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Clauses applicable to ITU-T standard systems – Control of echo suppressors

Logic for the control of echo control devices

ITU-T Recommendation Q.115

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SWITCHING AND SIGNALLING

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ITU-T Recommendation Q.115

Logic for the control of echo control devices

Summary

Echo is a common problem in long distance (propagation delay) telephony, and echo control devices are deployed to eliminate the effects of it. The switching centres involved in a telephony connection must use consistent logical procedures to analyse the available information related to echo control requirements in order to optimize the locations at which echo control devices are provided in the connection.

This ITU-T Recommendation defines the information and logical procedures employed within switching centres to optimize echo control device placement. The information elements and logic defined in this ITU-T Recommendation are applicable to basic telephony calls, and to calls using supplementary services and Intelligent Networking features, in both narrow-band and broadband networks, and should be applied regardless of the particular signalling systems that convey information between the switching centres involved in a connection.

FOREWORD

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NOTE

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

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Logic for the control of echo control devices

1 Scope

The propagation delay in telecommunication networks affects both computer communication protocols and audiovisual communication between humans. The most noted effect is the echo problem for telephony which depends heavily on the propagation delay of the connection.

In order to achieve transmission objectives on long connections (refer to 3.10), it is necessary to take into account the effects of echo. A general discussion of echo considerations is given in ITU-T Recommendation G.131 [6]. The characteristics of terminal half-echo control devices are given in ITU-T Recommendation G.164 [1]. The characteristics of echo cancellers are given in ITU-T Recommendations G.165 [2] and G.168 [14].

In order to achieve optimum echo control for each call, it is necessary to control both echo suppressors and echo cancellers.

This can be carried out at switching centres only if sufficient information is available to coordinate an overall control action.

Logical means to obtain pertinent information and the switching considerations governing its practicable use are detailed below. Control based on the transfer of signals between switching centres is given particular attention. Self-contained control action such as tone disablement of echo suppressors and echo cancellers for data transmission is not within the scope of this ITU-T Recommendation.

The target to be reached by the use of echo control logic is:

–   to optimize the location of provision/insertion of Echo Control Devices (ECD). The echo control logic should select an ECD as near to the echo source (hybrid or terminal equipment) as possible. The ECD should be close enough to the source of echo so that its echo control tail length is sufficient to cancel any echo that may be present;

–   to provide information about the insertion/provision of ECD in the connection in the forward and in the backward direction.

Where it is appropriate to extend the echo control methods and logic into national networks, this is subject to national guidelines.

The delay time counter procedures require the addition of transmission delay values, beginning at the origin of a call and ending at the destination of it. These values could only be representative, if the whole or at least most of the delay of the connection is considered.

If the configuration of a call is changed after the call set-up (e.g. a new leg is added to a conference call), the exchange having knowledge about this change is responsible to initiate the echo control logic procedures for this new configuration.

Echo control logic, i.e. the set of echo control logic procedures, covers the needs of echo control not only in the PSTN but also in the N-ISDN, B-ISDN, PLMN and IN. It is also capable of adaptation to the changing requirements in connections supporting services such as call forwarding and multiparty calls. It is independent of the signalling systems/protocols involved, but the optimal placement may depend on the capability of the signalling systems. Echo control logic described in this ITU-T Recommendation is compatible with the logic described in previous versions.

For new versions of signalling systems/protocols it is necessary to define parameters and messages to transmit the echo control information and requests as specified in Annex A.

It is outside the scope of this ITU-T Recommendation to determine when signalling messages are initiated.

2 References

The following ITU Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[1]   CCITT Recommendation G.164 (1988), *Echo suppressors*.

[2]   ITU-T Recommendation G.165 (1993), *Echo cancellers*.

[3]   CCITT Recommendation I.230 (1988), *Definition of bearer service categories*.

[4]   CCITT Recommendation G.172 (1988), *Transmission plan aspects of international conference calls*.

[5]   ITU-T Recommendation G.173 (1993), *Transmission planning aspects of the speech service in digital public land mobile networks*.

[6]   CCITT Recommendation G.131 (1988), *Stability and echo*.

[7]   CCITT Recommendation E.220 (1992), *Interconnection of public land mobile networks (PLMN)*.

[8]   ITU-T Recommendation Q.764 (1993), *ISDN user part signalling procedures*.

[9]   ITU-T Recommendation Z.100 (1993), *CCITT Specification and description language (SDL)*.

[10]   CCITT Recommendation Q.271 (1988), *Continuity check of the speech path: General*.

[11]   CCITT Recommendation Q.724 (1988), *Telephone user part signalling procedures*.

[12]   CCITT Recommendation Q.112 (1988), *Signal levels and signal receiver sensitivity*.

[13]   ITU-T Recommendation Q.2764 (1995), *Signalling System No. 7 B-ISDN User Part B-ISUP − Basic call procedures*.

[14]   ITU-T Recommendation G.168 (1997), *Digital network echo cancellers*.

3 Terms and definitions

3.1   Subsequent discussion of control measures will refer to the standard terminal half-echo suppressor specified in ITU-T Recommendation G.164 [1] and the echo cancellers specified in ITU-T Recommendations G.165 [2] and G.168 [14]. The terms "echo suppressor" and "echo canceller" will be used to denote these devices. The term "ECD" will comprise both echo suppressors and echo cancellers.

3.2   Two means of introducing ECDs are considered as acceptable. These are the use of permanently associated echo control devices, and the use of echo control devices inserted from a common pool.

3.3   With respect to control of permanently associated ECDs, control actions are said to enable or disable.

3.4   With respect to echo control devices provided from pools, control actions are concerned with inserting or not inserting. An inserted ECD is controlled in order to enable or disable it.

3.5 With respect to ECD provided in B-ISDN exchanges, the term "ECD" denotes echo cancellers only, as echo suppressors should not be used.

3.6 Information to assist in the placement of echo control devices is communicated between exchanges by ITU-compliant signalling.

3.7 Full ECD describes the situation where both an outgoing echo control device and an incoming echo control device (see 3.11) are enabled at a single exchange.

3.8 A **long circuit** is considered as one which, if used by itself, would require echo control.

3.9 A **short circuit** is considered as one which, if used by itself, would not require echo control.

3.10 A **long connection** is a connection that requires echo control.

A long connection may consist of several circuits in tandem. These circuits may or may not be long circuits, but their total propagation delay is such that echo control is required.

If not detected at call set-up time, the total propagation delay is calculated during call set-up based on information carried in signalling (see 8.2).

3.11 An **incoming echo control device (IECD)** is a device cancelling the echo returned from the destination network with reference to the direction in which the call is set up.

3.12 An **outgoing echo control device (OECD)** is a device cancelling the echo returned from the network of origin with reference to the direction in which the call is set up.

3.13 Two types of exchanges are defined:

3.13.1 exchange Type 1 invokes echo control logic procedures for all calls of the bearer capability "speech or 3.1 kHz audio". These procedures are described in this ITU-T Recommendation. Any exchange in a network can be of Type 1.

3.13.2 exchange Type 2 cannot invoke echo logic control procedures. The received echo control information is passed unchanged (in both directions). In case of interworking the echo control information is mapped from one signalling system/protocol to the other.

3.14 An **echo control initiating exchange** is the first exchange that recognizes the need to apply echo control procedures.

3.15 The **propagation delay initiating exchange** is the exchange that initiates the propagation delay determination procedure; e.g. a typical case is the originating local exchange.

3.16 The **propagation delay terminating exchange** is the exchange that terminates the propagation delay determination procedure; e.g. typically the local destination exchange.

3.17 Node of the Intelligent Network (IN) is a node which belongs temporarily or permanently to the IN, e.g.

a)   an SSP is normally considered to be a node of the PSTN/N-, B-ISDN, but when connecting a Specialized Resource Function (SRF) for the user interaction it is considered to be a node of the IN; and

b)   an SCP is considered to be a permanent node of the IN.

4 Abbreviations

This ITU-T Recommendation uses the following abbreviations:

B-ISDN   Broadband ISDN

B-ISUP   Signalling System No. 7 Broadband ISDN User Part ITU-T Recommendations Q.2761-Q.2764 (approved 1995)

CHI   Call History Information

CII   Control Information for IECD

CIO   Control Information for OECD

ECD   Echo Control Device

ECIB   Echo Control Information Backward

ECIBA   Echo Control Information Backward, Additional (ECD availability)

ECIBAp   Procedure to set the information in ECIBA

ECIBp   Procedure to set the information in the ECIB passed to the previous exchange when ECIB has been received from the subsequent exchange

ECIF   Echo Control Information Forward

ECIF/Ap   Procedure that is called when selecting an outgoing circuit

ECIFA   Echo Control Information Forward, Additional (ECD availability)

ECIFAp   Procedure for handling echo control information received from the previous exchange in ECIFA

ECIFp   Procedure for handling echo control information received from the previous exchange in ECIF

ECRB   Echo Control Request Backward (OECD request/IECD request)

ECRBp   Procedure for handling information in a backward echo control request

ECRF   Echo Control Request Forward (OECD request/IECD request)

ECRFp   Procedure for handling a forward request message (e.g. after fallback) when no ECDs are available in a previous exchange

ECRR   Echo Control Request for Release (OECD to be released/IECD to be released)

ECRRB   Echo Control Request for Release, backward direction

ECRRF   Echo Control Request for Release, forward direction

GMSC   Gateway Mobile Switching Centre

IN   Intelligent Network

IP   Intelligent Peripheral (IN)

I.a.   Incoming echo control device available

I.i.   IECD included

I.n.a.   Incoming echo control device not available

I.n.i.   IECD not included

I.n.r.   IECD not requested

I.n.x.   IECD not to be released

I.r.	IECD requested
I.x.	IECD to be released
IECD	Incoming Echo Control Device
ISUP'92	Signalling System No. 7 ISDN User Part ITU-T Recommendations Q.761-Q.764 (approved March 1993)
N-ISDN	Narrow-band ISDN
NNI	Network Node Interface
NOECDIp	Procedure called by ECIFp if no ECDs are in the connection up to this point
O.a.	Outgoing echo control device available
O.i.	OECD included
O.n.a.	Outgoing echo control device not available
O.n.i.	OECD not included
O.n.r.	OECD not requested
O.n.x.	OECD not to be released
O.r.	OECD required/requested
O.x.	OECD to be released
OECD	Outgoing Echo Control Device
OECDIp	Procedure called by ECIFp when a previous exchange has included an OECD
OECDRp	Procedure called by ECIFp when a previous exchange has requested this exchange to provide an OECD
PDC	Propagation Delay Counter
PLMN	Public Land Mobile Network
ROSRFp	Procedure for analysing the need to provide an OECD for the user interaction (SRF)
RROSRFp	Procedure for initiating the request for release of an OECD (SRF)
SCP	Service Control Point (IN)
SN	Service Node (IN)
SRF	Specialized Resource Function (IN)
SSP	Service Switching Point (IN)
T	If propagation delay > T, then echo control device(s) is (are) required (if at least one of the accesses has a source of echo) (refer to ITU-T Recommendation G.131 [6])
TUP	Signalling System No. 7 Telephone User Part ITU-T Recommendations Q.721-Q.764 (approved 1988)
UNI	User Network Interface

5 Bearer capabilities for which echo control is required

For connections controlled by ISUP'92 or later versions, the echo control logic procedures apply to the following bearer capabilities:

–   3.1 kHz audio or speech; and

–   64 kbit/s unrestricted preferred.

For connections controlled by B-ISUP, echo control applies when the Narrow-band Bearer Capability parameter is present in the B-ISUP Initial Address Message with the information transfer capability values:

–   3.1 kHz audio or speech.

The handling of ECDs in the case of different bearer capabilities is described in clause 12.

6 Arrangements of echo control devices with respect to signalling

Arrangements should be incorporated in the switching equipment to prevent echo control device action from disturbing simultaneous forward and backward in-band signalling via the speech paths.

Arrangements should be incorporated in the Systems No. 6 and No. 7 equipment to prevent actions by echo control devices from disturbing the procedure for making the continuity check of the speech path. Echo control devices must be permanently disabled if a circuit is used as a signalling channel for common channel signalling.

Echo control devices must be enabled when signalling indicates that a call has encountered fallback from 64 kbit/s preferred to speech/3.1 kHz audio (see 2.5/Q.764) if echo control is required for the call.

Typical arrangements are:

i)   locating the echo control devices in a position that does not lead to interference with signalling tones;

ii)   where echo control devices are located in a position where they interfere with signalling tones, they must be capable of being disabled by an appropriate condition extended from the signalling equipment to the ECD while signalling is in progress;

iii)   using an echo control device that is designed to be transparent to signalling tones (see Note 3 below).

NOTE 1 – The standard half-echo suppressor (see ITU-T Recommendation G.164 [1]) if located on the line side of line signalling equipment may adversely affect signalling. This difficulty is possible because with the new standard half-echo suppressor normal operation will at times cause 6 dB additional loss to appear in the path to a line signalling receiver. Operating margins are correspondingly reduced. For example, with signalling receivers for System No. 5 as specified in ITU-T Recommendation Q.112 [12], signalling reliability could be impaired. Accordingly, adequate operating margins should be assured or the echo suppressor should not be located on the line side of line signalling receivers. With regard to inter-register signalling which requires simultaneous transmission in both directions, similar considerations call for disabling the echo suppressors while inter-register signalling is in progress in order to prevent the 6 dB loss.

NOTE 2 – Echo cancellers will not introduce any fixed loss during in-band signalling. But some can cause a problem during the continuity check used in Signalling Systems No. 6 (see ITU-T Recommendation Q.271 [10]) and No. 7 (see ITU-T Recommendations Q.724 [11] and Q.764 [8]), or with compelled signals having the same frequency(ies) on both directions of transmission in Signalling System No. 5 (see ITU-T Recommendation Q.112 [12]) where the received signal is processed through the existing echo path model and produces an interfering signal in the return path.

NOTE 3 – Some echo control devices are capable of internally providing either signalling bypass or an appropriate internal function which permits transparent operation to in-band signalling or other in-band tones.

7 Operation without signals

In Signalling Systems No. 5 and R1, signals are not available for echo control information. In System No. 4, a signal may be applied only if multilateral or bilateral agreements authorize its use. Accordingly, the recommended control plan relies on means other than signals in cases where it has not been found practicable to provide signals. In the case of System No. 5, the normal field of application to long circuits typically indicates the presence of echo control devices. In the case of System R1, regional control procedures not requiring signals are applicable.

8 Considerations for the need of ECDs

8.1 Information taken into consideration

Exchanges must make decisions with respect to echo control requirements at the time an outgoing circuit is selected or at a later stage of call set-up. Unless echo control devices are not available, one or more of the following items of information should influence this decision:

i) address information indicating the destination (e.g. country code, area code);

ii) information about the actual routing of the call (this includes information related to the routing of a call to a destination, and to any interaction with intelligent network entities);

iii) nature of outgoing circuit (e.g. satellite circuit);

iv) nature of incoming circuit;

v) signalling information received in forward and backward direction:

    I.i.   IECD included

    I.n.i.   IECD not included

    I.r.   IECD requested

    I.n.r.   IECD not requested

    O.i.   OECD included

    O.n.i.   OECD not included

    O.r.   OECD required/requested

    O.n.r. OECD not requested

    O.a.   Outgoing echo control device available (Note)

    I.a.   Incoming echo control device available (Note)

    O.n.a. Outgoing echo control device not available

    I.n.a.   Incoming echo control device not available;

vi) bearer capability requested (see clause 12.);

vii) propagation delay counter, call history information;

viii) connecting a Specialized Resource Function (SRF).

NOTE – O.a. and I.a. also apply for accesses with no source of echo.

With respect to iii) and iv), the characteristic of primary interest is propagation time. Two general categories, long and short, are the basis of control action. See 3.8 and 3.9, for definition of terminology.

Signalling procedures convey echo control information to enable exchanges to perform echo control in a call dependent way. For example, see 2.6/Q.764, 2.7/Q.764 and Annex C/Q.764 [8].

Echo control logic will not be invoked in an exchange (acting as a Service Switching Point of the Intelligent Network) while interacting with Intelligent Network entities, unless there is a request to connect to a SRF during call set-up. The protocol entity will use routing or other information from call control to detect that the exchange is interacting with Intelligent Network entities. Echo control logic is invoked at the completion of Intelligent Network interactions when the onward routing of the call is determined. The echo control logic uses the echo control information that was received (e.g. in the IAM), and was stored until needed.

8.2   Propagation delay counter, call history information

Some signalling protocols provide procedures to determine the total propagation delay for a connection in order to have better means to evaluate the need for routing and/or echo control on the connection concerned.

The propagation delay information is accumulated during call set-up in the forward direction. The result is sent in the backward direction as call history information before the active phase of the call. This accumulated result normally represents the propagation delay of the whole connection. However, if the propagation delay terminating exchange has knowledge of the propagation delay of a possible succeeding part of the connection, the value of this delay will be added to the value of the propagation delay as received and the total value will be returned in the call history information. The call history information can be used by echo control logic at a later time during the call set-up.

The propagation delay initiating exchange has the possibility to start accumulating the propagation delay with a value > 0. The initiating exchange may set the propagation delay counter to a fixed value stored in the exchange.

The increment of the propagation delay counter is 1 ms, the maximum delay value is $2^{16} - 1$ ms.

The propagation delay counter is accumulated for every link in the connection for every call, if possible.

The propagation delay may not be used by every exchange for the decision to include echo control devices into a connection.

As not all exchanges support the propagation delay counting, the other criteria listed in 8.1. have to be used for echo control.

9   Functions of an exchange initiating echo control

All exchanges of Type 1 involved in a connection determine by factors i) to vii) in 8.1 above whether echo control devices are needed in the connection. If there is no need to provide echo control devices in a particular connection, then there is no distinction between these exchanges.

