether the calling user has the *waiting allowed* facility and which signal is received.

a) In the case where the *connect when free* signal is received and the calling user has the *waiting allowed* facility, the *connect when free* call progress signal is sent to the calling user. The calling user can then either wait for completion of the call or clear the call. In the case where the calling user chooses to wait, the connection is maintained but is not through-connected. The normal time out for completion of the call at the originating exchange is inhibited. The calling user cannot make or receive another call on the same access line during waiting.

b) In the case where the *connect when free* signal is received and the calling user does not have the *waiting allowed* facility, the *number busy* call progress signal is sent to the calling user and the call is cleared.

c) In the case where the *number busy* signal is received, the *number busy* call progress signal is sent to the calling user and the call is cleared; this is also the case when the calling user has the *waiting allowed* facility.

6.2.3 When an access line becomes free to the called user, the destination exchange connects the first call in the queue in the normal manner. A signal indicating that the call has been connected is sent towards the originating exchange.

6.2.4 When receiving the signal indicating that the call has been connected, the originating exchange through-connects the call in the normal manner.

6.2.5 The waiting time will be charged. The calling user may send a clear request at any time to terminate the waiting which will result in normal network clearing and removal of the call from the queue. The waiting may also be terminated by the destination exchange in some abnormal situations resulting in a clearing sequence towards the calling user.

Note – The possible provision of a network time-out to limit the waiting time is for further study.

7 Reverse charging and reverse charging acceptance

7.1 *General*

Reverse charging is an optional user facility that may be requested by the user on a per call basis. It enables a calling user to request that the call should be charged to the called user.

Reverse charging acceptance is an optional user facility assigned to the user for an agreed contractual period. It enables the user to accept reverse charging calls.

Note 1 – The international accounting arrangements for reverse charging calls and the consequent implications on network capabilities have not yet been defined.

Note 2 – All requirements of the *reverse charging* and *reverse charging acceptance* facilities have not yet been catered for in the DTE/DCE interface and interexchange signalling specifications.

The facilities are standardized for the circuit-switched and packet-switched services.

7.2 *Call set-up procedure*

7.2.1 A calling user may request reverse charging by means of a facility request over the DTE/DCE interface.

a) In the case where reverse charging is allowed by the originating network, the call control information forwarded to the succeeding exchange will include a *reverse charging request* indication.

b) In the case where reverse charging is not allowed by the originating network, the call is rejected and an *invalid facility request* call progress signal is returned to the calling user.

7.2.2 When receiving a call including a *reverse charging request* indication the destination exchange will act as follows:

a) In the case where the called user subscribes to the *reverse charging acceptance* facility, the incoming call information including an indication that reverse charging is requested is sent to the called user.

b) In the case where the called user does not subscribe to the *reverse charging acceptance* facility, the call is rejected and a *reverse charging acceptance not subscribed* signal is sent towards the originating exchange.

The call may also be rejected for other reasons not related to the *reverse charging* or *reverse charging acceptance* facilities.

When the incoming call information is sent to the called user, the called user may deny establishment of the call by clearing if he is not willing to accept reverse charging for this particular call.

Note – The DTE/DCE interface arrangements necessary in the circuit-switched service to allow the called user to deny establishment of a reverse charging call, for example after *calling line identification*, have not yet been defined. The procedure chosen is likely to affect the network procedures for reverse charging calls.

8 Manual answer

8.1 *General*

Manual answer is a DTE operating mode allowed by some networks for the circuit-switched service. DTEs operating in this mode may, when called, delay responding by the *call accepted* signal. Information indicating that a user DTE operates with *manual answer* is stored at the exchange to which the user is connected.

8.2 *Call set-up procedure*

In the case of a call to a user DTE operating with *manual answer*, the destination exchange sends the *terminal called* signal to the originating exchange at connection of the call. At the originating exchange this results in sending of the *terminal called* call progress signal to the calling user. It also results in extending the value of any time-out applicable to this phase of the call.

The call is completed as an ordinary call when the *call accepted* signal is received from the called user by the destination exchange and a signal indicating that the call has been connected is sent towards the originating exchange. If the *call accepted* signal is not received by the destination exchange within the applicable DCE time-out after sending of the *incoming call* signal to the called user, the call is cleared from the destination exchange without sending of any call progress type backward signal.

Note – In the case where the originating network does not allow *manual answer* and the called user operates with *manual answer*, the originating network may charge the calling user for the time from the receipt of the *terminal called* signal.

9 RPOA selection

9.1 *General*

RPOA selection is an optional user facility that may be requested by the user on a per call basis. It is standardized for the circuit-switched and packet-switched, virtual call and datagram, services.

RPOA selection enables a user to select a particular international carrier for a call in the case where more than one international carrier provide the data transmission service concerned to the destination network.

9.2 *Call set-up procedure*

A user in a network providing the *RPOA selection* facility may request selection of a particular RPOA for a call by a facility request including the DNIC identifying the RPOA transit network selected.

In the case where a calling user requests selection of a particular RPOA, the originating network will route the call to the gateway exchange of the RPOA transit network selected. In the case where the call is routed via one or more transit exchanges within the originating network, an *RPOA selection* request indication and the DNIC identifying the RPOA transit network requested will be included in the call control information forwarded by the originating exchange.

The call control information sent over the international network will be as for an ordinary call and will not contain any *RPOA selection* related information.

In the case where the selected RPOA transit network cannot accept the call, due to for example congestion or network failures, the call is rejected by the gateway exchange and an *RPOA out-of-order* signal is returned towards the originating exchange which sends the corresponding call progress signal to the calling user.

10 Network identification

10.1 *General*

The international *network identification* utilities provide information about the network(s) from, via or to which an international call is routed.

A network is identified by four decimal digits that indicate:

a) in the case of the network of a country using the DCC format of the international data numbering plan (Recommendation X.121), the applicable DCC plus one digit consistent with the numbering plan;

b) in the case of a network using the DNIC format of the international data numbering plan (Recommendation X.121), the applicable DNIC.

10.2 *Originating network identification*

The *originating network identification* utility identifies the originating network of a call.

In the packet-switched service, the identity of the originating network (DNIC) is transferred in the *call request* packet to the destination network as part of the international data number (Recommendation X.75). To perform the function of the *originating network identification* utility this DNIC, which is part of the international data number, is always either inserted or checked by the originating network.

Provision of *originating network identification* as an optional network utility on request by a transit or destination network on a per call basis is mandatory for the circuit-switched service.

Note – The need in the circuit-switched service for identification of the originating network for all calls without request from a transit or destination network is for further study (Recommendation X.110 [12]).

In the case of common channel signalling (Recommendation X.60), a network requiring identification of the originating network requests such identification by returning an *originating network identification request* indication. When receiving such a request the originating network responds by sending:

a) the complete calling line identity in accordance with § 3 in the case where the *calling line identification* facility is provided by the originating network and such identification is also requested;

b) the originating network identity in the case where calling line identification is not provided or requested.

In the case of decentralized signalling (Recommendations X.70 and X.71), a network requiring identification of the originating network requests such identification by returning a *calling line identification* request indication. When receiving such a request, the originating network responds with the calling line identity or the originating network identity depending on whether or not the *calling line identification* facility is provided by the originating network (see § 3).

10.3 *Destination network identification*

The destination *network identification* utility identifies the destination network of a call.

In the circuit-switched service *destination network identification* for all international calls is a mandatory network utility. Thus, for each international call the identity of the destination network is returned in accordance with the applicable signalling procedures (Recommendations X.60, X.70 and X.71).

In the packet-switched service, the identity of the destination network (DNIC) may be transferred in the *call connected* packet to the originating network as part of the international data number (Recommendation X.75). When transferred, this DNIC must either be inserted or checked by the destination network.

10.4 *Transit network identification*

The *transit network identification* utility identifies the transit network(s) via which the call has been set up.

In the packet-switched service *transit network identification*, in both the forward and backward directions, is a mandatory network utility for international calls (Recommendation X.75).

In the circuit-switched service transit network identification in the backward direction is a mandatory network utility for international calls (Recommendations X.60, X.70 and X.71).

Note – The need for transit network identification in the forward direction for international circuit-switched calls is for further study (Recommendation X.110 [12]).

In cases where more than one transit network is identified, the identities are indicated in the order of transit networks traversed by the call following the established path from the calling user towards the called user.

References

[1] CCITT Recommendation *International user services and facilities in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.2.

[2] CCITT Recommendation *Call progress signals in public data networks*, Vol. VIII, Fascicle VIII.7, Rec. X.96.

[3] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for start-stop transmission services on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.20.

[4] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for synchronous operation on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.21.

[5] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for terminals operating in the packet mode on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.25.

[6] CCITT Recommendation *DTE/DCE interface for a start-stop mode data terminal equipment accessing the packet assembly/disassembly facility (PAD) in a public data network situated in the same country*, Vol. VIII, Fascicle VIII.5, Rec. X.28.

[7] CCITT Recommendation *Procedures for the exchange of control information and user data between a packet assembly/disassembly facility (PAD) and a packet mode DTE or another PAD*, Vol. VIII, Fascicle VIII.5, Rec. X.29.

[8] CCITT Recommendation *Administrative arrangements for international closed user groups (CUG)*, Vol. VIII, Fascicle VIII.7, Rec. X.180.

[9] CCITT Recommendation *General explanation of the specification and description language (SDL)*, Vol. VI, Fascicle VI.8, Rec. Z.101.

[10] Question 12/VII.

[11] CCITT Recommendation *International numbering plan for public data networks*, Vol. VIII, Fascicle VIII.7, Rec. X.121.

[12] CCITT Recommendation *Routing principles for international public data services through switched public data networks of the same type*, Vol. VIII, Fascicle VIII.7, Rec. X.110.

SECTION 4

NETWORK ASPECTS

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 [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 [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.

