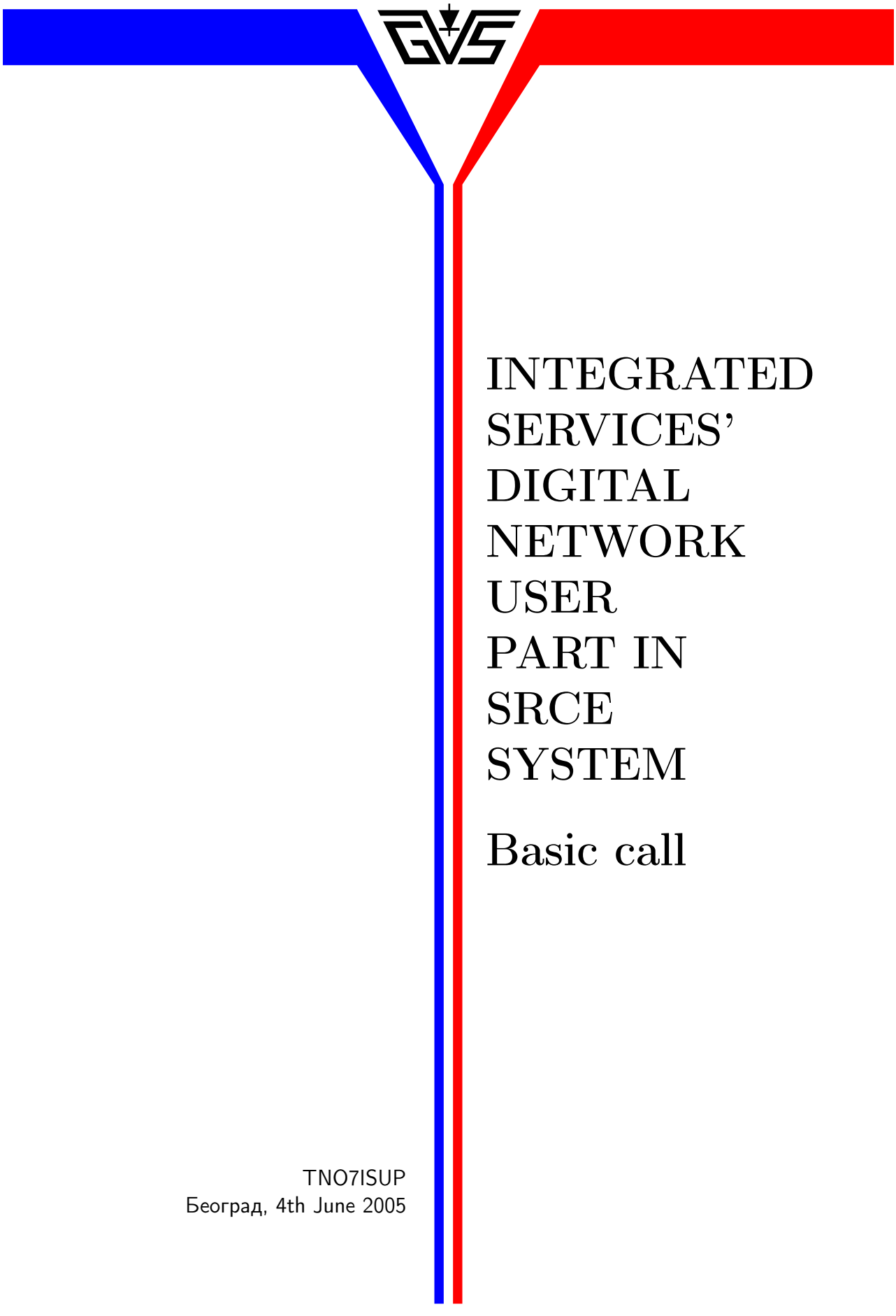

INTEGRATED SERVICES' DIGITAL NETWORK USER PART IN SRCE SYSTEM

Basic call

TNO7ISUP
Београд, 4th June 2005

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1 INTRODUCTION

ISUP is No.7 signalling system protocol designed to provide a support for basic modes of transmission and additional services for speech and non-speech applications in digital network of integrated services.

ISUP protocol is designed for applications within analog and combined analog/digital networks. Especially, ISUP meets requests defined within ITU-T recommendations for the international semiautomatic and automatic telephone traffic.

In addition to this, ISUP may also cover national applications. Most of signalling procedures, information elements and types of messages specified for the international use are also required in typical national applications.

ISUP uses services provided by *MTP - Message Transfer Part* and, in some cases, *SCCP - Signalling Connection Control Part* in process of information transfer between ISDN user parts.

The purpose of the document is to describe the implementation of No.7 signalling integrated services' user part in SRCE TC-011 switching system.

Enclosed specifications refer to appropriate *ITU-T* recommendations for ISUP:

- Q.761 Functional description of the integrated services' digital network user part
- Q.762 Telephone messages and signal basic functions
- Q.763 Formats and codes
- Q.764 Signalling procedures.

1.1 Services taken from MTP

While performing its functions, ISDN user part relies on services of data transmission part (*MTP*). Communication between these two parts of No.7 signalling system is performed using *Primitives* containing parameters with necessary data.

Primitives belonging to ISDN user part - MTP interface are:

- *MTP-TRANSFER* - ISDN user part uses this primitive to send user data to functions processing MTP signalling messages, or otherwise, MTP uses it to deliver information contained in messages to ISDN user part.
- *MTP-PAUSE* - this one is used by MTP indicating temporary inability of data transfer toward particular destination signalling point.
- *MTP-RESUME* - primitive used by MTP, indicative of a possibility of data transfer continuation toward particular destination signalling point.

- *MTP-STATUS* - indicates the inaccessibility of ISDN user part on a particular destination signalling point. Primitive is sent to ISDN user part on reception of MTP message leveled 3 - UPU (*User Part Unavailable*).

1.2 Basic principles of message coding

ISUP message are transferred over signalling links using signalling units which format was described in *ITU-T* Q.703 § 2.2 and *Q.704 § 14.2.*

Signalling information field (SIF) of each signalling message is included within ISUP message and consists of octet integer, containing parts shown in table 1.

Description of different parts of messages is included in following chapters.

Routing label
Circuit identification code
Message type code
Mandatory fixed part
Mandatory variable part
Optional part

Table 1: *Parts of ISUP message*

1.2.1 Routing label

Formats and codes used for routing label are described in *Q.704 § 2.2.* Same routing label ought to be used for each message transferred for any established connection.

8	7	6	5	4	3	2	1
DPC							
OPC				DPC			
OPC							
SLC				OPC			

Table 2: *ISUP message label format*

1.2.2 Destination and originating point code

Each telephone exchange having the role of a signalling point in No.7 signalling system has a dedicated code in accordance to numeration plans designed for purposes of unique identification of network signalling points.

DPC (*Destination Point Code*) is a code of destination signalling point, that is, a telephone exchange to which message is sent.

OPC (*Originating Point Code*) is a code of originating signalling point, that is, telephone exchange that sent the message.

1.2.3 Signalling link selection

In ISUP message structure, within routing label, SLS field (*Signalling link selection*) is presented regardless from CIC field (*Circuit Identification Code*).

Practically, same SLS value for all messages belonging to the same ISUP transaction may be provided by repeating the copy of 4 lowest bits of CIC field inside SLS field.

1.2.4 Circuit identification code

Circuit identification code (CIC) format is shown in the following table:

8	7	6	5	4	3	2	1
CIC least significant bit							
Reserve				CIC most significant bit			

Table 3: *Circuit identification code (CIC)*

The way that identification codes are assigned to particular telephone channels is determined in mutual agreements and/or in accordance with appropriate preliminary defined rules.

All channels connecting two exchanges should have a number between 1 and n (n < 4096). This numeration must be the same for both exchanges. This number, binary recorded in the label, is a channel identification code (CIC).

Connection between internal channel numeration at the exchange and mutual numeration between channels is realized for each channel and may be set by the operator.

As for CIC between two exchanges, for any CIC structure, if possible, it is recommended to assign CICs in sequences, with no spaces in numeration, starting from code lowest values. This way it is possible to balance while assigning parameters of *SLS - signalling link selection parameter* to one of possible values in range between 1 and 15. This parameter is contained in 4 lowest CIC bits. It is especially important when discussing routing mechanism (defining signalling link) and, above all, disposition of signalling load onto signalling network resources.

1.2.5 Message type code

Message type code consists of one byte field and is obligatory for each message. Message type code defines format and function of each ISUP message in a unique way.

View of message code values is given in table *Messages common within SRCE system*.

There should be no unused octets between message parameters. General message format chart is shown in General message format figure. Message formats are demonstrated in sequences of bytes. The first octet to be sent is the one at the top, and the last one is the one at the bottom.