If the information related to the factors i) to vii) indicates that the connection to be established will require echo control devices, the following distinction is made:

The exchange that first detects the requirement for echo control devices becomes the EC initiating exchange. This exchange has the responsibility for the optimum placement of the OECD.

If the EC initiating exchange has detected the requirement for echo control devices during forward call set-up, then that exchange has the responsibility for the optimum placement of an OECD. The EC initiating exchange either requests the preceding exchange/network to provide an OECD (when it has information that an OECD is available in the preceding exchange/network) or it provides an OECD. The EC initiating exchange informs the succeeding exchange/network that an OECD is being included, if this is possible on the outgoing signalling system/protocol.

If the EC initiating exchange has detected the requirement for echo control devices during backward call set-up, then that exchange has the responsibility for the optimum placement of an IECD. The EC initiating exchange provides the IECD. The EC initiating exchange informs the preceding exchange/network that an IECD has been included, if this is possible on the incoming signalling system/protocol.

Information on the action to be taken when an EC initiating exchange is unable to provide an IECD or OECD on the connection is provided in clause 10.

See clause 11 for information regarding the possibility of an exchange providing both an OECD and an IECD.

In the event that an EC initiating exchange is unable to provide an outgoing ECD when a need is known, it may call for cooperative action. (Signal I-11 in Signalling System R2 is specifically assigned to make possible a cooperative transfer of responsibility for ECD control from an outgoing gateway exchange – being the EC initiating exchange – to the transit exchange.) The EC logic in an EC initiating exchange will not cause a negotiation process (similar to that used in ISUP'92) to enable an OECD in the preceding exchange/network when it has no knowledge that an OECD is available in the preceding exchange/network.

10   Unavailability of echo control devices

It is recognized that when ECDs are inserted from pools, there is a small probability that no ECD will be available when needed. In this case, the echo control may be done by another exchange. Where EC logic recognizes that proper echo control is not in the connection, the call may be either allowed to complete or terminated. This decision is outside the scope of this ITU-T Recommendation.

11   Placement of echo control devices in the network

The objective of the EC logic is to select an outgoing echo control device and an incoming echo control device as near as possible to the sources of echo.

ECDs should be placed in such a position in the network that the echo cancellation tail length is sufficient to cover the round-trip end delay between the ECD and the source of echo.

Echo control devices in a connection should preferably be provided in the proper sequence. This means the incoming echo control device should be placed after the outgoing echo control device, seen in the direction of call set-up.

It follows from the above that in every case where a transit exchange interconnects two circuits and knows that ECD will be provided at a preceding location and also at a more distant location, the transit centre may disable or not insert its own ECD. The provision of tandem ECD for transit calls may be considered provided it does not result in degradation of the call.

An ECD (i.e. IECD and OECD) can be permanently associated with a circuit of the incoming and outgoing signalling system or can be provided from a pool.

Information about placement of echo control devices for PLMN to PSTN or ISDN interworking is given in ITU-T Recommendations G.173 [5] and E.220 [7].

B-ISDN networks may or may not provide ECDs or an equivalent functionality. For B-ISDN to N-ISDN interworking the ECDs or the equivalent functionality may be provided in either the B-ISDN or the N-ISDN.

Service Nodes and Intelligent Peripherals in an IN should provide their own ECDs, if full duplex user interaction is supported. Where an SN/IP has not provided an ECD then an OECD should be provided in the connection. This is necessary in a full-duplex operation mode even when the end-to-end delay would not require ECDs, in order to prevent unwanted echo of the SRF speech output from being mistaken as a subscriber input.

12 Handling of echo control devices in the case of different bearer capabilities

Echo control logic is invoked when the bearer capability information indicates that it is appropriate.

Different bearer capabilities are needed to provide the different services. Where common circuits are used to provide different basic services, ECDs have to be enabled depending on the requested service, and the results of echo control logic.

- If the bearer capability is speech or 3.1 kHz audio, an ECD should be enabled for this connection at the appropriate exchanges when echo control is required.

- If the bearer capability is 64 kbit/s unrestricted or multirate, or if digital connectivity is requested in TUP, no ECD is inserted. If the ECD is permanently associated, these ECDs have to be disabled and provide bit transparency.

- If the bearer capability is 64 kbit/s preferred, an ECD should be provided in the disabled mode for this connection, at the appropriate exchanges. If the bearer capability for the call changes to speech/3.1 kHz audio from 64 kbit/s preferred, the ECDs should then be enabled.

13 Other considerations

Nothing in this ITU-T Recommendation should be construed as discouraging control measures which may supplement the plan described and lead to improved results in specific situations. For example, regional procedures which introduce loss to control echo may be arranged to satisfy both regional and international needs on a selective basis.

ANNEX A

Echo control logic

A.1 General principles and definitions

A.1.1 General principles

The echo control logic is based on the following principles:

– Echo control devices can be either fix assigned to the circuits and associated with the incoming and/or outgoing signalling system/protocol or arranged in a pool (the probability of the availability of an echo control device in the pool should be very close to 1). Either method of providing ECDs will adequately meet the needs of network services and supplementary services (Note 1).

– Reservation of ECDs is not considered in this logic, as it would cause unnecessary complications in signalling procedures.

– Evaluation of propagation delay counter, if present.

– Evaluation of call history information, if present.

– Connections with only one echo control device (OECD or IECD) are treated as a regular case, i.e. these connections are not released.

– Signalling systems/protocols are required to transmit ECIFA, indicating whether a preceding exchange/network has the possibility to provide an OECD if required (Note 2).

– Signalling systems/protocols are required to transmit ECIBA, indicating whether a succeeding exchange/network has the possibility to provide an IECD if required (Note 3).

– Signalling systems/protocols are required to transmit ECIF, indicating whether a preceding exchange/network has provided an OECD (Note 2).

– Signalling systems/protocols are required to transmit ECIB, indicating whether a succeeding exchange/network has provided an IECD (Note 3).

– Calls having a connection type allowing the change of the bearer capability during the call are subject to echo control.

NOTE 1 – These are the basic configurations for providing ECDs:

normal associated

reversed associated

combined associated

pool

The ECD cancels the echo in the sending path (of the ISC)

The ECD cancels the echo in the receive path (of the ISC)

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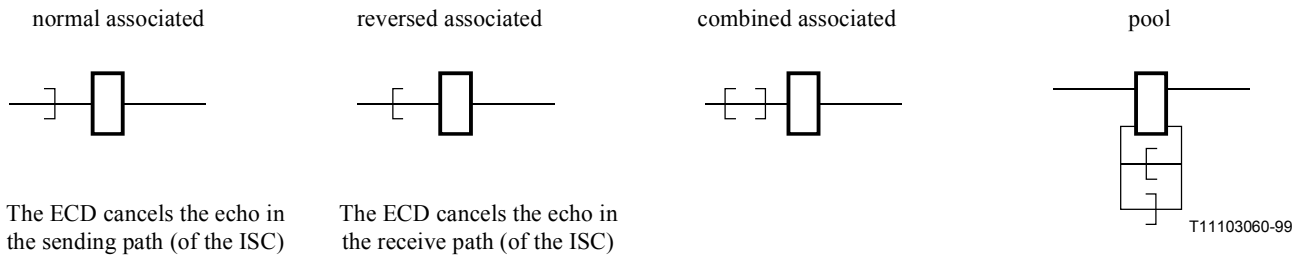
NOTE 2 – Incoming circuits (supported by signalling systems/protocols not capable of transmitting ECIFA) connected to an exchange where the availability of OECD in a preceding exchange/network is known, are marked accordingly (this allows an exchange to send an explicit request for OECD backward, only if it makes sense). Where the availability of ECD in the preceding network is not known, the default value of "ECD not available" should be used. Where ECIF is not supported, the default value "OECD not included" should be used, if it is known that the access/network can not provide an OECD, otherwise the default value "OECD included" should be used.

NOTE 3 – Outgoing circuits (supported by signalling systems/protocols not capable of transmitting ECIBA) connected to an exchange where the availability of IECD in a succeeding exchange/network is known, are marked accordingly (this allows an exchange to send an explicit request for IECD forward, only if it makes sense). Where the availability of ECD in the succeeding network is not known, the default value of "ECD not available" should be used. Where ECIB is not supported, the default value "IECD not included" should be used, if it is known that the access/network can not provide an IECD, otherwise the default value "IECD included" should be used.

A.1.2 Definitions

– An exchange of Type 1 contains echo control logic (see Figure A.1).

– An exchange of Type 2 does not contain echo control logic (see Figure A.2).

A.2 Abstract model

A.2.1 General description

Echo control logic is part of call control and has a common interface to the logic procedures of the incoming and outgoing signalling systems/protocols.

Echo control logic provides information to populate the echo control indicators in signalling messages.

The following information elements are interchanged between echo control logic and the signalling systems/protocol involved in setting up the connection:

- *Echo Control Information Forward (ECIF)*

  O.n.i.   OECD not in the connection

  O.i.   OECD in the connection

  O.r.   OECD required in subsequent exchange

- *Echo Control Information Backward (ECIB)*

  I.n.i.   IECD not in the connection

  I.i.   IECD in the connection

- *Echo Control Request Forward (ECRF)*

  I.n.r.   IECD not required

  I.r.   IECD required

  O.r.   OECD required

  O.n.r.   OECD not required

- *Echo Control Request Backward (ECRB)*

  I.n.r.   IECD not requested

  I.r.   IECD requested

  O.r.   OECD requested

  O.n.r.   OECD not requested

- *Echo Control Information Forward, Additional (ECIFA)*

  O.n.a.   OECD not available in preceding exchange/network

  O.a.   OECD available in preceding exchange/network (Note 4)

- *Echo Control Information Backward, Additional (ECIBA)*

  I.n.a.   IECD not available in succeeding exchange/network

  I.a.   IECD available in succeeding exchange/network (Note 4)

- *Echo Control Request for Release Forward/Backward (ECRRF/B)*

  I.n.x.   IECD not to be released

  I.x.   IECD to be released

  O.n.x.   OECD not to be released

  O.x.   OECD to be released

- *Control Information for IECD (CII)*

  Enable

  Disable

- *Control Information for OECD (CIO)*

  Enable

  Disable

NOTE 4 – O.a. and I.a. also apply for accesses with no source of echo.

The following information is available from call control (routing):

- Propagation Delay Counter (PDC) (Note 5)

  Received: $PDC = Di$

  Sent forward: $PDC = Di + Do$

- Call History Information (Note 5)

  Total propagation delay sent backward.

- Routing Information

  This includes information related to the routing of a call to a destination, and to any interaction with intelligent network entities.

NOTE 5 –   Di Propagation Delay time of the originating access, or of the incoming connection (PDC received)

   Do Propagation delay of the terminating access, or of the outgoing section of the connection.

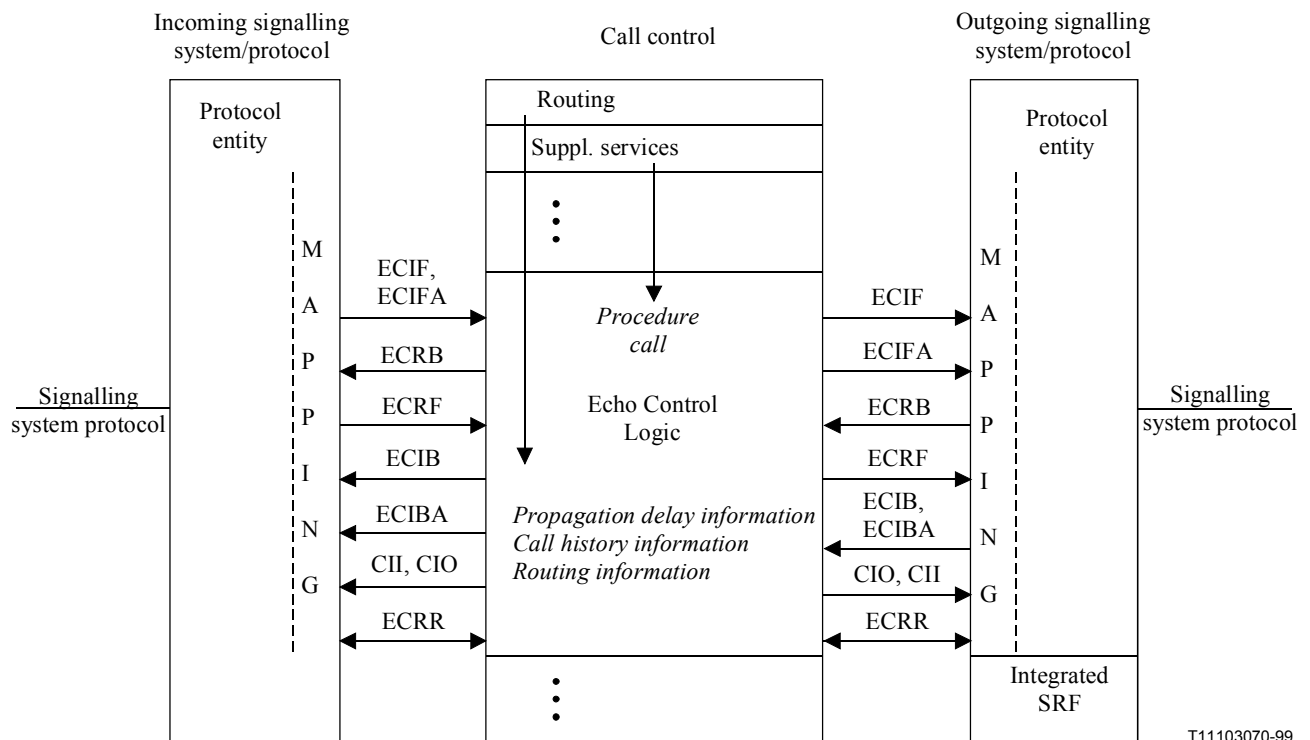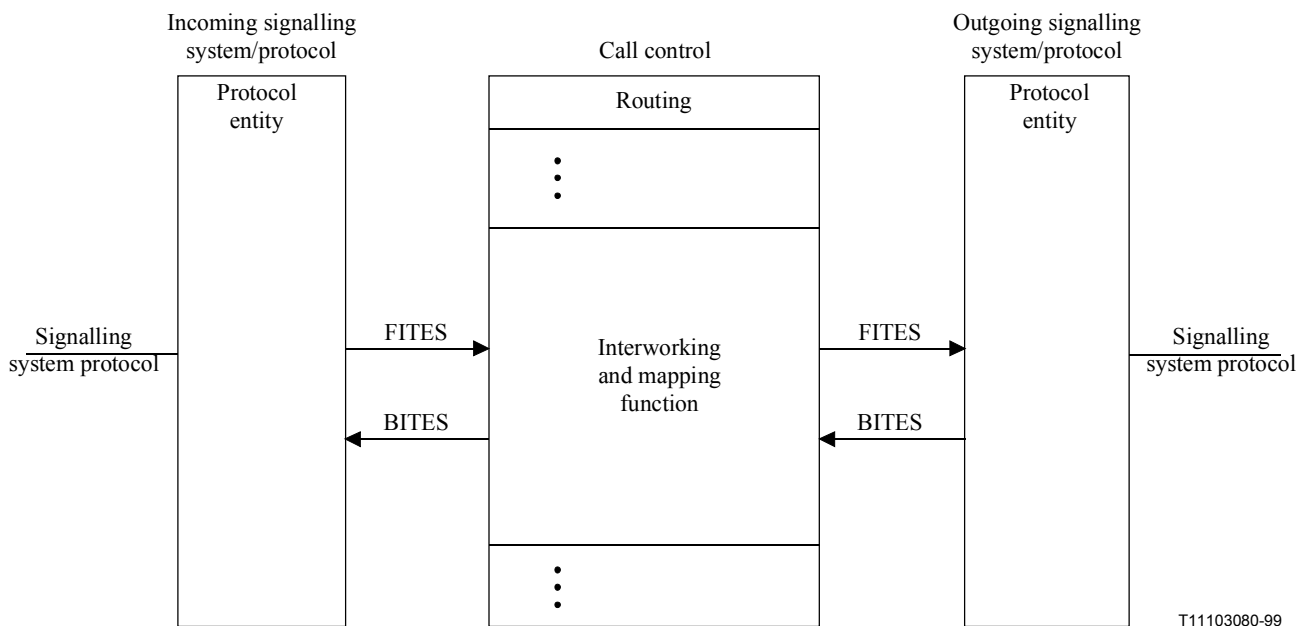If propagation delay/call history > T then echo control is required.

Figure A.1/Q.115 – Exchange Type 1

NOTE – Echo control information elements are included in FITES and BITES (see CCITT Recommendation Q.601ff).

Figure A.2/Q.115 – Exchange Type 2

A.2.2   Signalling system/protocol

A.2.2.1   General

The echo control information/requests received by the signalling systems/protocols have to be stored so that they can be interpreted by the echo control logic procedures (see A.2.1); ECIF has to be sent in conjunction with ECIFA (if not supported by the signalling system/protocol, a default value based on the knowledge of the adjacent exchange/network has to be used). The same applies for ECIB and ECIBA. The protocol entity of the signalling systems/protocols is responsible for the control of the echo control devices, i.e. the carrying out of the control information received from echo control is based on timing requirements (e.g. continuity check running) and on the bearer capability actually used (e.g. fall back). The signalling systems/protocols transmit the echo control information/requests resulting from echo control logic. See Table I.1 for details of the transmission of echo control information.

A.2.2.2   Backward compatibility

Some existing signalling systems/protocols have echo control signalling procedures based on their signalling information transfer capabilities. These signalling procedures may not adhere fully to the echo control logic described in this ITU-T Recommendation. Therefore, a backward compatibility mechanism may be required in an exchange using the echo control logic defined in this ITU-T Recommendation in conjunction with signalling procedures of ISUP'97. The figures in Appendix I show examples of such mechanisms.