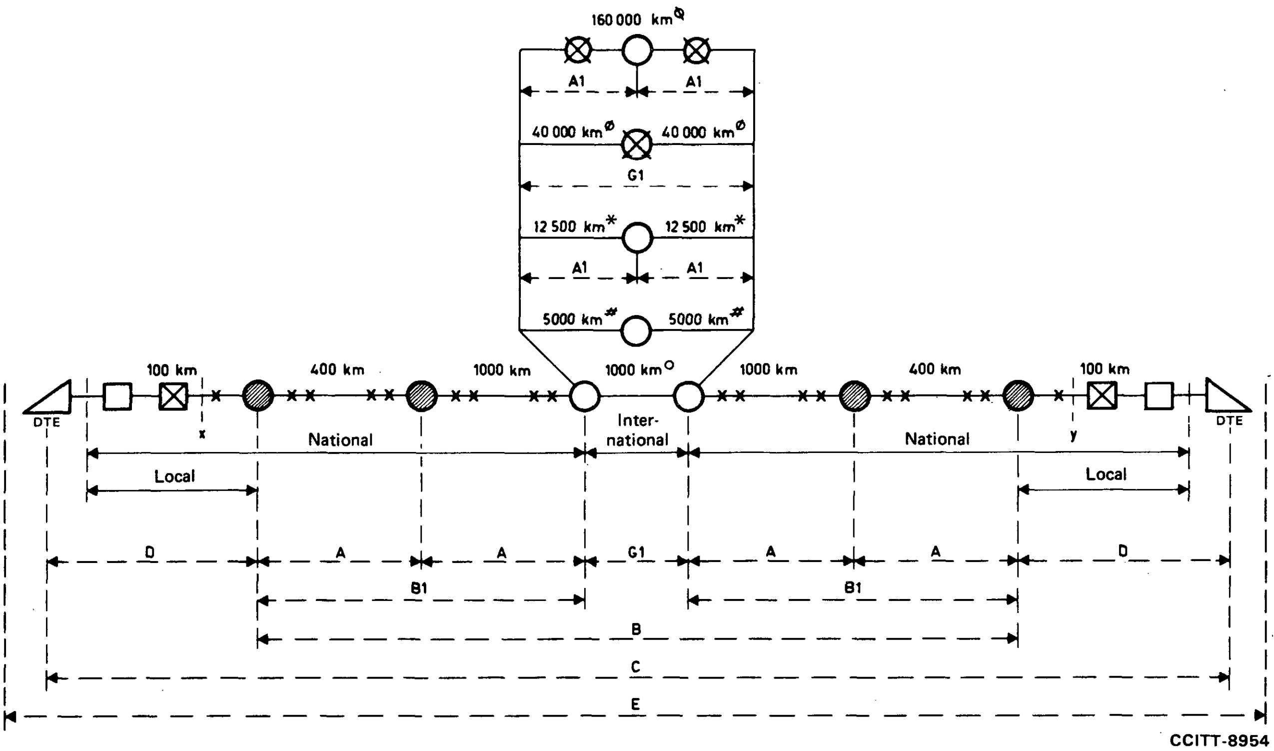
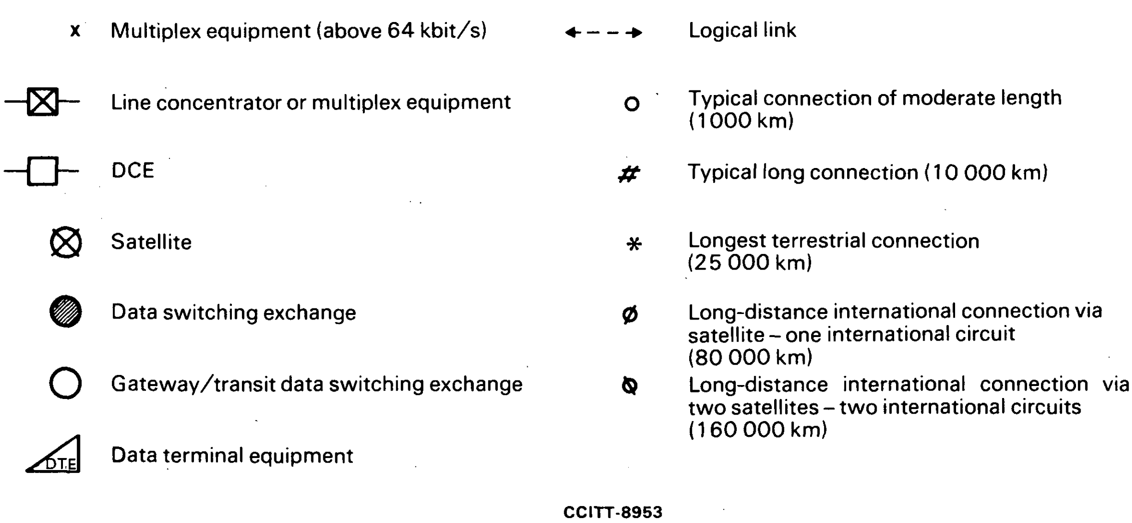


FIGURE 1/X.92

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 in 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.

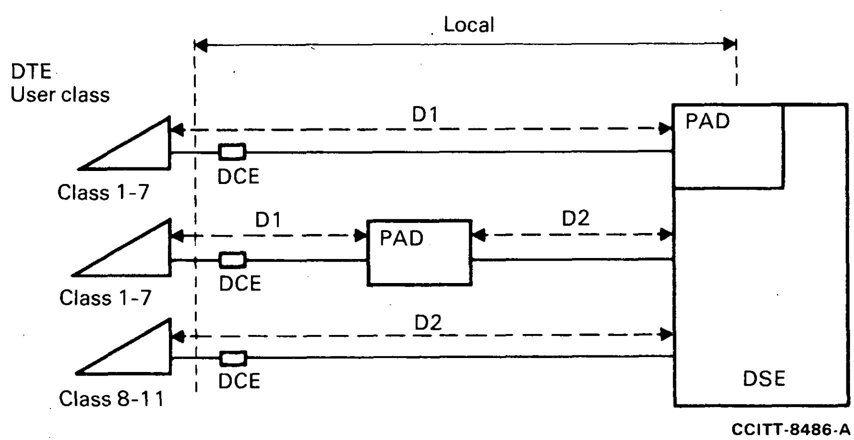
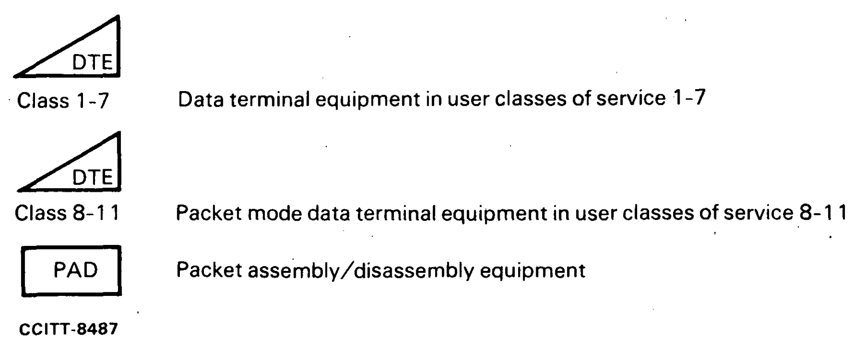


FIGURE 2/X.92

Variants of logical link D

The legend to the symbols used is as follows:



Link D1 = data link between a data terminal equipment in user class of service 1-7 and a packet assembly/ disassembly equipment

Link D2 = 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 D1 and D2).

Note 2 – Link D2 could provide an interface for a single access terminal as well as for a multiple access terminal.

Reference

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.1.

Recommendation X.96

CALL PROGRESS SIGNALS IN PUBLIC DATA NETWORKS

(Geneva, 1976, amended at Geneva, 1980)

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, there is a need to inform the caller about the progress of the call,

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 call;

that in addition, for packet-switched services, call progress signals should also be transmitted:

- if a problem is detected at a DTE/DCE interface which may have an impact on data integrity,
- for the virtual call (VC) service, to the calling and called DTEs when a call is reset or cleared after having been established,
- for the permanent virtual circuit (PVC) service between two DTEs to both DTEs when the permanent virtual circuit is reset,
- for the datagram (DG) service, when the logical channel is reset, and to the source DTE when a datagram is not delivered or if datagram delivery confirmation is given.

The call progress signals and their related circumstances giving rise to them are defined in Table 1/X.96.

Call progress signal format and coding shall be in accordance with relevant interface specifications in the Series X Recommendations.

In a circuit-switched service, call progress signals may only be transmitted during the call set-up phase. In a packet-switched service they may also be transmitted during the data transfer phase and the call clearing phase of a virtual call.

The significance of categories indicates broadly the type of action expected of the DTE receiving the signal, see Table 2/X.96.

TABLE 2/X.96

Category	Significance
A	Call not cleared. Calling DTE is expected to wait.
B	Call cleared because the procedure is complete.
C1 and C2	Call cleared. The calling DTE should call again soon: the next attempt may be successful. However, after a number of unsuccessful call attempts with the same response the cause could be assumed to be in Category D1 or D2. The interval between successive attempts, and the maximum number of attemps, will depend on a number of circumstances including: – nature of the call progress signal, – user's traffic pattern, – tariffs, – possible regulations by the Administrations, or reset (for packet-switched services only). The DTE may continue to transmit data recognizing that data loss may have occurred.
D1 and D2	Call cleared. The calling DTE should take other action to clarify when the call attempt might be successful, or reset (for permanent virtual circuit and datagram logical channel only). The DTE should cease data transmission and take other action as appropriate.
C1 and D1	Due to subscriber condition.
C2 and D2	Due to network condition.

The sequence of call progress signals in Table 1/X.96 implies, for categories C and D, the order of call set-up processing by the network. In general the DTE can assume, on receiving a call progress signal, that no condition higher up the table is present. Network congestion, long-term network congestion and no connection are exceptions to this general rule. The actual coding of call progress signals does not necessarily reflect this sequence.

Except as noted in Note 4 to Table 1/X.96, all call progress signals will be extended to the DTE unmodified. Users and DTE manufacturers are warned to make due allowance for possible later extensions to this table by providing appropriate fall-back routines for unexpected signals.

For the datagram service, which does not embrace the concept of a call, the term "call" should be interpreted as "datagram", "calling" as "source", "called" as "destination", "cleared" as "not delivered".

