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SIGNALLING PROCEDURES

1 Normal call set-up

In this Recommendation the signalling procedures are described for the normal call set-up of an international call. The messages and signals are defined in Recommendation Q.722 and the format and content are given in Recommendation Q.723.

Recommendation Q.724

1.1 *Initial address message*

An *initial address message* which is sent as the first message of a call set-up generally includes all of the information required by the next international exchange to route the call. The seizing function is implicit in the reception of this initial address message.

The sending sequence of address information will be the country code (not sent to an incoming international exchange) followed by the national (significant) number. For calls to operator positions (code 11 and code 12), refer to Recommendation Q.107 [1].

All digits required for routing the call through the international network will be sent in the initial address message. On calls with a country code in the address (except in the case of calls to special operators), the initial address message will contain a minimum of 4 digits and should contain as many digits as are available. All digits of the address may be included; however, the initial address message can contain one digit in specific circumstances, e.g. national applications.

Selection of the outgoing national circuit normally can start at the incoming international exchange on receipt of the initial address message and signalling can proceed on the first national link.

When no echo suppressor or nature-of-circuit indication is received from a preceding circuit using a signalling system with fewer facilities, the indicators will be considered as received *no* , unless exchange data indicates otherwise.

Note — When additional signalling information (e.g. related to supplementary services) is to be sent, an initial address message with additional information may be used.

1.2 *Subsequent address message*

The remaining digits, if any, of the address may be sent individually in one-digit messages or in groups in multidigit messages. Efficiency can be gained by grouping together as many digits as possible.

However, to prevent an increase in post-dialling delay in those cases where overlap operation with subscribers’ dialling is used, it may be desirable to send the last few digits individually. With reference to the withholding of digits, sufficient digits should be withheld to avoid the operation at subsequent exchanges of the short 4-6 second timeout which may be used in certain cases to determine the address complete condition. (See Recommendation Q.608, § 8.2.1).

Subsequent address messages can be sent on the national network as they are received. If a continuity-check has to be performed on one or more of the international circuits involved in the connection, appropriate measures [e.g. by withholding the last digit(s) of the national number] must be taken at the last common channel exchange to prevent ringing the called subscriber or alerting the operator until the continuity of such speech circuits has been verified.

Note — If in the international network the code 0000 in the number of address signals field is received the message is considered as faulty.

1.3 *End-of-pulsing (ST) signal*

The end-of-pulsing (ST) signal is always sent in the following situations:

a) semiautomatic calls,

b) test calls, and

c) when the end-of-pulsing signal is received from a preceding circuit.

In automatic working, the end-of-pulsing signal will be sent whenever the outgoing international exchange is in a position to know, by digit analysis, that the final digit has been sent. Digit analysis may consist of an examination of the country code and counting the maximum (or fixed) number of digits of the national number. In other cases, the end-of-pulsing signal is not sent and the end-of-address information is determined by the receipt of one of the address-complete signals from the incoming international exchange.

1.4 *Continuity-check of the telephone circuits*

Because the signalling in Signalling System No. 7 does not pass over the speech path, facilities should be provided for making a *continuity-check* of the speech path in the circumstances described below.

The application of the continuity-check depends on the type of the transmission system used for the telephone circuit.

For transmission systems having some inherent fault indication features giving an indication to the switching system in case of fault, a continuity check is not required. This situation commonly occurs when fully digital circuits are used. However, a per-call continuity check may be needed on fully digital circuits when circuits or bundles of circuits in primary multiplex groups are dropped and inserted en route between switches and alarm indications carried on bits of the primary multiplex frame structure are lost in passing through an intermediate transmission facility that does not relay them transparently. Typically, per-call continuity checks may be needed when the transmission link between switches contains a TDMA satellite system, a digital circuit multiplication system or a digital access and crossconnection system, where fault indications are lost.

When an initial address message is received with a request for a continuity-check relating to a digital circuit having inherent fault indication, one of the following actions is taken:

a) the continuity-check request is disregarded; or

b) a continuity-check loop is connected and the maintenance system is alerted. In this case the call may fail since no continuity signal may be received from the distant end.

Note — The reception of such a request could only be caused by an abnormal condition such as administrative errors or the occurrence of signalling errors.

When the circuit type is unknown to a Signalling System No. 7 exchange, or in an application where both analogue and digital circuits may be served, or when no inherent fault indication is available, a continuity-check loop should always be connected in the following cases:

i) when the exchange has the capability to process initial address messages with continuity-check request and such messages are received;

ii) when continuity-check requests are received.

For analogue circuits with pilot supervision it is sufficient to perform the continuity-check on a statistical basis or by test calls (see § 7.5) i.e. analogue and digital circuits, the continuity-check should be performed on a per call basis. Within mixed connections, i.e. connections composed of circuits with and without continuity-check on a per call basis, it shall be ensured that the continuity signal be forwarded to the destination point although no continuity-check may have been performed on one or more parts of the end-to-end connection.

The continuity-check is not intended to eliminate the need for routine testing of the transmission path.

The continuity-check of the speech circuit will be done, link-by-link, on a per call basis or by a statistical method prior to the commencement of conversation. Procedures and requirements are specified in § 7.

The actions to be taken when pilot supervision is used are described in § 9.

1.5 *Cross-office check*

For digital exchanges the requirements mentioned in Recommendation Q.504 [2] shall be met. For other exchanges Administrations shall ensure the reliability of a connection through a switching machine (cross-office check) either on a per call basis or by a statistical method. With either method, the probability of the connection being established with an unacceptable speech path transmission quality should not exceed 10^{D}lF261^{5} as the long-term average.

1.6 *Address-complete signals*

An *address-complete* signal will not be sent until the continuity signal has been received and the cross-office check made, if they are applicable.

If the succeeding network does not provide electrical called-party's-line-condition signals, the last Signalling System No.7 exchange shall originate and send an address-complete signal when the end of address signalling has been determined and a possible GRQ/GSM cycle has been completed:

a) by receipt of an end-of-pulsing signal;

b) by receipt of the maximum number of digits used in the national numbering plan;

c) by analysis of the national (significant) number to indicate that a sufficient number of digits has been received to route the call to the called party;

d) by receipt of an end-of-selection signal from the succeeding network (e.g. number received signal in Signalling System No. 4); or

e) exceptionally, if the succeeding network uses overlap signalling and number analysis is not possible, by observing that 4 to 6 seconds have elapsed since the last digit was received, and that no fresh information has been received; in such circumstances, transmission to the national network of the last digit received must be prevented until the end of the waiting period which causes an address-complete signal to be sent over the international circuit. In this way, it is ensured that no national answer signal can arrive before an address-complete signal has been sent.

Specifically, in cases d) and e) above, the address-complete charge signal should be sent.

Note — If the succeeding network provides electrical called-party's-line-condition signals, the last Signalling System No. 7 exchange shall originate and send address-complet signal when that condition has been received from the succeeding network and a possible GRQ/GSM cycle has been completed.

If in normal operation, delay in the receipt of an address-complete or equivalent signal from the succeeding network is expected, the last common channel signalling exchange will originate and send an address-complete signal 15 to 20 seconds after receiving the latest address message. This time-out condition is an upper limit considering the clauses

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The application to the international circuits and the quantitative aspects (in particular, the frequency of performing the continuity-check) are for further study.

of § 6.4.1 (20 to 30 seconds for outgoing international exchanges in abnormal release conditions).

On receipt of an address-complete signal, the first Signalling System No. 7 exchange will through-connect the speech path of the interconnected circuit

It is envisaged that in the future evolution of the Telephone User Part (e.g. in the context of an integrated services digital network) the through-connection immediately after sending of the initial address message may become a mandatory requirement.

After an address-complete signal, only the following signals relating to the call set-up may be sent in the backward direction:

a) in normal operation, one of the answer or release-guard signals;

b) call-failure signal; or

c) the national network congestion signal; or

d) the circuit group congestion signal.

Note — Cases b), c) and d) can only occur after an address complete signal without subscriber free.

Any further information about the called-party's-line-condition will be transmitted to the calling subscriber or operator as audible tones or announcements.

The address-complete signal with the subscriber-free indication is sent when it is known that the called subscriber's line is free (not busy). It must be originated in the called subscriber's exchange, and therefore cannot be followed by one of the unsuccessful backward set-up information signals.

If an incoming international exchange has sent a general request message, then an address complete message must not be sent until a general forward set-up information message has been received in response to that general forward set-up information message.

1.7 *Address-incomplete signal*

The determination that the proper number of digits has not been received can be made at once if the end-of-pulsing signal is received or by receipt of an *address-incomplete* signal (or equivalent) from the national network. When overlap working is used and the end-of-pulsing signal has not been received, the address-incomplete signal will be sent by the last common channel Signalling exchange 15 to 20 seconds after receipt of the latest digit.

Each Signalling System No. 7 exchange on receipt of the address-incomplete signal will send the signal to the preceding Signalling System No. 7 exchange, if any, and clear forward the connection. The first Signalling System No. 7 exchange will send a suitable signal on the preceding circuit if the related signalling system permits to do so; otherwise the appropriate tone or announcement for the national network concerned will be sent to the calling party.

1.8 *Congestion signals*

As soon as the congestion condition is detected one of the *congestion* signals (see Recommendation Q.722, § 3.4) is sent without waiting for the completion of a possible continuity-check sequence.

Reception of a congestion signal at any Signalling System No. 7 exchange will cause the clear-forward signal to be sent and cause an appropriate signal to be sent to the preceding exchange if the signalling system allows this or an appropriate tone or announcement to be sent to the originating subscriber or operator.

1.9 *Called-party's-line-condition signals*

The *called-party's-line-condition* signals (see Recommendation Q.722, § 3.4) will be sent when the appropriate electrical signals are received at the incoming international exchange from the national network.

The *called-party's-line-condition* signals will be sent without waiting for the completion of a possible continuity check. On receipt of one of these signals, the first Signalling System No. 7 exchange (or the outgoing international exchange) will clear forward the connection and cause an appropriate signal to be sent to the preceding exchange if the signalling system allows this or an appropriate tone or announcement to be sent to the originating subscriber or operator.

Each Signalling System No. 7 exchange on receipt of one of these signals has to clear forward the connection.

1.10 *Answer signals*

The signals *answer*, *charge and answer*, *no charge* are sent as received from the national network or from the succeeding international link.

The signals answer, charge and answer, no charge are used only as a result of the first off-hook signal from the called party.

1.11 *Clear-back signal*

A *clear-back* signal must not disconnect the speech path at a Signalling System No. 7 exchange. The requirements for the release of a connection in the event that a clear-forward signal is not received are given in Recommendation Q.118 [3].

1.12 *Reanswer and clear-back signal sequences*

Subsequent off-hook, on-hook signals from the called party, such as will result from switch-hook flashing, will cause the following sequence of signals to be sent:

— clear-back,

— reanswer,

— clear-back,

— reanswer,

— etc.

It is necessary that a flashing sequence be retransmitted to the operator (or the preceding link) and that the final condition of the circuit represents the final position of the called party's switch hook.