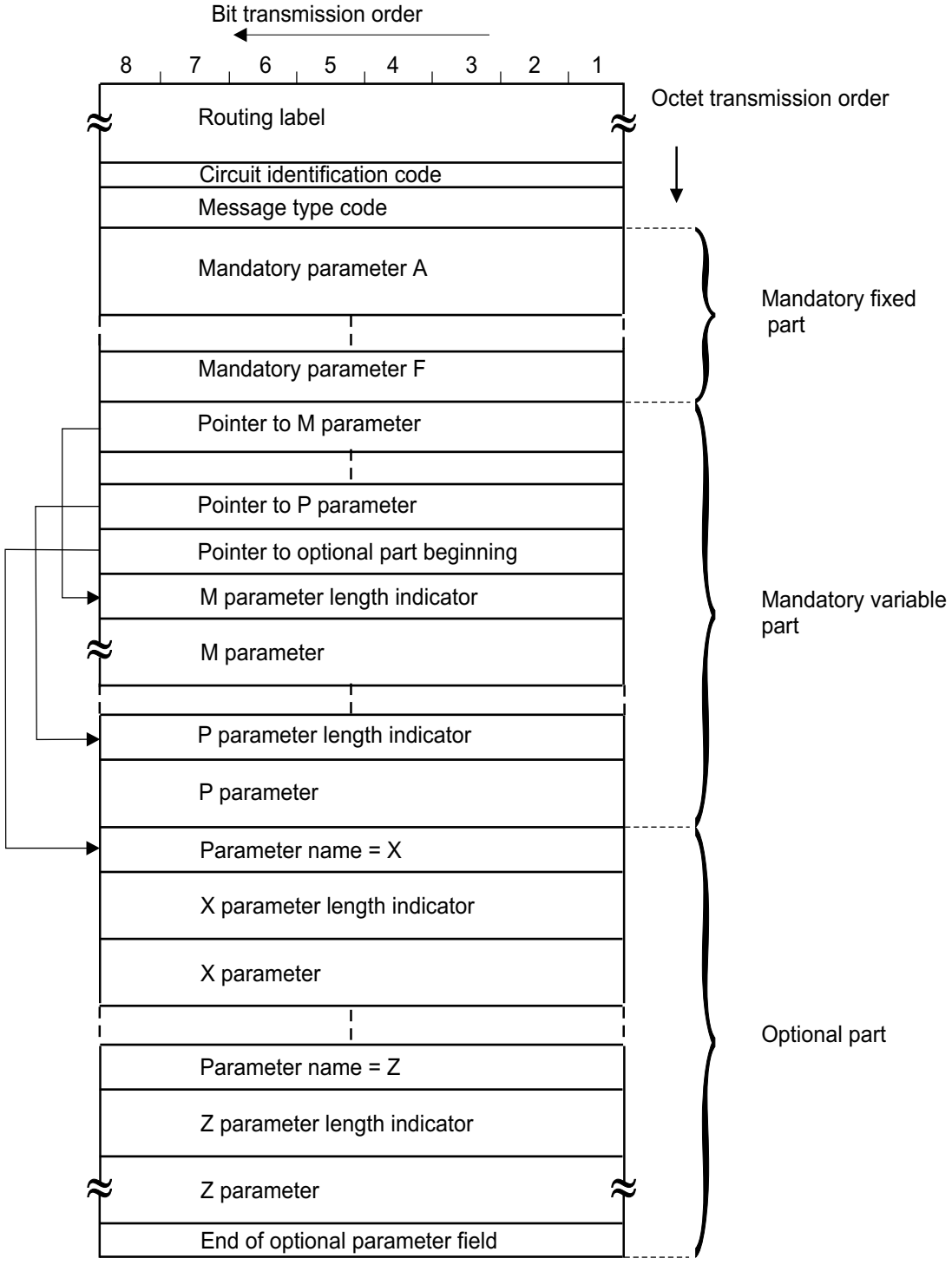

Figure 1: *General message format*

1.3 Parameters in ISDN user part messages

ISUP message formats are not additionally described in this document since they are already accommodated within *ITU-T* recommendation *Q.763*.

Each message consists of parameters listed in the table List of parameters, recognizable within SRCE system. Parameter length may be fixed or variable. Message formatting is described in the text below.

Mandatory fixed part

Mandatory parameters of fixed length for particular message are contained in mandatory fixed part. Position, length and disposition of parameters are specially defined with message type, in the way that name and length indicators are not contained in the message.

Mandatory variable part

Mandatory parameters of variable length are included in mandatory variable part. Pointers are used to mark the beginning of each parameter. Each pointer is coded in one octet. Pointer value is a number of octets between pointer (which is calculated) and the first parameter octet the pointer points at (not calculated). Name of each parameter and disposition of pointer sending is determined by message type. Therefore, parameter name is not contained in the message.

Parameter number, and consequently the pointer number is defined by message type.

All parameters are sent one after another at the beginning of mandatory variable part. Each parameter contains parameter length indicator followed with parameter contents. Octet for parameter name and octet for length indicator is not considered for length.

Optional part

Optional part contains parameters which may, but not obligatory, appear in a certain message type. Both fixed and variable length parameter may be contained within the message. Some optional parameters may appear several times in one message, some not. Optional parameters may be transferred in any disposition wanted. For this reason, each optional parameter contains parameter name (one octet) and length indicator (one octet) followed with parameter contents.

Pointer used to designate the beginning of the optional part may be or not contained in the message. If an optional part is not allowed for certain message type, this pointer will not be contained in the message. If an optional part is allowed, but not contained in a particular message, pointer field containing all digits is used. If there is no mandatory variable parameters, but optional parameters are possible, message will contain the pointer of optional parameter beginning (coded all with zero if there is no optional parameters or with ”00000001” if there is any).

If there are some optional parameters, and after they are all sent, parameter ”end of optional parameters” consisting all of digits is sent. If there are no optional parameters, parameter ”end of optional parameters” is not sent.

Message	*Message type code*
Address complete (ACM)	00000110
Answering (ANM)	00001001
Blocking (BLO)	00010011
Blocking acknowledgement (BLA)	00010101
Call progress (CPG)	00101100
Circuit group blocking (CGB)	00011000
Circuit group blocking acknowledgement (CGBA)	00011010
Circuit group query message (CQM)	00101010
Circuit group query response (CQR)	00101011
Circuit group reset (GRS)	00010111
Circuit group reset acknowledgment (GRA)	00101001
Circuit group unblocking (CGU)	00011001
Circuit group unblocking acknowledgment (CGUA)	00011011
Charge information (CRG)	00110001
Confusion (CFN)	00101111
Connect (CON)	00000111
Continuity (COT)	00000101
Continuity check request (CCR)	00010001
Service request (FAR)	00011111
Identification request (IDR)	00110110
Identification response (IRS)	00110111
Information (INF)	00000100
Information request (INR)	00000011
Initial address message (IAM)	00000001
Release (REL)	00001100
Release complete (RLC)	00010000
Reset circuit (RSC)	00010010
Resume (RES)	00001110
Segmentation (SGM)	00111000
Subsequent address message (SAM)	00000010
Suspend (SUS)	00001101
Unblocking (UBL)	00010100
Unblocking acknowledgement (UBA)	00010110
User part available (UPA)	00110101
User part test (UPT)	00110100

Table 4: *Messages common within SRCE system*

Message	*Message type code*
Automatic level congestion	00000110
backward call indicators	00010001
Call history information	00101101
Called subscriber number	00000100
Calling subscriber number	00000101
Calling subscriber category	00001001
Cause indicators	00010010
Circuit group supervision message type indicator	00010101
Circuit state indicator	00100110
Limited user group code	00011010
Through-connected number	00100001
Continuity indicators	00010000
End of optional parameters	00000000
Call forward indicators	00000111
Information indicators	00001111
Information request indicators	00001110
MCID request indicators	00111011
MCID request response indicators	00111100
Message compatibility information	00111000
Connection nature indicators	00000110
backward call optional indicators	00101001
Call forward optional indicators	00001000
Parameter compatibility information	00111001
Transmission delay	00110001
Range and status	00010110
Next number	00000101
Suspend/resume indicators	00100010
Transit network selection	00100011
Transmission medium requirement	00000010
Transmission medium requirement prime	00111110
Transmission medium used	00110101
User service information	00011101
User service information prime	00110000
User-user indicators	00101010
User-user information	00100000

Table 5: *Parameters used in SRCE system*

2 SIGNALLING PROCEDURES AND BASIC CALL CONTROL

2.1 Introduction

Basic call directing procedure may be divided into three phases:

- call set-up,
- conversation phase and
- call release.

In SRCE system, processing of messages transferred by signalling link defines different call stages. Corresponding tones are sent to calling subscriber to inform him/her of call progress.

2.2 Sending the address signals forward - ”en bloc” (sending the digits as a whole) and ”overlap” (digits send apart) procedure

2.2.1 Messages

Initial address message IAM
This is the first message sent in direction of call establishing in order to seize the outgoing circuit. It also transfers the number of called subscriber and other information in relation to routing and call processing. Mandatory parameters are: *connection type indicators, call forward indicators, calling subscriber category, transmission medium requirements* and *called subscriber number*. Other parameters are optional.

Subsequent address message SAM
Message may be sent in direction of call establishing after initial address message IAM, to transfer additional information concerning the number of called subscriber. Message contains mandatory variable parameter *next number*.

2.2.2 Parameters

Called party number
Parameter is sent only in the initial address message (IAM) and contains called subscriber digits in addition to following information:

- Indicator of called party odd number of digits,
- Address nature indicator,
- Numeration plan indicator.

Calling party category

Parameter is obligatory in IAM message, and may be also found in INF message, if requested by INR message. Calling party category is coded as following:

- 0000 0000 unrecognized category,
- 0000 0001 international operator, French,
- 0000 0010 international operator, English,
- 0000 0011 international operator, German,
- 0000 0100 international operator, Russian,
- 0000 0101 international operator, Spanish,
- 0000 0110, 0000 0111 and 0000 1000 are reserved for languages defined in mutual agreement,
- 0000 1001 national operator,
- 0000 1010 ordinary subscriber,
- 0000 1011 subscriber with priority,
- 0000 1100 data transfer,
- 0000 1101 test call,
- 0000 1111 pay phone,
- 0001 0000 emergency account.

Except for these standard categories, some other russo - ukraine calling subscriber national categories were added:

- 0010 0000 AON category no. 10,
- 0010 0001 AON category no. 2,
- 0010 0010 AON category no. 5,
- 0010 0011 AON category no. 7,
- 0010 0100 AON category no. 3,
- 0010 0101 AON category no. 6,

- 0011 0000 Automatic call - priority 1,
- 0011 0001 Semiautomatic call - priority 1,
- 0011 0010 Automatic call - priority 2,
- 0011 0011 Semiautomatic call - priority 2,
- 0011 0100 Automatic call - priority 3,
- 0011 0101 Semiautomatic call - priority 3,
- 0011 0110 Automatic call - priority 4,
- 0011 0111 Semiautomatic call - priority 4,

Forward call indicators

It consists of two octets and, as a mandatory parameter, is contained only in IAM message which is sent in direction of call establishment.

Parameter contains following information:

- National/international call indicator,
- *end-to-end* operation indicator,
- interworking indicator (if No.7 signalling covers the entire transmission path),
- *end-to-end* information indicator (available or not),
- ISUP indicator (continuously used or not),
- ISUP priority indicator (priority for the entire transmission path, no priority, required for the entire transmission path),
- ISDN access indicators (coded with zero since SRCE has no ISDN access for the case of non-transit call, and if the call is a transit one, it is transferred with no changes),
- SCCP method indicator (coded with 0 since SRCE has no support for SCCP method).

Connection indicator nature

Parameter is contained only in IAM message and is mandatory. It consists of one octet with following information included:

- Satellite connection indicator,
- Continuity check request indicator,

- Echo control indicator.