Call progress signal	Definition	Category	Applicable to: Circuit Switching	Packet Switching: VC	PVC	DG	See Note
Terminal called	The incoming call was signalled to the DTE and call acceptance is awaited.	A	(M)	FS	–	–	1
Redirected call	The call has been redirected to another number assigned by the called subscriber.	A	(M)	–	–	–	
Connect when free	The called number is busy and the call has been placed in a queue. The call will be connected when the called number becomes free if the caller waits.	A	(M)	–	–	–	
Delivery confirmation	The datagram has been accepted by the destination DTE.	A	–	–	–	(M)	
Registration/cancellation confirmed	The facility registration or cancellation requested by the calling DTE has been confirmed by the network.	B	(M)	–	–	–	
Redirection facility active	The redirection facility is active.	B	(M)	–	–	–	2
Redirection facility not active	The redirection facility is not active.	B	(M)	–	–	–	2
No connection	Cause unspecified.	C1	M	FS	–	FS	
Selection signal transmission error	A transmission error has been detected in the selection signals by the first Data Switching Exchange (DSE).	C2	M	–	–	–	
Local procedure error	A procedure error caused by the DTE is detected by the DCE at the local DTE/DCE interface. Possible reasons are indicated in relevant Series X interface Recommendations (e.g.: incorrect format, expiration of a time-out).	C1	M	M	M	M	3
Network congestion	A condition exists in the network such as: 1) temporary network congestion, 2) temporary fault condition within the network, including procedure error within a network or an international link.	C2	M	M	M	M	
Invalid facility request	A facility requested by the calling DTE is detected as invalid by the DCE at the local DTE/DCE interface. Possible reasons include: – request for a facility which has not been subscribed to by the DTE; – request for a facility which is not available in the local network; – request for a facility which has not been recognized as valid by the local DCE.	D1 or D2	M	M	–	M	
RPOA out of order	The RPOA nominated by the calling DTE is unable to forward the call.	D2	(M)	(M)	FS	FS	4
Changed number	The called DTE has been assigned a new number.	D1	M	–	–	–	
Not obtainable	The called DTE address is out of the numbering plan or not assigned to any DTE.	D1	M	M	–	M	
Access barred	The calling DTE is not permitted the connection to the called DTE. Possible reasons include: – unauthorized access between the calling DTE and the called DTE; – incompatible closed user group.	D1	M	M	–	M	
Reverse charging acceptance not subscribed	The called DTE has not subscribed to the reverse charging acceptance facility.	D1	FS	(M)	–	(M)	
Incompatible user class of service	The called DTE belongs to a user class of service which is incompatible with that of the calling DTE.	D1	M	–	–	–	5
Fast select acceptance not subscribed	The called DTE has not subscribed to the fast select acceptance facility.	D1	–	(M)	–	–	

TABLE 1/X.96 *(continuation)*

Call progress signal	Definition	Category	Applicable to: Circuit Switching	Packet Switching: VC	PVC	DG	See note
Incompatible destination	The remote DTE/DCE interface or the transit network does not support a function or facility requested (e.g. the datagram service).	D1	–	M	–	M	
Out of order	The remote number is out of order. Possible reasons include: – DTE is uncontrolled not ready – DCE power off – network fault in the local loop – in packet switched services only: X.25 [1] level 1 not functioning X.25 [1] level 2 not in operation	D1 or D2	See note 6	M (See note 7)	M (See note 7)	M (See note 7)	8
Network fault in the local loop	The local loop associated with the called DCE is faulty	D2	M (Unless out of order is provided)	See Note 7			9
DCE power off	Called DCE has no mains power or is switched off.	D1	M (Unless out of order is provided)	See Note 7			9
Uncontrolled not ready	Called DTE is uncontrolled not ready.	D1	M (Unless out of order is provided)	See Note 7			9
Controlled not ready	Called DTE is signalling controlled not ready.	D1	M	FS	FS	FS	1
Number busy	The called DTE is detected by the DCE as engaged on other call(s), and therefore as not being able to accept the incoming call. In the case of the datagram service, the queue at the destination DCE is full.	C1	M	M	–	M	
Call the information service	The called number is temporarily unobtainable, call the network information service for details.	D1	M	–	–	–	
Remote procedure error	A procedure error caused by the remote DTE is detected by the DCE at the remote DTE/DCE interface. Possible reasons are indicated in relevant Series X interface Recommendations.	D1	–	M	M	M	
Long term network congestion	A major shortage of network resource exists.	D2	M	–	–	–	10
Network operational	Network is ready to resume normal operation after a temporary failure or congestion.	C1	–	M See Note 11	M	M	
Remote DTE operational	Remote DTE/DCE interface is ready to resume normal operation after a temporary failure or out of order condition (e.g. restart at the remote DTE/DCE interface). Loss of data may have occurred.	C1 or D1	–	–	M	–	
DTE originated	The remote DTE has initiated a clear, reset or restart procedure.	B or D1	–	M	M	–	12
PAD clearing	The call has been cleared by the local PAD as an answer to an invitation from the remote DTE (X.28 [2] only).	B	–	M (X.28 [2] only)	–	–	

– Not applicable
M Mandatory in all networks
(M) Mandatory where the relevant optional user facility is provided
FS Further study

Notes concerning Table 1/X.96:

Note 1 – The international implications of *controlled not ready* and *manual answering* are for further study.

Note 2 – Sent as confirmation/answer for the *redirection activation/deactivation* facility.

Note 3 – For circuit switching, applicable only to the calling DTE.

Note 4 – The *RPOA out-of-order* call progress signal will not be returned to a DTE which does not subscribe to the *RPOA selection* facility.

Note 5 – Some networks may use the *not obtainable* call progress signal to signal this condition.

Note 6 – Used as an alternative signal in networks where one or more of the conditions *uncontrolled not ready, DCE power off* and *network fault in the local loop* cannot be uniquely identified.

Note 7 – Although the basic *out-of-order* call progress signal is transmitted for these conditions, the diagnostic field in the *clearing, resetting* or *datagram service signal* packet may give more precision.

Note 8 – 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.

Note 9 – Should be provided where the network can identify the condition.

Note 10 – Activated by the operational staff of the network.

Note 11 – Applicable only to the DTE/DCE interface (*restart* packets).

Note 12 – Possible reasons for this include *reverse charging not accepted. Reset* and *restart* are not applicable to the circuit-switching service.

References

[1] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for terminals operating in the packet mode on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.25.

[2] CCITT Recommendation *DTE/DCE interface for a start-stop mode data terminal equipment accessing the packet assembly/disassembly facility (PAD) in a public data network situated in the same country*, Vol. VIII, Fascicle VIII.5, Rec. X.28.

Recommendation X.110

ROUTING PRINCIPLES FOR INTERNATIONAL PUBLIC DATA SERVICES THROUGH SWITCHED PUBLIC DATA NETWORKS OF THE SAME TYPE

(Geneva, 1980)

1 Introduction

Routing of an international call through switched public data networks (PDNs) includes aspects different from those within a national network. This mainly results from the involvement of nonidentical networks in capability and facility, and the interworking of the networks managed independently. This leads to the necessity of routing principles for international public data networks, together with other Recommendations serving for international interworking.

This Recommendation sets forth primary guidelines of the routing to be applied to international interworking among the same types (i.e. packet-to-packet, circuit-to-circuit) of switched public data networks. Aiming at the optimization of quality of service and efficiency of operation, this Recommendation is to be further developed.

2 General routing principles

2.1 Routing of a call (see Note 1) will be a matter for the responsibility of the Administrations.

2.2 All Administrations concerned with a given call should be able to obtain the routing information for that call (e.g. the DNIC of each network concerned) (see Note 2).

2.3 The international route to be used in each relation will be determined by agreements amongst Administrations concerned.

2.4 The route for a call should be determined on a link-by-link basis.

2.5 Only the international data number as defined in Recommendation X.121 will be forwarded on the international route, i.e. any prefix used used nationally to gain access to the international gateway will not be forwarded.

3 Routing procedures applicable to international interworking between switched PDNs of the same type

3.1 International gateway switches will recognize the calling and the called DNICs or DCCs to determine the destination of a call and the routing (see Notes 2 and 3).

3.2 Routes may be selected on a per call basis.

3.3 The selection of a physical path (e.g. satellite and/or submarine cable) for a call should be determined by the Administrations concerned.

3.4 The same route (i.e. set of gateway DSEs) will be maintained for the duration of a call.

3.5 Barring procedures for particular routing will be provided by each Administration and will be the subject of bilateral agreement.

3.6 Transit networks will check routing information of each call to prevent the routing back to the originating network or a prior transit network.

Note 1 – For datagram service, which does not embrace the concept of a call, the term "call" should be interpreted as "datagram", "calling" as "source", and "called" as "destination".

Note 2 – The application of this principle to circuit-switched networks is for further study.

Note 3 – Possible digit analysis up to the first one or two digit(s) of the national number or network terminal number is also for further study.

Recommendation X.121

INTERNATIONAL NUMBERING PLAN FOR PUBLIC DATA NETWORKS

(provisional, Geneva, 1978; amended, Geneva, 1980)

The purpose of this International Numbering Plan is to facilitate the introduction of public data networks and provide for their interworking on a worldwide basis.

1 Design considerations

The design considerations that form the basis of this Plan are as follows:

1.1 There could be a number of public data networks in a country [1)].

1.2 Where a number of public data networks are to be established in a country [1)], it should not be mandatory to integrate the numbering plans of the various networks.

[1)] Country or geographical area.

1.3 The International Numbering Plan should permit the identification of a called country [1] as well as a specific public data network in that country [1].

1.4 The number of digits comprising the code used to identify a country [1] and a specific public data network in that country [1] should be the same for all countries [1].

1.5 A national data number assigned to a data terminal should be unique within a particular national network. This national data number should form part of the international data number which should also be unique on a worldwide basis.

1.6 The number of digits to be used in an international data number should be governed by national and international requirements but a reasonable limit on the overall number of digits should be imposed.

1.7 The Numbering Plan should make provision for the interworking of data terminals on public data networks with data terminals on public telephone and telex networks.

Note – The term "telex" employed in this Recommendation, includes TWX networks.

1.8 The International Numbering Plan should provide for substantial spare capacity to accommodate future requirements.

1.9 The Numbering Plan should not preclude the possibility of a single national network providing an integrated telecommunications system for services of all kinds.

1.10 Where multiple RPOA facilities exist providing service to the same country [1], provision for the selection of a specific RPOA facility should be allowed for in the *facility request* part of the *selection* signals.

Note – The term RPOA in this Recommendation refers to Recognized Private Operating Agency.

2 Characteristics and application of the Numbering Plan

2.1 *Number system*

2.1.1 The 10 digit numeric character set 0-9 should be used for numbers (or addresses) assigned to data terminals on public data networks. This principle should apply to both national and international data numbers.

2.1.2 Use of the above number system will make it possible for data terminals on public data networks to interwork with data terminals on public telephone and telex networks.