1.13 *Forward-transfer signal*

The *forward-transfer* signal may be sent in semiautomatic working in either of the following two cases:

a) following a call switched automatically to a subscriber, or following a call established via a special operator, the controlling operator wishes to call in an assistance operator. On receipt of the forward-transfer signal at the incoming international exchange, an assistance operator is called in;

b) following a call via code 11 and 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. Receipt of the forward-transfer signal at the incoming international exchange recalls the incoming operator on calls completed via the operator positions at the exchange.

1.14 *Clear-forward and release-guard sequences*

The *clear-forward* signal is overriding and all exchanges must be in a position to respond by releasing the circuit and sending a *release-guard* signal at any time during the progress of a call and even if the circuit is in the idle condition. If sent while a circuit is blocked it will not result in unblocking the circuit concerned (see § 5). The fact that the circuit is blocked will not delay the transmission of the release-guard signal.

1.15 *Reset of circuits and circuit groups*

In systems which maintain circuit status in memory there may be occasions when the memory becomes mutilated. In such a case the circuits must be reset to the idle condition in both exchanges to make them available for new traffic. Since the exchange with the mutilated memory does not know whether the circuits are idle, busy outgoing, busy incoming, blocked, etc., reset-circuit signals or a circuit group reset message should be sent as appropriate for the affected circuits. The reset-circuit signal may also be sent, in certain cases, when a signalling fault occurs (see §§ 6.2 and 6.5).

1.15.1 *Reset-circuit signal*

If only a few circuits are concerned a reset-circuit signal should be sent for each affected circuit.

On receipt of a reset-circuit signal the unaffected exchange will:

a) accept the signal as a clear-forward signal and respond by sending a release-guard signal, after the circuit has been made idle, if it is the incoming exchange on a connection in any state of call set-up or during a call;

b) accept the signal as a clear-back or call-failure signal, whichever is appropriate, and respond by sending a clear-forward signal immediately if it is the outgoing exchange on a connection;

c) accept the signal as a clear-forward signal and respond by sending a release-guard signal if the circuit is in the idle condition;

d) if it has previously sent a blocking signal, or if it is unable to release the circuit as described above, respond by the blocking signal. If an incoming or outgoing call is in progress, this call should be disconnected and the circuit returned to the idle (blocked) state. A clear-forward or release-guard signal may be sent. The blocking signal should be acknowledged by the affected exchange. If the acknowledgement is not received, the repetition procedure specified in § 6.4.4 should be followed;

e) if it had previously received the blocking signal, respond by disconnecting any connected call, remove the blocked condition and restore the circuit to the idle state. If an outgoing call had been in progress, respond with a clear-forward or, in all other cases, a release-guard signal;

f) if a reset-circuit signal is received after the sending of an initial address message but before receipt of a backward signal relating to that call, clear the circuit and make an automatic repeat attempt on another circuit if appropriate.

g) if a reset-circuit signal is received after having sent a reset-circuit signal, respond by a release-guard signal. The circuit should be restored to traffic;

h) send an appropriate clearing signal on an interconnected circuit (e.g., clear-forward, or a suitable backward signal).

The affected exchange will then reconstruct its memory according to the received acknowledgement to the reset-circuit signal, and respond to the signals received in the normal way, i.e. release-guard in response to a clear-forward, blocking-acknowledgement in response to a blocking signal.

In addition, an interconnected circuit may be cleared by the use of an appropriate signal. If no acknowledgement to the reset-circuit signal is received before 4-15 seconds, the reset-circuit signal should be repeated. If an acknowledgement for the signal is not received within 1 minute after the sending of the initial reset-circuit signal, maintenance personnel should be notified to permit manual restoration procedures. However, the sending of the reset-circuit signal should continue at 1-minute intervals until maintenance intervention occurs.

1.15.2 *Circuit group reset message*

If a considerable number of circuits or all circuits are affected by the memory mutilation, circuit group reset messages should be used to make these circuits available for new traffic.

Since the effect of erroneous circuit group reset messages generated by undetected errors may seriously affect the quality of service, each circuit group reset message has to be sent twice.

On receipt of two circuit group reset messages with 5 seconds for the same group or parts thereof the unaffected exchange will:

i) If the range field is not coded all zero:

a) restore the circuits involved to the idle state;

b) send the appropriate group blocking message(s) if it had previously sent a hardware failure oriented and/or software generated group blocking message;

c) respond by a circuit group reset-acknowledgement message in which the status indicator bits of the circuits available for service or blocked for reasons of hardware failure or a software generated alarm are coded 0 and the status indicator bit of all circuits blocked for maintenance reasons are set to 1.

ii) If the range field is coded all zero (national option)

a) send the appropriate group blocking message(s) if it had previously sent a hardware oriented and/or a software generated group blocking message;

b) start the restoration of the circuits on a per circuit basis in the same way as after receipt of a reset circuit for each circuit within the group (see § 1.15.1);

c) respond by a circuit group reset-acknowledgement message indicating that the restoration of the circuits concerned was started.

iii) Independent from the coding of the range field the following actions should take place in the unaffected exchange after receipt of two circuit group reset signals within 5 seconds:

a) if it had previously received (a) blocking signal(s) or (a) blocking message(s) for one or more of the circuit(s) involved the blocked condition will be removed and the circuits will be made available for service;

b) if a circuit group reset message is received after having sent a circuit group reset message or (a) reset circuit signal(s) the circuits involved in both the sent and the received message/signal(s) are made available for service;

c) appropriate signals should be sent on interconnected circuits to release them.

The affected exchange will then reconstruct its memory according to the possibly received blocking messages and the received circuit group reset-acknowledgement message. It will respond to the possibly received group blocking messages in the normal way.

If no acknowledgement to a circuit group reset message is received before 4-15 seconds the circuit group reset message should be repeated (twice). If acknowledgement for the message is not received within 1 minute after sending the initial circuit group reset message maintenance personnel should be notified to permit manual restoration procedures. However, the sending of the circuit group reset message should continue at 1 minute intervals until maintenance intervention occurs.

1.16 *Analysis of digit information for routing*

(See Recommendation Q.107 **|** fIbis .)

1.17 *Diagrams showing signal sequence*

Some examples of call set-up sequences are shown diagrammatically (Tables 1/Q.724 and 2/Q.724).

1.18 *Use of the General Request Message and the General Forward Set-up Information Message (GRQ/GSM)*

The following procedures shall be applicable to exchanges generating or receiving GRQ or GSM messages:

a) The GRQ/GSM protocol can only be initiated during call set-up.

b) A unique GSM must be sent in response to a GRQ and must only contain answers to all requests contained in the GRQ.

c) At a transit exchange, once a GRQ has been sent, there is no requirement to wait for the resultant GSM before setting up a connection to a succeeding exchange, unless the information requested is necessary for routing/analysis functions for that call.

d) An exchange having sent a GRQ should wait until the GSM is received before sending an Address Complete Message (ACM). However, in a whole Signalling System No. 7 international network there is no requirement in the international transit exchange to delay sending the ACM, even if the GRQ/GSM cycle is not completed (i.e. ignore GSM).

e) A subsequent GRQ must not be sent from the same exchange before a reply (GSM) has been received in response to the previous GRQ. Consequently any GRQ's received by an exchange subsequent to the first GRQ and prior to replying with a GSM shall be ignored.

f) The GRQ-GSM interchange shall always take place on a link-by-link basis. This means that an exchange receiving a GRQ for which it does not hold the information, must initiate a separate GRQ/GSM cycle on the preceding link.

g) Information received in the GSM, other than that specifically requested in the associated GRQ, will be ignored.

h) An exchange shall store any information gained on a call by using the GRQ/GSM interchange or receipt of an IAM/IAI, until the call is completed successfully or failed.

i) If a call attempt fails (e.g., receipt of CGC, NCC, CFL, etc.) during the period when an exchange is waiting for a GSM, then the appropriate backward call failure shall be sent without waiting for the GSM.

j) Failure to receive a GSM in response to a GRQ will result in the preceding exchange failing the call due to non-receipt of the ACM (T2 timer expires in 20-30 seconds).

H.T. [T1.724]

TABLE 1/Q.724

Semiautomatic (SA) and automatic (A) terminal traffic

(error-free operation assumed)

TABLEAU 1/Q.724 [T1.724] MONTAGE RECUP DE L'ORIGINAL

H.T. [T2.724]

TABLE 2/Q.724 (sheet 1 of 4)

Semiautomatic (SA) and automatic (A) transit traffic

(error-free operation assumed)

TABLEAU 2/Q.724 [T2.724] MONTAGE RECUP DE L'ORIGINAL + MONTER

LA NOTE SUR LA JUSTIF.

a) Solid arrows denote common channel signals; dotted arrows are tones sent via the speech path (check-tone and audible tones).

H.T. [T3.724]

TABLE 2/Q.724 (sheet 2 of 4)

TABLEAU 2/Q.724 [T3.724] MONTAGE RECUP DE L'ORIGINAL + MONTER LES NOTES SUR LA JUSTIF.

b) The address-complete signal may come from the national network.

c) Unless a no-charge answer or address-complete signal has been received.

H.T. [T4.724]

TABLE 2/Q.724 (sheet 3 of 4)

TABLEAU 2/Q.724 [T4.724] MONTAGE RECUP DE L'ORIGINAL

H.T. [T5.724]

TABLE 2/Q.724 (sheet 4 of 4)

TABLEAU 2/Q.724 [T5.724] MONTAGE RECUP DE L'ORIGINAL

Table 1/Q.724 [T1.724], p.

H.T. [T2.724]

TABLE 2/Q.724 (sheet 1 of 4)

Semiautomatic (SA) and automatic (A) transit traffic

(error-free operation assumed)

TABLEAU 2/Q.724 [T2.724] MONTAGE RECUP DE L'ORIGINAL + MONTER

LA NOTE SUR LA JUSTIF.

a)

Solid arrows denote common channel signals; dotted arrows are tones sent via the speech path (check-tone and audible tones).

H.T. [T3.724]

TABLE 2/Q.724 (sheet 2 of 4)

TABLEAU 2/Q.724 [T3.724] MONTAGE RECUP DE L'ORIGINAL + MONTER LES

NOTES SUR LA JUSTIF.

b) The address-complete signal may come from the national network.

c) Unless a no-charge answer or address-complete signal has been received.

H.T. [T4.724]

TABLE 2/Q.724 (sheet 3 of 4)

TABLEAU 2/Q.724 [T4.724] MONTAGE RECUP DE L'ORIGINAL

H.T. [T5.724]

TABLE 2/Q.724 (sheet 4 of 4)

TABLEAU 2/Q.724 [T5.724] MONTAGE RECUP DE L'ORIGINAL

Table 2/Q.724 (Sheet 1 of 4) [T2.724], p.

H.T. [T3.724]

TABLE 2/Q.724 (sheet 2 of 4)

TABLEAU 2/Q.724 [T3.724] MONTAGE RECUP DE L'ORIGINAL + MONTER LES

NOTES SUR LA JUSTIF.

b)

The address-complete signal may come from the national network.

c)

Unless a no-charge answer or address-complete signal has been received.