A.2.2.3   Interactions with the Intelligent Network (IN)

In a Service Switching Point (SSP) the protocol entity is responsible for providing default echo control values in a backward direction when interaction to intelligent network entities occurs during call set-up. Echo control information received (e.g. in an IAM) is stored during this period. The default values for the echo control information are "I.n.i." and "I.n.a.". This is applicable to both Type 1 and Type 2 exchanges.

Connection to a Specialized Resource Function (SRF): if an answer message is required to allow user network interaction, it should not include, in case of ISUP, Call History information. If this node is a Type 1 exchange supporting full-duplex user interaction, then echo control logic will decide, if an OECD is required.

A.2.2.4   Supplementary services

A.2.2.4.1   Multi-party (three-party service, conference calling)

The echo control logic assumes that the conference bridge, used for the multi-party service, complies to ITU-T Recommendation G.172 [4]. Therefore by using echo control signalling procedures for basic call and the echo control logic described in this ITU-T Recommendation, applied separately for each leg, optimal echo control performance is guaranteed.

A.2.2.4.2   Call offering

A.2.2.4.2.1 Call forwarding (busy, no reply, unconditional)

All call forwarding exchanges have to pass all relevant echo control information (e.g. O.i./O.n.i., propagation delay) to the new leg in the diverted call. The use of echo control signalling procedures for basic call, which are based on the echo control logic described in this ITU-T Recommendation, will then guarantee optimal echo control performance.

A.2.2.4.2.2 Explicit call transfer

In case of explicit call transfer in an exchange Type 1, the echo control logic procedure for ECT analyses the changed situation and decides if and where ECDs have to be provided. ECT, combining two connections (legs) which have been previously set up independently, leads to one of the following configurations.
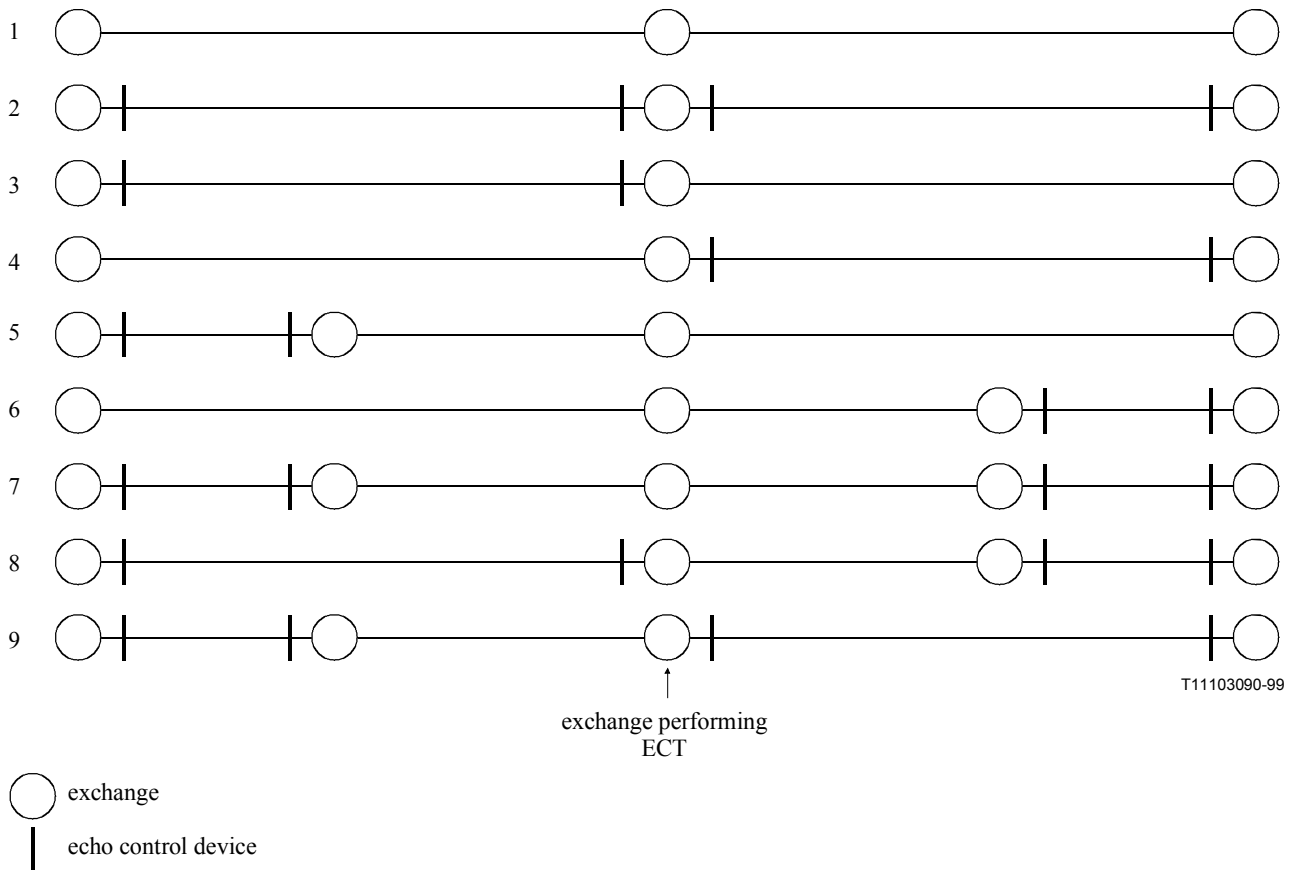
NOTE – If ECT occurs in an exchange Type 2, this may result in a non-optimal placement of ECDs or no ECDs (however required) respectively.

Figure A.3/Q.115 – ECD grouping to be analysed by echo control logic

A.2.2.5 Connection type allowing fallback

Based on the actual bearer capability the protocol entity carries out or ignores the CII (enable IECD) or the CIO (enable OECD) received from echo control logic.

A.2.3 Interworking

In case of exchange Type 2 the received echo control information/requests are mapped (by the interworking function) from one signalling system/protocol to the other.

A.2.4 Special network nodes

A.2.4.1 Nodes belonging to the Intelligent Network (IN)

Those nodes with a circuit interface can be set up either as a Type 1 or Type 2 exchange.

Type 1: In a Service Switching Point (SSP) with integrated SRF echo control logic will decide for a connection to an SRF, if the network has to provide an OECD. At disconnect of the SRF the echo control logic will issue an OECD release request in those cases where an OECD request has been issued. Echo control logic will perform the above stated functions within an Intelligent Peripheral (IP) and within a Service Node (SN).

Type 2: If backward messages/information have to be sent to the network, the following default values have to be used "IECD not included", "IECD/OECD not requested" and "no call history".

A.2.4.2 Gateway of mobile networks

Mobile networks are connected to the fixed network (ISDN/PSTN) through the Gateway Mobile Switching Centre (GMSC). This is a Type 1 exchange. The GMSC may provide on a per call basis an ECD to cancel the echo originated in the fixed network in case the fixed network does not provide the ECD itself. The mobile terminal is considered to be free of echo; see ITU-T Recommendation E.220.

Mobile originating call: The echo control information sent from the GMSC towards the fixed network is "OECD available" (if supported by the signalling system) and "OECD included". The GMSC will provide the IECD in case the echo control information "IECD not included" and "IECD not available" (if supported by the signalling system) is received from the fixed network.

Mobile terminating call: If the received echo control information indicates "OECD not included" and "OECD not available" (if supported by the signalling system) the GMSC will provide the OECD. The echo control information "IECD available" (if supported by the signalling system) and "IECD included" is sent in the backward direction towards the fixed network.

NOTE – Propagation delay and call history should also be conveyed between the networks.

A.2.5 Echo control logic

The echo control logic analyses the echo control information/requests and propagation delay/call history values received via the signalling systems/protocols as well as origin/destination related information that is stored in the database of the exchange. Based on all these data the echo control logic determines:

a)   echo control device related actions; and

b)   the echo control information/requests that have to be transmitted by the signalling systems/protocols.

The echo control logic does not directly control the echo control devices. It is the task of the protocol entity of the signalling systems/protocols to disable and enable echo control devices. The reason is: The echo control logic does not know if e.g. in-band signalling is still going on, if continuity check is still running, or the value of the currently used bearer capability.

A.3 SDL diagrams

The following pages (Figures A.4 to A.23) show the finite state machine and the procedures. Refer to ITU-T Recommendation Z.100 [9] for definitions of the symbols and syntax used in these diagrams.

NOTE – In the context of the SDLs:

–   "normal associated" is referred to as "IECD associated with the incoming circuit" and "OECD associated with the outgoing circuit" respectively.

–   "reversed associated" is referred to as "IECD associated with outgoing circuit" and "OECD associated with incoming circuit".

PROCESS Echo Control Logic

Init. State

/* NOTE – Throughout these SDL diagrams, procedures are denoted by a name ending in "p".*/

/* The finite state machine "Echo Control Logic" in an IP or SN (with SRF for user interaction) may contain only those state transitions marked with " * ".   */

Active

[*

| ECIF, ECIFA | ECRF | ECIB, ECIBA | ECRB |

ROUT. INFO (NNI, UNI), P.D.C.

CALL HISTORY

| Store ECIF, ECIFA | ECRFp | Store ECIB, ECIBA | ECRBp |

| ECIF/Ap | ECIB/Ap | CHp |

Active

[*   [*

| ROUT.INFO (conn.SRF) | ROUT.INFO (disc.SRF) | ECRRB | ECRRF | ECT |

| ROSRFp | RROSRFp | ECRRBp | ECRRFp | ECTp |

Active

T11103100-99

Figure A.4/Q.115 – Finite State Machine "Echo Control Logic" *(sheet 1 of 2)*

ECIF/Ap

Procedure ECIF/Ap (Echo Control Information Forward/Additional)
is called after the exchange has selected the outgoing circuit. It analyses
ECIF and ECIFA information received from the incoming signalling system
together with routing information available from Call Control, to determine
whether an ECD is needed. It provides an ECD if possible and appropriate,
and passes ECIF, ECIFA, ECIB and ECRB indications to the outgoing and
incoming signalling systems accordingly.

ECRFp

Procedure ECRFp (Echo Control Request Forward)
analyses a request for an ECD received from the incoming signalling
system. It provides an ECD if appropriate and passes ECRF indications
to the outgoing signalling system accordingly.

ECIB/Ap

Procedure ECIB/Ap (Echo Control Information Backward/Additional)
analyses ECIB and ECIBA information received from the outgoing signalling system.
It provides an ECD if required, and passes appropriate ECIB and ECIBA indications
to the incoming signalling system.

ECRBp

Procedure ECRBp (Echo Control Request Backward)
analyses ECRB information received from the outgoing signalling system.
It provides the requested ECD if possible, and if appropriate. It passes
ECRB and ECIB indications to the incoming signalling system accordingly.

CHp

Procedure CHp (Call History)
analyses the call history information received from call control.
It provides an ECD if required.

ECTp

Procedure ECTp (Explicit call transfer)
analyses the combination of leg1 and leg2 with respect
to echo control needs.

ECRRFp
ECRRBp

Procedure ECRRFp/ECRRBp (Request for Release of an ECD)
analyses the need to release a previously provided ECD

ROSRFp

Procedure ROSRFp (Request OECD for SRF)
analyses the need to provide an OECD for the User Interaction

RROSRFp

Procedure RROSRFp (Request for Release of an OECD (for SRF))
analyses the need to release a previously provided OECD (for SRF)

T11103110-99

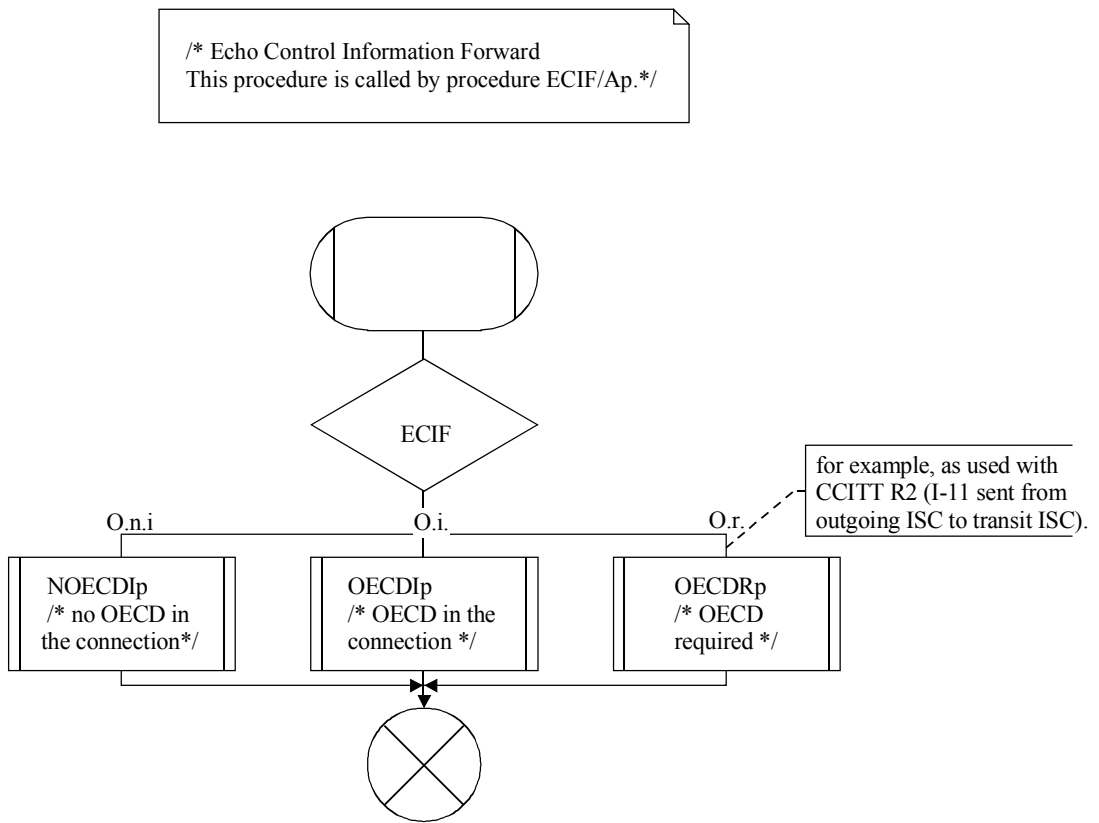**Figure A.4/Q.115 – Finite State Machine "Echo Control Logic"** *(sheet 2 of 2)*

/* Echo Control Information Forward/Additional.
This procedure is called when selecting the outgoing circuit. */

ECIFp

ECIFAp

T11103120-99

Figure A.5/Q.115 – Echo Control Procedure for ECIF/A

/* Echo Control Information Forward
This procedure is called by procedure ECIF/Ap.*/

ECIF

for example, as used with
CCITT R2 (I-11 sent from
outgoing ISC to transit ISC).

O.n.i

O.i.

O.r.