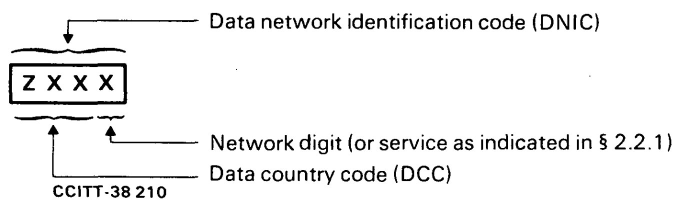
2.2 *Data network identification codes*

2.2.1 A Data Network Identification Code (DNIC) should be assigned to each public data network or, possibly, where all networks are contained within an integrated numbering scheme, to each specific service.

2.2.2 All data network identification codes (DNIC) should consist of four digits. The first three digits should always identify a country [1] and could be regarded as a Data Country [1] Code (DCC). The fourth, or network digit, should identify a specific data network or service in the country [1] as indicated in § 2.2.1 above.

2.2.3 Each country [1] should be assigned at least one 3-digit data country [1] code (DCC). The data country [1] code (DCC) in conjunction with the fourth digit can identify up to 10 public data networks. The format for data network identification codes (DNIC) should be as indicated in Figure 1/X.121.

[1] Country or geographical area.



X denotes any digit from 0 through 9

Z denotes any digit from 2 through 7 as indicated in § 2.2.4

FIGURE 1/X.121

Format for data network identification codes (DNIC)

2.2.4 In the system of data network identification codes, the first digit of such codes should be in accordance with Table 1/X.121.

TABLE 1/X.121

First digit of data network identification code

0 – 1 –	Reserved
2 – 3 – 4 – 5 – 6 – 7 –	For data network identification codes (DNIC)
8 –	For interworking with telex networks
9 –	For interworking with telephone networks

Note 1 – The allocation of codes for non-zoned services, such as the marine satellite services, is for further study. The following points could be considered:

– select a data country [1] code (DCC) in each zone to indicate the location, or

– use an escape DNIC such as 11XX.

Note 2 – Details of the Numbering Plan aspects of interworking between public data networks and public telephone and telex networks will be given in another Recommendation.

2.2.5 The system of data network identification codes (DNIC) indicated in §§ 2.2.3 and 2.2.4 above will provide for 600 data country [1] codes (DCC) and a theoretical maximum of 6000 DNIC.

2.2.6 Should a country [1] have more than 10 public data networks, an additional data country [1] codes(s) (DCC) would be assigned to it.

2.2.7 A list of data country [1] codes (DCC) to be used in the development of data network identification codes (DNIC) is given in Annex B to this Recommendation. This list was prepared in accordance with the requirement that the first digit of a DNIC, which is also the first digit of the embedded data country [1] code (DCC), should be restricted to the digits 2-7 inclusive (see § 2.2.4 above). As first digits of data country [1] codes (DCC), the digits 2-7 are arranged to represent world zones.

[1] Country or geographical area.

2.2.8 The assignment of data country [1] codes (DCC) is to be administered by the CCITT. The assignment of network digits will be made nationally and the CCITT Secretariat notified.

The Member countries of the International Telecommunication Union not mentioned in this list who wish to take part in the international data service or those Members who require an additional data country [1] code(s) (DCC) should ask the Director of the CCITT for the assignment of an available 3-digit data country [1] code(s) (DCC). In their request, they may indicate the available 3-digit code(s) preferred.

Assignments by the Director of the CCITT of data country [1] codes (DCC) as well as assignments by countries [1] of the network digits will be published in the Operational Bulletin of the International Telecommunication Union.

2.2.9 Examples indicating how data network identification codes (DNIC) could be developed, are given in Annex A to this Recommendation.

2.3 *International data number*

2.3.1 A data terminal on a public data network when called from another country [1] should be addressed by its international data number. The international data number should consist of the data network identification code (DNIC) of the called public data network, followed by the network terminal number (NTN) of the called data terminal, or, for example, where an integrated numbering scheme exists within a country [1], the data country [1] code (DCC) followed by the National Number (NN) of the called terminal, i.e.:

International data number = DNIC + NTN, or, DCC + NN

2.3.2 The Network Terminal Number (NTN) should consist of the full address that is used when calling the data terminal from within its serving public data network. The national number (NN) should consist of the full address used when calling the data terminal from another terminal within the national integrated numbering scheme. These numbers should consist of all the digits necessary to uniquely identify the data terminal within the serving network and should not include any prefix (or access code) that might be employed for such calling.

2.4 *Maximum number of digits*

2.4.1 International data numbers could be of different lengths but should not consist of more than 14 digits. With the data network identification code (DNIC) fixed at 4 digits and the data country [1] code (DCC) fixed at 3 digits, it would, therefore, be possible to have a network terminal number (NTN) of 10 digits maximum, or, a national number (NN) of 11 digits maximum.

Note – The limit of 14 digits specified above applies exclusively to the address information. Adequate register capacity should be made available at data switching exchanges to accommodate the above address digits as well as any additional digits that might be introduced for signalling, or other purposes.

2.5 *International prefix*

2.5.1 For outgoing international calls from a public data network, an international prefix (or access code) would generally be required to access appropriate facilities for international interworking. The composition of this prefix is a national matter as the prefix does not form part of the international data number. However, the possible need to accommodate such a prefix with regard to digit register capacity in the calling network should be noted.

2.6 *Number analysis – international calls between public data networks*

2.6.1 In the case of international calls between public data networks, provision should be made in originating countries [1] to interpret the first three digits of the international data number. These digits constitute the data country [1] code (DCC) component of the data network identification code (DNIC) and identify the terminal country [1]. This information is required in the originating country [1] for routing purposes.

[1] Country or geographical area.

2.6.2 In originating countries [1], it might also be necessary to interpret the fourth, or network, digit of a DNIC. Such interpretation would provide the identity of a specific network in a country [1] where several public data networks are in service. This information might be required for billing purposes or for the selection of specific routes to called networks.

Note – With regard to RPOA selection, see § 1.10 above.

2.6.3 Countries [1] receiving international calls for public data networks should receive the complete international data number including the data network identification code (DNIC). However, where a country [1] of destination indicates that it does not wish to receive the data country [1] code (DCC) component of the DNIC, arrangements should be made to suppress the DCC.

2.6.4 For destination countries [1] with more than ten public data networks, interpretation of the first three digits of the DNIC [i.e., the data country [1] code (DCC)] would identify the group of networks within which the called network is included. Interpretation of the fourth, or network, digit of the DNIC would identify the called network in that group. Interpretation of the first three digits would also make it possible to verify that an incoming call has in fact reached the correct country [1].

2.6.5 In the case of destination countries [1] where there are fewer than ten public data networks, the first three digits of the DNIC could provide the verification indicated in § 2.6.4 above. Interpretation of the fourth, or network, digit of the DNIC would identify the specific network being called.

2.6.6 In transit countries [1] the complete international data number including the data network identification code (DNIC) must always be received. Interpretation of the first three digits would identify the called country [1]. Interpretation of the fourth or network digit would identify a specific data network or a service in the called country [1]. Interpretation of the fourth digit might be required for billing purposes or for route selection beyond the transit country [1].

2.6.7 Where a data call is to be routed beyond a transit country [1] through a second transit country [1], the complete international data number, including the data network identification code (DNIC), should always be sent to the second transit country [1]. Where the data call is to be routed by a transit country [1] to the country [1] of destination, the arrangements indicated in § 2.6.3 above should apply.

2.7 *Directories and letterheads*

2.7.1 Directories for public data networks should include information on the procedures to be followed for making international data calls. A diagram, such as that of Figure 2/X.121, could assist the customer in these procedures.

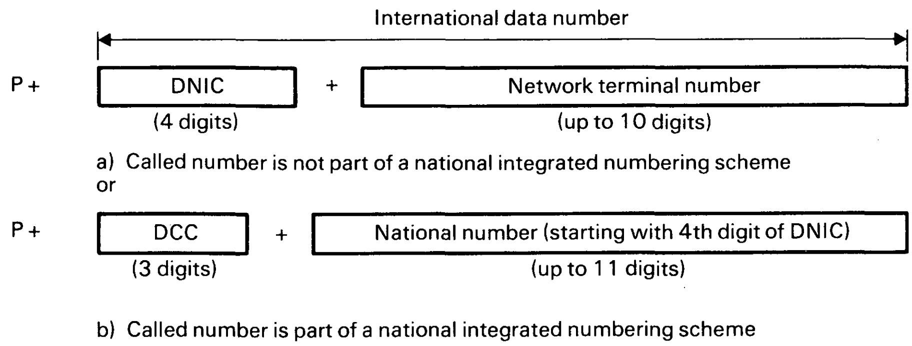
2.7.2 With regard to the prefix (or access code) shown in Figure 2/X.121, it should be noted that the same prefix (designated P) could be used for all three types of calls. The choice of prefix is, however, a national matter.

2.7.3 With regard to RPOA selection (see § 1.10 above), it should be noted that an RPOA facility request designator would be used only in international data calls. Provision of this facility as well as the designation of the RPOA facility selection designator is a national matter in the originating country [1].

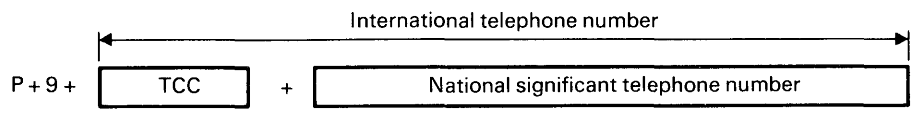
2.7.4 With regard to the publication of international data numbers on letterheads or other written material, it is recommended that the network terminal number (NTN) or national number (NN) should be easily distinguished within the international number, i.e. that there be a space between the 4-digit DNIC and the network terminal number (NTN) or, between the 3-digit data country [1] code (DCC) and the national number (NN), where the fourth digit of the DNIC is included in the national number (NN).

---

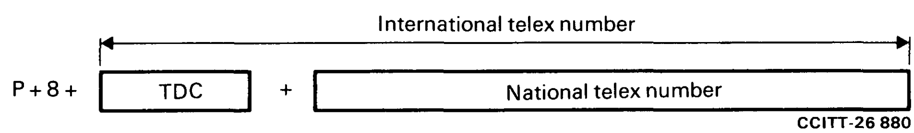
[1] Country or geographical area.



A. International identification of data terminals on public data networks



B. An example of the international identification of a data terminal on the public telephone network when accessed to or from a public data network (see Note)



C. An example of the international identification of a data terminal on the public telex network when accessed to or from a public data network (see Note)

P	international prefix
DNIC	data network identification code
DCC	data country code
TCC	telephone country code
TDC	telex destination code

Note – This illustrates the case where the data terminal on the public telephone or telex network is identified by the telephone or telex number. Other cases are possible. The various interworking scenarios will be described in a separate Recommendation.