H.T. [T4.724]

TABLE 2/Q.724 (sheet 3 of 4)

TABLEAU 2/Q.724 [T4.724] MONTAGE RECUP DE L'ORIGINAL

H.T. [T5.724]

TABLE 2/Q.724 (sheet 4 of 4)

TABLEAU 2/Q.724 [T5.724] MONTAGE RECUP DE L'ORIGINAL

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H.T. [T4.724]
TABLE 2/Q.724 (sheet 3 of 4)
TABLEAU 2/Q.724 [T4.724] MONTAGE RECUP DE L'ORIGINAL
H.T. [T5.724]
TABLE 2/Q.724 (sheet 4 of 4)
TABLEAU 2/Q.724 [T5.724] MONTAGE RECUP DE L'ORIGINAL
Table 2/Q.724 (Sheet 3 of 4) [T4.724], p.

H.T. [T5.724]

TABLE 2/Q.724 (sheet 4 of 4)

TABLEAU 2/Q.724 [T5.724] MONTAGE RECUP DE L'ORIGINAL

Table 2/Q.724 (Sheet 4 of 4) [T5.724], p.

2 Dual seizure with both-way operation

2.1 *Dual seizure*

Since Signalling System No. 7 circuits have the capability of *both-way* operation, it is possible that the two exchanges will attempt to seize the same circuit at approximately the same time.

2.2 *Unguarded interval*

Considering that with Signalling System No. 7:

a) signalling data link propagation time may be relatively long,

b) there may be significant delay due to retransmissions,

c) quasi-associated operation may add extra message transfer time(s) at signalling transfer points,

the unguarded interval during which *dual seizure* can occur may be relatively long in some instances. The exchange must therefore detect dual seizure and take action as defined in § 2.5.

2.3 *Detection of dual seizure*

A dual seizure is detected by an exchange from the fact that it receives an initial address message for a circuit for which it has sent an initial address message (see also § 7.5.1).

2.4 *Preventive action*

Different methods for circuit selection can be envisaged to minimize the occurrence of dual seizure. In the following, two methods are described. Further study is required to determine the field of application of each method and to ensure that the two methods do interwork satisfactorily.

Other methods for circuit selection may also be used provided that they give the same degree of protection against dual seizure also when one of the methods specified is used at the other end.

Method 1

An opposite order of selection is used at each terminal exchange of a both-way circuit group.

Method 2

Each terminal exchange of a both-way circuit group has priority access to the group of circuits which it is controlling (see § 2.5). Of this group the circuit which has been released the longest is selected *(first-in* | (hy | fIfirst-out) . In addition each terminal exchange of a both-way circuit group has nonpriority access to the group of circuits which it is noncontrolling. Of this group the latest released circuit is selected *(last-in* | (hy | fIfirst-out) .

For call control purposes a both-way circuit group can be subdivided into subgroups in an exchange.

It is necessary to take preventive action in cases where Signalling System No. 7 uses a signalling data link with long propagation time.

2.5 *Action to be taken on detection of dual seizure*

Each exchange will control one half of the circuits in a both-way circuit group. On detection of a dual seizure, the call being processed by the control exchange for that circuit will be completed and the received initial address message will be disregarded.

Under these conditions, the call being processed by the control exchange will be allowed to complete although, when continuity-check has to be performed, the continuity of the circuit may have been checked in the direction from noncontrol to control only. The call being processed by the noncontrol exchange will be backed off, switches released, the continuity-check transceiver removed, and the check-loop connected unless or until a continuity signal has been received from the control exchange. A clear-forward signal will not be sent. The noncontrol exchange will make an automatic repeat attempt on the same or on an alternative route.

For the purpose of resolution of dual seizure on both-way circuits, the exchange with the higher signalling point code will control all even-numbered circuits (circuit identification code) and the other exchange the odd-numbered circuits. The designation of control may also be used for maintenance control purposes.

3 Automatic repeat attempt

Automatic repeat attempt, as defined in Recommendation Q.12 [4], is provided in Signalling System No. 7.

An automatic repeat attempt will be made:

— upon failure of the continuity-check (see § 7.3);

— on detection of dual seizure (at the noncontrol exchange) (see § 2.5);

— on receipt of the blocking signal after sending an initial address message and before any backward signal has been received (see § 6);

— on receipt of a reset-circuit signal after sending an initial address message and before a backward signal has been received;

— on receipt of unreasonable signalling information after sending an initial address message and before one of the backward signals required for call set-up has been received.

4 Speed of switching and signal transfer in international exchanges

4.1 *Outgoing international exchange*

At the outgoing international exchange:

— if overlap operation is used, the sending of the initial address message shall take place as soon as sufficient digits are received and analyzed to permit the selection of an outgoing circuit;

— if ‘‘en bloc’’ operation is used, the initial address message should be sent as soon as all the digits of the address including the end-of-pulsing signal are available and the outgoing circuit has been chosen.

4.2 *International transit exchange*

At the international transit exchange, the selection of an outgoing circuit should begin as soon as the digits necessary to determine the routing have been received and analyzed.

4.3 *Incoming international exchange*

At the incoming international exchange:

— if overlap operation is used in the national network, the setting-up of the national part of the connection should start as soon as a sufficient number of digits has been received for routing;

— if ‘‘en bloc’’ operation is used in the national network, the setting-up of the national part of the connection should start as soon as all the digits of the address including the end-of-pulsing signal have been received.

5 Blocking and unblocking of circuits and circuit groups

The circuit blocking (unblocking) signal and the group blocking (unblocking) message are provided to permit the switching equipment or maintenance personnel to remove from (and return to) traffic, the distant terminal(s) at a circuit or circuit group because of fault or to permit testing. Specific conditions for automatic sending of blocking and unblocking signals and messages by the switching equipment in case of use of the interruption control on interexchange circuits appear in § 9.

Since circuits served by Signalling System No. 7 have both-way capability, the blocking signal or a group blocking message can be originated by either exchange. The receipt of the blocking signal or a group blocking message will have the effect of prohibiting calls on the relevant circuit(s) outgoing from that exchange until an unblocking signal or the appropriate group unblocking message is received, but will not in itself prohibit calls incoming to that exchange. Acknowledgement sequences are always required for the blocking and unblocking signals as well as for the group blocking and group unblocking messages, using the blocking-acknowledgement signal, the unblocking-acknowledgement signal, the appropriate group blocking-acknowledgement message and the appropriate group unblocking-acknowledgement message, respectively. The acknowledgement is not sent until the appropriate action, either blocking or unblocking, has been taken. The clear forward signal should not override a blocking condition and return circuits to service which might be faulty. (A) blocked circuit(s) will be returned to service on transmission of the unblocking-acknowledgement signal or the appropriate group unblocking-acknowledgement message at one exchange and on receipt of the unblocking-acknowledgement signal or the appropriate group unblocking-acknowledgement message at the other exchange.

A circuit that has been maintenance blocked by a blocking signal can be unblocked by either an unblocking signal or a maintenance oriented group unblocking message. A circuit that has been maintenance blocked by a maintenance oriented group blocking message can be unblocked by either an unblocking signal or a maintenance oriented group unblocking message.

5.1 *Other actions on receipt of a blocking signal*

In the event of the receipt of a blocking signal:

— after an initial address message has been sent, and

— before a backward signal relating to that call has been received,

an automatic repeat attempt will be made on another circuit. The exchange receiving the blocking signal should clear forward the original attempt in the normal manner after sending the blocking-acknowledgement signal.

If the blocking signal for a circuit is received:

— in the outgoing exchange after at least one backward signal relating to a call has been received, or

— in the incoming exchange after at least one backward signal relating to a call has been sent,

the exchange will not seize that circuit for subsequent calls.

The fact that the circuit is engaged on a call will not delay transmission of the blocking (unblocking)-acknowledgement signal.

If a blocking signal is sent and subsequently an initial address message is received in the opposite direction, the following action is taken:

— for test calls, the call should be accepted, if possible. In the case where the test call cannot be accepted, the blocking signal must be returned;

— for calls other than test calls, the blocking signal must be returned.

Blocking of a circuit that has not been withdrawn from service by use of the blocking signal should not exceed five minutes, after which an alarm should be given at each terminal of the circuit. Should a call be in progress on the circuit involved, the five minutes time will commence when that call is cleared. If the work on the circuit must exceed five minutes, the circuit should be withdrawn from service.

5.2 *Group blocking and unblocking messages*

The following group blocking (unblocking) messages and the appropriate acknowledgement messages are provided:

— maintenance oriented group blocking (unblocking) message;

— hardware failure oriented group blocking (unblocking) message;

— software generated group blocking (unblocking) message (national option).

The range of circuits to be blocked (unblocked) is dependent on the coding of the range field:

— if the range field is not coded all zero, the circuits indicated in the status field have to be blocked (unblocked);

— if the range field is coded all zero all circuits of the predetermined circuit group have to be blocked (unblocked).

The same rule applies to the acknowledgements.

Since the effect of erroneous group blocking (unblocking) messages generated by undetected errors may seriously affect the quality of service, each group blocking (unblocking) message has to be sent twice. Therefore, at the receiving exchange actions only take place after a blocking (unblocking) message was received twice within 5 seconds.

For the circuits blocked for maintenance reasons the same conditions apply and the same actions have to be taken as described in § 5.1.

For the circuits blocked for reasons of hardware failure or software generated alarm, the following actions will be taken:

— the maintenance personnel will be alerted;

— all interconnected circuits will be released by the appropriate signals;

— the affected circuits will be set to the condition idle/hardware or software blocked without any exchange of clearing signals.

6 Release of international connections and associated equipment

6.1 *Normal release conditions*

Connections are normally released in the forward direction as a result of the receipt of a clear-forward signal from the preceding exchange.

In addition, the normal release of connections (or circuits) occurs as follows:

— on continuity-check failure (see § 7.3);

— on receipt of an address-incomplete signal (see § 1.7);

— on receipt of one of the congestion signals (see § 1.8);

— on receipt of one of the called-party’s-line-condition signals (see § 1.9);

— on receipt of the blocking signal or the maintenance oriented group blocking message after sending an initial address message and before a backward signal relating to that call has been received (see § 5);

— on receipt of unreasonable signalling information after sending an initial address message and before one of the backward signals required for call set-up has been received (see § 6.5).

If the conditions for the normal release of connections as described above are not fulfilled, release is provided as follows:

— in the release under abnormal conditions (see § 6.4);

— on receipt of a call-failure signal (see § 6.3);

— on failure to receive a clear-forward signal after sending a clear-back signal (see § 6.4);

— on failure to receive an answer signal (see § 6.4);

— on receipt of a reset-circuit signal or circuit group reset message (see § 1.15).

Address and routing information are released from memory in each of the exchanges of a connection as described in the following subsections.

6.1.1 *Outgoing international exchange*

Address and routing information stored at the outgoing international exchanges can be erased on receipt of one of the following backward signals:

a) one of the address-complete signals,

b) the address-incomplete signal,

c) one of the congestion signals,

d) one of the called-party’s-line-condition signals,

e) the call-failure signal,

or when the connection is cleared earlier and no automatic repeat attempt has to be made.