Subsequent number

Parameter is of variable length and is included only in SAM message, as a mandatory one. The parameter contains additional information about called subscriber address that was not previously sent in IAM message. Parameter also contains address signals and their odd number indicator.

2.2.3 Actions required at an outgoing call

Circuit selection

After complete information on dialling was received from calling subscriber in case of *en bloc procedure* (figure 3) or enough information in case of *overlap procedure* (figure 2) and is definite that a call should be routed to subsequent exchange, appropriate free circuit is selected within SRCE exchange. On selection performed, IAM message is sent to subsequent exchange. IAM message indicates circuit seizure performed. Relating routing data are saved during the call.

Route selection depends on called number, required type of connection and network signalling facilities.

Address information sequence

Within national connections, address information may be subscriber number or national number. Address information sequence for international calls is country code followed with national number.

IAM contents (and SAM message for overlap procedure)

IAM and SAM messages contain all information necessary for call to be forwarded to destination exchange and connection to be through-connected between called and calling subscriber. Calling subscriber number is sent within IAM message, except if the calling subscriber has no "identification restriction" additional service.

The only purpose of SAM is to transfer following digits. Remaining digits may be sent in SAM messages containing one or several digits. Efficiency may be increased by grouping as more digits as possible. However, in order to prevent waiting for sending in case *overlap procedure*, it is recommendable to send last few digits in separate SAM messages.

Transmission path completion

Transmission path is completed in direction of connection establishment after CON or ANM message is received. Transmission path through-connection is completed in direction opposite to direction of connection establishment in the originating exchange unless prevented by outgoing circuit state:

- immediately after IAM message sending,
- when it is definite that all digits were received, according to digit analysis, time out used (VK) or based on ACM message reception.

Time out for network protection

After the originating exchange has sent IAM message, VK is started on ACM message waiting. On VK expiry, connection is released and corresponding indication is sent to calling subscriber.

2.2.4 Actions required at transit call

Circuit selection

When concerning transit call and after reception of IAM message, called subscriber number is analized same as other information on routing in order to specify further call routing.

As concerning *overlap procedure*,with call routed using information from IAM message, appropriate circuit is seized and IAM message is sent to subsequent exchange. In case when number of digits in called subscriber number is not enough to route the call, routing is performed after reception of additional digits in SAM message. All address digits received in SAM messages during call routing may be sent in IAM message. If more digits are received in SAM messages after IAM message sending, these are sent to subsequent exchange as SAM messages.

Parameters in IAM message

Signalling information received from the previous exchange may be changed according to properties of selected outgoing route. Signalling information that may be changed are connection indicator nature and the indicator of network signalling facilities. Other information are transferred unchanged.

Transmission path completion

Through-connection of transmission path in both directions for transit call is completed immediately after IAM message sending, excluding situations when the state of outgoing circuits does not allow this (required continuity check failed or both way seizure occurred).

2.2.5 Actions required at the incoming call

Selection of called subscriber

On IAM message reception, called subscriber number is analized to determine the subscriber that the call should be through-connected to. Furthermore, the state of called subscriber line is checked and various checks concerning the connection being allowed or not are performed. These checks include compatibility checks, in addition to those related to additional services.

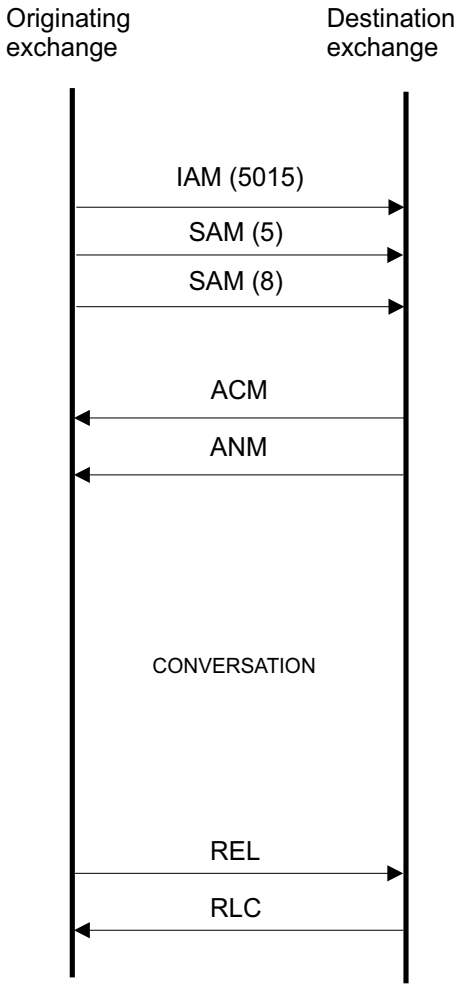

Figure 2: *Overlap procedure*

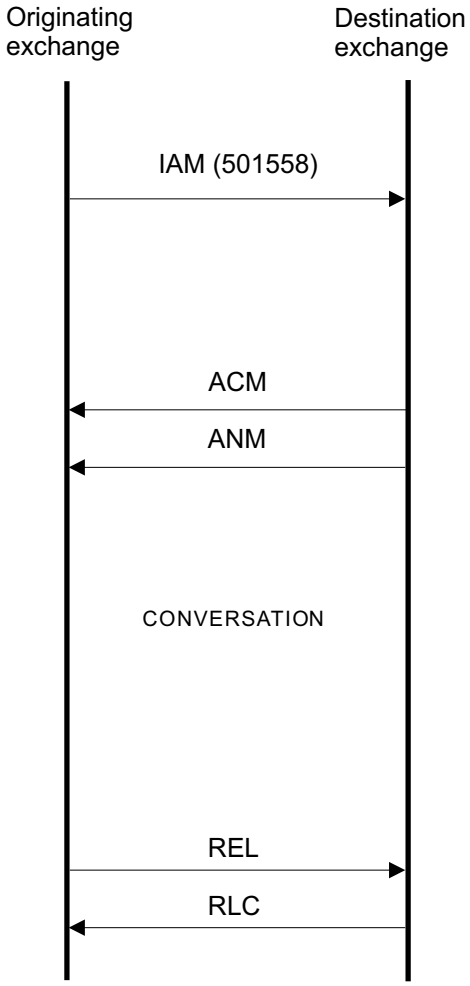

Figure 3: *En bloc procedure*

Approved that connection is allowed, it is established toward called subscriber. If a continuity check should be performed on one or more involved circuits, connection set-up toward called subscriber must be delayed until continuity of the circuits is confirmed.

2.3 Calling subscriber identification

2.3.1 Calling subscriber number parameter

Except for digits of calling subscriber number, the parameter contains following information:

- Odd number indicator of address signals,
- Nature of address indicator,
- Incomplete calling number indicator,
- Numeration plan indicator,
- View permission indicator,
- Calling number origin indicator.

2.3.2 Information request INR

Message is sent by the exchange when requiring the information relating to a call. It contains mandatory fixed parameter *information request indicators* indicating the information required from the remote exchange.

2.3.3 Information request indicators

Parameter may be contained only in INR message and it includes the call information request indicators in two octets:

- Calling party address request,
- Call hold information request,
- Calling subscriber category request,
- Call charging information request,
- Malicious call tracing request.

2.3.4 Information INF

Message is sent as a response to INR message and transmits required information in relation to a call. It contains one mandatory fixed parameter - *information indicators*, others are optional.

2.3.5 Information indicators parameter

May be contained only in INF message and include the indicators of the information contained in the rest of the message. It consists of two octets including:

- Calling party address indicator (whether address is contained or not),
- Call hold indicator,
- Calling subscriber category indicator,
- Charging information indicator,
- Required information indicator describing whether INF message is a response to information request message (INR) or not.

2.3.6 Calling subscriber identification

Calling subscriber number parameter may be either contained in IAM or specially requested from destination exchange.

For the originating call, IAM message contains the number of calling subscriber.

As concerning the incoming call, the calling subscriber number, if not contained in received IAM message, may be requested by sending INR message. Calling subscriber number is obligatory requested if called subscriber has the additional *calling subscriber identification* service.

In case that calling subscriber number is requested with INR message, ACM message sending is delayed to the reception of calling subscriber number in INF message.

Furthermore, calling subscriber number may be found in the identification response message (IRS).

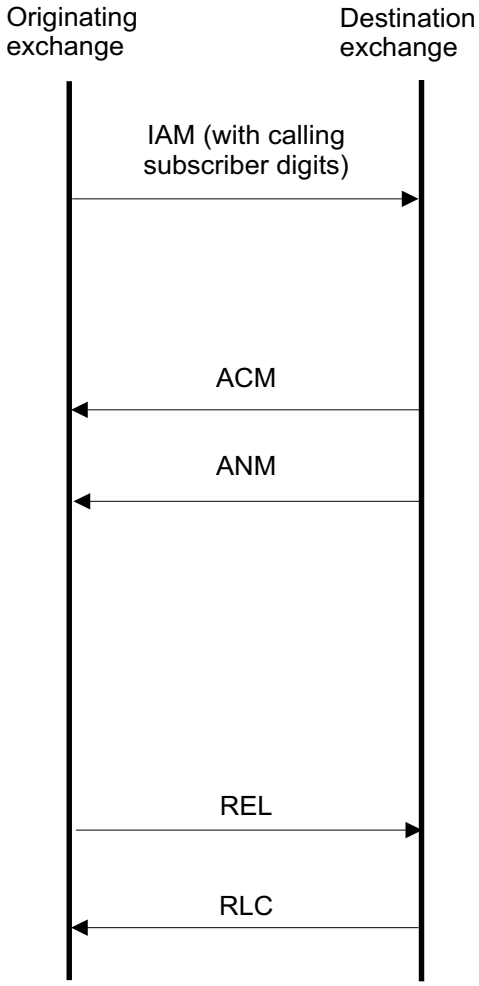

Figure 4: *Calling subscriber identification in IAM message*

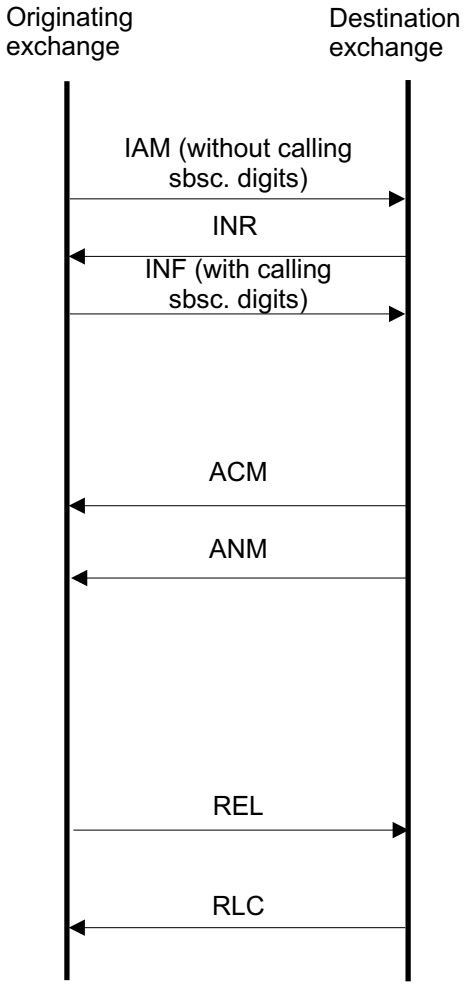

Figure 5: *Calling subscriber identification in INF message*

2.4 Address complete and through-connection message

2.4.1 Messages

Address complete message ACM

Message is sent in direction opposite to direction of connection establishment and indicates that all signals necessary for call routing to called subscriber were received. The only mandatory parameter (fixed) except message type is *backward call indicators* parameter. Other parameters are optional.