FIGURE 2/X.121

International format

ANNEX A

(to Recommendation X.121)

Development of Data Network Identification Codes (DNIC)

Example 1

In this example, it is assumed for illustrative purposes only, that the Netherlands has established its first public data network. To develop the data network identification code (DNIC) for this network, it would be necessary for the Netherlands to assign to it a network digit to follow the listed data country [1] code (DCC) 204 (see Annex B). Assuming that the Netherlands selected the digit 0 as the network digit, the data network identification code (DNIC) for this initial network would be 2040.

Example 2

In this example, it is assumed for illustrative purposes only, that five public data networks have been established in Canada. To develop the data network identification codes for these networks, it would be necessary for Canada to assign to each of these networks a network digit to follow the listed data country [1] code (DCC) 302 (See Annex B). Assuming that Canada assigned the network digits 0-4 to the five networks, the resulting data network identification codes (DNIC) would be 3020, 3021, 3022, 3023 and 3024.

Example 3

In this example, it is assumed for illustrative purposes only, that eight public data networks have been established in the United States of America. It is also assumed that network digits 0-7 would be assigned by the United States of America to follow the listed data country [1] code (DCC) 310 (see Annex B). The data network identification codes (DNIC) thus formed for these eight networks would be 3100, 3101, 3102, 3103, 3104, 3105, 3106 and 3107.

If, some time later, four additional public data networks were to be introduced in the United States of America, two of the four new networks could be assigned network digits 8 and 9 in association with data country [1] code (DCC) 310, to produce the data network identification codes (DNIC) 3108 and 3109.

For the remaining two public data networks, the United States of America would have to ask the CCITT for an additional data country [1] code (DCC). A request for a code next in sequence, i.e. 311, could be made if this code appeared to be spare. If code 311 could be made available it would be assigned to the United States of America. If it was not available, a spare code in the "300" series of data country [1] codes (DCC) would be assigned. Assuming data country [1] code (DCC) 311 was available and issued to the United States of America, the two remaining public data networks could be assigned network digits 0 and 1 in association with data country [1] code (DCC) 311, to produce the data network identification codes (DNIC) 3110 and 3111.

The data network identification codes (DNIC) for the 12 public data networks would then be 3100, 3101, 3102, 3103, 3104, 3105, 3106, 3107, 3108, 3109, 3110 and 3111.

Example 4

In this example, it is assumed for illustrative purposes only, that a public data network is to be established in each of two Caribbean islands that are part of the group of islands known as the French Antilles. The islands concerned are Guadeloupe and Martinique.

To develop the data network identification codes (DNIC) for these public data networks, it is assumed that the French Administration would assign network digit 0 to the network in Guadeloupe and network digit 1 to the network in Martinique and associate these network digits with the listed data country [1] code (DCC) 340 for the French Antilles (see Annex B). The data network identification codes (DNIC) thus formed would be 3400 for Guadeloupe and 3401 for Martinique.

This example indicates that the system of data network identification codes (DNIC) is appropriate for application to groups of islands or regions of a country [1] since one data country [1] code (DCC) could provide for up to ten public data networks dispersed over several islands or regions. At the same time such island or regional networks would be distinguishable from each other.

---

1) Country or geographical area.

ANNEX B

(to Recommendation X.121)

List of data country or geographical area codes

Note – The countries or geographical areas shown in this Annex include those that already have code assignments in the case of other public telecommunication networks.

Zone 2

Code	*Country or Geographical Area*
202	Greece
204	Netherlands (Kingdom of the)
206	Belgium
208	France
212	Monaco
214	Spain
216	Hungarian People's Republic
218	German Democratic Republic
220	Yugoslavia (Socialist Federal Republic of)
222	Italy
226	Roumania (Socialist Republic of)
228	Switzerland (Confederation of)
230	Czechoslovak Socialist Republic
232	Austria
234	United Kingdom of Great Britain and Northern Ireland
238	Denmark
240	Sweden
242	Norway
244	Finland
250	Union of Soviet Socialist Republics
260	Poland (People's Republic of)
262	Germany (Federal Republic of)
266	Gibraltar
268	Portugal
270	Luxembourg
272	Ireland
274	Iceland
276	Albania (Socialist People's Republic of)
278	Malta (Republic of)
280	Cyprus (Republic of)
284	Bulgaria (People's Republic of)
286	Turkey

Zone 2, Spare Codes: 68

Zone 3

Code	*Country or Geographical Area*
302	Canada
308	St. Pierre and Miquelon
310	United States of America
330	Puerto Rico
332	Virgin Islands (USA)

Zone 3 *(cont'd)*

Code	*Country or Geographical Area*
334	Mexico
338	Jamaica
340	French Antilles
342	Barbados
344	Antigua
346	Cayman Islands
348	British Virgin Islands
350	Bermuda
352	Grenada
354	Montserrat
356	St. Kitts
358	St. Lucia
360	St. Vincent
362	Netherlands Antilles
364	Bahamas (Commonwealth of the)
366	Dominica
368	Cuba
370	Dominican Republic
372	Haiti (Republic of)
374	Trinidad and Tobago
376	Turks and Calcos Islands

Zone 3, Spare Codes: 74

Zone 4

Code	*Country or Geographical Area*
404	India (Republic of)
410	Pakistan (Islamic Republic of)
412	Afghanistan (Democratic Republic of)
413	Sri Lanka (Democratic Socialist Republic of)
414	Burma (Socialist Republic of the Union of)
415	Lebanon
416	Jordan (Hashemite Kingdom of)
417	Syrian Arab Republic
418	Iraq (Republic of)
419	Kuwait (State of)
420	Saudi Arabia (Kingdom of)
421	Yemen (Arab Republic)
422	Oman (Sultanate of)
423	Yemen (People's Democratic Republic of)
424	United Arab Emirates
425	Israel (State of)
426	Bahrain (State of)
427	Qatar (State of)
428	Mongolian People's Republic
429	Nepal
430	United Arab Emirates (Abu Dhabi)
431	United Arab Emirates (Dubai)
432	Iran (Islamic Republic of)
440	Japan
450	Korea (Republic of)
452	Viet Nam (Socialist Republic of)
454	Hong Kong
455	Macao

Zone 4 *(cont'd)*

Code	*Country or Geographical Area*
456	Democratic Kampuchea
457	Lao People's Democratic Republic
460	China (People's Republic of)
470	Bangladesh (People's Republic of)
472	Maldives (Republic of)

Zone 4, Spare Codes: 67

Zone 5

Code	Country or Geographical Area
502	Malaysia
505	Australia
510	Indonesia (Republic of)
515	Philippines (Republic of)
520	Thailand
525	Singapore (Republic of)
528	Brunei
530	New Zealand
535	Guam
536	Nauru (Republic of)
537	Papua New Guinea
539	Tonga (Kingdom of)
540	Solomon Islands
541	New Hebrides
542	Fiji
543	Wallis and Futuna Islands
544	American Samoa
545	Gilbert & Ellice Islands
546	New Caledonia and Dependencies
547	French Polynesia
548	Cook Islands
549	Western Samoa

Zone 5, Spare Codes: 78

Zone 6

Code	*Country or Geographical Area*
602	Egypt (Arab Republic of)
603	Algeria (Algerian Democratic and Popular Republic)
604	Morocco (Kingdom of)
605	Tunisia
606	Libya (Socialist People's Libyan Arab Jamahiriya)
607	Gambia (Republic of the)
608	Senegal (Republic of the)
609	Mauritania (Islamic Republic of)
610	Mali (Republic of)
611	Guinea (Revolutionary People's Republic of)
612	Ivory Coast (Republic of the)
613	Upper Volta (Republic of)
614	Niger (Republic of the)

Code	*Country or Geographical Area*
615	Togolese Republic
616	Benin (People's Republic of)
617	Mauritius
618	Liberia (Republic of)
619	Sierra Leone
620	Ghana
621	Nigeria (Federal Republic of)
622	Chad (Republic of the)
623	Central African Republic
624	Cameroon (United Republic of)
625	Cape Verde (Republic of)
626	Sao Tome and Principe (Democratic Republic of)
627	Equatorial Guinea (Republic of)
628	Gabon Republic
629	Congo (People's Republic of the)
630	Zaire (Republic of)
631	Angola (People's Republic of)
632	Guinea-Bissau (Republic of)
633	Seychelles
634	Sudan (Democratic Republic of the)
635	Rwanda (Republic of)
636	Ethiopia
637	Somali Democratic Republic
638	Republic of Djibouti
639	Kenya (Republic of)
640	Tanzania (United Republic of)
641	Uganda (Republic of)
642	Burundi (Republic of)
643	Mozambique (People's Republic of)
645	Zambia (Republic of)
646	Madagascar (Democratic Republic of)
647	Reunion (French Department of)
648	Zimbabwe
649	Namibia
650	Malawi
651	Lesotho (Kingdom of)
652	Botswana (Republic of)
653	Swaziland (Kingdom of)
654	Comoros (Federal and Islamic Republic of the)
655	South Africa (Republic of)

Zone 6, Spare Codes: 47

Zone 7

Code	*Country or Geographical Area*
702	Belize
704	Guatemala (Republic of)
706	El Salvador (Republic of)
708	Honduras (Republic of)
710	Nicaragua
712	Costa Rica
714	Panama (Republic of)
716	Peru
722	Argentine Republic

Code	*Country or Geographical Area*
724	Brazil (Federative Republic of)
730	Chile
732	Colombia (Republic of)
734	Venezuela (Republic of)
736	Bolivia (Republic of)
738	Guyana
740	Ecuador
742	Guiana (French Department of)
744	Paraguay (Republic of)
746	Suriname (Republic of)
748	Uruguay (Oriental Republic of)

Zone 7, Spare Codes: 80

Recommendation X.130

PROVISIONAL OBJECTIVES FOR CALL SET-UP AND CLEAR-DOWN TIMES IN PUBLIC SYNCHRONOUS DATA NETWORKS (CIRCUIT SWITCHING)

(Geneva, 1980)

The establishment of public synchronous data networks in various countries and the subsequent interconnection of these networks creates a need to define objective values for the call set-up and clear-down times.

The CCITT,

considering that

(a) Recommendation X.1 [1] defines the international user classes of service,

(b) Recommendation X.21 [2] defines the interface characteristics,

(c) Recommendation X.60 [3] defines the common channel signalling for synchronous data applications – data user part,

(d) Recommendation X.92 defines the hypothetical reference connections for public synchronous data networks,

(e) Recommendation X.121 defines the international numbering plan,

unanimously declares the view

that the objective values for call set-up and clear-down times should provisionally [1] be as indicated in Tables 1/X.130 to 6/X.130.