6.1.2 *Incoming international exchange*

Address and routing information stored at the incoming international exchange can be erased on receipt of one of the backward signals indicated in § 6.1.1 (or equivalent) from a national signalling system, or when one of the following signals has been originated and sent to the outgoing international exchange:

a) one of the address-complete signals,

b) the address-incomplete signal,

c) one of the congestion signals,

d) the call-failure signal,

e) the reset-circuit signal, or circuit group reset message,

or on receipt of a clear-forward signal.

6.1.3 *International transit exchange*

Address and routing information stored at an international transit exchange can be erased on receipt of one of the backward signals indicated in § 6.1.1, on receipt of a clear-forward signal, or when one of the congestion signals is originated in that exchange.

6.2 *Abnormal release conditions — Clear-forward, release-guard sequences*

6.2.1 *Inability to release in response to a clear-forward signal*

If an exchange is unable to return the circuit to the idle condition in response to a clear-forward signal, it should remove the circuit from service and send the blocking signal. Upon receipt of the blocking-acknowledgement signal, the release-guard signal is sent in acknowledgement of the original clear-forward signal.

6.2.2 *Inability to release in response to a backward signal*

If an exchange is unable to release a circuit in response to an address-incomplete, congestion, called-party's-line-condition or call-failure signal, it should remove the circuit from service by sending the blocking signal. Upon receipt of the blocking-acknowledgement signal, the clear-forward signal should be sent in reply to the original backward signal.

6.2.3 *Failure to receive a release-guard signal in response to a clear-forward signal*

If a release-guard signal is not received in response to a clear-forward signal before 4-15 seconds, the clear-forward signal will be repeated.

If, after sending a clear-forward signal, a release-guard signal is not received within a period of one minute after the first clear-forward signal, the maintenance personnel shall be alerted. The repetition of the clear-forward signal is ceased, and circuit reset is initiated.

6.3 *Call-failure signal*

The *call-failure* signal is sent as the result of time-out situations, described in § 6.4 and whenever a call attempt fails and other specific signals do not apply, viz:

— the address-incomplete signal,

— the congestion signals, or

— the called-party's-line-condition signals.

Reception of the call-failure signal at any Signalling System No. 7 exchange will cause the clear-forward signal to be sent and, if the signalling system permits to do so, the appropriate signal to be sent to the preceding exchange or the appropriate tone or announcement to be sent to the national network.

Failure to receive a clear-forward signal within 4-15 seconds of sending a call-failure signal causes the latter to be repeated. If no clear-forward signal is received within 1 minute of sending the call-failure signal, repetition of the call-failure signal is ceased, maintenance personnel is alerted and circuit reset initiated.

6.4 *Abnormal release condition — other sequences*

If the conditions for normal release as covered in § 6.1 are not fulfilled, release will take place under the following conditions:

6.4.1 *Outgoing international exchange*

An outgoing international exchange shall:

a) release all equipment and clear forward the connection on failure to meet the conditions for normal release of address and routing information as covered in § 6.1.1 before 20-30 seconds after sending the latest address message;

b) release all equipment and clear forward the connection on failure to receive an answer signal within the interval specified in Recommendation Q.118 [3];

c) release all equipment and clear forward the connection on failure to receive a clear-forward signal from the national network after having received a clear-back signal within the interval specified in Recommendation Q.118 [3].

6.4.2 *Incoming international exchange*

An incoming international exchange shall:

a) release all equipment, clear forward the connection into the national network and send back a call-failure signal in the following cases:

— on failure to receive a continuity or continuity-failure signal if applicable (see Recommendation Q.723, § 3.3.1) before 10-15 seconds after receipt of the initial address message; or

— on failure to receive one of the backward signals indicated in § 6.1.1 (or equivalent) from a national network (where expected) before 20-30 seconds after receipt of the latest address message, unless the timing for sending the address-incomplete signal (see § 1.7) is provided; or

— on receipt of an address-incomplete signal after an address-complete signal has been generated;

b) send the call-failure signal on failure to receive a clear-forward signal for the incoming circuit before 4-15 seconds after sending an address-incomplete, congestion, call-failure or a called-party's-line-condition signal indicating inability to complete the call.

If a clear-forward signal is not received within a period of one minute after sending the call-failure signal, the repetition of the call-failure signal should be ceased, maintenance personnel should be alerted, and a reset-circuit signal should be sent for the concerned circuit.

c) release all equipment and clear forward the connection into the national network on failure to receive a clear-forward signal after sending a clear-back signal within the interval specified in Recommendation Q.118 [3].

6.4.3 *International transit exchange*

An international transit exchange shall:

a) release all equipment, clear forward the connection and send back the call-failure signal in the following cases:

— on failure to receive a continuity or continuity-failure signal if applicable (see Recommendation Q.723, § 3.3.1) before 10-15 seconds after receipt of the initial address message; or

— on failure to meet the conditions for normal release as covered in § 6.1.3 before 20-30 seconds after sending the latest address message; or

b) send the call-failure signal on failure to receive a clear-forward signal for the incoming circuit before 4-15 seconds after sending an address-incomplete, congestion, call-failure or a called-party's-line-condition signal indicating inability to complete the call.

If a clear-forward signal is not received within a period of one minute after sending the call-failure signal, the repetition of the call-failure signal should be ceased, maintenance personnel should be alerted, and a reset-circuit signal should be sent for the concerned circuit.

6.4.4 *Failure in the blocking/unblocking sequence*

An exchange will repeat the blocking (unblocking) signal or the group blocking (unblocking) messages on failure to receive the appropriate acknowledgement in response to one of these signals/messages before 4-15 seconds (see § 5).

If an acknowledgement is not received within a period of one minute after sending the initial blocking (unblocking) signal or group blocking (unblocking) messages, maintenance personnel should be alerted, the repetition of the blocking (unblocking) signal or group blocking (unblocking) messages should be continued at one minute intervals.

6.5 *Receipt of unreasonable signalling information*

The Message Transfer Part of the signalling system will avoid mis-sequencing, or double delivery, of messages with a high reliability (Recommendation Q. 706, § 2). However, undetected errors at the signalling link level and exchange malfunctions may produce signalling information in messages that is 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 clear-forward signal is received relating to an idle circuit it will be acknowledged with a release-guard signal;

b) if a release-guard signal is received relating to a circuit for which a clear-forward signal has not been sent, the following actions will be undertaken:

— if the circuit is idle, the release-guard signal is discarded;

— if the circuit is seized by a call, the release-guard signal is considered as an ordinary unreasonable information (see item g));

c) if a blocking signal is received for a blocked circuit, a blocking-acknowledgement signal will be sent;

d) if an unblocking signal is received for an unblocked circuit, an unblocking-acknowledgement signal will be sent;

e) if a blocking-acknowledgement signal for which no blocking signal has been sent is received:

— relating to a circuit blocked by sending a blocking signal, the blocking-acknowledgement signal will be discarded,

— relating to a circuit which is not blocked by sending a blocking signal, an unblocking signal will be sent;

f) if an unblocking-acknowledgement signal for which no unblocking signal has been sent, is received:

— relating to a circuit blocked by sending a blocking signal, the blocking signal will be sent,

— relating to a circuit which is not blocked by sending a blocking signal, the unblocking-acknow ledgement signal will be discarded;

g) if other unreasonable signalling information is received, the following actions will be undertaken:

— if the circuit is idle, the reset-circuit signal is sent;

— if the circuit is seized by a call, after receipt of a backward signal required for the call set-up, the unreasonable signalling information is discarded;

— if the circuit is seized by a call, before receipt of a backward signal required for the call set-up, the reset-circuit signal is sent. If the circuit is seized by an incoming call, the call will be released. If the circuit is seized by an outgoing call, an automatic repeat attempt is provided on another circuit.

7 Continuity-check for 4-wire speech circuits

7.1 *General*

This specification relates only to that part of a 4-wire connection served by Signalling System No. 7. The part of the speech path to be checked may include a circuit with speech interpolation. As the presence of active echo suppressors in the circuit would interfere with the continuity-check, it is necessary to disable the suppressors during the check and to re-enable them, if required, after the check has been completed.

The *transceiver* | check-tone transmitter and receiver) is connected to the *go* and *return* paths of the outgoing circuit at the first and each succeeding exchange, excluding the last exchange, in that part of the connection served by Signalling System No. 7. The *check-loop* should be connected to the *go* and *return* paths of the incoming circuit at each exchange except the first in that part of the connection served by Signalling System No. 7. A continuity-check is considered successful when a tone is sent on the *go* path and is received on the *return* path within acceptable transmission and timing limits.

7.2 *Transmission requirements*

7.2.1 *Transmitting equipment*

The *check-tone* frequency will be 2000 ± 20 Hz. For international application the sending level of the check-tone will be —12 ± 1 dBm0.

7.2.2 *Check-loop*

The check-loop will have a loss of 0 dB, taking into account any difference between the relative levels of the two paths at the point of attachment.

7.2.3 *Receiving equipment*

The check-tone receiver will have the following characteristics:

a) *Operating requirements*

Check-tone frequency: 2000 ± 30 Hz

Check-tone level range for international application:

The absolute power level N of the check-tone shall be within the limits (—18 + n) N (—6 + n) dBm where n is the relative power level at the receiver input.

Recognition time: 30-60 ms

The frequency and level range tolerances allow for variations at the sending end and for variations in line transmission that are considered acceptable.

b) *Non-operating requirements*

Signal frequency: outside the frequency band 2000 ± 200 Hz

Signal level for international application: below or equal to —22 + n dBm.

The limit is 10 dB below the nominal absolute level of the check-tone at the input of the receiver. If the level falls below this point, transmission is considered unacceptable.

Signal duration: shorter than 30 ms

The level range of (—18 + n) N (—6 + n) dBm will serve as a Go/No-go check on the links in that part of the international connection served by Signalling System No. 7.

c) *Release requirements*

If the receiver is used to test for the removal of check-tone (see § 7.3):

— after recognition of tone, interruptions of up to 15 ms shall be ignored; this will prevent switching through the speech path prematurely;

— the indication of tone removal should not be delayed more than 40 ms; and

— the release level of the receiver should be lower than —27 + n dBm for international application.

7.3 *Continuity-check procedure*

Decision on whether continuity-check should be performed or not on a given circuit should be made by an outgoing exchange according to the criteria described in § 1.4. The outgoing exchange will indicate whether continuity-check is required or not by the continuity-check indicator in the initial address message (Recommendation Q.723, § 3.3.1) or by a continuity check request in a continuity-check-test call (see Rec. Q.723 § 9 and Rec. Q.724, § 7.5). If it is required, the outgoing exchange will connect a transceiver to the speech circuit when it sends an initial address message. If continuity-check is not required either on the incoming circuit or on the outgoing circuit, the outgoing exchange can switch-through the speech path immediately after having sent the initial address message.