Message exceeding 272 octet length is segmented using simple segmentation procedure.

Through-connection (Connect - CON)

Message is sent in direction opposite to connection establishment direction and indicates that all address signals necessary for call routing to called subscriber were received and the called subscriber answered. SRCE sends CON message only in case of transit call, if the CON message was received (figure 7). In all other cases, ACM and ANM messages are sent (figure 6). mandatory parameter in this message is *backward call indicators*. Other parameters are optional.

Message exceeding 272 octet length is segmented using simple segmentation procedure.

2.4.2 Parameters

Backward call indicators

Parameter contains more different indicators packed in two octets. Indicators are:

- Charging indicator (whether call is charged or not),
- State indicator of called party ("subscriber free" is in usage),
- Called subscriber category indicator (ordinary subscriber or pay phone),
- Transmission mode indicator (*SCCP* method - *end-to-end* or other),
- Interworking indicator (indicating presence),
- *End-to-end* information indicator (available or not),
- ISUP indicator (used through the whole transmission path or not),
- Call hold indicator,
- ISDN access indicator,
- Echo control indicator,
- *SCCP* method indicator (with or without call establishment, both of it or none of it).

backward call indicators are contained in messages in direction opposite to direction of call establishment. It is mandatory in ACM and CON message, and optional in CPG and ANM.

2.4.3 Actions required at the incoming call

ACM message is sent when it's definite that called subscriber number is complete and the subscriber is free. Indicators in ACM message are defined as following:

- state of called subscriber line is "subscriber free",
- *ISDN* access indicator is "not *ISDN*".

Regardless from connection type, waiting on answer indication is sent (call control tone). Call is through-connected on reception of through-connection indication from called subscriber and before ANM message is sent to the previous exchange.

CON message is never sent in case of the incoming call.

2.4.4 Actions required at transit call

On reception of ACM message, corresponding ACM message is sent to previous exchange. In the same time, time out is started on answering. On time out expiry, connection is released.

Had message CON been received instead of ACM message, CON message is sent to previous exchange.

Additional information in optional parameters are transmitted unchanged in ACM or CON messages. And if ACM or CON are segmented messages, additional information in SGM message are forwarded unchanged.

2.4.5 Actions required at an outgoing call

On reception of ACM with indicator set to "subscriber free", conversation phase is started. Time out on ACM waiting is stopped and is started for waiting on answer. On its expiry, call is cleared and indication is sent to calling subscriber.

If CON message is received, conversation phase is started and time out on ACM message waiting is stopped.

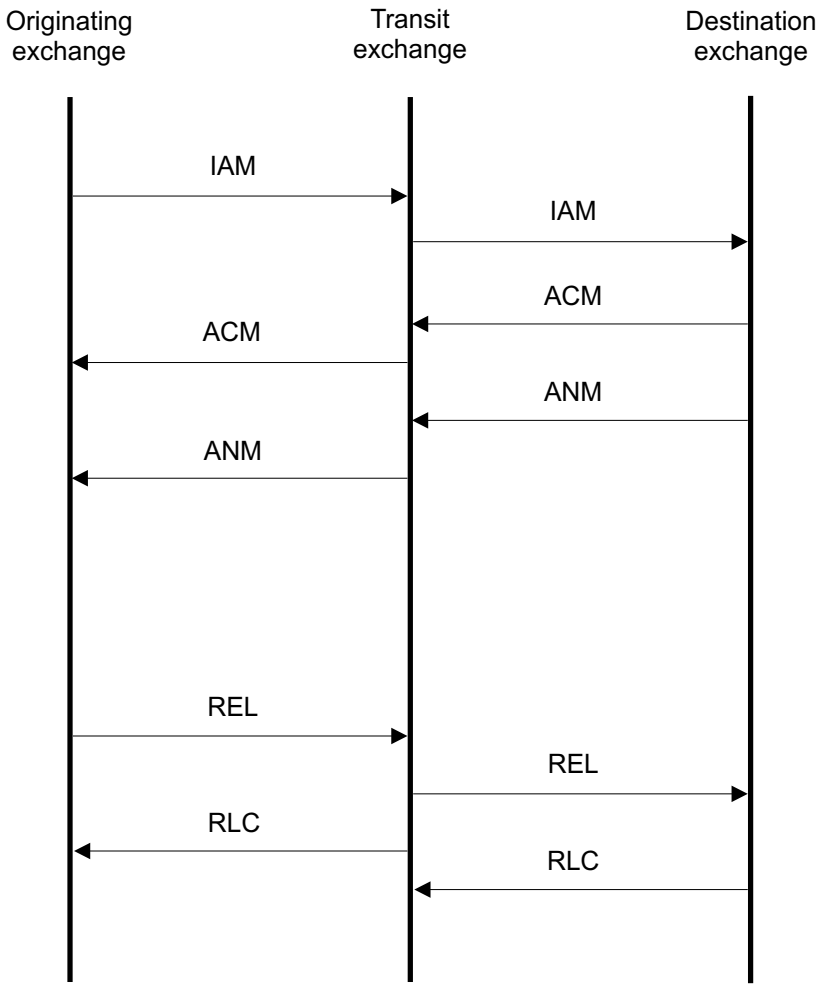

Figure 6: *Transit call with ACM*

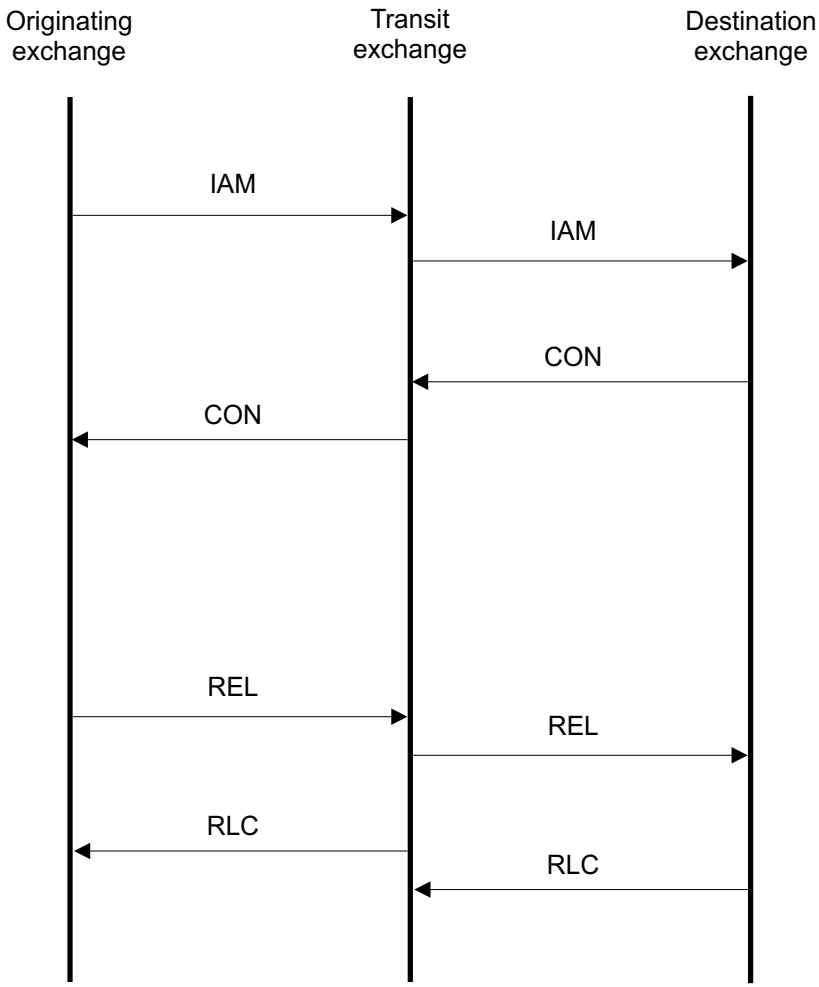

Figure 7: *Transit call with CON message*

2.5 Call progress

CPG - Call Progress message may be sent only after ACM in direction opposite to direction of call establishment. Message indicates some events during call establishment that the calling party should be informed of.

Message exceeding 272 octet length is segmented using simple segmentation procedure.