Explanatory considerations

1. Call set-up and clear-down times are defined referring to the hypothetical reference connections of Recommendation X.92, Link B.

[1] It is expected that these values will be subject to further refinements as a consequence of enhancements of other CCITT Recommendations and following the experience gained from the implementation of public data networks.

2. Call set-up time is defined for a basic call with no additional facilities.

3. Clear-down time is defined as the time to disconnect a call in order that a new call may be initiated.

4. Common channel signalling is considered between Data Switching Exchanges (DSEs) with both the associated and nonassociated mode of operation.

The nonassociated mode of operation is considered with two Signalling Transfer Points (STPs) in each national network and one STP in the international network when the basic signalling rate of 64 kbit/s is used.

5. The objective values given in this Recommendation are also applicable to lower signalling rates (less than 4.8 kbit/s) when the associated mode of operation is assumed.

6. Automatic call from the DTE is assumed.

7. DTE response delay is assumed to be of one character emission time at user rate.

8. A 5 ms/1000 km figure is assumed for propagation delay.

9. Call set-up time is subdivided into: call request, selection and post selection times. The first two times depend mainly on the characteristics of the DTE/DCE interface and on signalling towards the network; only the post selection time is fully network dependent.

Average values are defined within the Recommendation.

TABLE 1/X.130

Call set-up time; typical connection of moderate length

User rate (bit/s)	Call request time (ms)	Selection time (ms)	Post selection time (ms)
600	180	260	1200
2400	80	70	1000
4800	60	40	900
9600	60	20	900
48000	50	5	900

TABLE 2/X.130

Call set-up time; typical long connection

User rate (bit/s)	Call request time (ms)	Selection time (ms)	Post selection time (ms)
600	180	260	1400
2400	80	70	1200
4800	60	40	1100
9600	60	20	1100
48000	50	5	1100

TABLE 3/X.130

Call set-up time; longest terrestrial connection

User rate (bit/s)	Call request time (ms)	Selection time (ms)	Post selection time (ms)
600	180	260	1600
2400	80	70	1400
4800	60	40	1300
9600	60	20	1300
48000	50	5	1300

TABLE 4/X.130

Call set-up time; long-distance international connection via satellite – one international circuit

User rate (bit/s)	Call request time (ms)	Selection time (ms)	Post selection time (ms)
600	180	260	2000
2400	80	70	1800
4800	60	40	1700
9600	60	20	1700
48000	50	5	1700

TABLE 5/X.130

Call set-up time; long-distance international connection via two satellites – two international circuits

User rate (bit/s)	Call request time (ms)	Selection time (ms)	Post selection time (ms)
600	180	260	3000
2400	80	70	2800
4800	60	40	2700
9600	60	20	2700
48000	50	5	2700

TABLE 6/X.130

Clear down time

User rate (bit/s)	Clear down time (ms)
600	230
2400	120
4800	100
9600	100
48000	100

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.1.

[2] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for synchronous operation on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.21.

[3] CCITT Recommendation *Common channel signalling for synchronous data applications – data user part*, Vol. VIII, Fascicle VIII.6, Rec. X.60.

Recommendation X.132

PROVISIONAL OBJECTIVES FOR GRADE OF SERVICE IN INTERNATIONAL DATA COMMUNICATIONS OVER CIRCUIT SWITCHED PUBLIC DATA NETWORKS

(Geneva, 1980)

The CCITT,

considering that

(a) Recommendation X.1 [1] defines the user classes of service in public data networks,

(b) Recommendation X.20 [2] defines the DTE/DCE interface for start-stop transmission services in public data networks,

(c) Recommendation X.21 [3] defines the DTE/DCE interface for synchronous transmission services in public data networks,

(d) Recommendations X.60 [4], X.70 [5] and X.71 [6] define the international signalling procedures between public data networks,

(e) Recommendation X.92 defines hypothetical reference connections for public synchronous data networks,

(f) the Grade Of Service (GOS), as a measure of the traffic handling capability of the network, is a component of the overall quality of service experienced by the users, as well as a factor influencing the overall cost of the network,

(g) traffic engineering needs some GOS objectives for network planning,

unanimously declares the view that

the values of GOS defined in this Recommendation be observed as design objectives for the average busy hour.

1 Introduction

In circuit-switched networks, the parameters that critically affect the GOS are:

- the congestion in various network sections traversed by the call,
- the network response time for call set-up.

In §§ 2, 3 and 4 the values of these GOS parameters are specified for the following parts of the connection, as defined in Recommendation X.92:

- originating national network (Link B1 in Recommendation X.92),
- international path (Link G1 in Recommendation X.92),
- destinating national network (Link B1 in Recommendation X.92),
- end-to-end connection (Link B in Recommendation X.92).

2 GOS referred to network congestion

2.1 The GOS referred to congestion phenomenon depends on many factors, such as routing systems in national and international parts of the connection, congestion in trunk circuits between DSEs, congestion within DSEs, noncoincidence of busy hours in different countries, etc.

In § 2, limiting values for congestion probabilities in each part of the international connection are established as GOS parameters.

2.2 In circuit-switched networks, the GOS referred to congestion will be defined by the probability of a call request not being satisfied within a certain time limit, because of network congestion.

This time limit depends on the type of DTE/DCE interface owned by the user, and is specified in relevant Recommendations X.20 [2], X.21 [3], etc.

2.3 In each of the three parts (B1, G1 and B1 in Recommendation X.92) that compose the international connection, the GOS objective referred to network congestion will be a% for the last choice route.

Administrations or RPOAs operating the origin and destination national networks should dimension their networks in order to ensure the a% of congestion probability in Link B1.

In the same way, the dimensioning of the international path, G1, should ensure such a% of congestion probability.

With this condition, congestion limits should be assigned to different DSEs and trunk circuits between them to ensure the overall recommended value.

2.4 The overall end-to-end GOS of the international connection will always be less than the sum of congestion probabilities in each of the three parts into which the connection is divided.

The overall value will then be less than $3a$%.

2.5 In order to attain the GOS objectives established above, the number of tandem sections traversed by the call should be limited, both in national and international parts of the connection. While no other Recommendation is established, such a limit will fit the HRC defined in Recommendation X.92.

3 GOS referred to network response time

3.1 The GOS referred to response time will be expressed as a limiting value of the call set-up time, by means of a probability of exceeding such a limit.

3.2 In call set-up through a circuit-switched network, there is a previous delay between the transmission of the *call request* signal by the subscriber and the reception, by that subscriber, of the *proceed-to-select* signal from the network. This delay may be called Call Request Time (CRT).

Once the selection signals have been transmitted by the subscriber, a time elapses up to the instant at which the network confirms that call set-up is finished and data transfer phase may commence. This call set-up time is composed, on one hand of the time taken by the network in setting up the connection between originating and destinating exchanges and, on the other hand of the time taken by the called DTE to respond to the incoming call signal. These times may be called respectively, Post Selection Time (PST) and Subscriber Response Time (SRT).

Times CRT and PST are the GOS parameters that affect, on the part of the network, the total call set-up time.

3.3 The specification of a GOS figure referred to call request time is a national responsibility of the Administrations.

However, it might be recommended that such a time would be less than t seconds for b% of call requests. This means:

$$\text{Prob}(\text{CRT} \geqslant t) \leqslant (100 - b)10^{-2}$$

3.4 The post selection time will be less than T seconds, end-to-end of the connection (Link B in Recommendation X.92), for c% of calls entering the selection phase. That is to say:

$$\text{Prob (PST} \geqslant T) \leqslant (100 - c)10^{-2}$$

The contribution of each of the originating and destinating national networks, as well as the international part of the connection, to this overall delay is for further study.

3.5 The call Set-Up Time (SUT) would be in the worst case:

$$\text{SUT} = (\text{PST} + \text{SRT}) < (T + \text{SRT}) \text{ (in seconds)}$$

for c% of calls.

4 Factors that improve the GOS

4.1 The noncoincidence of busy hours in origin and destination national networks as well as in the international network, will improve the overall grade of service with respect to the sum of the nominal values of GOS established for each part.

4.2 Time differences will also improve the overall GOS.

4.3 The GOS parameters established in this Recommendation are to be considered as design objectives in network planning, together with the forecast traffic for the planned period. The actual GOS that will be obtained will depend on the accuracy of the traffic estimations. Normally the actual GOS will not coincide with the one utilized in the planning. Furthermore, if the network is planned for the traffic forecast at the end of the period considered, the GOS will stand over the design values, decreasing gradually up to the end of the planning period.

Note – The numerical values of the parameters a, b, c, t and T are for further study.

References

[1] CCITT Recommendation *International user classes of service in public data networks*, Vol. VIII, Fascicle VIII.4, Rec. X.1.

[2] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for start-stop transmission services on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.20.

[3] CCITT Recommendation *General purpose interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for synchronous operation on public data networks*, Vol. VIII, Fascicle, VIII.5, Rec. X.21.

[4] CCITT Recommendation *Common channel signalling for synchronous data applications – data user part*, Vol. VIII, Fascicle VIII.6, Rec. X.60.

[5] CCITT Recommendation *Terminal and transit control signalling system for start-stop services on international circuits between anisochronous data networks*, Vol. VIII, Fascicle VIII.6, Rec. X.70.

[6] CCITT Recommendation *Decentralized terminal and transit control signalling system on international circuits between synchronous data networks*, Vol. VIII, Fascicle VIII.6, Rec. X.71.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

SECTION 5

MAINTENANCE

Recommendation X.150

DTE AND DCE TEST LOOPS FOR PUBLIC DATA NETWORKS

(Geneva, 1980)

1 Introduction

The CCITT,

considering

(a) the increasing use being made of data transmission systems,

(b) the volume of the information circulating on data transmission networks,

(c) the savings to be made by reducing interruption time on such data circuits,

(d) the importance of being able to determine responsibilities in maintenance questions for networks, of necessity involving several parties, and

(e) the advantages of standardization in this field,

unanimously declares the view

that the locating of faults can be facilitated in many cases by data circuit loop testing procedures in DTEs and DCEs.

2 Scope

This Recommendation, at present, only details the procedures for DTE/DCE test loops in synchronous data networks employing interfaces according to Recommendation X.21 [1] or X.21 *bis* [2]. However, the definitions of the loops given in § 3 are also applicable for asynchronous DTEs and the loop activation procedures and the events at the DTE/DCE interfaces for such DTEs are found in the appropriate interface Recommendations X.20 [3] and X.20 *bis* [4].