A description of the procedure using the specification and description language is given in the state transition diagrams in Figures 4/Q.724 and 5/Q.724. The Signalling System No. 7 exchange will send forward the continuity signal after completion of all the following actions:

— the continuity-check performed on the outgoing circuit is completed;

— the speech path across the exchange has been checked and found correct (see § 1.4); and

— if the continuity-check indicator in the received initial address message indicates that continuity-check is being (has been) performed on previous circuit(s), receipt of a continuity signal from the preceding exchange.

The speech path may be switched through at an international transit or incoming exchange and the transceiver disconnected after the continuity-check of the circuit has been successfully completed. However, the switching through of the speech path should be delayed until the residual check-tone has propagated through the return path of the speech circuit.

This determination may be made by timing, or by using the check-tone receiver to test for the removal of the check-tone, or other appropriate means.

As a national option the following single report procedure may be used to assure that on terrestrial circuits a complete check has been made of both directions of transmission in the face of high noise and in the double seizing situations. With this procedure, the continuity check is not considered successful until the check tone is recognized and its subsequent removal recognized within the continuity check timing interval. On tone recognition it

must be ensured that at least 60 ms of continuity check tone has been sent. In the double seizing case, this procedure will ensure that both ends will recognize the check tone if both directions of transmission are within acceptable transmission limits. The end originating the continuity check and, in the case of double seizing, the control end send the continuity signal on successful completion of the check. The exchange at the other end of circuit removes the loop (or transceiver in the case of double seizing) on receipt of the continuity signal. If this exchange is the last common channel signalling exchange, the address-complete signal is not returned until either the loop (or transceiver or in the double seizing case) is disconnected.

With the single report continuity check procedure, the first exchange that has initiated the continuity check must delay through-connect until receipt of an address complete signal to avoid the potential hazards associated with delayed loop removal.

On receipt of the continuity signal in the following international exchange, the continuity-check loop will be removed if inserted. Also, any digits of the national number which were withheld may be released (see § 1.2).

If in an interworking situation a continuity check has to be performed on one or more of the circuits involved in the connection preceding the interworking point, appropriate measures must be taken to prevent alerting of the called party until the continuity of such circuits has been verified. Interworking situations which could be discriminated are:

a) Signalling System No. 7 any non No. 7 Signalling System.

b) International Signalling System No. 7 national Signalling System No. 7 not performing continuity check.

For a) the last digit(s) of the national number have to be withheld in any (interworking) transit exchange or terminating exchange in case of DDI (direct dialling in) or the alerting of the called party is postponed in the terminating exchange in case of non-DDI.

For b) either the last digit(s) of the national number are withheld in the incoming international transit exchange, a transit exchange in the national network or the terminating exchange in case of DDI or the alerting of the called party is postponed in the terminating exchange in case of non-DDI.

At the Signalling System No. 7 exchange, on failure of the outgoing circuit to satisfy the continuity-check:

— the continuity-check transceiver will be removed and an automatic repeat attempt will be made on another circuit,

— a continuity-failure signal will be sent to the following exchange.

A repeat of the continuity-check of the speech path will be made on the failed outgoing circuit within 1-10 seconds of detection of the continuity-check failure, in case of the initiation of the procedure has been made by an initial address message.

The second continuity-check will be initiated by the Signalling System No. 7 exchange detecting the failure using the continuity-check-request signal.

If the repeated check passes on this call, the speech circuit will be returned to idle with a clear-forward/release-guard sequence. If the second check fails, the maintenance staff will be alerted that a failure has occurred and the check will be repeated at intervals of 1-3 minutes. The repeated continuity-check will only be finished when continuity is detected.

According to transmission maintenance requirements, Signalling System No. 7 may provide for:

a) a print-out each time a second continuity-check is started. In such cases, the circuit involved should be identified;

b) a print-out each time a continuity-check results in a warning being given to maintenance personnel.

Since a continuity-check failure can be caused by a faulty transceiver, precautions should be taken to ensure a low probability of selecting a faulty one for both the initial continuity-check and the second check, e.g. by ensuring the selection of a different transceiver for each of the checks.

7.4 *Continuity-check timing*

7.4.1 *Time-out period*

The continuity-check is considered to have failed if the receiver has not responded within a period determined by the Administration concerned. This period should not exceed two seconds.

The time-out period of the continuity-check should always exceed the continuity recognition time, T_{CR}, given by:

$$T_{CR} = 2T_P + T_{IAM} + T_{TC} + T_L + T_R - T_T$$

where

T_P One-way propagation time of the speech circuit and the signalling link (where these times are the same),

T_{TC} Speech interpolation clip time for two speech interpolation systems in series (for connections not using speech interpolation $T_{TC} = 0$),

T_R Receiver response time,

T_L Loop connecting time (maximum),

T_T Transceiver connecting time (minimum),

T_{IAM} Emission time of the longest initial address message.

If retransmission of an initial address message is to be included in T_{CR}, the following formula may be used:

$$T_{CR} = 4T_P + 2T_{IAM} + T_{FISU} + 2T_X + T_L + T_R - T_T$$

where

T_{FISU} Emission time of a fill-in signal unit (length of a fill-in signal unit),

T_X Time between receiving an initial address message and emitting a signal unit containing an acknowledgement for that initial address message, or

time between receiving a signal unit asking for retransmission and emitting the initial address message to be retransmitted.

7.4.2 *Switching of continuity-check equipment*

The connection and disconnection of the equipment used for the continuity-check and also the disabling and subsequent enabling of echo suppressors should be related to the following stages of progress in the establishment of the connection:

a) *Preparation at Signalling System No. 7 exchange applying the transceiver* — Action should be initiated when the initial address message is available for transmission in the Message Transfer Part.

b) *Preparation at Signalling System No. 7 exchange connecting the check-loop* — Action should be initiated at the moment of recognition of the initial address message received.

c) *Disconnection at Signalling System No. 7 exchange connecting the check-loop* — Action follows the receipt of the continuity signal, the continuity-failure signal or the clear-forward signal, or the emission of signals indicating that the call cannot be established, e.g. circuit-group-congestion signal.

d) *Disconnection at Signalling System No. 7 exchange applying the transceiver* — Action should be initiated on the successful completion or the failure of the continuity-check.

Exceptionally, if disconnection has not previously occurred, action should be initiated at the moment of recognition of the address-complete signals, the answer signals, signals indicating that the call cannot be established, or on the emission of a clear-forward signal.

It is recommended that the mean time, both for the connection and for the disconnection, is less than 100 ms. A mean time of 200 ms should not be exceeded.

7.5 *Continuity-check test calls*

7.5.1 The following procedure may be used in the cases when continuity-check is performed by test calls. This procedure is used to test a single interexchange circuit, which must be idle when the procedure is initiated.

7.5.2 When the outgoing Signalling System No. 7 exchange intends to initiate the procedure, it sends to the following exchange a continuity-check-request message and it connects the transceiver to the outgoing speech circuit. On receipt of the continuity-check-request message, the following exchange connects the loop to the involved circuit. On detection of the backward tone within the time-out specified in § 7.4.1, the outgoing exchange will disconnect the transceiver and the circuit will be returned to idle with a clear-forward/release-guard sequence.

7.5.3 In the case that no backward tone is detected within the specified time-out, the same actions apply as in the case of continuity-check failure during normal call set-up, see § 7.3 (the clause referring to the repeat attempt is not relevant in this case).

7.5.4 If an exchange receives an initial address message relating to a circuit for which it has sent a continuity-check-request message (i.e. in case of collision on a both-way operated circuit), it will abort the continuity-check test call, disconnect the transceiver and complete the incoming call.

An exchange receiving a continuity-check-request message after having sent an initial address message, will ignore it and continue the call set-up procedure.

8 Continuity-check for 2-wire speech circuits

In general the same procedure as described in § 7 is used for the continuity-check of 2-wire speech circuits except the check-loop which has to be replaced by a transponder and the fact that in the backward direction the frequency 1780 ± 20 Hz is used.

9 Interruption control for multiplex systems

9.1 *Digital circuits*

When fully digital circuits are applied between two exchanges, which have some inherent fault indication features giving an indication to the switching system in case of fault (cf. § 1.4), the switching system should inhibit new local seizures of the concerned circuits when the fault indication arises and for as long as it persists.

9.2 *FDM circuits*

9.2.1 *General*

Interruption of the pilot in frequency-division multiplex systems corresponds to loss of continuity of speech circuits or a considerable reduction of level. Therefore a switching equipment monitoring this indication

(see § 1.4) should inhibit local seizure of the concerned speech circuits in case of interruption. Moreover, seizure by the remote exchange should be prevented, as long as the interruption persists, by sending blocking and unblocking signals as specified in § 9.2.2.

When interruption control is implemented, possible use of the specifications contained in Recommendation Q. 416 [5] could be applied.

9.2.2 *Blocking and unblocking of speech circuits*

Blocking signals are sent to the other end, with regard to the relevant speech circuits, whenever an interruption is detected which lasts more than 4-15 seconds.

When an interruption indicated terminates, unblocking signals are sent to the other end after 4-15 seconds, provided that blocking signals were previously sent on occurrence of the interruption.

10 Supplementary services

10.1 *General*

The supplementary services general descriptions in an ISDN environment are covered by other Recommendations, e.g.: Recommendations Q.80 to Q.83 and Q.85 to Q.87.

In principle, many of these descriptions might be applied also in telephone dedicated digital/analogue networks.

This Recommendation includes variants of supplementary services procedures and/or descriptions. It contains its own supplementary services descriptions for the services presented in this chapter.

In this part the signalling procedures related to a number of supplementary services are also described. The messages and signals are defined in Recommendation Q.722 and the format and the content are given in Recommendation Q.723.

10.2 *Closed User Group*

10.2.1 *General*

The closed user group (CUG) facilities enable users to form groups with different combinations of restrictions for access from or to the users having one or more of these facilities. The following CUG facilities are standardized:

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 users 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 networks, and from users 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 parties belong to the same CUG as indicated by interlock codes.

The data for each CUG that a user belongs to can either be stored, associated to the user at the local exchange to which the user is connected (decentralized administration of CUG data) or in dedicated point(s) in the network. (Centralized administration of CUG data.)

The validation checks at call set-up when using decentralized administration of the CUG data are performed in the originating and destination exchange. When using centralized administration of CUG data most of the validation checks are made in the dedicated point(s), and a minimum of the CUG data is stored in the local exchanges.

In § 10.2.2 the call set-up procedures based on decentralized administration of CUG data is specified.

The centralized administration of CUG data is not specified in this Recommendation as it requires non-circuit related protocols.

10.2.2 *Call set-up procedure with decentralized administration of CUG data*

10.2.2.1 *Originating exchange*

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.

a) 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 based on the following criteria:

In the case where the calling party 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 party makes no facility request identifying a particular CUG, the originating exchange selects the preferential (or only) CUG.

Thus in the case where the calling party belongs to a CUG, no facility request concerning CUG facilities is made if:

i) the user belongs to one CUG only;

ii) a user who belongs to more than one CUG (with or without outgoing access) makes a call within the preferential CUG;

iii) 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.

b) Call set-up from a user having the closed user group or the closed user group with incoming access facility

In this case the CUG selection is performed in accordance with a) above.