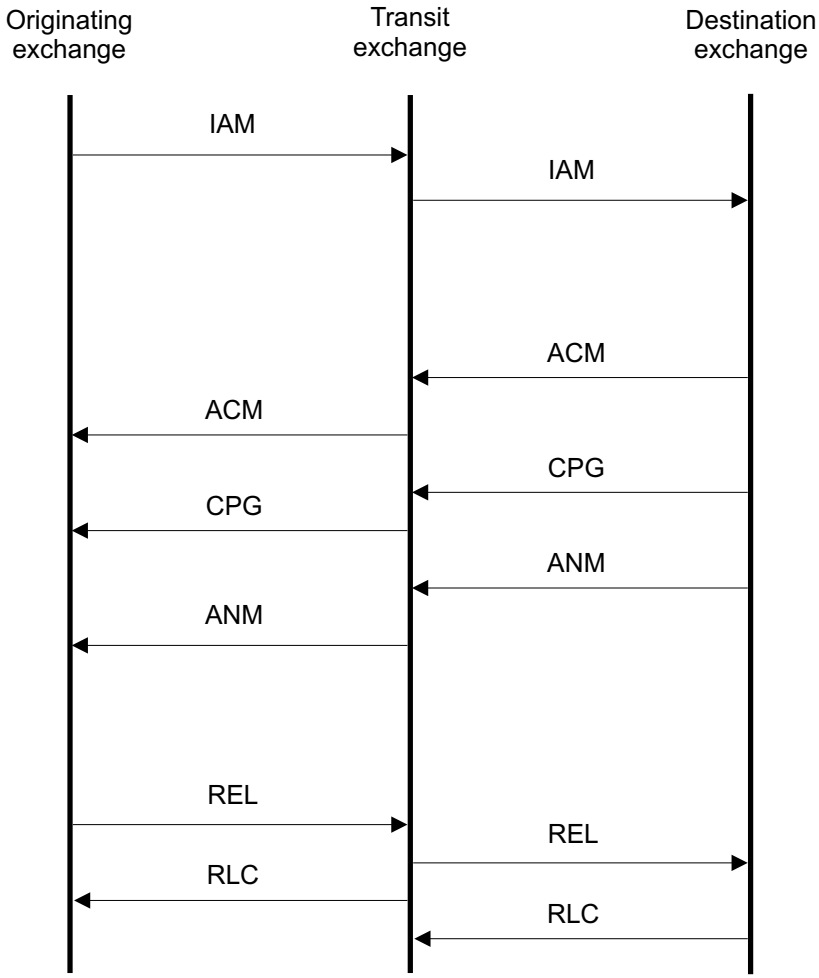

Figure 8: *Transit call with CPG message*

SRCE system never sends this message, but forwards it when received in transit call (figure 8). Compatibility of parameters found in message is checked.

2.6 Call establishment failure

Any time when call establishment cannot be successfully completed, exchange does one of the following:

- performs another call set-up attempt,
- starts clearing procedure toward previous and/or subsequent exchange (REL message always contains the reason for call failure).

2.6.1 Incomplete address

In case of end of dialling or address incomplete signal received from the national network, it may be concluded that sufficient number of digits was not received.

In case when end of dialling signal was not received, the incomplete address signal (REL message with cause value 28) may be sent by the end exchange with No.7 signalling, on expiry of specified period after reception of the last digit, in case that minimum number of digits required for call routing was not received.

2.6.2 Actions required on the initiation of connection clearing

The first action to be taken when starting connection clearing is to clear the transmission path, if being busy. REL message is sent toward previous and/or subsequent exchange and time out on waiting for RLC message from previous and/or subsequent exchange is started.

2.6.3 Actions required at transit call

On REL message received, it is started with transmission path clearing. When circuit gets available again, RLC message is sent. In the same time, REL message is sent to previous or subsequent exchange. Time out is started on waiting for RLC message from previous or subsequent exchange.

2.6.4 Operations during REL message reception

On reception of REL message, it is started with transmission path clearing, and appropriate indication is sent to calling subscriber. When the circuit gets available again, RLC message is sent.

2.7 Answer message

Answer message ANM is sent in direction opposite to direction of call establishment and indicates that the called subscriber answered. Message is used in combination with charging information in order to start charging of calling subscriber or timing of call in the international traffic. In addition to the message type, ANM contains optional parameters.

2.7.1 Actions during incoming call

On called subscriber answer, ringing control tone is canceled, answer message is sent in direction opposite to direction of call establishment and if call is to charge, charging may begin.

2.7.2 Actions at transit call

On reception of ANM, this same message is sent to previous exchange. Time out on waiting for answer is stopped.

All additional information (referring to additional services etc.) are transferred unchanged.

2.7.3 Actions at the outgoing call

On reception of ANM, time out on waiting for answer is stopped and charging may begin, if call is to be charged.

2.8 Suspend and resume

2.8.1 Messages and parameters

Suspend SUS message

Message is sent in both directions of call establishment and indicates that the called subscriber or calling subscriber hung up the phone and is not connected temporarily. It contains one mandatory fixed parameter *suspend indicator*.

Resume RES

Message is sent in both directions of call establishment and indicates that the called or calling subscriber has established the speech path again, after hook on. It contains one mandatory fixed parameter *resume indicator*.

Suspend/Resume indicators

Parameter is contained in (SUS) and (RES) messages as a mandatory one. It consists of one octet with only the least significant bit used to indicate whether suspend or resume was initiated by network or an ISDN subscriber.

2.8.2 Suspend message

SUS message indicates temporary suspension of communication without call clearing. It may be accepted only in conversation phase.

Network generates SUS message as a response to suspend indication received from the point where signalling conversion is performed or from analog called subscriber.

When suspend conditions are defined for the incoming call, SUS message is sent to previous exchange. SUS message is also sent when conversion from another signalling into signalling no. 7 is performed, provided that suspend signal was received.

As for the transit call, on reception of SUS message, SUS message is sent to previous exchange.

In case of the outgoing call, after called subscriber hook on or after reception of suspend signal by another signalling, time out on reanswering is started.

2.8.3 Resume

RES message denotes the request to restart the communication.

Network sends RES message after previously sent SUS message, as a response to received indication of reanswering from the place where signalling conversion is performed or is a response to recognition of reanswering from analog called subscriber.

In transit call, when received, RES message is forwarded to previous exchange.

If RES message is received during outgoing call, time out on waiting for reanswering is stopped.

If RES message is not received before time out expiry on waiting for resume, connection is cleared, and 102 cause indicator is sent in REL message. Had connection release request been sent during this time out from calling subscriber, sequence of messages SUS/RES is ignored and connection clearing procedure is started.

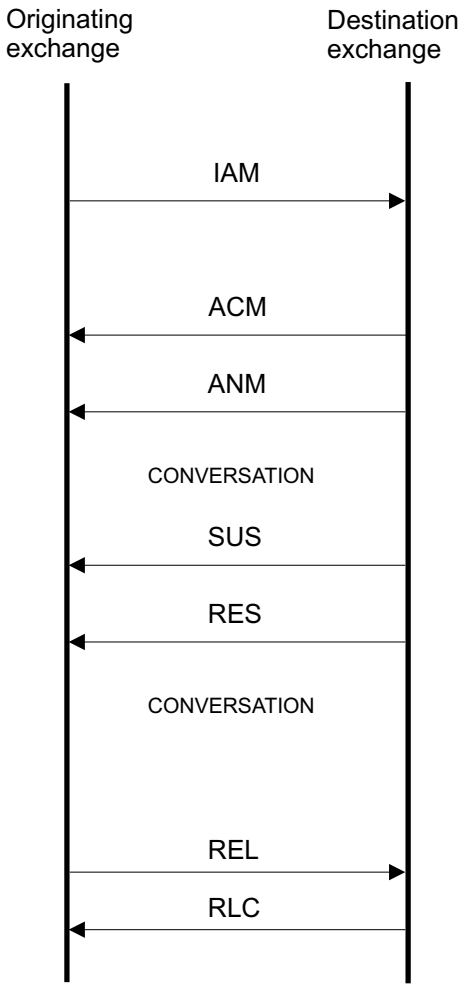

Figure 9: *Suspend and resume of called subscriber*

2.9 Simple segmentation

2.9.1 Segmentation message SGM

SRCE never sends segmentation message in the outgoing call operation. However, if there is a segmentation indicator in the received segmented message, that is, additional information about call follows in SGM message, SGM message is forwarded unchanged in case of transit call.

2.9.2 Segmentation procedure

Simple segmentation procedure uses SGM to transfer additional information, in case of message length exceeding 272 octets. Any message containing either *forward call optional indicators* or *backward call optional indicators*, may be segmented using this method.

This procedure provides the mechanism for transfer of messages with length between 272 and 544 octets.

Procedure is performed as following:

- Exchange controlling message sending may decrease the length of message when confirmed longer than 272 octets and this by sending some parameters additionally in SGM immediately after the first part of message.
- Parameters that may be sent in the segment are: *user-to-user information, common digits, general notification, general number, final access parameter*. If user-to-user information and final access information cannot be included in the original message, nor in SGM, user-to-user information is ignored.
- Exchange controlling message sending sets the indicator of simple segmentation in the optional indicator of forward call (for IAM, figure 10) or backward call (for ACM, CPG, CON, ANM, figure 11), to indicate that the message is followed with an additional information.
- On message received with set indicator of simple segmentation indicating the additional information in SGM, VK is started on waiting for SGM.
- On reception of SGM, time out is stopped and call processing is continued.
- If any message has been received before SGM, the exchange considers the other segment lost, resulting in time out on waiting for SGM termination and continuation of call processing. Exception to this are following messages: COT, BLO, BLA, CGB, CGBA, UBL, UBA, CGU, CGUA, CQM and CQR. Had any of these messages been received, segmentation procedure is continued regularly.

- On the expiry of time out on waiting for SGM, call is continued and SGM, if received later, is ignored. SRCE does not use information from SGM message when receiving SGM in the outgoing call operation.