NOECDIp
/* no OECD in
the connection*/

OECDIp
/* OECD in the
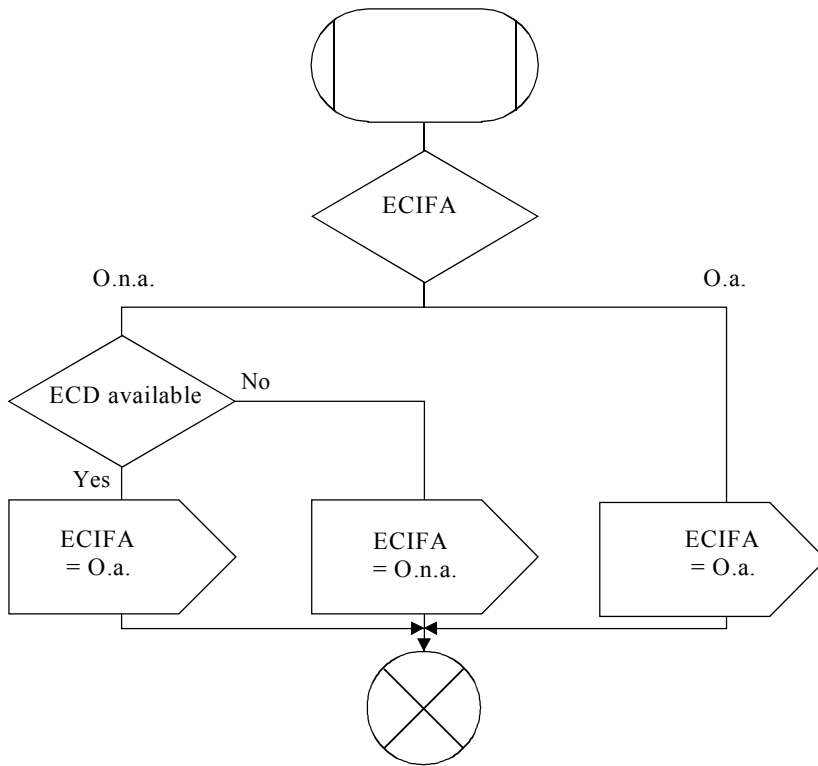connection */

OECDRp
/* OECD
required */

T11103130-99

Figure A.6/Q.115 – Echo Control Procedure for ECIF
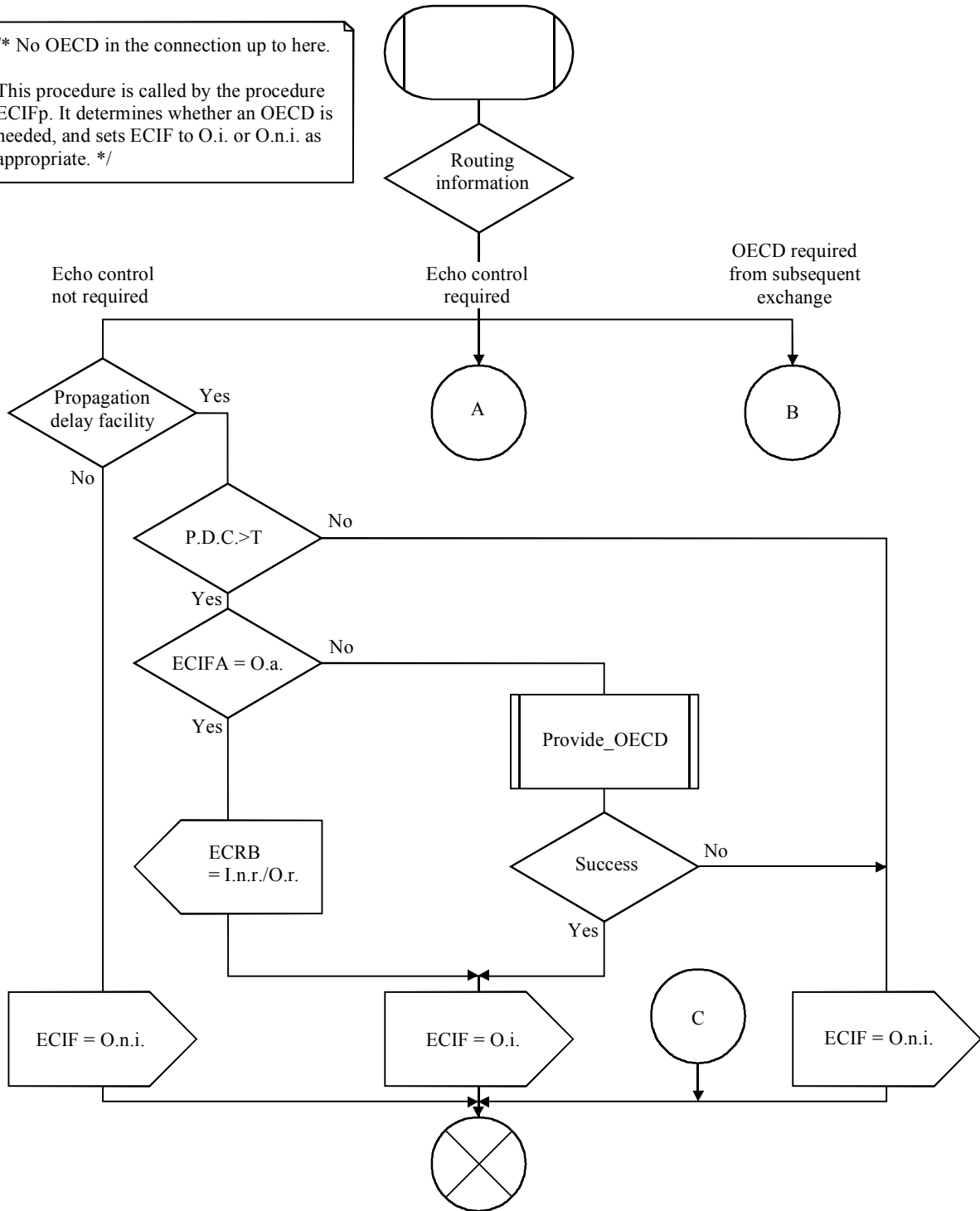
/* Echo Control Information Forward Additional

This procedure is called by procedure ECIF/Ap
when an exchange having the capability to process
Echo Control Information/Additional (ECIFA) is selecting an
outgoing circuit. It sets the ECIFA information to O.a. or O.n.a.
as appropriate, to indicate the availability of an OECD in this,
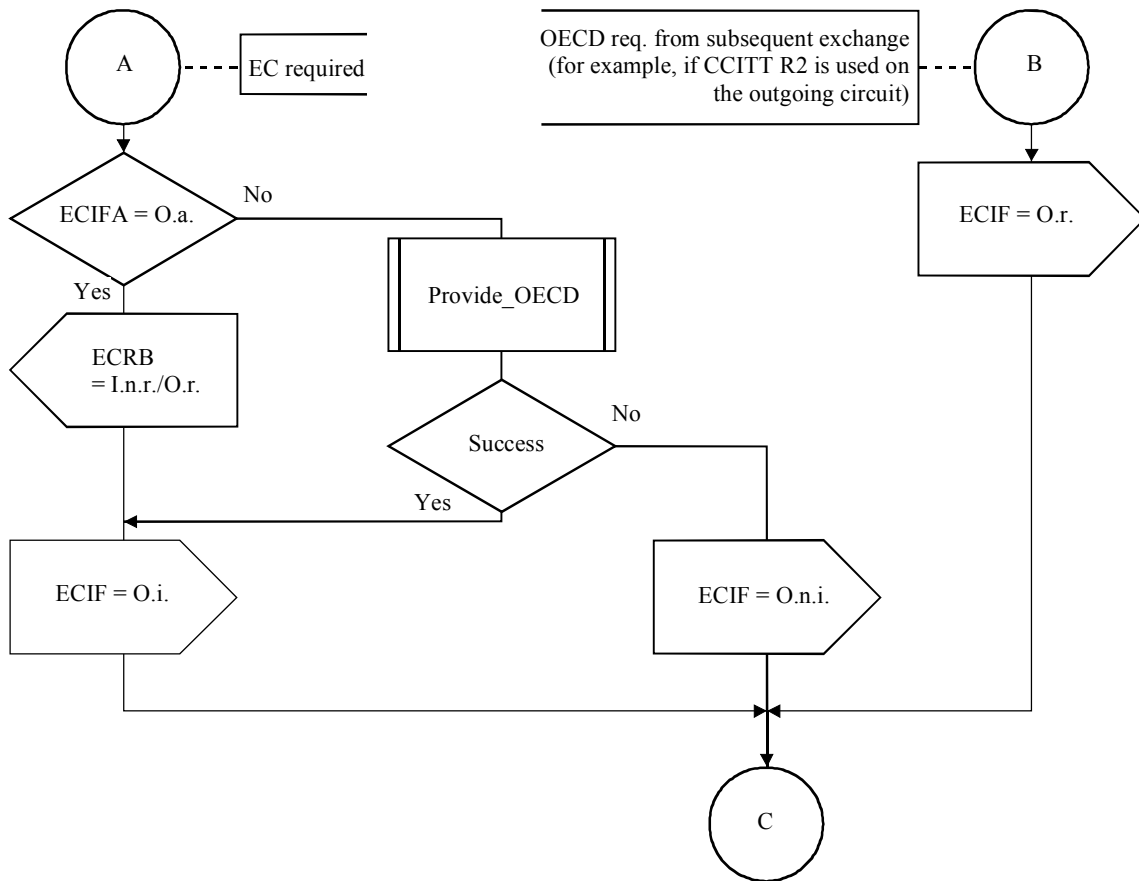or a preceding exchange.*/

T11103140-99

Figure A.7/Q.115 – Echo Control Procedure for ECIFA

/* No OECD in the connection up to here.

This procedure is called by the procedure ECIFp. It determines whether an OECD is needed, and sets ECIF to O.i. or O.n.i. as appropriate. */

Routing information

Echo control not required

Echo control required

OECD required from subsequent exchange

Propagation delay facility

Yes

No

A

B

P.D.C.>T

No

Yes

ECIFA = O.a.

No

Yes

Provide_OECD

ECRB = I.n.r./O.r.

Success

No

Yes

ECIF = O.n.i.

ECIF = O.i.

C

ECIF = O.n.i.

T11103150-99

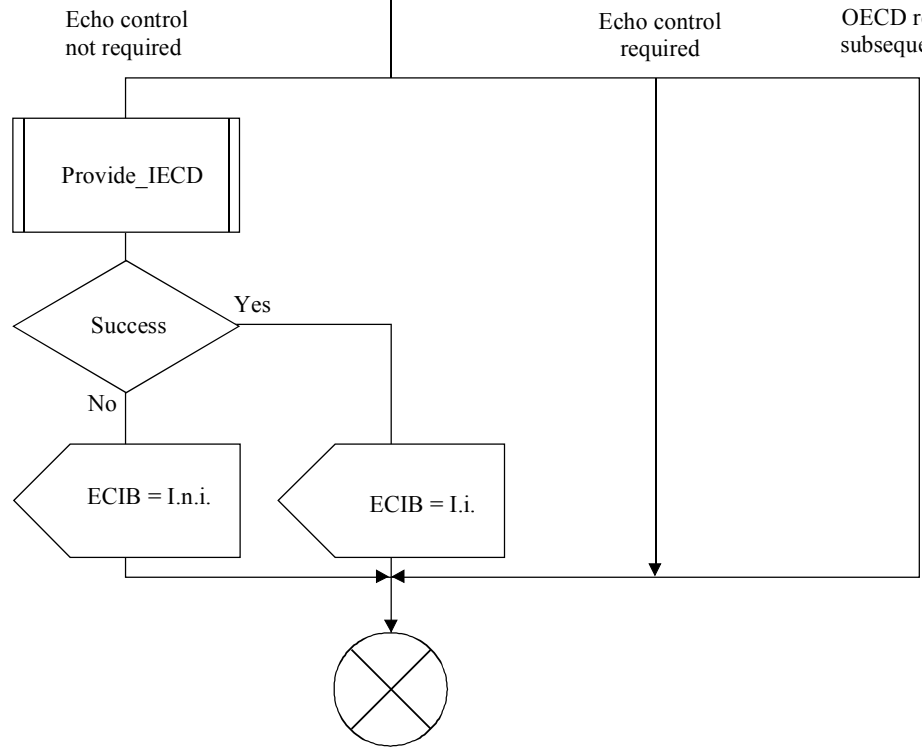**Figure A.8/Q.115 – Echo Control Procedure for ECIF = O.n.i.** *(sheet 1 of 2)*
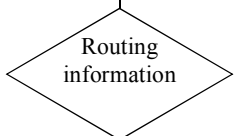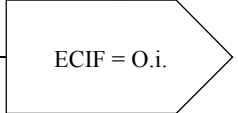
T11103160-99

Figure A.8/Q.115 – Echo Control Procedure for ECIF = O.n.i. *(sheet 2 of 2)*

/* This procedure is called by the procedure ECIFp when an OECD is included in a preceding exchange/network. */

Pass on the "O.i." indication received from the preceding exchange

ECIF = O.i.

Routing information

Echo control not required

Echo control required

OECD req. from subsequent exch.
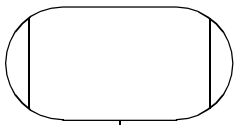
Provide_IECD

Success

Yes

No

ECIB = I.n.i.

ECIB = I.i.

T11103170-99

Figure A.9/Q.115 – Echo Control Prodedure for ECIF = O.i.

/* This procedure is called by the procedure
ECIFp when the preceding exchange requests
this exchange to provide an OECD;
(e.g. CCITT R2). */

Routing
information

Echo control
required

Echo control
not required

Provide_OECD

Yes

Success

No

ECIF = O.i.

Release call, or act according to
bilateral agreement or network
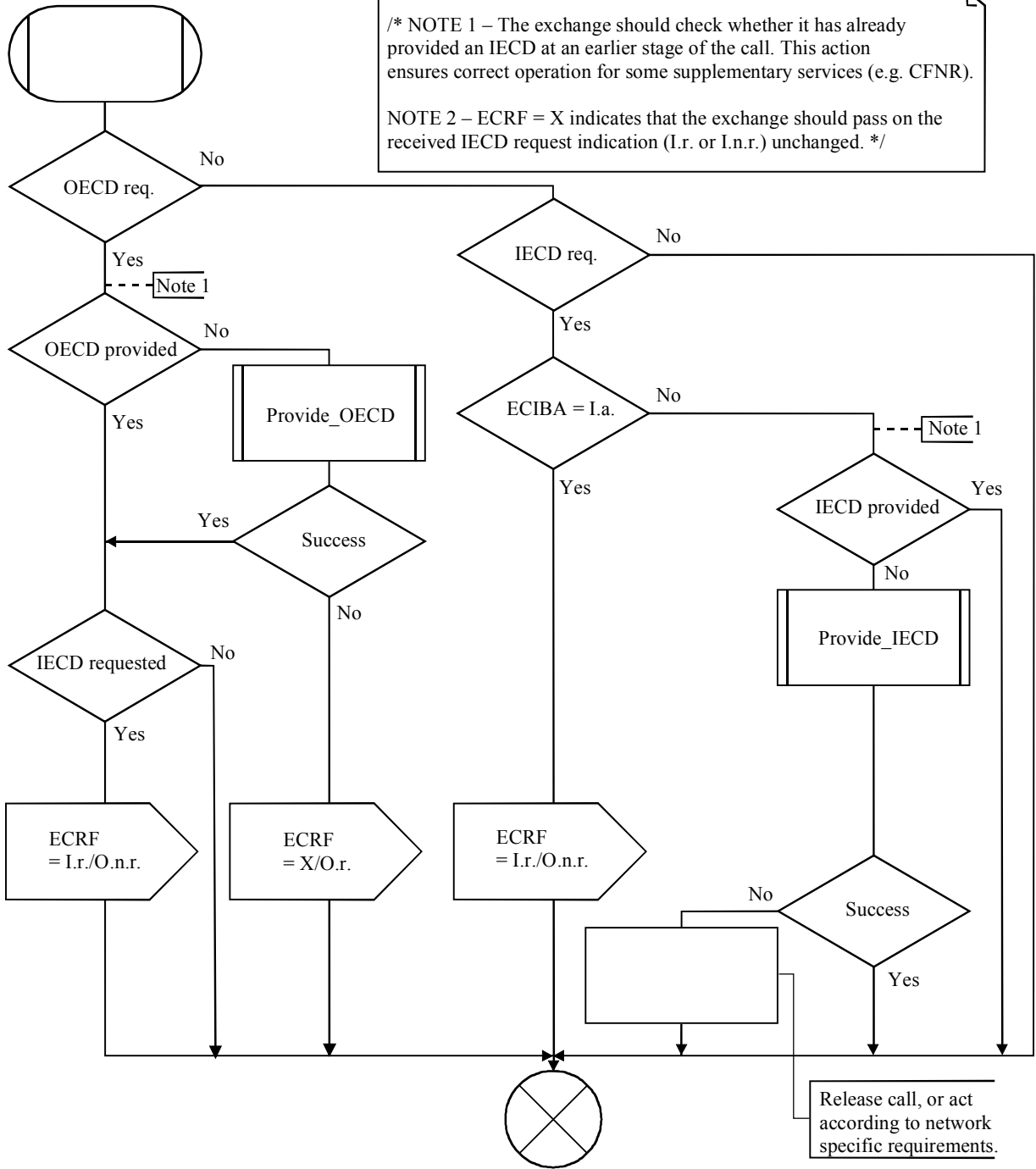specific requirements.
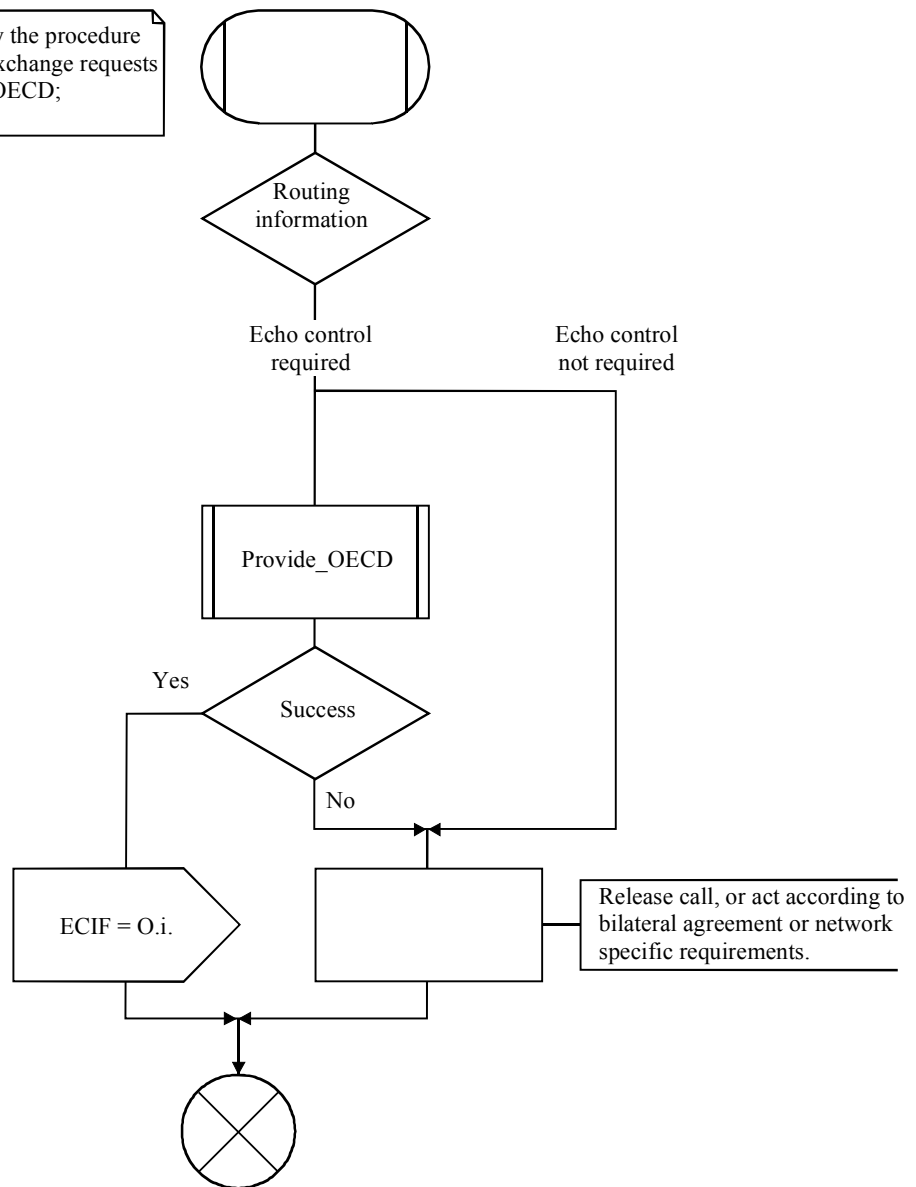
T11103180-99

Figure A.10/Q.115 – Echo Control Procedure for ECIF = O.r.