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 c) below.

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 initial address message 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.

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 signal is returned to the calling party.

c) 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 party 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 selected CUG, the call is set up at the originating exchange. The initial address message forwarded to the next exchange then includes the interlock code of the selected CUG together with an indication that the call is a CUG for which outgoing access is allowed.

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 initial address message forwarded to the next exchange.

In the case where the calling party makes a facility request identifying a particular CUG and the outgoing calls barred within the closed user group applies for this CUG, the call is rejected and an access barred signal is sent to the calling party.

10.2.2.2 *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.

10.2.2.3 *Destination exchange*

At the destination exchange a validation check of the acceptability of a call is made where either the calling party (as indicated by a CUG call indication in the initial address message received) or the called party

belongs to CUG. The call is connected only in cases where the information received checks with the information stored at the destination exchange, as specified in the following. In cases where a call is rejected because of incompatible CUG information an unsuccessful backward set-up information message including the access barred signal is sent towards the originating exchange.

a) 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:

i) it is a CUG call, including the case where outgoing access is allowed, and

ii) correspondence is found between the interlock code received and an interlock code associated with the called party, and

iii) 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.

b) Calls to a user having the closed user group with incoming access facility

In this case an incoming call is accepted when it is:

i) an ordinary call;

ii) a CUG call for which outgoing access is not allowed, if both conditions specified in ii) and iii) of a) above are met;

iii) a CUG call for which outgoing access is allowed.

c) CUG calls to a user not belonging to any CUG

In the case where the incoming call is:

i) a CUG call for which outgoing access is allowed, it is accepted;

ii) a CUG call for which outgoing access is not allowed, it is rejected.

10.2.3 *International interlock code*

Each international CUG is assigned a unique International CUG number (ICN) according to the administrative rules defined in Recommendation X.180.

10.3 *Users access to the calling line identification*

10.3.1 *General*

Users access to the calling line identification is a user facility that enables a user to be informed at incoming calls of the identity of the calling line. When provided, the facility applies to all incoming calls except when the calling party has the calling line identity presentation restricted facility or when the complete identity of the calling line is not available at the destination exchange.

The calling line identity is the telephone number of the calling party.

The calling line identity presentation restricted facility enables a user to prohibit the forwarding of the calling line identity to the called party.

In the case where a national network does not always provide the calling line identity facility, the calling line identity is the known part of the telephone number at the interworking point (e.g. Trunk Code).

In the case where the calling is a PABX the network will send the telephone number of the PABX or, in alternative the full DDI number. The latter case is possible if the PABX provides the calling line identification facility to the network.

The information indicating that a user has the calling identity or the calling line identity presentation restricted facility is available in the exchange to which the user is connected.

10.3.2 *Call set-up procedure*

The call control procedure and the information included in call control messages vary depending on whether the calling party has indicated to use the calling line identity presentation restricted facility for this call and whether the calling line identity is included in the initial address message.

Two different call control procedures can be used to provide the calling line identity facility. Both procedures are specified for international use:

10.3.2.1 *The calling line identity is included in the initial address message*

In the case where the calling party has indicated the calling line identity restricted facility, the initial address message includes the calling line identity restricted request indicator.

In the case where the complete identity of the calling party is not available or not allowed to be forwarded outside the network:

a) in international network no information regarding the calling line identity is included;

b) in national networks, the known part of the calling line identity could be included. In this case an incomplete calling line identity indicator is included in the message.

The calling party address is sent to the called party.

In the case where the destination exchange receives the calling party address restricted request indicator or a calling party incomplete address indicator, the calling line identity is not forwarded to the called party.

10.3.2.2 *The calling line identity is not included in the initial address message*

In the case where the called party has the user access to the calling line identification facility, a request is sent towards the originating exchange. The request is included in a general request message.

When receiving the request for calling line identity the originating/interworking exchange sends a response including the calling line identity. In the case where the calling party has the calling line identity presentation restricted facility the response sent from the originating exchange includes the calling line identity presentation restricted request indicator. The response is included in a general forward set-up information message. The information included in the response in addition to the calling line identity presentation restricted indicator (where applicable) is as follows:

a) in the case where the complete identity of calling line is known, the originating exchange includes the complete telephone number of the calling party;

b) in the case where the complete identity of the calling party address is not available or is not allowed to be forwarded outside the network, the response includes:

i) in international networks the calling line identity unavailable signal;

ii) in national networks, in addition to the calling line identity unavailable signal, the response can include the known part of the calling line identity. In this case the response includes the incomplete calling line identity indicator.

The calling party address is sent to the called party.

In the case where the destination exchange receives the calling party address restricted request indicator or a calling party incomplete address indicator, the calling line identity is not forwarded to the called party.

The destination exchange must not connect through until the complete calling line identity has been sent to the called party or the called party has been notified that the calling line address identity will not be forwarded.

10.4 *Redirection of calls*

10.4.1 *General*

The redirection of calls facility enables a user to have calls to a telephone number, for which the facility is subscribed, redirected to another predetermined number during periods when the facility is activated.

The redirection of calls rejected facilities enables a user to have redirected calls to his telephone number automatically rejected during periods when the facility is activated.

The redirection of calls information prohibited facility enables the user, who has activated the redirection of calls facility, to prevent the calling party from being informed that the call is redirected.

Depending on the possibilities offered by the Administration 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 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.

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.

10.4.2 *Call set-up procedure not involving other facilities affecting the procedure*

Information that a user has the redirection of calls rejected facility is stored at the exchange to which the user is connected. When a redirected call arrives at such a user, the call is rejected in the same manner as if this user had activated the redirection of calls facility.

Information that a user has the redirection of calls information prohibited facility is stored at the exchange, where the user is connected, together with the redirection address.

Information that a subscriber 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:

10.4.2.1 *The redirection address is at the same exchange*

In this case the destination exchange connects the call to the redirection address and returns an address complete message including the call forwarding indicator. In the case where the called party has the redirection of calls information prohibited facility activated the address complete message includes the redirection of calls information prohibited indicator. When receiving the call forwarding indicator the originating exchange sends a signal to inform the calling party that the call has been redirected, except for the case when the address complete message includes the redirection of calls information prohibited indicator. In this case no information related to the redirection of calls facility is sent to the calling party.

In the case where the user at the redirection address has the redirection of calls or the redirection of calls rejected facility activated, the destination exchange rejects the call and returns an indication in an unsuccessful backward set-up message.

10.4.2.2 *The redirection address is at another exchange*

In this case the call is set-up to the redirection address in accordance with the following procedure.

The call forwarding procedure is based on the principle that the connection is extended forward from the destination exchange to the new destination exchange.

i) The first destination exchange sets up the forward connection to the redirection address. The initial address message forwarded includes a redirected call indicator and the redirection address and redirection of calls information prohibited indicator (if applicable). In national networks the first called party address and the called line identity (if applicable) and the calling line identity presentation prohibited indicator (if applicable) could also be included in the initial address message.

ii) Upon receipt of the redirected call the new destination exchange connects or rejects the call in accordance with § 10.4.2.1. The redirected call indicator received is used to prevent a further redirection. The first called party address could be used for special acceptance tests, or be sent to the calling party.

iii) In the case where the call is connected to the redirection address the destination exchange will send an address complete message including the call forwarding indicator and the redirection of calls information prohibited indicator (if applicable). The call forwarding indicator is used to inform

the originating/controlling exchange, that the first destination exchange performs the charging for the redirected call. It could also be used to indicate to the calling party that the call is redirected. Except for the case, when the address complete message includes the redirection of calls information prohibited indicator. In this case no information relating to the redirection of calls facility is sent to the new called party.

iv) When the first destination exchange receives a message, e.g. request for calling line identity from the new destination exchange, it sends it further backwards to the originating exchange.

10.4.3 *Calls involving other facilities affecting the procedure*

10.4.3.1 *Calls involving a closed user group facility*

Redirected calls are subject to the restrictions applying for the closed user group (CUG) facilities.

— In the case where the call is a CUG call, or the originally called party has a CUG facility, the call is rejected before

redirection unless the validation check requirements applying for the CUG facility(ies) concerned are satisfied.

— 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.

— 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 § 10.4.2.2 (i.e. call forwarding procedure),

the first destination has to send the CUG information received (e.g. the CUG call indication and the interlock code) forward to the new destination exchange in the initial address message.

10.4.3.2 *The redirection address has the user's access to the calling party identification*

In the case where a redirected call arrives at a user, who has the users access to the calling party address identification facility, the succeeding actions at the redirection exchange depend on if the calling party address is available at the original called exchange.

In the case where the calling party address is not available, a request for the calling party address is sent to the preceding exchange(s) in accordance with § 10.3.2.2. When the new destination exchange has the calling party address available, it sends it to the new called party unless the calling party address presentation restricted indicator is received at the new destination exchange.

10.4.3.3 *The redirection address has the malicious call identification capability*

In the case where a call arrives at a user marked as an MCI user, the call set-up procedure depends on whether the calling party address and/or the original called party address is included in the initial address message and if the hold option should apply for the call.

a) The hold option does not apply for the call. In this case the call control procedure depends on whether the calling party address and/or the original called party address is included in the initial address message.

In the case where one or both of the addresses are not available, a request is sent to the preceding exchange(s). The request will indicate which address(es) are requested.

As a response the preceding (e.g. the originating or the original called) exchange will include the concerned address(es), which has been requested.

b) The hold options applies for the call. In this case the call set-up procedure depends on whether the calling party address and/or the original called party address is included in the initial address message. In this case a request is sent to the preceding exchange(s) indicating that the holding of the circuit is required.

In the case where one or both of the address(es) are not available, a request is sent to the preceding exchange(s).

In their response the preceding (e.g. original called or originating) include the addresses concerned, which have been requested and apply the holding of circuit.

In the case of interworking, the interworking exchange will send in addition to the information specified in § 10.5.3, the original called party address.

When the original called exchange receives the request when both addresses are not available in this exchange, it repeats the request to the originating exchange. When the original called exchange receives the response it repeats the response towards the destination exchange. When the original called exchange receives the delayed release message, it sends it forward to the destination exchange.

10.5 *Network access to the calling line identification*

10.5.1 *General*

The network access to the calling line identification is a network capability which enables a network to obtain the calling party address inside or outside their own network. The capability is used for example for malicious call identification, charging, etc.

10.5.2 *Malicious call identification* (MCI)

The malicious call identification gives the possibility to obtain by an appropriate request the identification of the calling line and the original called party (in the case of a redirected call). The identification request provokes in the destination exchange, the print-out of the following items:

— called line identity;

— calling line identity and possibly the original called line identity;

— time and date of the call.

The same print-out may be, optionally, obtained in the originating exchange.

The identification request can either be activated before, during or after the conversation phase.

Two different options of the utility are defined namely:

a) MCI with hold (national use);

b) MCI without hold.

One or both options should be provided in a national network.