3 Definition of the loops

Nine loops are defined as shown in Figure 1/X.150. For clarity these nine loops have been grouped as follows:

a) DTE test loop – type 1 loop	(§ 3.1)
Loop 1	(§ 3.1.1)
b) local test loops – type 3 loops	(§ 3.2)
Loop 3d	(§ 3.2.1)
Loop 3c	(§ 3.2.2)

Loop 3b (§ 3.2.3)

Loop 3a (§ 3.2.4)

c) Subscriber-line test loops – type 4 loops (§ 3.3)

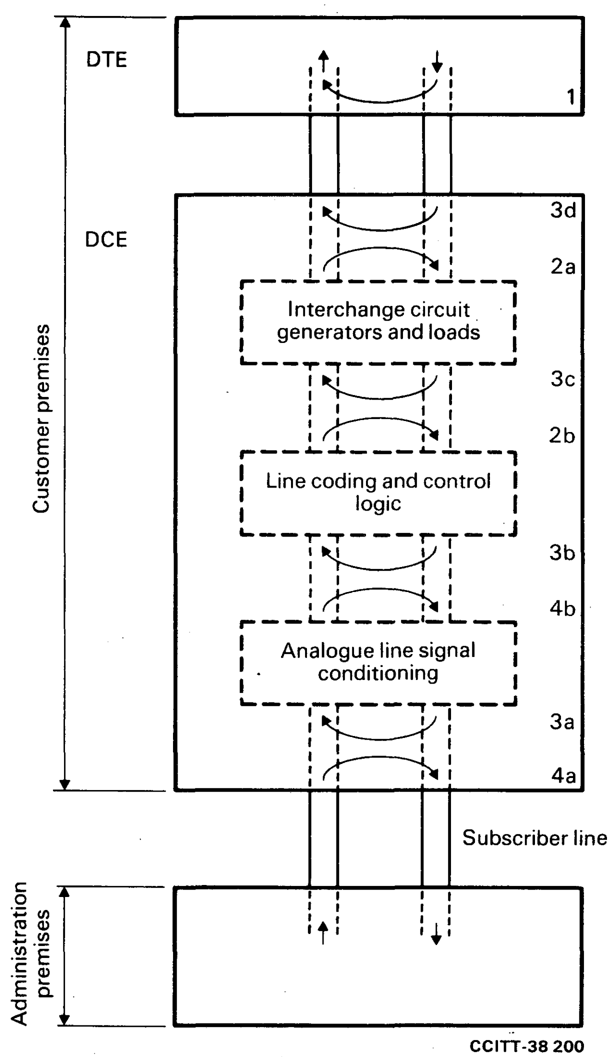
Loop 4a (§ 3.3.1)

Loop 4b (§ 3.3.2)

d) Network test loops – type 2 loops (§ 3.4)

Loop 2b (§ 3.4.1)

Loop 2a (§ 3.4.2)



Note – The back-to-back loopbacks (e.g. 3d/2a. 3c/2b. 3b/4b and 3a/4a) that are provided should be configured in such a manner that there is no active equipment between the loopbacks. For example: an Administration may operate the back-to-back loopbacks simultaneously in the same relay or switch.

FIGURE 1/X.150

3.1 *DTE test loop – type 1 loop*

3.1.1 *Loop 1*

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

3.1.1.1 *X.21 [1] interface*

While the DTE is in the loop 1 test condition:

- circuit T is connected to circuit R inside of the DTE;
- circuit C is connected to circuit I inside of the DTE;
- at the interface, the DTE signals t = 0, c = OFF or, alternatively, may present an open circuit or power off condition on circuit T and circuit C;
- the DCE continues to present signal element timing on circuit S and, if implemented, byte timing on circuit B. The DTE need not make use of the timing information.

3.1.1.2 *X.21 bis [2] interface*

While the DTE is in the loop 1 test condition:

- circuit 103 is connected to circuit 104 inside of the DTE;
- circuit 103 as presented to the DCE must be in the binary 1 condition;
- circuit 105 must be in the OFF condition;
- circuit 108/1 or 108/2 may be in the same condition as it was before the test;
- circuit 125 should continue to be monitored by the DTE so that an incoming call can be given priority over a routine loop test;
- circuits 140 and 141, if implemented, must be in the OFF condition;
- the DCE continues to present signal element timing information on circuits 114 and 115. The DTE need not make use of the timing information.

The conditions of the other interchange circuits are not specified.

3.2 *Local test loops – type 3 loops*

3.2.1 *Loop 3d*

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

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

3.2.1.1 *X.21 [1] interface*

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

- circuit T is connected to circuit R inside of the DCE;
- circuit C is connected to circuit I inside of the DCE;
- the DCE behaves to the subscriber line as if the DTE were signalling t = 0, c = OFF: this does not prevent the DCE from making type 2 or 4 loop tests during the loop 3d test condition;
- the DCE continues to present signal element timing on circuit S and, if implemented, byte timing on circuit B. The DTE must make use of the timing information.

3.2.1.2 *X.21 bis [2] interface*

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

- circuit 103 is connected to the circuit 104 interface lead;
- circuit 105 is connected to both circuits 106 and 109;

  Note – DTE designers should note that this connection results in one generator driving two loads in parallel.
- circuits 107 and 142 are placed in the ON condition;
- the DCE will react as if circuit 108/1 or 108/2 were in the OFF condition: this does not prevent the DCE from making type 2 or 4 loop tests during the loop 3d test condition;
- the DCE continues to present signal element timing information on circuits 114 and 115. The DTE must make use of the timing information.

3.2.2 *Loop 3c*

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

3.2.2.1 *X.21 [1] interface*

The configuration is identical to that given for loop 3d in § 3.2.1.1 with the exception that the looping of circuit T to circuit R and the looping of circuit C to circuit I include the interchange circuit generators and loads. The note concerning restriction of interface cable length is not applicable.

3.2.2.2 *X.21 bis [2] interface*

The configuration is identical to that given for loop 3d in § 3.2.1.2 with the exception of the location of the looping. Signals transmitted on circuits 103 and 105 are presented on circuits 104 and 109, respectively. Circuit 106 should follow circuit 105 with the usual delay or with no delay. The notes concerning restriction of interface cable length and load input impedance are not applicable.

3.2.3 *Loop 3b*

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

Note – In some DCEs, the setting of loop 3b will result in momentary loss of envelope alignment causing random signals to appear on the receiving interchange circuit for a period of time. This may impact upon the DTE test procedure. Refer to the DCE Recommendations for information regarding the signal element timing.

3.2.3.1 *X.21 [1] interface*

The configuration is identical to that given for loop 3c in § 3.2.2.1 except for the location of the point of loopback. The DTE must make use of the timing information.

3.2.3.2 *X.21 bis [2] interface*

The configuration is identical to that given for loop 3c in § 3.2.2.2 except for the location of the point of loopback. The DTE must make use of the timing information.

3.2.4 *Loop 3a*

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

Note – In some DCEs, the setting of loop 3a will result in momentary loss of envelope alignment causing random signals to appear on receiving interchange circuits for a period of time. This may impact upon the DTE test procedure. Refer to the DCE Recommendations for information regarding the signal element timing.

3.2.4.1 *X.21 [1] interface*

The configuration is identical to that given for test loop 3b in § 3.2.3.1 except for the location of the point of loopback.

3.2.4.2 *X.21 bis [2] interface*

The configuration is identical to that given for test loop 3b in § 3.2.3.2 except for the location of the point of loopback.

3.3 *Subscriber-line test loops – type 4 loops*

3.3.1 *Loop 4a*

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

3.3.1.1 *X.21 [1] interface*

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

– the DCE signals to the local DTE r = 0, i = OFF,

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

3.3.1.2 *X.21 bis [2] interface*

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

– circuit 104 to the DTE is placed in the binary 1 condition,

– circuits 106, 107, 109 and 125 to the DTE are placed in the OFF condition,

– circuit 142 to the DTE is placed in the ON condition,

– the DCE provides timing information on circuits 114 and 115.

3.3.2 *Loop 4b*

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

3.3.2.1 *X.21 [1] interface*

The configuration is identical to that given for loop 4a in § 3.3.1.1.

3.3.2.2 *X.21 bis [2] interface*

The configuration is identical to that given for loop 4a in § 3.3.1.2.

3.4 *Network test loops – type 2 loops*

3.4.1 *Loop 2b*

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

3.4.1.1 *X.21 [1] interface*

The configuration is identical to that given for loop 4a in § 3.3.1.1. Signals incoming from the network towards circuits R and I are diverted from these circuits and looped back to the network in place of signals from circuits T and C, respectively.

- At the DTE/DCE interface the DCE signals r = 0, i = OFF.
- The DCE provides timing information on circuit S and, if implemented, on circuit B.

3.4.1.2 *X.21 bis [2] interface*

The operation is identical to that given for loop 4a in § 3.3.1.2. 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.

- While the test is in progress the DCE will place circuit 104 in the binary 1 condition, circuits 106, 107, 109 and 125 in the OFF condition and circuit 142 in the ON condition.
- The DCE provides timing information on circuits 114 and 115.

3.4.2 *Loop 2a*

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

3.4.2.1 *X.21 [1] interface*

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

- circuit R is connected to circuit T inside of the DCE,
- circuit I is connected to circuit C inside of the DCE,
- at the interface, the DCE signals r = 0, i = OFF or, alternatively may present an open circuit or power off condition on circuit R and circuit I,
- the DCE provides timing information on circuit S and, if implemented, on circuit B.

3.4.2.2 *X.21 bis [2] interface*

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

- circuit 104 is connected to circuit 103 inside of the DCE,
- circuit 109 is connected to circuit 105 inside of the DCE,
- at the interface, the DCE places circuit 104 in the binary 1 condition and circuit 109 in the OFF condition or, alternatively, may present an open circuit or power off condition on circuits 104 and 109,
- circuits 106, 107 and 125 to the DTE are placed in the OFF condition,
- circuit 142 to the DTE is placed in the ON condition,
- the DCE provides timing information on circuit 114 and 115.

4 Minimum implementation of test loops

4.1 *DCE test loops*

Sufficient test loops should be provided in the DCE to allow the customer and/or the Administration's maintenance personnel to positively distinguish between DTE and DCE/line faults.