/* This procedure is called,
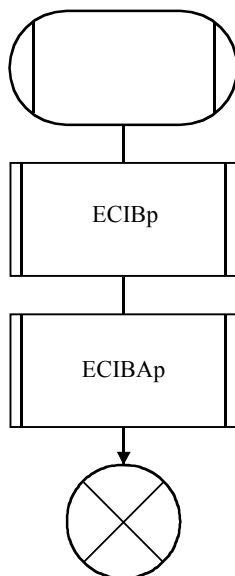when receiving a forward request. */

/* NOTE 1 – The exchange should check whether it has already
provided an IECD at an earlier stage of the call. This action
ensures correct operation for some supplementary services (e.g. CFNR).

NOTE 2 – ECRF = X indicates that the exchange should pass on the
received IECD request indication (I.r. or I.n.r.) unchanged. */

OECD req.   No

Yes
- - - - Note 1

OECD provided   No

Provide_OECD

Yes

IECD req.   No

Yes

ECIBA = I.a.   No
- - - Note 1

Yes   IECD provided   Yes

Success
Yes   No

Provide_IECD

IECD requested   No

Yes

ECRF
= I.r./O.n.r.

ECRF
= X/O.r.

ECRF
= I.r./O.n.r.

No   Success

Yes

Release call, or act
according to network
specific requirements.

T11103190-99

Figure A.11/Q.115 – Echo Control Procedure for ECD request (forward)

/* This procedure is called to process Echo Control Device Information
received in the Backward direction. */

```
          ┌─────────────┐
         (               )
          └─────────────┘
                │
        ┌───────┴───────┐
        │     ECIBp     │
        └───────┬───────┘
                │
        ┌───────┴───────┐
        │    ECIBAp     │
        └───────┬───────┘
                ▼
              (  ✕  )
```
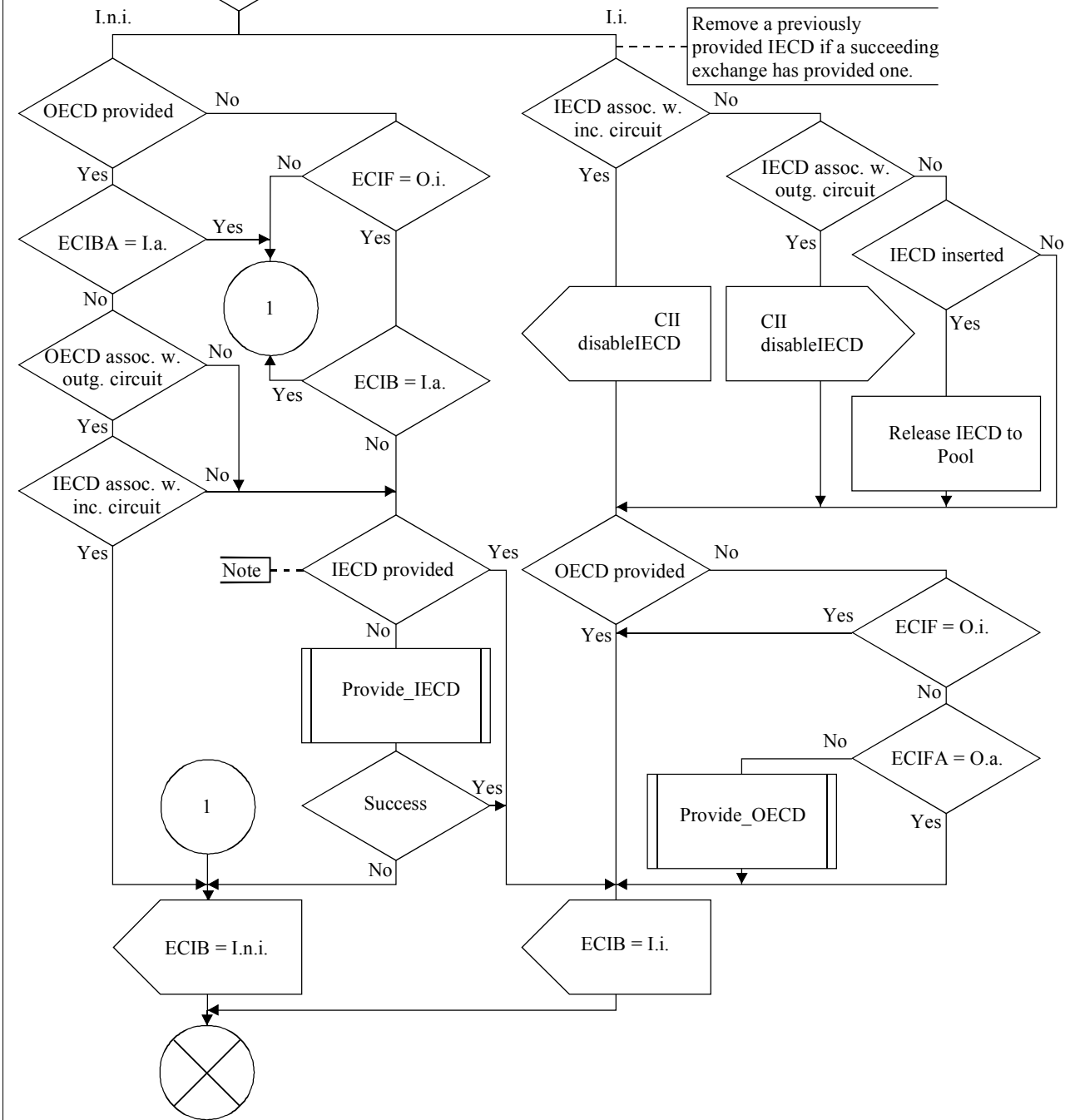
T11103200-99

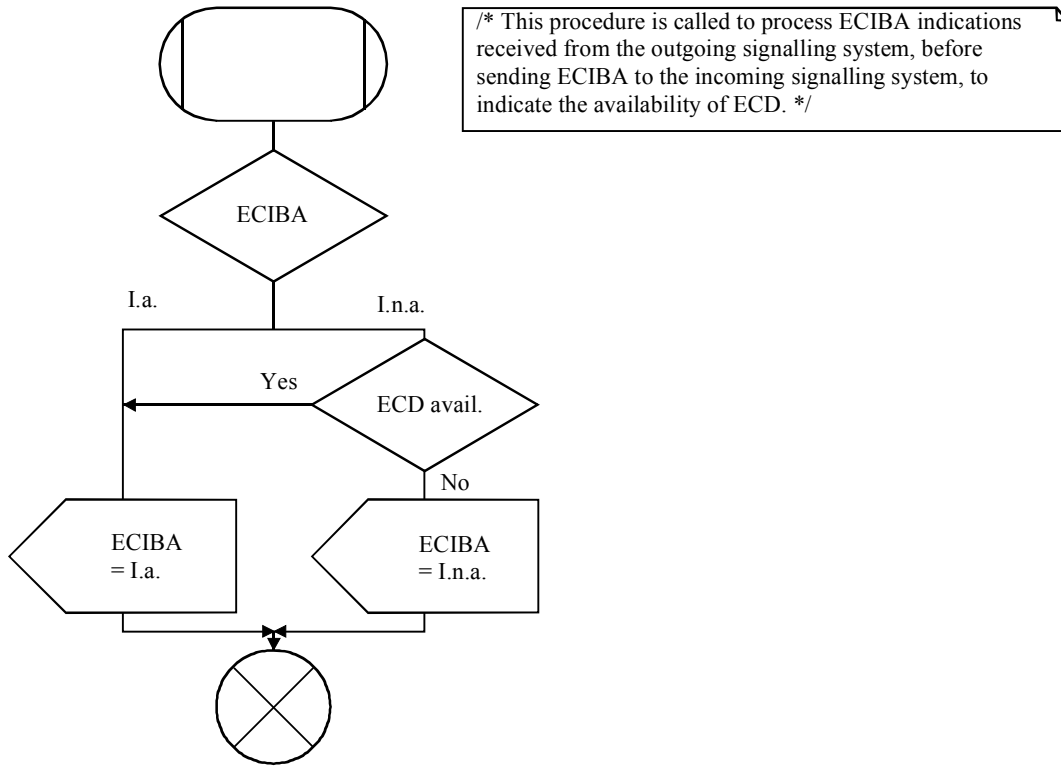**Figure A.12/Q.115 – Echo Control Procedure for ECIB/A**

PAGE 12(24)

/* This procedure is called to analyse ECIB indications received from the outgoing signalling system. It provides or disables an IECD or OECD as appropriate, and passes appropriate ECIB indications to the incoming signalling system. */

/* NOTE – The exchange should check whether it has already provided an IECD at an earlier stage of the call. This action ensures correct operation for some supplementary services (e.g. CFNR) .*/

ECIB

I.n.i.

I.i.

Remove a previously provided IECD if a succeeding exchange has provided one.

OECD provided — No

IECD assoc. w. inc. circuit — No

Yes

IECD assoc. w. outg. circuit — No

No — ECIF = O.i.

ECIBA = I.a. — Yes

Yes

Yes

IECD inserted — No

1

CII disableIECD

CII disableIECD

OECD assoc. w. outg. circuit — No

ECIB = I.a.

Yes

Yes

Release IECD to Pool

IECD assoc. w. inc. circuit — No

No

Note — IECD provided — Yes

OECD provided — No

No

Yes

Yes

ECIF = O.i.

Provide_IECD

No

ECIFA = O.a.

No

1

Success — Yes

Provide_OECD

Yes

No

ECIB = I.n.i.

ECIB = I.i.

⊗

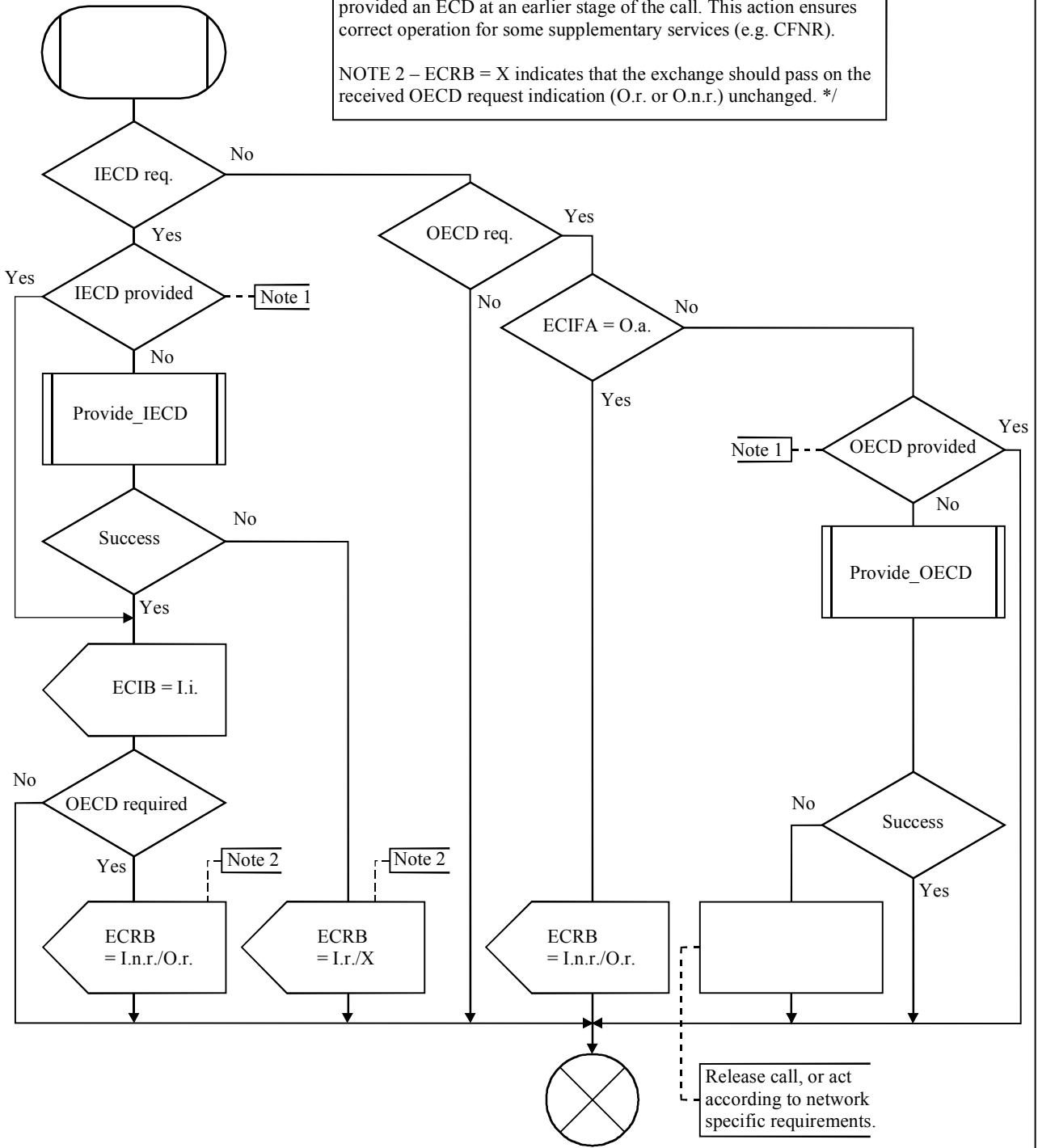T11103210-99

Figure A.13/Q.115 – Echo Control Procedure for ECIB

Figure A.14/Q.115 – Echo Control Procedure for ECIBA

/* This procedure is called to analyse ECRB indications received from the outgoing signalling system. */

/*
NOTE 1 – The exchange should check whether it has already provided an ECD at an earlier stage of the call. This action ensures correct operation for some supplementary services (e.g. CFNR).

NOTE 2 – ECRB = X indicates that the exchange should pass on the received OECD request indication (O.r. or O.n.r.) unchanged. */

IECD req.

No

Yes

OECD req.

Yes

IECD provided — Note 1

Yes

No

ECIFA = O.a.

No

Provide_IECD

Yes

Note 1 — OECD provided

Yes

No

Success

No

Provide_OECD

Yes

ECIB = I.i.

OECD required

No

Success

No

Yes

Note 2

Note 2

Yes

ECRB = I.n.r./O.r.

ECRB = I.r./X

ECRB = I.n.r./O.r.

Release call, or act according to network specific requirements.