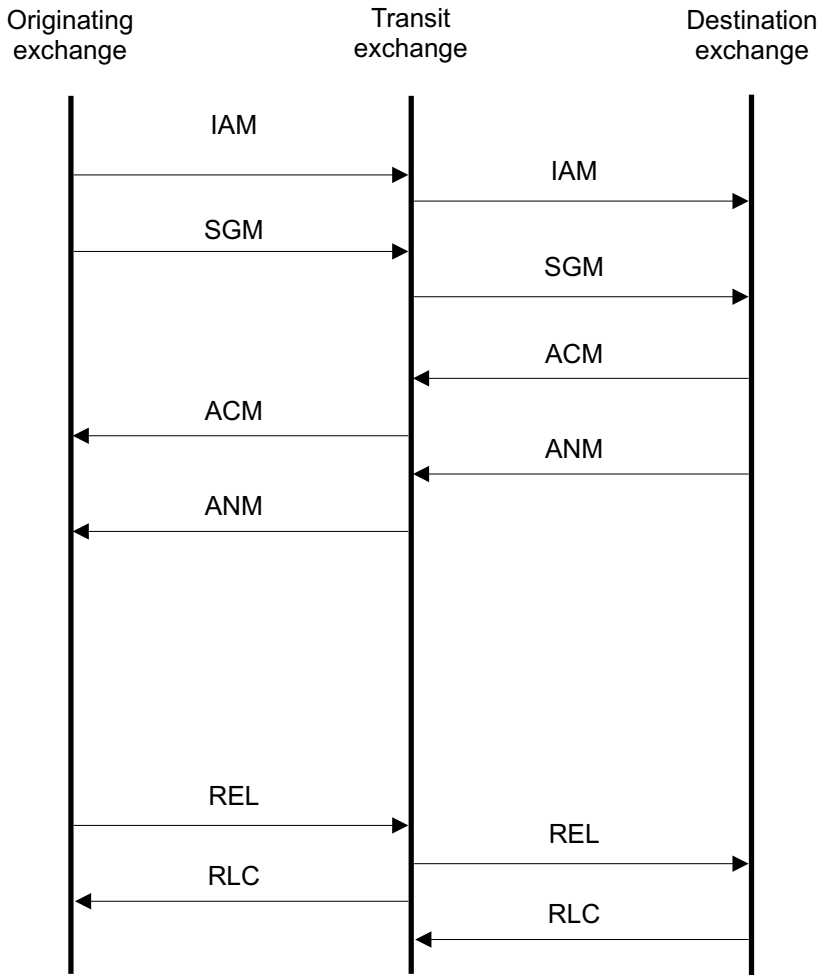

Figure 10: *Transit call with segmented IAM message*

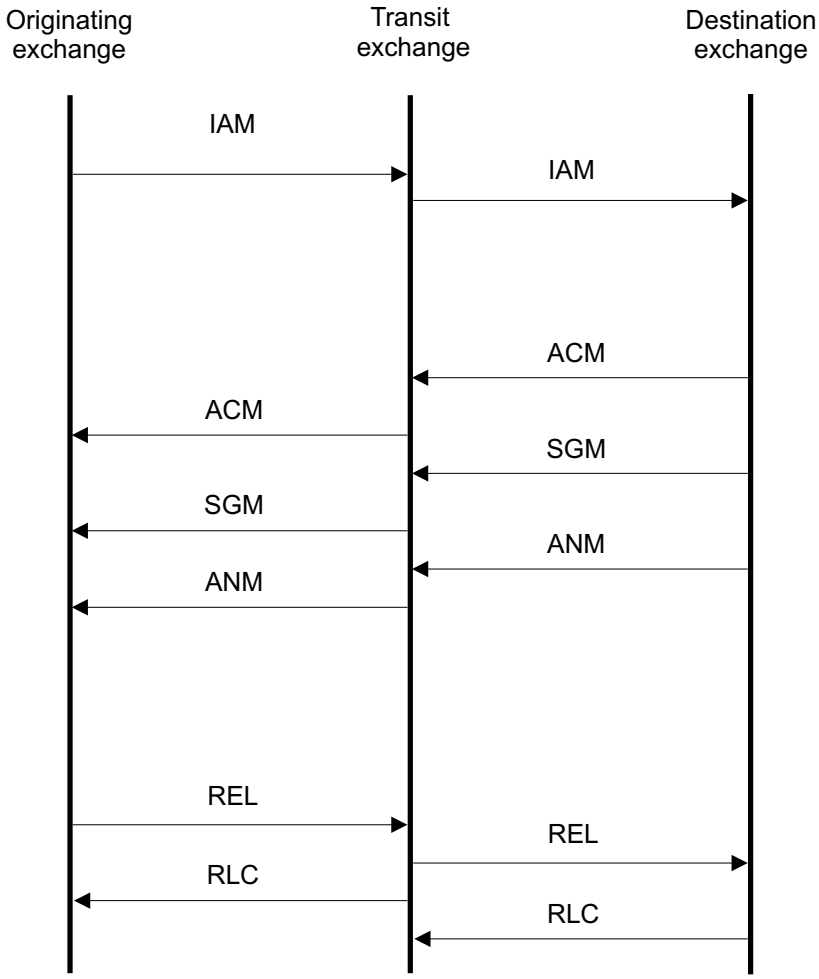

Figure 11: *Transit call with segmented ACM message*

2.10 Dual seizure in both way operation

Since circuits with No.7 signalling have a possibility of both way operation. It is possible that two exchanges attempt to seize the same circuit almost in the same time.

In signalling system No.7, message transfer through signalling link may last for a while, also there might be a considerable delay for the reasons of retransmission and as for quasi-assigned operation mode, it may cause an additional waste of time for message transfer in transit signalling point. Therefore, the unprotected interval in which both way seizure may appear can take some time in some cases. Exchange should recognize this both way seizure and react appropriately.

2.10.1 Actions required at both way seizure

Both way seizure is recognized in case of IAM message reception on the circuit from which IAM message was sent, before any valid message is received in direction opposite to direction of call establishment. Each exchange controls half of both way seizure group.

On both way seizure recognized on a controlled circuit, call is realized on this circuit and received IAM message is discarded (figure 13).

On both way seizure recognized on an uncontrolled circuit, outgoing call is interrupted and connection is released, while incoming call is missed (figure 12). If there is a continuity check performed on this circuit tone transmitters for continuity check are removed and a loop for continuity check is connected. REL is not sent. Than comes another attempt of call establishment over another circuit in the same or an alternative route.

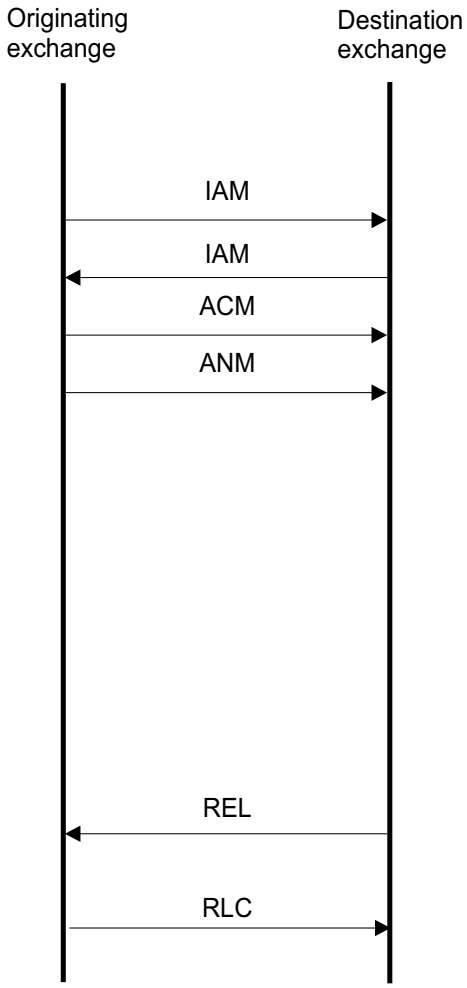

Figure 12: *Both way seizure over the uncontrolled circuit; incoming call missed*

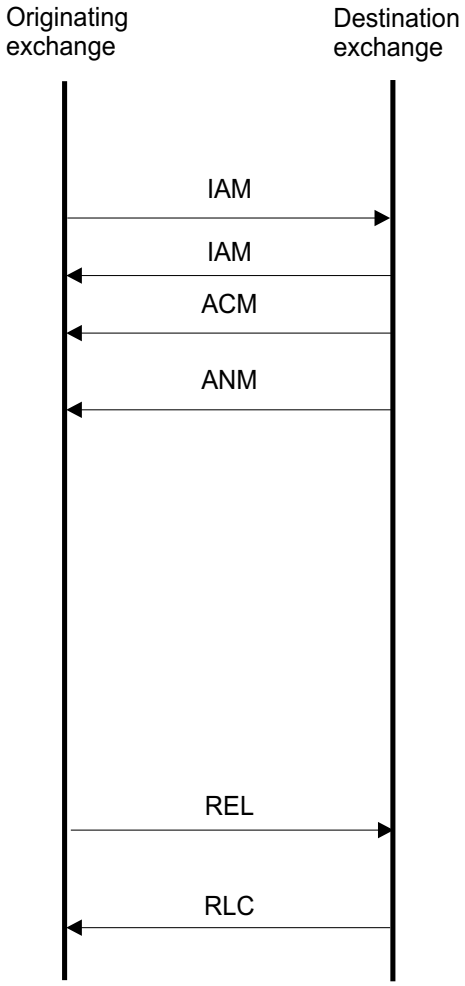

Figure 13: *Both way seizure over controlled circuit; incoming call discarded*

2.11 Automatic repeat attempt

In SRCE system No.7 signalling, automatic repeat attempt of call set up is possible in following cases:

- after continuity check failure,
- after recognition of dual seizure (figure 15),
- on reception of BLO message after IAM message sending, and before reception of any message in direction opposite to direction of connection establishment,
- on reception of RSC message after IAM message sending, and before reception of any message in direction opposite to direction of connection establishment (figure 14),
- on reception of an unexpected signalling information after IAM message was sent, and before any other message is received in direction opposite to direction of connection establishment.

Automatic repeat implies the selection of new outgoing circuit, if possible, in order to route the call which is to be established. In the same time the call which failed by the first seized circuit is terminated, by conducting the appropriate procedure for circuit clearing, except in case of both way seizure, when the incoming call is missed.

IAM message sent for a new circuit contains all digits received from the moment of sending.