The DCE will implement at least one of the four local test loops (type 3). The DCE also will implement at least one of the two network test loops (type 2). The implementation of the loops within the DCE is a national matter. Implementation of test loops beyond the minimum set specified above may be provided by some Administrations.

4.2 *DTE test loops*

It is suggested that all new DTEs provide loop 1.

5 Loop control

5.1 *General*

Means are not provided for remotely controlling a loop in one country from a location in another country. This is for further study.

In leased circuit services, subscriber-line and network test loops should *not* be activated before the customer has been informed. However, some Administrations may activate these loops when abnormal conditions are detected in the network without first informing the customer.

In circuit-switched services, subscriber-line and network test loops should not be activated when the DTE is engaged in a call. In case of a collision between call request and the activation of these loops, the loop activation command will have priority and the call request will be cancelled. These loops may be activated without the prior knowledge and agreement of the customer for periods which, provisionally, do not exceed one second. This time limit should be confirmed or amended after further study.

5.2 *Control of the local test loops*

To facilitate the testing of the DTE by the customer, manual activation (by means of a switch on the DCE) will be provided for at least one of the four local test loops (type 3); however the precise implementation is a national matter. However, customer-controlled automatic activation of the local test loops via the DTE/DCE interface should be considered, as follows:

a) In the case of the X.21 *bis* [2] interface, the automatic activation of the local test loops is controlled by circuit 141, in conformance with Recommendation V.24 [5].

b) In the case of the X.21 [1] interface, the automatic activation of the local test loops is for further study.

Note – With the introduction of the new electrical interchange circuits as defined in Recommendations X.26 [6]/X.27 [7], some Administrations may locate the DCE in a location that is remote (up to 1000 metres) from the DTE. Therefore, manual loop activation by the customer may be either difficult or impossible. Thus, some form of an automatic activation of these loops should be considered. Also the limitations in the Note of § 3.2.1 loop 3d, should be considered.

5.3 *Control of the network test loops*

5.3.1 *General*

Each network test loop implemented in the DCE will be activated either by a manual switch on the DCE or remotely from the Administration's test centre(s) or both. The means for loop activation, the method for achieving remote control and the method for notifying the network of manual activation are national matters. Random signals may be delivered to the DTE prior to closing of loops.

Where loop 2a or loop 2b is provided for customer use, the procedure for their use (including the way the customer obtains the result) must be studied further.

5.3.2 *Leased circuits*

5.3.2.1 *Point-to-point leased lines*

In case of point-to-point leased line circuits, the Administrations will provide one or more of the following:

a) customer control of the network test loop in the local DCE via a manually operated switch on the DCE,

b) customer control of the network test loop via the remote DTE/DCE interface.

Note – As stated above, the provision for the remote control of a loop in one country from a location in another country is for further study.

c) remote control from the Administration's data test centre.

In order to provide a standard method for activation of the network test loop in a DCE by a control signal from the remote DTE/DCE interface, the following procedures are provisionally accepted:

i) In case of the X.21 [1] interface, the procedures are for further study.

ii) In case of the X.21 *bis* [2] interface, customer control of the loop should be by interchange circuit 140, in conformity with Recommendation V.24 [5] (see also [8]).

In either case, the control signal between international networks, is for further study.

Note – Some Administrations may use the remote control technique within their networks, as in i) and ii) above, but may block the control signal coming from another country or from a remote DTE/DCE interface within the country.

5.3.2.2 *Centralized multipoint leased circuits*

The remote control of network test loops in centralized multipoint circuits is for further study. In this regard, the techniques of Recommendation V.54 [9] will be taken into account.

5.3.3 *Switched networks*

In a similar manner to the technique described in § 5.3.2.1 above, Administrations may provide a means for remotely controlling the network test loop from their maintenance centre(s). This is recognized to be a national matter, but the procedure to be used is for further study. The automatic control of network test loops in a DCE via the remote DTE/DCE interface is for further study.

5.4 *Control of subscriber-line test loops*

These loops are provided in the case of 4-wire subscriber lines. They are designed for the maintenance of lines by Administrations using analogue type measurements. The provision of and use of these loops is a national matter.

References

[1] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for synchronous operation on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.21.

[2] CCITT Recommendation *Use on public data networks of data terminal equipment (DTE) which is designed for interfacing to synchronous V-Series modems*, Vol. VIII, Fascicle VIII.5, Rec. X.21 *bis.*

[3] CCITT Recommendation *Interface between data terminal equipment (DTE) and data circuit terminating equipment (DCE) for start-stop transmission services on public data networks*, Vol. VIII, Fascicle VIII.5, Rec. X.20.

[4] CCITT Recommendation *Use on public data networks of data terminal equipment (DTE) which is designed for interfacing to asynchronous duplex V-Series modems*, Vol. VIII, Fascicle VIII.5, Rec. X.20 *bis.*

[5] CCITT Recommendation *List of definitions for interchange circuits between data terminal equipment and data circuit terminating equipment*, Vol. VIII, Fascicle VIII.2, Rec. V.24.

[6] CCITT Recommendation *Electrical characteristics for unbalanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications*, Vol. VIII, Fascicle VIII.5, Rec. X.26.

[7] CCITT Recommendation *Electrical characteristics for balanced double-current interchange circuits for general use with integrated circuit equipment in the field of data communications*, Vol. VIII, Fascicle VIII.5, Rec. X.27.

[8] CCITT Recommendation *Use on public data networks of data terminal equipment (DTE) which is designed for interfacing to synchronous V-Series modems*, Vol. VIII, Fascicle VIII.5, Rec. X.21 *bis*, § 3.3.

[9] CCITT Recommendation *Loop test devices for modems*, Vol. VIII, Fascicle VIII.3, Rec. V.54.

SECTION 6

ADMINISTRATIVE ARRANGEMENTS

Recommendation X.180

ADMINISTRATIVE ARRANGEMENTS FOR INTERNATIONAL CLOSED USER GROUPS (CUGs)

(Geneva, 1980)

The CCITT,

bearing in mind

(a) the introduction of international CUGs in public data networks;

(b) the need to standardize a scheme for international CUG numbers;

(c) the need to standardize administrative procedures for allocation of international CUG numbers and the establishment of international CUGs;

unanimously declares the view that

1 One subscriber, hereafter called the "responsible subscriber", shall clearly be allocated the responsibility for all organizational matters relating to an international CUG. The responsible subscriber shall be nominated by the subscribers intending to form an international CUG (see Note 1).

2 The Administration of the country housing this "responsible subscriber" (hereafter called the "coordinating Administration") shall act as the controlling and coordinating Administration for that CUG and shall carry out the discussions with the responsible subscriber about changes to the CUG. The coordinating Administration shall also be responsible for allocating the International CUG Number (ICN) and for issuing the necessary information to other Administrations involved in the CUG.

3 The DNIC or DCC used for the construction of the ICN would be one proper to the coordinating Administration. If the responsible subscriber changes his country of residence, the ICN shall be changed in accordance with the DNIC or DCC of the new coordinating Administration.

4 The ICN allocated by the coordinating Administration shall be retained for the period of existence of the international CUG even if the location of members of the CUG changes, as long as the responsible subscriber is located within the area of the coordinating Administration.

5 The ICN will be represented by two decimal numbers A/B, where A is the DNIC or DCC (plus one digit) in accordance with § 3 above, and B is a 1-5 digit number (see Note 2).

6 In order to allow efficient conversion of CUG information, where required, for international CUG calls, restrictions on allocation of the ICNs used by each coordinating Administration have to be applied. Provisionally the following guidelines should apply:

i) each coordinating Administration should allocate the ICNs to international CUGs in sequence within a certain range of the available total range of ICNs;

ii) information should be sent regularly to the Administrations concerned about the size and allocation of the range used for ICNs in i) above;

iii) the size of the range used should not be bigger than necessary for the operation of the network.

7 The following procedures should apply for the interchange of information between Administrations and subscribers of an international CUG. Where a subscriber belongs to more than one international CUG the procedures in this Recommendation must be applied separately for each international CUG.

7.1 A subscriber applying for membership of an international CUG shall apply to his own Administration using standard application procedures. He should supply full details of the responsible subscriber (see Note 3).

7.2 The Administration receiving the request should pass details in a standard format to the coordinating Administration as indicated in Annex A.

7.3 The coordinating Administration will then verify with the responsible subscriber whether the application can be permitted and, if acceptable, will inform the applying subscriber's Administration of the ICN allocated for that particular CUG.

7.4 The Administration of the applying subscriber shall inform the coordinating Administration when the applying subscriber is connected.

7.5 The existing member Administrations of an international CUG shall be informed by the coordinating Administration when a subscriber of a new Administration has become a member of that CUG.

7.6 Changes in membership of an international CUG or cessation of a CUG shall similarly be arranged between the responsible subscriber and the coordinating Administration following individual applications from the members of the CUG concerned.

7.7 The coordinating Administration shall, on request from the responsible subscriber or one of the member Administrations of an international CUG, supply information (print out) of all subscribers in that particular CUG. The approval of the responsible subscriber is needed in the latter case (see Note 4).

8 The fact that the applying subscriber may be a member of other CUGs or may wish to have outgoing or incoming access in addition to the CUG facility is of no relevance to the administrative procedures contained in this Recommendation.

Note 1 – It is assumed that in a CUG of an international organization the headquarters branch probably will be the responsible subscriber.

Note 2 – According to Recommendation X.87 [1], the value B should not be greater than $2^{16} - 1 = 65535$.

Note 3 – To simplify the administrative arrangements, the procedures in §§ 6.1 and 6.2 should be followed also in the case where the applying subscriber is a branch of an international organization and another branch of that organization is the responsible subscriber.

Note 4 – Legal, or other, considerations may preclude some coordinating Administrations from supplying such information at the request of other member Administrations of an international CUG.

ANNEX A

(to Recommendation X.180)

The format and information to be passed to the coordinating Administration following an application from a subscriber to join or cease membership of an international closed user group is as follows:

1 Application to join/cease membership of an international closed user group (CUG) on a public data network (PDN) has been received from:

Firm
Address
Country
PDN No.
Date of application

2 The responsible subscriber for this international CUG is:

Firm
Address
PDN No.

3 The responsible subscriber's international CUG number (ICN) or national data number:

4 The applying subscriber requires the following facility (if any):

- incoming calls barred within the CUG
- outgoing calls barred within the CUG

Reference

[1] CCITT Recommendation *Principles and procedures for realization of international user facilities and network utilities in public data networks*, Vol. VIII, Fascicle VIII.6, Rec. X.87.

Printed in Switzerland — ISBN 92-61-01171-3