T11103230-99

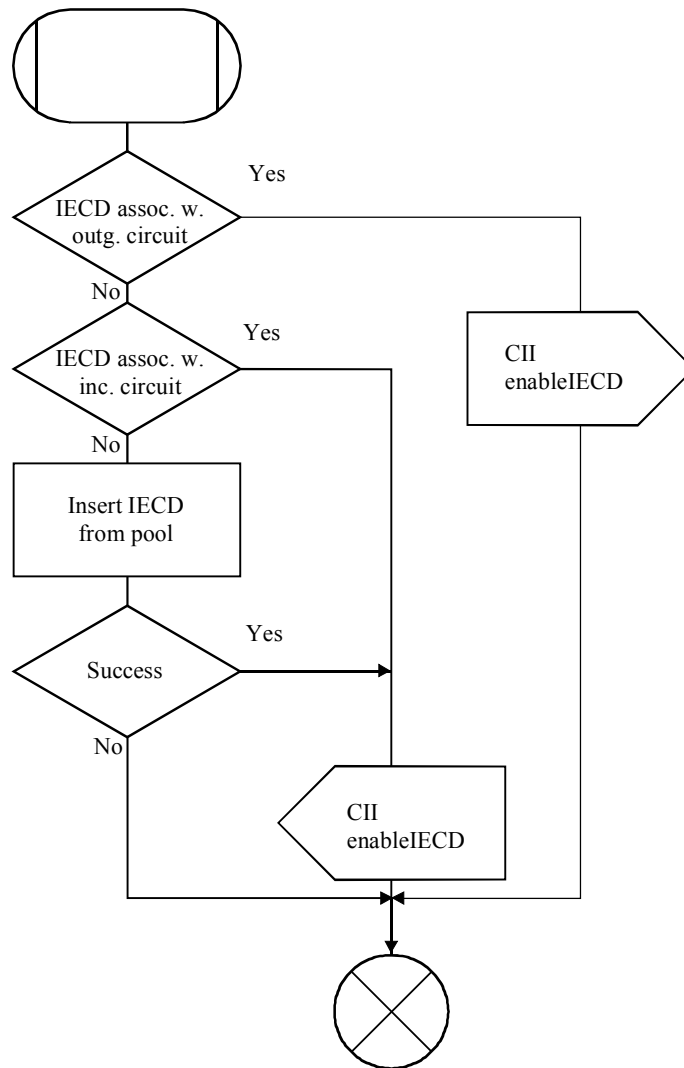**Figure A.15/Q.115 – Echo Control Procedure for ECD request (backward)**

/* This procedure provides an OECD.
It returns a value of True or False to the calling procedure
indicating whether an OECD was correctly provided. */
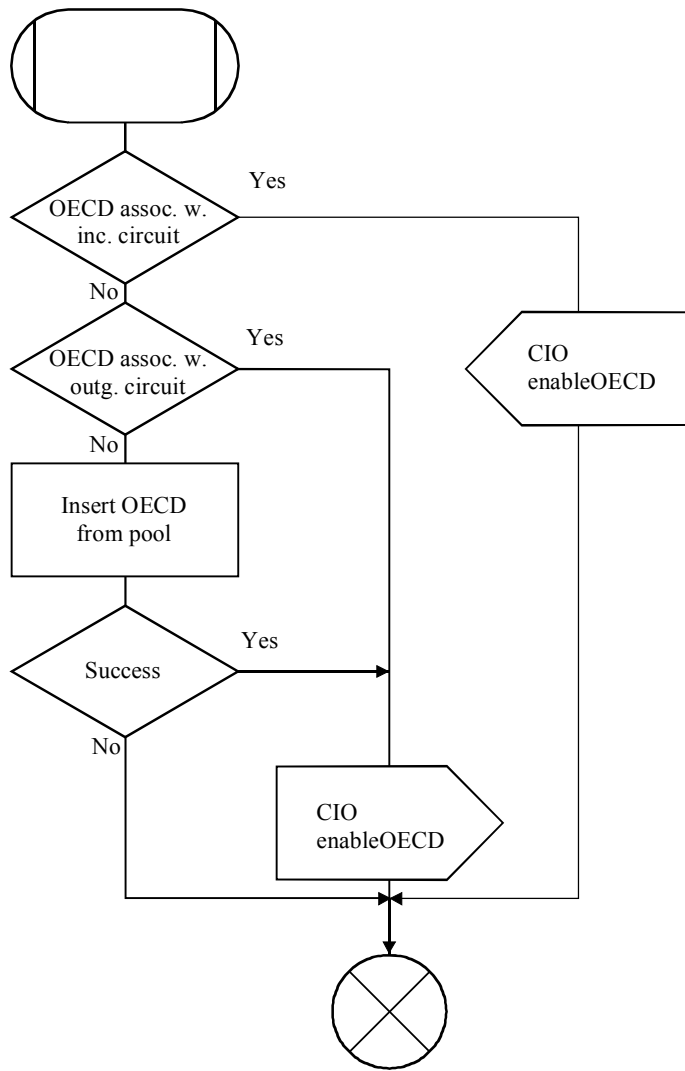
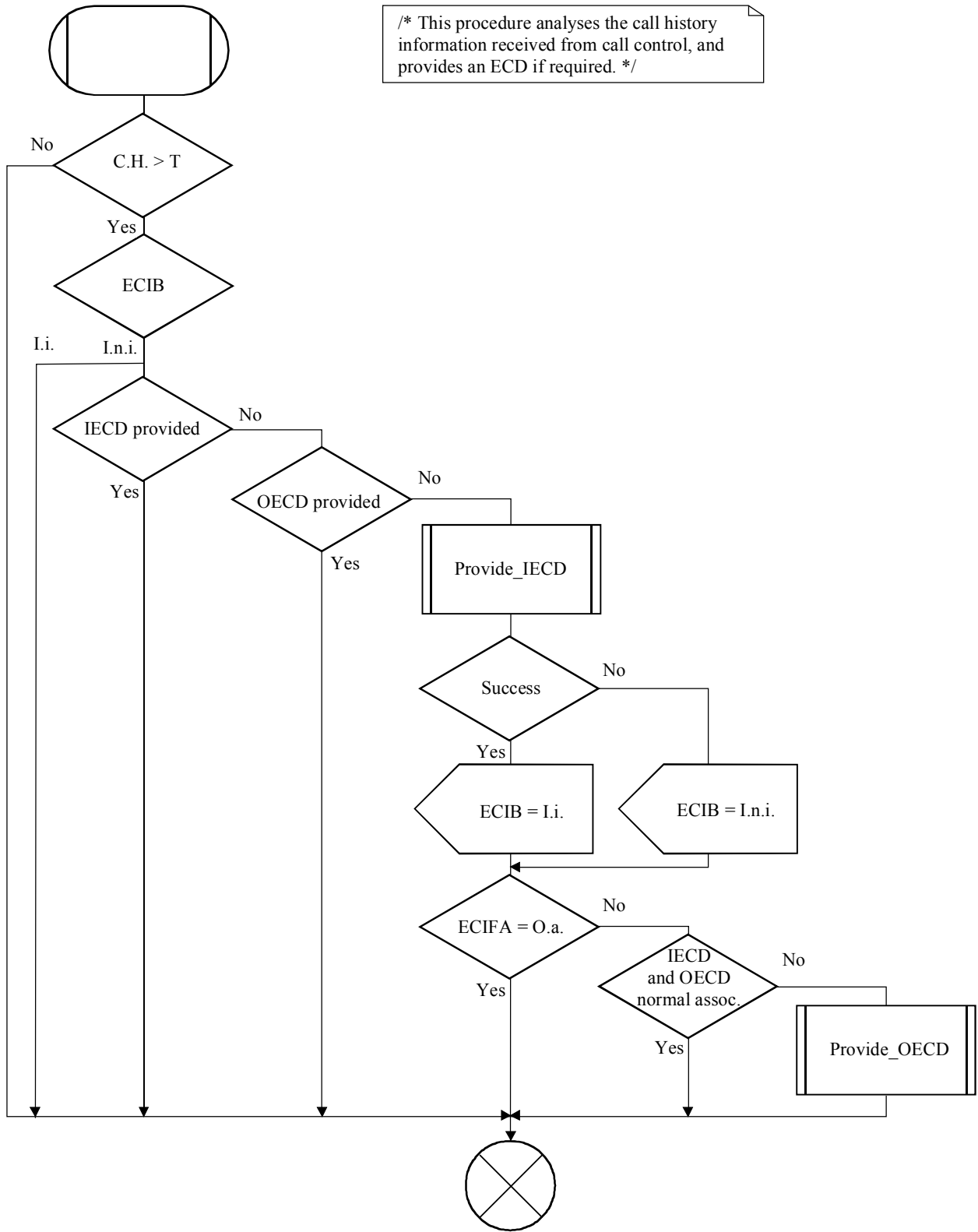Figure A.16/Q.115 – Echo Control Procedure for providing an OECD

/* This procedure provides an IECD.
It returns a value of True or False to the calling procedure
indicating whether an IECD was correctly provided. */

IECD assoc. w.
outg. circuit

Yes

No

IECD assoc. w.
inc. circuit

Yes

No

CII
enableIECD

Insert IECD
from pool

Success

Yes

No

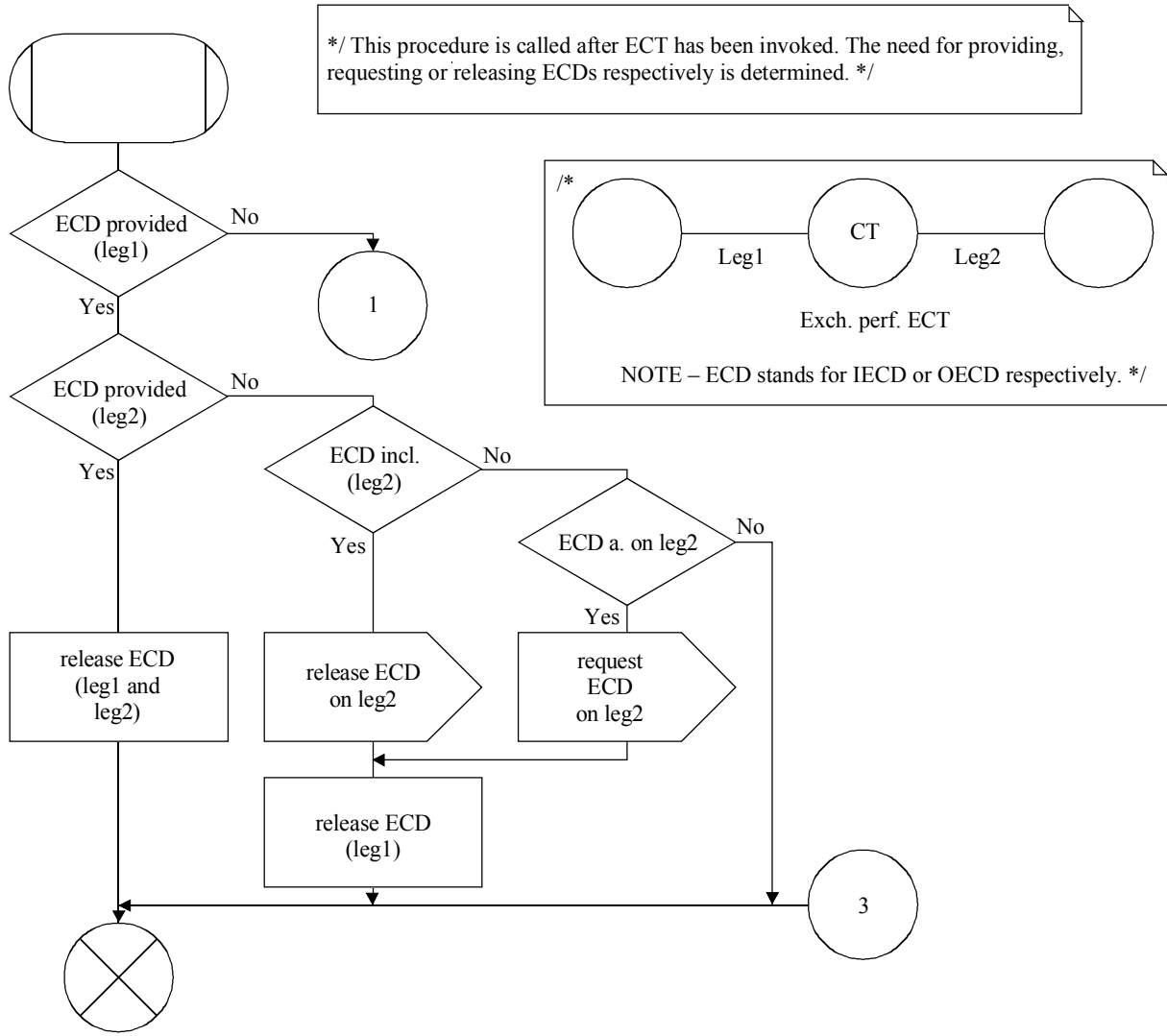CII
enableIECD

T11103250-98

Figure A.17/Q.115 – Echo Control Procedure for providing an IECD

/* This procedure analyses the call history
information received from call control, and
provides an ECD if required. */

C.H. > T

No

Yes

ECIB

I.i.   I.n.i.

IECD provided   No

Yes

OECD provided   No

Yes

Provide_IECD

Success   No

Yes

ECIB = I.i.   ECIB = I.n.i.

ECIFA = O.a.   No

Yes

IECD
and OECD
normal assoc.   No

Yes

Provide_OECD

T11103260-99

Figure A.18/Q.115 – Echo Control Procedure for Call History

*/ This procedure is called after ECT has been invoked. The need for providing, requesting or releasing ECDs respectively is determined. */

/*

CT

Leg1   Leg2

Exch. perf. ECT

NOTE – ECD stands for IECD or OECD respectively. */

ECD provided (leg1)   No

1

Yes

ECD provided (leg2)   No

Yes

ECD incl. (leg2)   No

Yes

ECD a. on leg2   No

Yes

release ECD (leg1 and leg2)

release ECD on leg2

request ECD on leg2

release ECD (leg1)

3

T11103270-99

Figure A.19/Q.115 – Echo Control Procedure for Explicit Call Transfer *(sheet 1 of 3)*
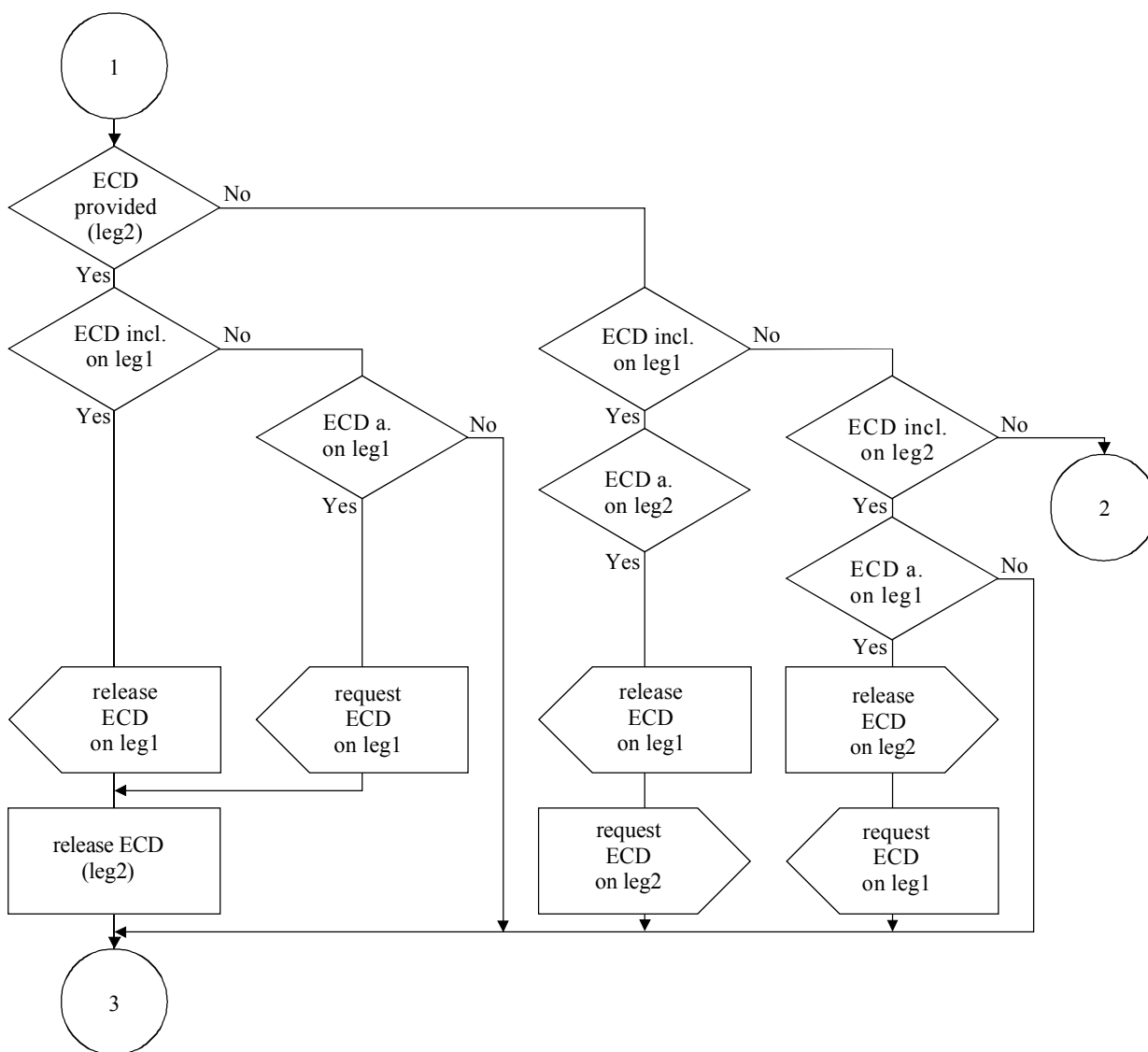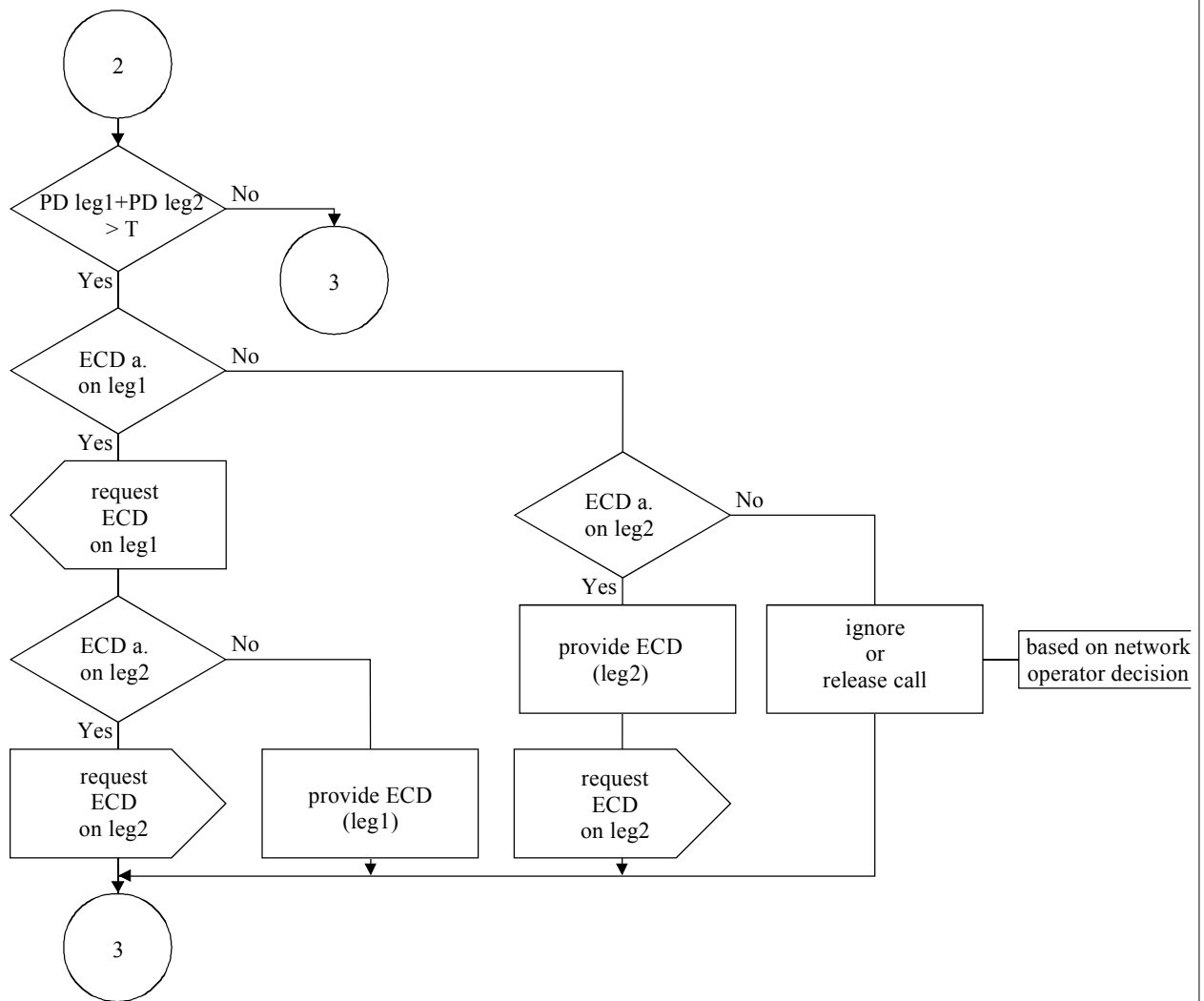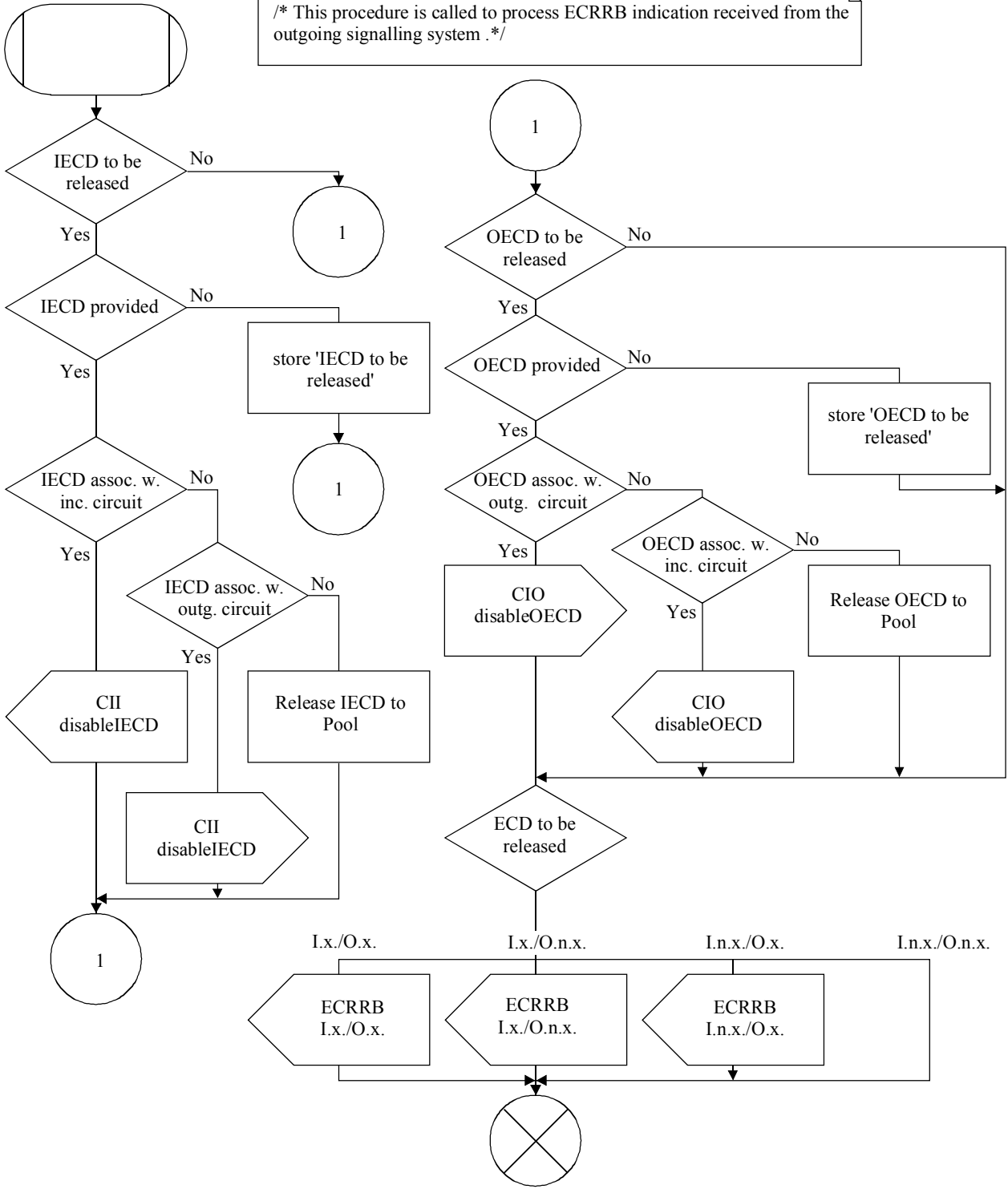
T11103280-99