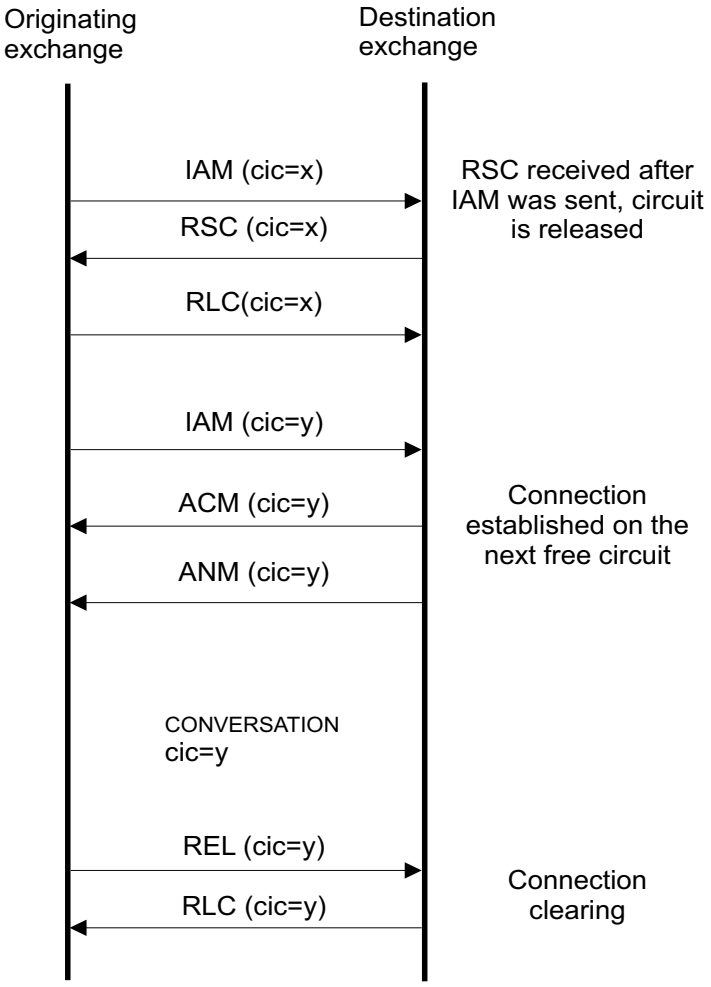

Figure 14: *Automatic repeat attempt in the event of RSC reception after IAM sending*

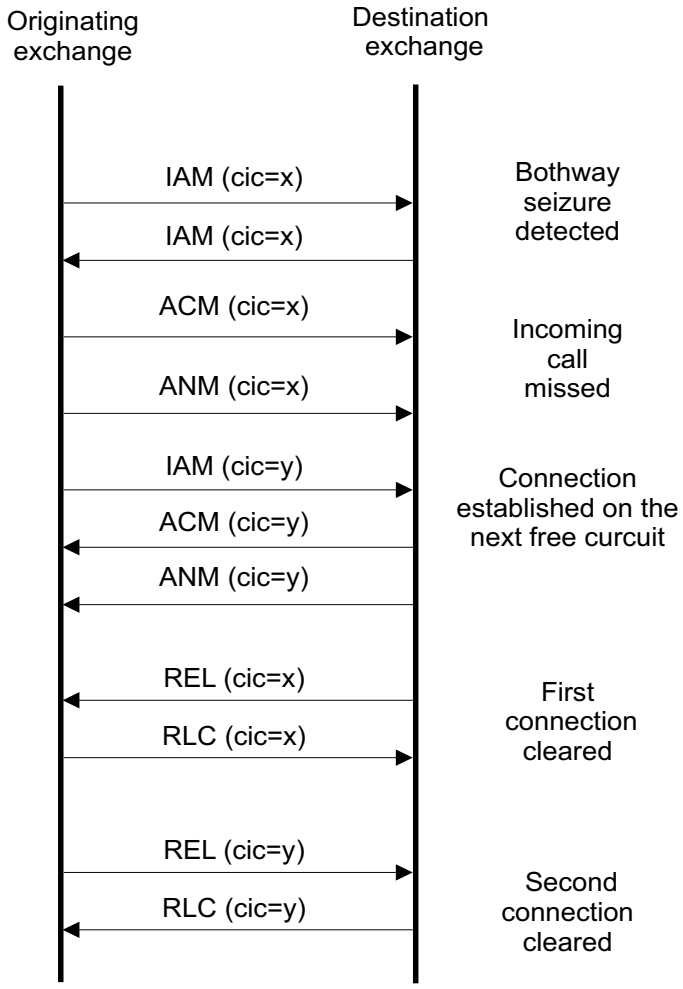

Figure 15: *Automatic repeat in the event of both way seizure*

2.12 Blocking and unblocking of circuit and group of circuits

2.12.1 Messages and parameters for blocking and unblocking of circuits and circuit group

Blocking BLO

Message is sent toward the exchange on the other end of the circuit, to cause circuit state blocked for further outgoing calls. When the circuit is used in both way mode operation, the exchange receiving BLO message must be capable of receiving the incoming calls by that circuit. In other words, IAM message may unblock the circuit blocked this way. Message contains message type and no other parameter.

Blocking acknowledgment BLA

Message is sent as a response to BLO message and indicates the blocked circuit. Message contains only message type parameter.

Unblocking UBL

Message is sent to the exchange on the other end of the circuit in order to end busy state for outgoing calls caused by previously sent BLO or CGB message. Message includes only message type parameter.

Unblocking acknowledgment UBA

Message is sent as a response to UBL message and indicates the unblocked circuit. Message contains only message type parameter.

Circuit group blocking CGB

Message is sent to the exchange on the other end of certain circuit group in order to cause busy state of this circuit group for further outgoing calls. The exchange receiving CGB message, must be able to receive the incoming calls by a trunk from the group of the blocked ones, except when BLO has already been sent.

Circuit group blocking acknowledgment CGBA

Message is sent as a response to CGB and indicates that the requested circuit group is blocked.

Circuit group unblocking CGU

Message is sent to the exchange on the other end of the group in order to cancel circuit group busy state for the outgoing calls, the state previously caused by sending of CGB or BLO message.

Circuit group unblocking acknowledgment CGUA

Message is sent as a response to CGU message showing that the requested circuit group is unblocked and it is possible to establish further outgoing calls by it .

Circuit group

Parameter consists of one octet with only two lowest buts used and is mandatory in group blocking and unblocking messages.

Depending on message parameter *Circuit group unblocking acknowledgment* for group blocking and unblocking, messages may be:

- circuit group blocking (unblocking) messages, maintenance,
- circuit group blocking (unblocking) messages, hardware irregularity.

Range & status

Parameter is of variable length and is mandatory in CGB, CGBA, CGU, CGUA, GRS (2.15.2) and CQM (2.12.5) messages. Within parameter range, the circuits to be blocked or unblocked are defined. Parameter contains following data:

- Range is presented by a number which may be between 0 and 255. Range number plus one gives the number of circuit to which the messages refers,
- Status contains 2 - 256 status bits numbered from 0 to 255. Number of bits in status field coded with 1 (to which the message refers), is equal to range plus 1. Each status bit is related to one circuit identification code (CIC) in the way as following: if m circuit identification code (CIC) is contained in message label, than status bit n is related with CIC $m + n$ (e.g. bit *3* relates to CIC = *m+3*).

2.12.2 Blocking and unblocking procedure

Circuit or group circuit blocking (unblocking) message provides a possibility for switching equipment or operators at the exchange to disconnect from the traffic (or connect again) a remote circuit or circuit group end for the causes of testing or an error.

Circuits using No.7 signalling system are both way, therefore BLO or CGB message may be sent in both directions. Reception of BLO or CGB messages restricts outgoing calls from these circuit until UBL or CGU message is received, but no incoming calls to those circuits are restricted. An acknowledgement is always requested for circuit or circuit group blocking and unblocking messages. The acknowledgement is not sent until blocking or unblocking is completed. REL message wouldn't cancel blocking state or return a circuit with possible irregularity to the traffic. Blocked circuit or circuit group are brought back to traffic by sending UBA or CGUA corresponding message from one exchange and reception of UBA or CGUA corresponding message in the other exchange.

2.12.3 Other actions during blocking message reception

Had BLO message been received after IAM message was sent, and before any message reception in direction opposite to direction of call establishment (ACM, CON...), the attempt of connection set-up is repeated over next free circuit. Previous connection is than cleared in a usual way, after sending BLA (figure 16). On reception of BLO:

- in the outgoing call, after sending IAM message and reception of at least one backward signal for this call or,
- in the incoming call after reception of IAM message,

the circuit is not seized for further calls, but call already started is continued.

If circuits are engaged for the call, on reception of BLO (UBL) message, BLA (UBA) message is sent.

On BLO message sent, and IAM message received from the opposite direction, IAM message is ignored.

2.12.4 Errors in blocking-unblocking loop

If BLO message is received for the blocked circuit, BLA will be sent with no additional actions.

If UBL message is received for the circuit that was not blocked, UBA message will be sent with no further actions.

Had no corresponding acknowledgement been received in 15-60 seconds after sending any of blocking or unblocking messages, same blocking or unblocking message will be sent again.

If the acknowledgement was not received in 5-15 minutes after sending of first blocking (unblocking) message or circuit group blocking (unblocking) message, the alarm is reported and messages are repeated on each one minute passed.

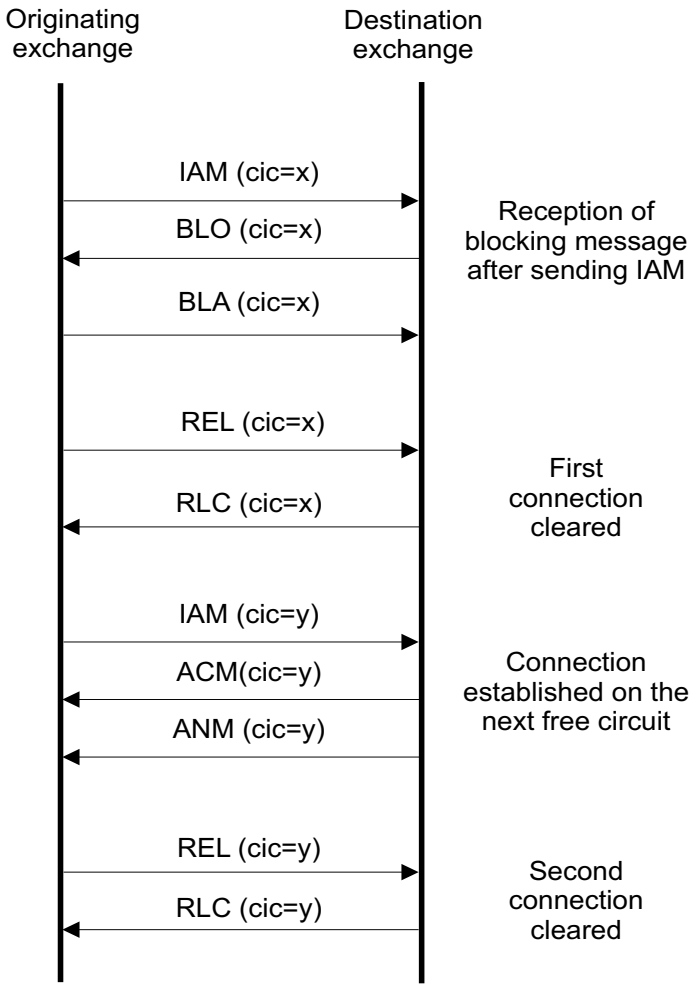

Figure 16: *Automatic repeat attempt on BLO message reception*

2.12.5 Circuit group testing

Circuit group testing enables the testing of a particular circuit group state. Maximum range in circuit group testing messages is 31. When exceeding 31, circuit group testing message is ignored.