In case a), the holding of the connection is requested in addition to the identification of the calling party. In case b), only the identification of the calling line is requested.

In case a), the clearing of the connection is subject to called party clearing.

10.5.3 *Call set-up procedure*

In case of an incoming call to a user having the MCI facility the call set-up procedure depends on whether the calling line identity is included in the initial address message and which options, without hold or with hold, the called party has been assigned:

a) if the calling line identity is included in the initial address message:

— in the case where the called party has the MCI without hold indication, the calling party address and possibly the original called address is stored in the destination exchange;

— in the case where the called party has the MCI with hold indication, the calling party address and possibly the original called party address is stored at the destination exchange, and a request for holding of the circuit is sent to the originating exchange.

b) if the calling line identity is not included in the initial address message:

— in the case where the called party has the MCI without hold indication, a request is sent to the originating exchange containing the calling line identity request;

— in the case where the called party has the hold indication, the request will include requests for the holding of the circuit and for calling line identity.

In addition to the information mentioned above the request will also include the MCI facility encountered indicator. The request will be sent in a general request message.

When receiving the MCI request the transit exchange normally repeats the request. However, in two cases the transit exchange acts in another way:

— In the case of interworking with networks that do not provide the calling line identification facility, the relevant transit exchange will send a response including the identity of the transit exchange. The identity of the transit exchange could either be the known part of the calling party address in that exchange or, in national networks, the signalling point code of the transit exchange. In addition to the identity of the transit exchange the response can also include the identity of the

incoming trunk. The interworking exchange may also arrange the holding of the incoming trunk even if not explicitly requested (i.e. also in the option ‘‘MCI without hold’’). In the case where the MCI request also includes the hold request the transit exchange will make the clearing of circuit subject to the called party clearing.

— In the case where the MCI cannot operate (due to administrative or technical reasons), the relevant exchange includes in the MCI response message the MCI not provided indicator.

At the receipt of the MCI request, the originating exchange sends a general forward set-up information message containing the calling line identity and the hold indicator. If holding of the connection is provided the clearing of the circuit will be subject to the called party clearing (i.e. subject to the receipt of the clear-back signal). When the identification request is made the destination exchange produces the print-out of the related MCI information and sends backwards, optionally, the *MCI print-out request* (for further study) message to obtain the print-out of the same information in the originating exchange.

10.5.4 *Clearing procedures*

In the case where no holding of the circuit is requested, the normal release procedure will apply.

In the case where the holding of the circuit is requested, the following procedures apply at the originating exchange and the destination exchange:

a) In the case where the calling party hangs up first, the originating exchange will apply the hold of the connection and stop the charging (if applicable). Moreover, the originating exchange may send forward the optional ‘‘calling party clear signal’’.

When receiving the calling party clear signal an intermediate charging point stops the charging (if applicable) and forwards the calling party clear signal to the succeeding exchange.

When receiving the calling party clear signal the destination exchange starts a timer T1, if the identification request is not received.

The value of T is a national option.

b) In the case where the identification request is made before the called party disconnects, no clear-back signal will be sent until appropriate action has been taken (e.g. maintenance action). If applicable T1 is stopped when the identification request is received.

c) When the called party disconnects the destination exchange may start a timer T2 to allow for making the identification request after the conversation is terminated.

The succeeding actions at the destination exchange will depend on whether an identification request has been made or not.

In the case where the request was not made identification request, the expiration of the timer T2 will result in sending of the clear-back message. The timer T1 is stopped (if applicable).

In the case where the called party makes the request for identification is made before the timer T2 expires, no clear-back signal will be sent until appropriate actions have been taken. The timers T2 and T1 (if applicable) are stopped when receiving the identification request is made.

11 Digital connectivity

11.1 *General*

The digital connectivity is a user facility that enables a user to establish a fully digital path at 64 kbit/s user-to-user. It is an optional facility assigned to the user and provided on a call request basis or specific category.

11.2 *Call set-up procedure*

In the case of a call for which the digital connectivity is required, the IAM/IAI message includes *the all digital path required* indicator.

On recognition of this request each exchange (originating/transit) makes a check on the possibility to route the call on a digital path:

— if the check is positive the call is routed and the request of this facility is forwarded to the succeeding exchange;

— if negative, the call is rejected and one of the following unsuccessful signals is sent backwards:

— *congestion* | r *call-failure signal* | n case where a digital path exists but it is not possible to complete the call due to congestion or failure (see Recommendation Q.722, § 3.4).

— *digital path not provided* | n case where a routing that allows a complete digital path doesn't exist.

In the destination exchange, at the reception of an incoming call with the digital connectivity request, the appropriate validation check is made and, if positive, the call is completed using the standard procedures. In the negative case the call is rejected and the *access barred* signal is sent backwards.

12 Echo suppressor control

12.1 *General*

The echo suppressor control signalling procedure is used on per call basis to convey information between exchanges about the demand and ability to insert echo suppressors.

The procedure is mainly intended to be used in the case where the echo suppressors are provided in pools.

The procedure is initiated by the exchange which upon analysis of an initial address message of a call realizes that the call is to be routed on a connection for which echo suppressor is necessary, and no indication is received that an outgoing half-echo suppressor is already included (see Note).

The exchange shall always be able to insert outgoing half-echo suppressors.

One of the exchanges succeeding the above-mentioned exchange shall always be able to insert incoming half-echo suppressors.

The procedure is for application in national networks and could be applied in the international network upon bilateral agreement.

Note — In the case where this exchange knows that there is no echo suppressor situated in the preceding network the procedure is not initiated.

12.2 *Actions at the exchange initiating the echo suppressor control procedure*

Upon receipt of an initial address message the following actions are taken if no indication is received that an outgoing half-echo suppressor is already included:

— a request for outgoing half-echo suppressor is sent in the backward direction;

— a timer T is started (see Note);

— an outgoing half-echo suppressor is reserved;

— the initial address message is sent on with the indication outgoing half-echo suppressor included.

Upon receipt of a response on the outgoing half-echo suppressor request the following actions are taken:

a) if the response is negative:

— the reserved outgoing half-echo suppressor is included;

— the timer T is stopped;

b) if the response is positive:

— the reserved outgoing half-echo suppressor is released;

— the timer T is stopped.

Note — If response on the request for outgoing half-echo suppressor has not been received before timer T has expired, then the reserved half-echo suppressor is included.

12.3 *Actions at the originating exchange*

Upon receipt of a request for outgoing half-echo suppressor the following actions are taken:

a) if the originating exchange is not able to insert outgoing half-echo suppressor:

— a negative response is sent in the forward direction;

b) if the originating exchange is able to insert outgoing half-echo suppressor:

— a half-echo suppressor is included;

— a positive response is sent in the forward direction.

12.4 *Actions at an intermediate exchange*

12.4.1 *The exchange being able to insert a half-echo suppressor*

Upon receipt of a request for outgoing half-echo suppressor the following actions are taken (see Note 1):

— an outgoing half-echo suppressor is reserved;

— the request message is sent on;

— a timer T is started (see Note 2).

Note 1 — If the intermediate exchange knows that there is no echo suppressor in the preceding network the intermediate exchange performs actions in accordance with § 12.3.

Note 2 — If response on the request for outgoing half-echo suppressor has not been received before timer T has expired, then the reserved half-echo suppressor is included and a positive response is sent in the forward direction.

Upon receipt of a response on the outgoing half-echo suppressor request the following actions are taken:

a) the response is negative:

— the reserved outgoing half-echo suppressor is included;

— the timer T is stopped;

— a positive response is sent in forward direction;

b) the response is positive:

— the reserved outgoing half-echo suppressor is released;

— the timer T is stopped;

— the response is sent on.

Upon receipt of an initial address message with the indication ‘‘outgoing half-echo suppressor included’’ the following actions are taken:

— an incoming half-echo suppressor is reserved;

— the initial address message is sent on.

Upon receipt of an address complete message with an indication on incoming half-echo suppressor the following actions are taken:

a) the indication is negative:

— the reserved incoming half-echo suppressor is included;

— the address complete message is sent on with a positive indication;

b) the indication is positive:

— the reserved incoming half-echo suppressor is released;

— the address complete message is sent on.

12.4.2 *The exchange not being able to insert half-echo suppressor*

No special actions are required.

12.5 *Actions at the destination exchange*

Upon receipt of an initial address message with the indication ‘‘outgoing half-echo suppressor included’’ the following actions are taken:

a) if the destination exchange is not able to insert an incoming half-echo suppressor:

— a negative indication on the inclusion of incoming half-echo suppressor is given in the address complete message;

b) if the destination exchange is able to insert incoming half-echo suppressor:

— a half-echo suppressor is included;

— a positive indication on the inclusion of incoming half-echo suppressor is given in the address complete message.

13 Congestion control

13.1 *Exchange congestion control*

13.1.1 *Automatic congestion control*

Automatic Congestion Control (ACC) is used when an exchange is in an overload condition (see also Recommendation Q.542, § 5.4.5). Two levels of congestion are distinguished, a less severe congestion threshold (congestion level 1) and a more severe congestion threshold (congestion level 2). If either of the two congestion levels is reached, an automatic congestion control information message may be sent to the adjacent exchanges indicating the level of congestion (congestion level 1 or 2). The adjacent exchanges, when receiving an automatic congestion control information message, should reduce their traffic to the overload affected exchange.

The automatic congestion control information message is sent by the overloaded exchange after receiving the clear-forward signal and before sending the release-guard signal for a circuit. If the overloaded exchange returns to normal traffic load, no more automatic congestion control information messages are sent. The adjacent exchanges then, after a predetermined time, automatically return to their normal status.

13.2 *Telephone User Part signalling congestion control*

13.2.1 *General*

On receipt of congestion indication primitives, CIP (see also Recommendation Q.704, § 10.2.3), the TUP should reduce traffic load (call attempts) into the affected direction in several steps.

13.2.2 *Procedure*

When the first CIP is received by the TUP, the traffic load into the affected direction is reduced by one step. At the same time, two timers Tue1 and Tue2 are started. During Tue1, all the following received CIPs for the same direction are ignored in order not to reduce traffic too rapidly. Reception of a CIP after the expiry of Tue1, but still during Tue2, will decrease the traffic load by one more step and restart Tue1 and Tue2.

If Tue2 expires (i.e. no CIPs have been received during the corresponding period), traffic will be increased by one step and Tue2 will be restarted unless full traffic load has been resumed.

Tue1 = 300-600 ms

provisional values

Tue2 = 5-10 s

The number of steps of traffic reduction and the type and/or amount of increase/decrease of traffic load at the various steps are considered to be an implementation dependent function.

14 Telephone User Part outage

When a Telephone user part outage occurs, actions should be taken as follows:

— The user parts at the nodes connected to the failing node should receive an indication from the user's flow control functions and react by stopping the seizure of circuits to that failing node and by routing the traffic on alternative routes.

— In the user part which has previously failed, after the initialization procedures, the resumption of the signalling relation is obtained by sending circuit group messages in all the circuits affected by the outage, as specified in § 1.15 (Reset of circuits and circuit groups).