Figure A.19/Q.115 – Echo Control Procedure for Explicit Call Transfer *(sheet 2 of 3)*

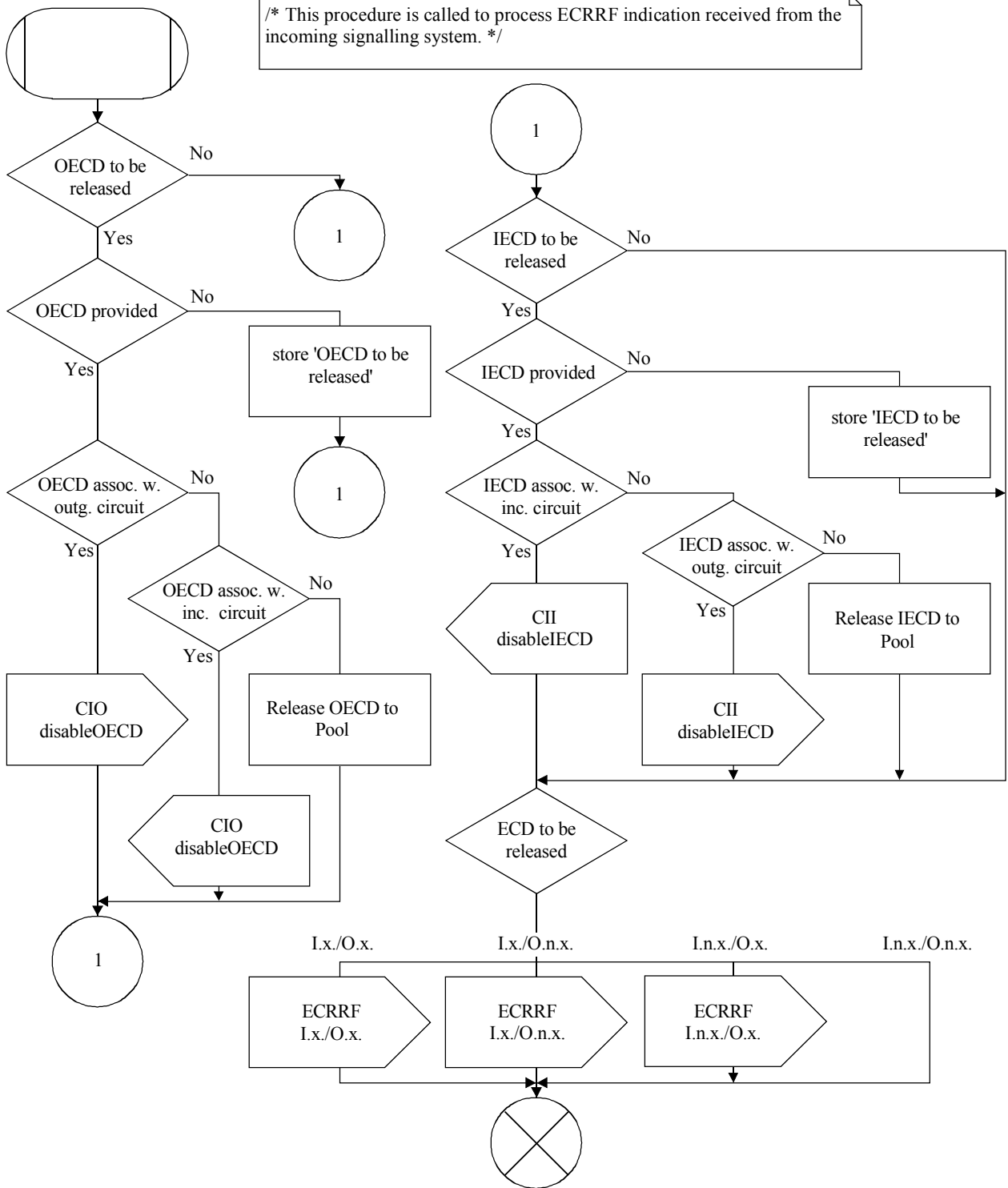**Figure A.19/Q.115 – Echo Control Procedure for Explicit Call Transfer** *(sheet 3 of 3)*

/* This procedure is called to process ECRRB indication received from the
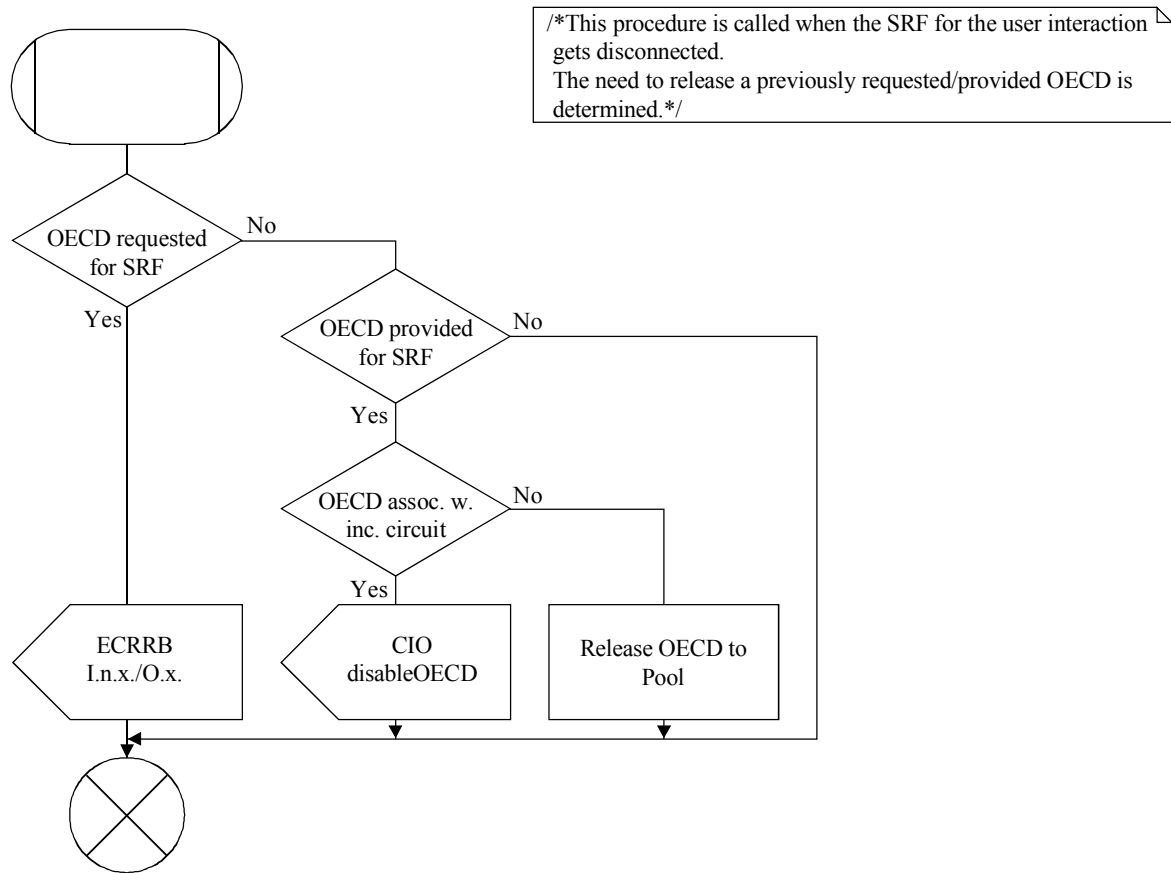outgoing signalling system .*/

Figure A.20/Q.115 – Echo Control Procedure for the Release of an ECD (backward)

/* This procedure is called to process ECRRF indication received from the incoming signalling system. */

**Figure A.21/Q.115 – Echo Control Procedure for the Release of an ECD (forward)**

/* This procedure is called, when a SRF for the User
Interaction is connected.*/

SRF

integrated   non-integrated

ECIF   ECIF

O.i.   O.n.i.   O.i.   O.n.i.

integrated ECD   No   ECIF = O.i.   ECIF = O.n.i.

Yes

ECIFA = E.a.   No

Yes   Provide_OECD

ECRB
= I.n.r./O.r.   success   No

Yes

Store   Store
'OEC requested   'OECD provided
for SRF'   for SRF'

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Figure A.22/Q.115 – Echo Control Procedure for the Request of an OECD (IN)

/*This procedure is called when the SRF for the user interaction
gets disconnected.
The need to release a previously requested/provided OECD is
determined.*/

OECD requested
for SRF — No

Yes

OECD provided
for SRF — No

Yes

OECD assoc. w.
inc. circuit — No

Yes

ECRRB
I.n.x./O.x.

CIO
disableOECD

Release OECD to
Pool

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Figure A.23/Q.115 – Echo Control Procedure for the Release of an OECD (IN)

APPENDIX I

Transmission of echo control information elements via signalling systems

Figures I.1 to I.7 provide examples of how the exchange signalling functions interact with the echo control logic described in this ITU-T Recommendation. The signalling blocks are responsible for deriving ECIFA and ECIBA information from signalling indicators or from default route data.
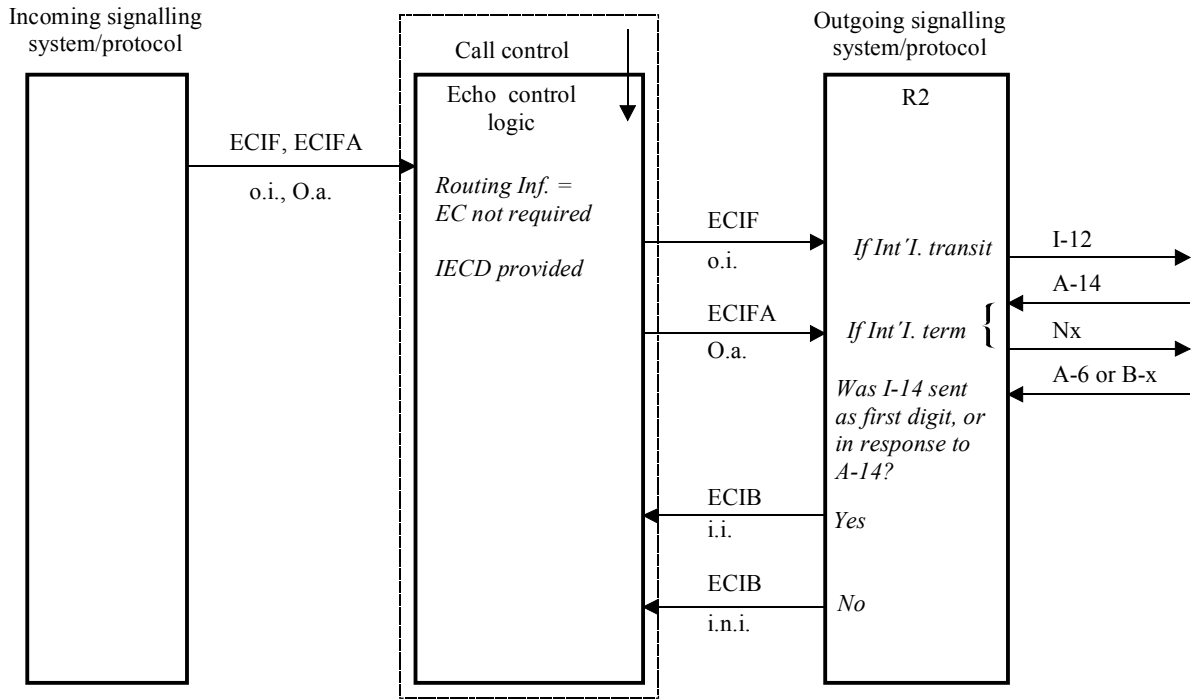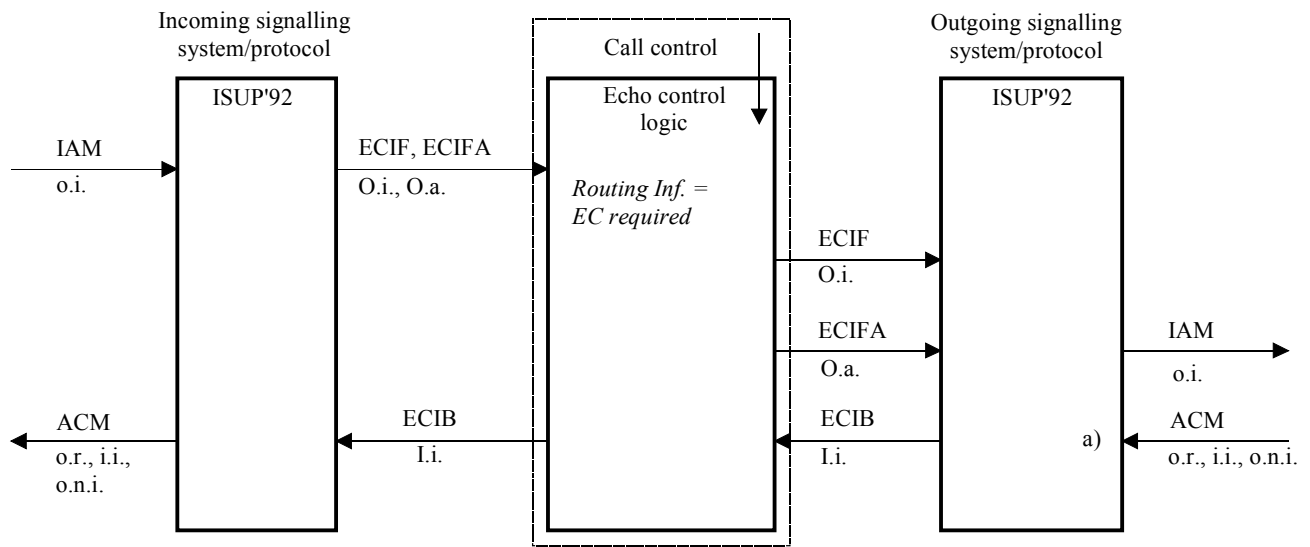

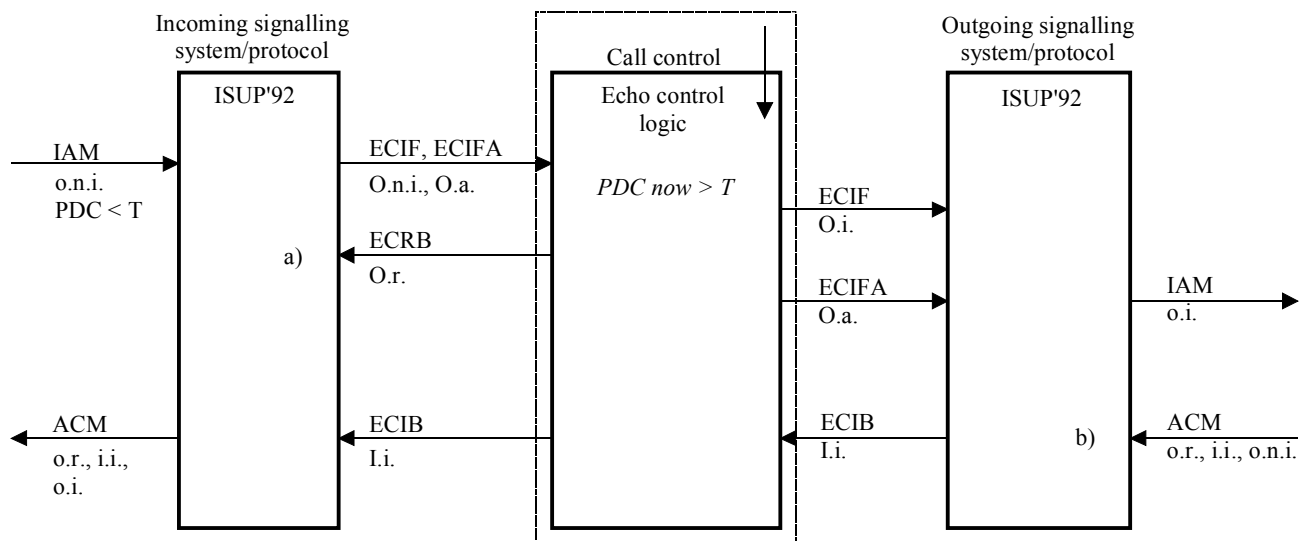Figure I.1/Q.115 – Interactions between echo control logic and CCITT R2
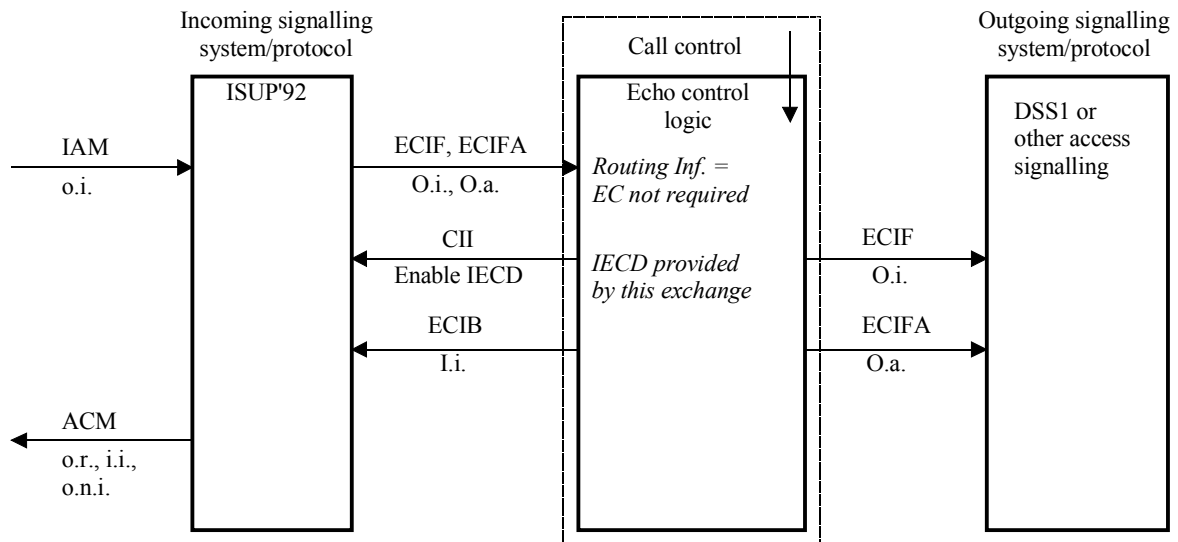
Figure I.2/Q.115 – Interactions between echo control logic and ISUP'92
(refer to Exchange 6 in Figure C.1/Q.764, 1993)

a)   Do not pass the request for OECD to the Echo Control Logic if ECIFA = O.a.

**Figure I.3/Q.115 – Interactions between echo control logic and ISUP'92
(refer to Exchange 5 in Figure C.1/Q.764, 1993)**

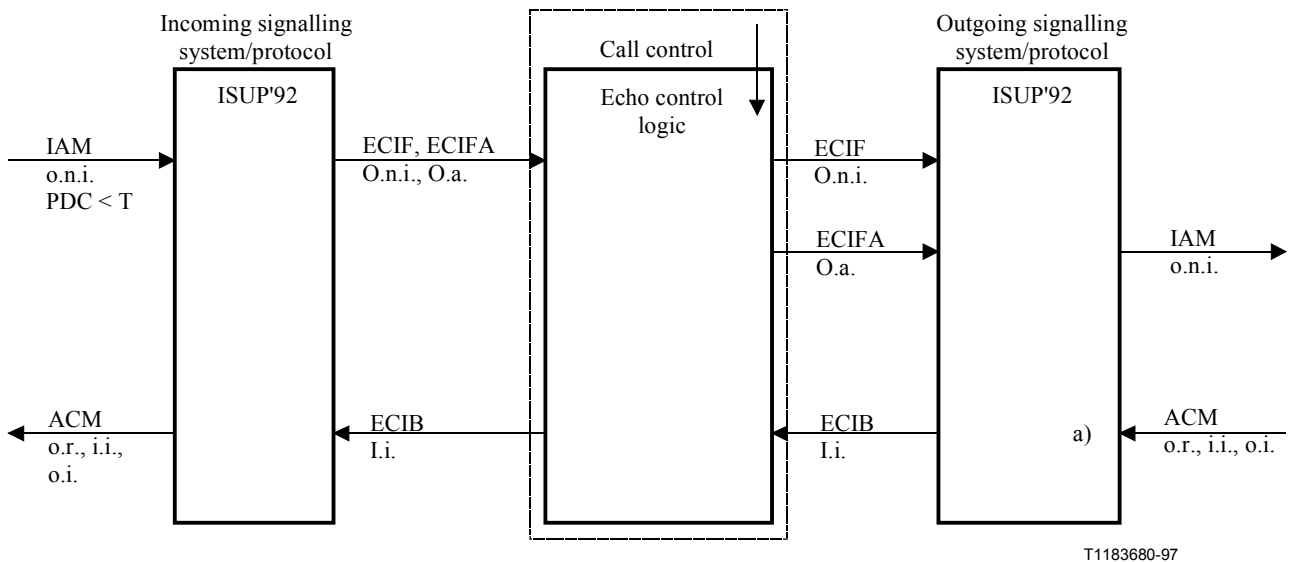a)   Send request for OECD in first backward message.
b)   Do not pass the request for OECD to the echo control logic if ECIFA = O.a.

**Figure I.4/Q.115 – Interactions between echo control logic and ISUP'92
(refer to Exchange 4 in Figure C.1/Q.764, 1993)**

a) Do not pass the request for OECD to the echo control logic if ECIFA = O.a.

**Figure I.5/Q.115 – Interactions between echo control logic and ISUP'92
(refer to Exchanges 2 and 3 in Figure C.1/Q.764, 1993)**
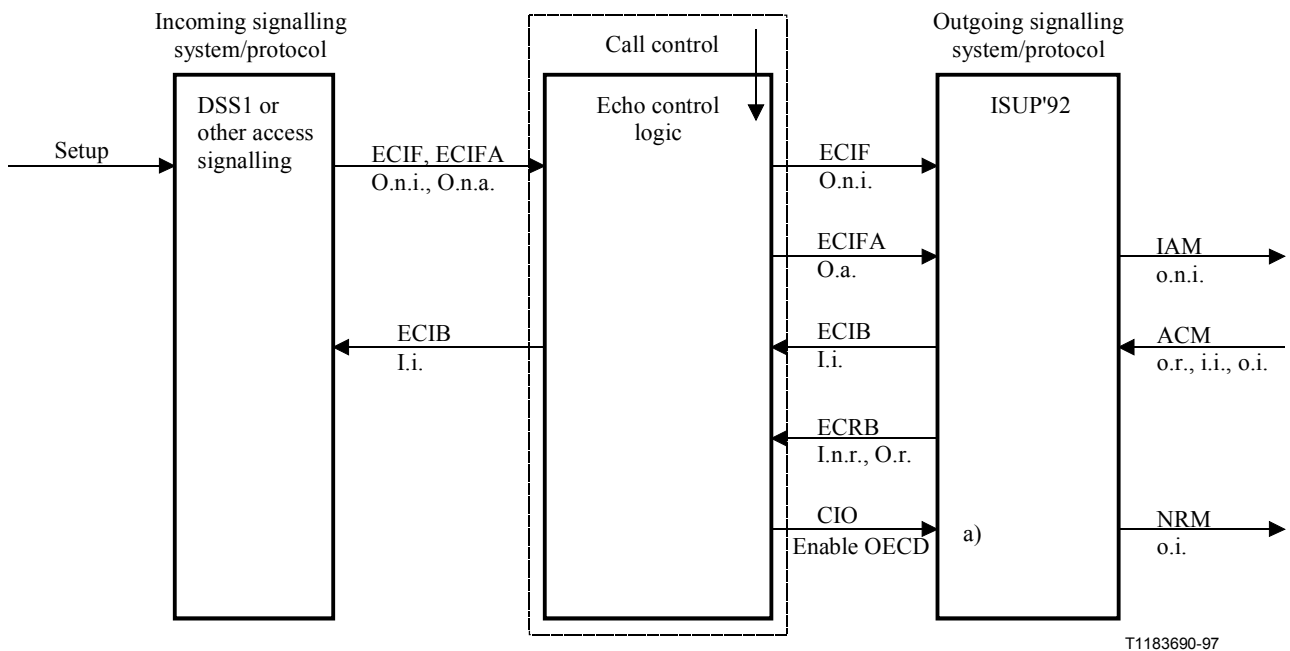
a) The CIO = enable OECD information causes ISUP'92 to provide an OECD and send a forward NRM with o.i. indication to cancel T37 in succeeding ISUP'92 exchanges that do not use the echo control logic described in this ITU-T Recommendation.

**Figure I.6/Q.115 – Interactions between echo control logic and ISUP'92
(refer to Exchange 1 in Figure C.1/Q.764, 1993)**
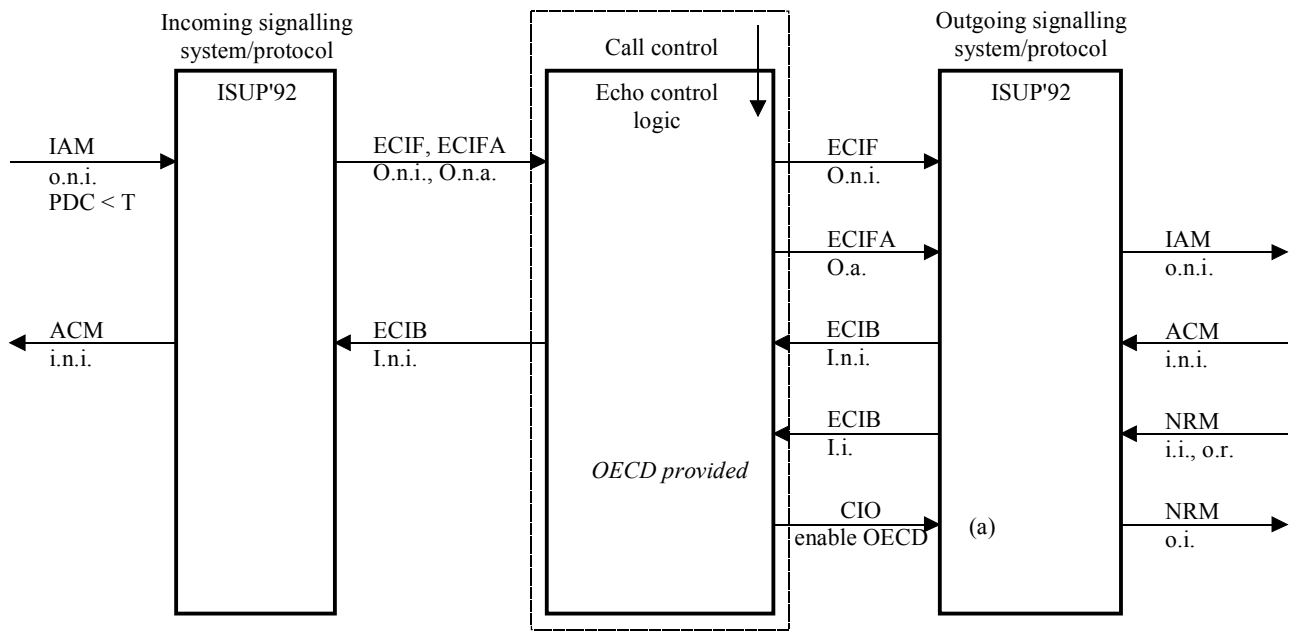
a) The CIO = enable OECD information causes ISUP'92 to provide an OECD and send a forward NRM with o.i. indication to cancel T37 in succeeding ISUP'92 exchanges that do not use the echo control logic described in this ITU-T Recommendation.

Figure I.7/Q.115 – Interactions between echo control logic and ISUP'92 OECD provided in response to a request after ACM

Table I.1/Q.115 – Echo control information/request and the corresponding signalling information elements of international signalling systems/protocols

Signalling System / ECIF	CCITT R2	CCITT No. 5	TUP	*Blue Book* ISUP	ISUP'92
No OECD in the connection	I-12 N1 (A-14)	–	IAM (OHES n.i.) GFI (OHES n.i.)	IAM (o.n.i.)	IAM/NRM (o.n.i.)
OECD in the connection	I-14 I-14 (A-14)	–	IAM (OHES i.) GFI (OHES i.)	IAM (o.i.)	IAM/NRM (o.i.)
OECD required from succ. exch.	I-11 I-14 (A-14)	–	–	–	–

Signalling System / ECIF	CCITT R2	CCITT No. 5	TUP	*Blue Book* ISUP	ISUP'92
No ECD available	–	–	–	–	–
ECD available	–	–	–	–	–

Table I.1/Q.115 – Echo control information/request and the corresponding signalling information elements of international signalling systems/protocols *(concluded)*

Signalling System / ECIF	CCITT R2	CCITT No. 5	TUP	*Blue Book* ISUP	ISUP'92
No IECD in the connection	–	–	ACM (i.n.i.)	ACM (i.n.i.)	ACM/CPG/CON/ NRM (i.n.i.)
IECD in the connection	–	–	ACM (i.i.)	ACM (i.i.)	ACM/CPG/CON/ NRM (i.i.)

Signalling System / ECIF	CCITT R2	CCITT No. 5	TUP	*Blue Book* ISUP	ISUP'92
No ECD available	–	–	–	–	–
ECD available	–	–	–	–	–

Signalling System / ECIF	CCITT R2	CCITT No. 5	TUP	*Blue Book* ISUP	ISUP'92
No IECD required	–	–	–	–	NRM (i.n.r.)
IECD required	–	–	–	–	NRM (i.r.)
No OECD required	–	–	–	–	NRM (o.n.r.)
OECD required	–	–	–	–	NRM (o.r.)

Signalling System / ECIF	CCITT R2	CCITT No. 5	TUP	*Blue Book* ISUP	ISUP'92
No IECD requested	–	–	–	–	NRM (i.n.r.)
IECD requested	–	–	–	–	NRM (i.r.)
No OECD requested	–	–	–	–	ACM/NRM (o.n.r.)
OECD requested	–	–	GRQ (o.r.)	–	ACM/NRM (o.r.)

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