15 State transition diagrams

15.1 *General*

This section contains the description of the signalling procedures described in this Recommendation in the form of state transition diagrams according to the CCITT Specification and Description Language (SDL).

In order to facilitate functional description, the Telephone User Part signalling procedure function is divided into functional blocks, as shown in Figure 1/Q.724; state transition diagrams are provided for each functional block, as shown below:

— Signalling procedure control (SPRC): Figure 2/Q.724

— Call processing control (CPC): Figure 3/Q.724

— Continuity-check outgoing (CCO): Figure 4/Q.724

— Continuity-check incoming (CCI): Figure 5/Q.724

— Continuity-recheck outgoing (CRO): Figure 6/Q.724

— Continuity-recheck incoming (CRI): Figure 7/Q.724

— Blocking and unblocking signal sending (BLS): Figure 8/Q.724

— Blocking and unblocking signal reception (BLR): Figure 9/Q.724

— Circuit reset (CRS): Figure 10/Q.724

— Circuit group control (CGC): Figure 11/Q.724

— Circuit group reset sending (CGRS): Figure 12/Q.724

— Circuit group reset receipt (CGRR): Figure 13/Q.724

— Maintenance oriented circuit group blocking and unblocking sending (MBUS): Figure 14/Q.724

— Maintenance oriented circuit group blocking and unblocking receipt (MBUR): Figure 15/Q.724

— Hardware failure oriented circuit group blocking and unblocking sending (HBUS): Figure 16/Q.724

— Hardware failure oriented circuit group blocking and unblocking receipt (HBUR): Figure 17/Q.724

— Software generated circuit group blocking and unblocking sending (SBUS): Figure 18/Q.724

— Software generated circuit group blocking and unblocking receipt (SBUR): Figure 19/Q.724

The detailed functional breakdown shown in the diagrams is intended to illustrate a reference model and to assist interpretation of the text in the earlier sections. The state transition diagrams are intended to show precisely the behaviour of the signalling system as viewed from a remote location. It must be emphasized that the functional partitioning shown in the diagrams is used only to facilitate understanding of the system behaviour and is not intended to specify the functional partitioning to be adopted in a practical implementation of the signalling system.

15.2 *Drafting conventions*

a) Abbreviations used in Figures 1/Q.724 to 19/Q.724 are listed in § 15.3.

b) External inputs and outputs are used for interactions with different functional blocks. Internal inputs and outputs are used for interactions within each functional block, e.g. to indicate control of time-outs.

c) External inputs and outputs contain as part of their name, the abbreviations of their source and destination functional block names, with an arrow in between, e.g. Start CPCCCO.

d) For interexchange signals or signal messages, external input and output symbols are used as shown below to indicate the direction of each signal on message.

Figure, p.

Note — The functions covered by Figures 1/Q.724 to 19/Q.724 are limited in the following points:

— they refer only to call processing functions in international transit exchanges;

— they do not necessarily cover all the abnormal situations.

However, they include some operations on receipt of unreasonable signalling information as specified in § 6.5.

15.3 *Abbreviations and timers used in Figures 1/Q.724 to 19/Q.724*

General

BBR Circuit blocked by reception of the blocking signal

BBS Circuit blocked by sending the blocking signal

CC Continuity-check

CCT Telephone circuit

ICC Incoming trunk circuit

NOK Not OK

OGC Outgoing trunk circuit

Functional block names | See Figure 1/Q.724)

BLR Blocking and unblocking signal reception

BLS Blocking and unblocking signal sending

CCI Continuity-check incoming

CCO Continuity-check outgoing

CGC Circuit group control

CGRR Circuit group reset receipt

CGRS Circuit group reset sending

CPC Call processing control

CRI Continuity-recheck incoming

CRO Continuity-recheck outgoing

CRS Circuit-reset

HBUR Hardware failure oriented circuit group blocking and unblocking receipt

HBUS Hardware failure oriented circuit group blocking and unblocking sending

L3 Level 3 (Signalling network functions)

L4 Level 4 (Telephone user part)

MBUR Maintenance oriented circuit group blocking and unblocking receipt

MBUS Maintenance oriented circuit group blocking and unblocking sending

SBUR Software generated circuit group blocking and unblocking receipt

SBUS Software generated circuit group blocking and unblocking sending

SPRC Signalling procedure control

Messages and signals

ACM Address complete message

ADC Address complete signal, charge

ADI Address incomplete signal

ADN Address complete signal, no charge

ADX Address complete signal, coin box

AFC Address complete signal, charge, subscriber free

AFN Address complete signal, no charge, subscriber free

AFX Address complete signal, coin box, subscriber free

ANC Answer signal, charge

ANN Answer signal, no charge

BLA Blocking-acknowledgement signal

BLO Blocking signal

CBK Clear-back signal

CCF Continuity-failure signal

CCH Continuity-check indicator:

— 0: CC not required

— 1: CC required on this circuit

— 2: CC is being (has been) performed on a previous circuit

CCR Continuity-check-request signal

CFL Call-failure signal

CGC Circuit-group-congestion signal

CLF Clear-forward signal

COT Continuity signal

FOT Forward-transfer signal

GRA Circuit group reset-acknowledgement message

GRS Circuit group reset message

HBA Hardware failure oriented group blocking-acknowledgement message

HGB Hardware failure oriented group blocking message

HGU Hardware failure oriented group unblocking message

HUA Hardware failure oriented group unblocking-acknowledgement message

IAM Initial address message

LOS Line-out-of-service signal

MBA Maintenance oriented group blocking-acknowledgement message

MGB Maintenance oriented group blocking message

MGU Maintenance oriented group unblocking message

MUA Maintenance oriented group unblocking-acknowledgement message

NNC National-network-congestion signal

RAN Reanswer signal

RLG Release-guard signal

RSC Reset-circuit signal

SAO Subsequent address message with one signal

SAM Subsequent address message

SBA Software generated group blocking-acknowledgement message

SEC Switching-equipment-congestion signal

SGB Software generated group blocking message

SSB Subscriber-busy signal (electrical)

SST Send-special-information-tone signal

SUA Software generated group unblocking-acknowledgement message

UBA Unblocking-acknowledgement signal

UBL Unblocking signal

UNN Unallocated-number signal

Timers

T1 Timer ‘‘waiting for continuity or continuity-failure signal’’ [10-15 seconds, see § 6.4.3 a)]

T2 Timer ‘‘waiting for address-complete signal’’ [20-30 seconds, see § 6.4.3 a)]

T3 Timer ‘‘waiting for clear-forward signal after sending unsuccessful message’’ [4-15 seconds, see § 6.4.3 b)]

T4 Timer ‘‘waiting for clear-forward signal after sending call-failure signal’’ [4-15 seconds, see § 6.4.3 b)]

T5 Timer ‘‘stop sending call-failure messages on time out’’ [1 minute, see § 6.4.3 b)]

T6 Timer ‘‘waiting for release-guard signal’’ (4-15 seconds, see § 6.2.3)

T7 Timer ‘‘stop sending clear-forward signal on time out’’ (1 minute, see § 6.2.3)

T8 Timer ‘‘waiting for backward check-tone’’ (should not exceed 2 seconds, see § 7.4.1)

T9 Timer ‘‘delay to start first-time continuity-recheck’’ (1-10 seconds, see § 7.3)

T10 Timer ‘‘delay for multiple retests of continuity’’ (1-3 minutes, see § 7.3)

T11 Timer ‘‘waiting to alert maintenance personnel following initiation of blocking’’ (5 minutes, see § 5)

T12 Timer ‘‘waiting for blocking-acknowledgement signal’’ (4-15 seconds, see § 6.4.4)

T13 Timer ‘‘waiting to alert maintenance personnel on failure to receive BLA’’ (1 minute, see § 6.4.4)

T14 Timer ‘‘delay to repeat sending of blocking signals’’ (1 minute, see § 5.1)

T15 Timer ‘‘waiting for unblocking acknowledgement’’ (4-15 seconds, see § 6.4.4)

T16 Timer ‘‘waiting to alert maintenance personnel on failure to receive unblocking acknowledgement’’ (1 minute, see § 6.4.4)

T17 Timer ‘‘delay to repeat sending of unblocking acknowledgement’’ (1 minute, see § 5.1)

T18 Timer ‘‘waiting for a response to the reset-circuit signal’’ (4-15 seconds, see § 1.15)

T19 Timer ‘‘delay to send the reset-circuit signal’’ (1 minute, see § 1.15)

T20 Timer ‘‘waiting for second group reset message’’ (5 seconds, see § 1.15.2)

T21 Timer ‘‘waiting for circuit group reset acknowledgement message’’ (4-15 seconds, see § 1.15)

T22 Timer ‘‘delay to send the circuit group reset message’’ (1 minute, see § 1.15)

T23 Timer ‘‘waiting for second maintenance oriented group blocking message’’ (5 seconds, see § 5.2)

T24 Timer ‘‘waiting for second maintenance oriented group unblocking message’’ (5 seconds, see § 5.2)

T25 Timer ‘‘waiting to alert maintenance personnel following initiation of maintenance oriented group blocking’’ (5 minutes, see § 5)

T26 Timer ‘‘waiting for maintenance oriented group blocking acknowledgement message’’ (4-15 seconds, see § 6.4.4)

T27 Timer ‘‘delay to send the maintenance oriented group blocking message’’ (1 minute, § 6.4.4)

T28 Timer ‘‘waiting for maintenance oriented group unblocking acknowledgement message’’ (4-15 seconds, see § 6.4.4)

T29 Timer ‘‘delay to send the maintenance oriented group unblocking message’’ (1 minute, see § 6.4.4)

T30 Timer ‘‘waiting for second hardware failure oriented group blocking message’’ (5 seconds, see § 5.2)

T31 Timer ‘‘waiting for second hardware failure oriented group unblocking message’’ (5 seconds, see § 5.2)

T32 Timer ‘‘waiting for hardware failure oriented group blocking acknowledgement message’’ (4-15 seconds, see § 6.4.4)

T33 Timer ‘‘delay to send hardware failure oriented group blocking message’’ (1 minute, see § 6.4.4)

T34 Timer ‘‘waiting for hardware failure oriented group unblocking acknowledgement message’’ (4-15 seconds, see § 6.4.4)

T35 Timer ‘‘delay to send hardware failure oriented group unblocking message’’ (1 minute, see § 6.4.4)

T36 Timer ‘‘waiting for second software generated group blocking message’’ (5 seconds, see § 5.2)

T37 Timer ‘‘waiting for second software generated group unblocking message’’ (5 seconds, see § 5.2)

T38 Timer ‘‘waiting for software generated group blocking acknowledgement message’’ (4-15 seconds, see § 6.4.4)

T39 Timer ‘‘delay to send software generated group blocking message’’ (1 minute, see § 6.4.4)

T40 Timer ‘‘waiting for software generated group unblocking acknowledgement message’’ (4-15 seconds, see § 6.4.4)

T41 Timer ‘‘delay to send software generated group unblocking message’’ (1 minute, see § 6.4.4)

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