Circuit group query message CQM

Message is sent to a remote exchange as a request for states of all circuits in a particular range. It contains one mandatory variable parameter (*range and status*).

Circuit group query response CQR

Message is sent as a response to received circuit group query message and contains states of circuits in range requested. It contains two mandatory variable parameters: *range and status* and *circuit state indicator*.

Circuit state indicator

Number of octets in this parameter is equal to *range plus 1*. Each octet of circuit state is related to circuit identification code (CIC) in a way that octet n is attached to CIC $m+n-1$, where m, CIC is contained in message label. Each octet coding is described in in *ITU-T* recommendation *Q.763 § 3.14*.

Circuit state explanation

For the procedure of circuit group testing, certain states, classified in four basic categories, were introduced:

- unequipped and transient state,
- call processing state,
- maintenance blocking state,
- hardware blocking state, caused by electronic equipment irregularity.

Unequipped and *transient* state cannot overlap with other states.

Call processing states are:

- idle,
- circuit incoming busy,
- circuit outgoing busy,
- circuit in reset.

Maintenance blocking states are:

- unblocked,
- remote blocked,

- local blocked,
- local and remote blocked.

Hardware blocking states are:

- unblocked,
- remote blocked,
- local blocked,
- local and remote blocked.

Circuit is in state *unequipped* when unavailable for ISDN user part. Call processing or maintenance operations cannot be performed in this state. It will not overlap with other states.

Transient state refers to any transient state of call processing or maintenance. Call processing is in transient state in following situations:

- after IAM message sent, while waiting for the first message backwards,
- after having sent REL message, while waiting for RLC message.

Transient maintenance states occur in case blocking or unblocking message (of a circuit or circuit group) was sent and is waited for corresponding acknowledgement message.

Circuit state is also considered transient until RSC or GRS message is confirmed.

Idle state of call processing refers to the state of an equipped, not seized circuit. States *circuit incoming busy* and *circuit outgoing busy* correspond to stable states of call processing.

Remote blocking state, resulted from electronic equipment irregularity or for the reasons of maintenance, relates to the circuit marked by the exchange after blocking was started from a remote exchange. Maintenance blocking state may coexist with states *idle*, *circuit incoming busy* or *outgoing busy*. Electronic equipment blocking state may coexist solely with a *idle* state of call processing, since the call should be released in a situation of blocking for reasons of electronic equipment irregularity.

Local blocked state, caused either by hardware irregularity or maintenance, refers to the circuit marked by the exchange after it has started blocking toward remote exchange and received appropriate acknowledgement. Maintenance blocking state may coexist with states *idle*, *circuit incoming busy* or *circuit outgoing busy*. Hardware blocking state may coexist solely with *idle* state of call processing, since the call is to be released immediately in situation of hardware blocking.

2.13 Connection clearing and equipment release

2.13.1 Messages and parameters

Release message - REL

Message may be sent in both directions and informs of the circuit being released for the reason described in parameter *Cause value*. Cause value is the only mandatory parameter in this message. Circuit is ready to be restored to idle state on reception of release complete message.

Release complete message - RLC

Message is sent in both directions as a response to REL or RSC message. On RLC sent, circuit is brought to idle state. Message may contain only the optional parameter *cause value*.

Cause value parameter

Parameter is mandatory in following messages:

- REL - to indicate the cause of connection clearing,
- CFN - to indicate the cause for message rejection in compatibility procedure (cause may be an unrecognized message, parameter within the message etc).

Codes for cause value within this parameter are described in recommendation *ITU-T Q.850*.

2.13.2 Regular connection clearing

Connection clearing procedure is based on the exchange of REL and RLC messages while REL message initiates circuit release in a through-connected call. Same procedure is used for clearing, regardless of whether it was started by network, calling or called subscriber.

Clearing initiated by calling subscriber

On clearing request received from calling subscriber in the outgoing call, transmission path release is initiated. REL message is sent toward subsequent exchange and time out on waiting for RLC message is started (figure 4).

If REL message is received in transit call, it is immediately started with switching equipment release, and when the circuit gets available again, RLC message is sent. In the same time, REL message is sent to subsequent exchange and time out on waiting for release is started (figure 10).

On REL message received in the incoming call, it is started with transmission path release and, when the circuit gets available, RLC message is sent.

In the moment of REL message reception or after clearing request was received from the calling subscriber, call charging is stopped.

Had REL message been sent or clearing of transmission path started and REL message received, RLC message is sent to the exchange from which REL was received.

Clearing started by called subscriber

As concerning the clearing initiated by called subscriber, same procedure is applied as the one described in previous paragraph, only with the destination and originating point replaced mutually.

Clearing initiated by network

Same procedure was applied in this case too, only that the clearing may be also started in transit exchange.

2.13.3 Irregular clearing

If circuit release is not possible after reception of REL message, the circuit disconnects from the operation and BLO message is sent. On blocking acknowledgement received, RLC message is sent as a response to previously received REL message.

If it happens that the call fails during connection establishment, and there is no appropriate cause value, REL message sends cause value *call error*.

In case that the conditions for regular connection clearing were not fulfilled, exchange in the outgoing call shall:

- release all equipment and clear the connection forward, if no conditions for regular clearing of address and routing information were conducted in 20-30 seconds after last address message was sent.
- release all equipment and clear the connection forward if no ANM was received within 1-3 minute defined period.

  As concerning the incoming call, the exchange releases all equipment, clears the connection and sends REL message backwards in following cases:

- COT message was not received, while continuity check is performed 10-15 seconds after IAM message reception,
- no signal backward was received in 20-30 seconds after last address message reception,
- REL message was received after ACM had already been sent,
- 15-20 seconds after reception of last address message no other address message is yet received, neither the minimum number of digits required for sending.

In transit call, exchange releases all equipment, clears the connection and and sends REL message backwards if:

- COT message is not received during continuity check, in 10-15 seconds after IAM message reception,

- there are no conditions (of those described in 2.13.1) for regular connection release after 20 - 30 seconds after last address message sending.
- 15-20 seconds after reception of last address message no other address message is yet received, neither the minimum number of digits required for sending.

REL message sending will be repeated in case of no RLC message received in 15-60 seconds after REL message was first sent.

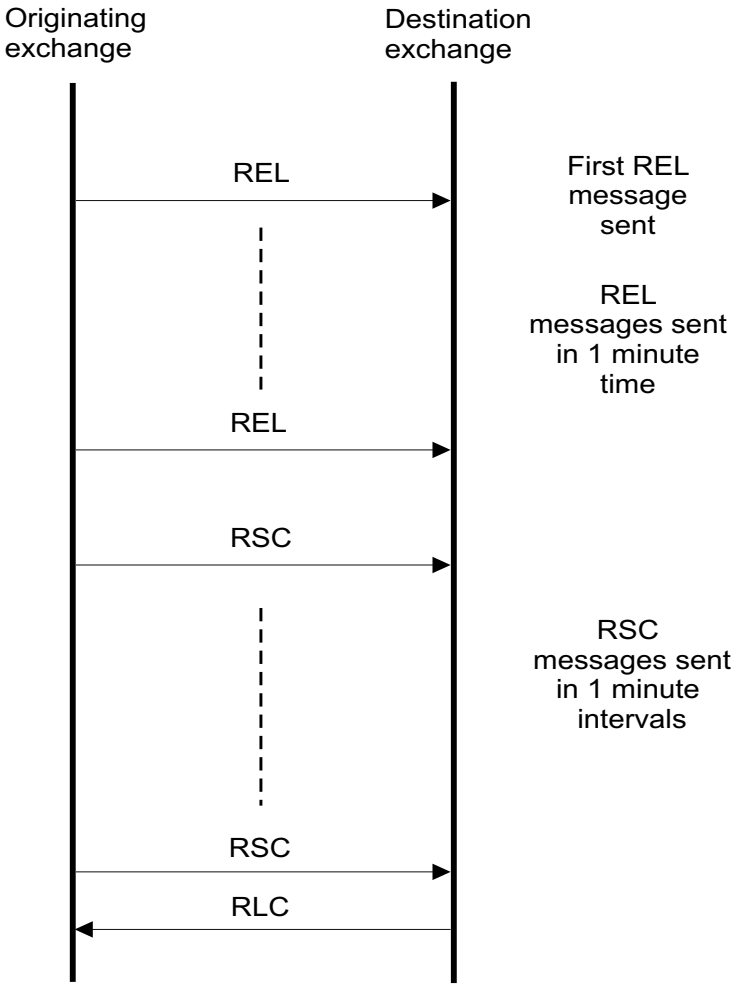

Figure 17: *Irregular connection clearing - RLC not received*

Had RLC message not been received in 1 minute period after first REL message was sent, RSC message sending will be continuously repeated in 1 minute intervals (figure 17).

2.14 Continuity check procedure

2.14.1 Messages and parameters

Continuity message COT

Message is sent in direction of connection establishment toward a remote exchange and includes speech path check on a selected circuit. Message also indicates the presence of continuity on previous circuits. It contains one mandatory fixed parameter *continuity indicators*.

Continuity check request CCR

Message is sent for the circuit for which the continuity check is to be performed, to the exchange on the other end of the circuit, with request for continuity check equipment activation.

Continuity indicators parameter

Parameter is contained only in COT message. It consists of one octet with only the lowest bit used. This bit denotes whether the continuity check was successful (1) or not (0).

2.14.2 Call with continuity check

Continuity check procedure provides speech channel continuity check in signalling system No.7. Channels on which the continuity check is to be performed are specified by the operator.

On the outgoing side, it is determined whether continuity check is necessary according to continuity check indicators received in IAM. If requested, transmitter is connected to the outgoing speech circuit in the moment of IAM sending.

COT message is sent forward after all other actions completed:

- continuity check performed on the outgoing circuit is completed (figure 19);
- speech path through the exchange is checked and is confirmed regular;
- the continuity check indicator received in IAM message confirms that continuity check is performed (or was performed) on a previous circuit, after reception of COT messages from the previous exchange.

Speech path may be through-connected in transit or incoming exchange. Speech path through-connection is held until continuity tone is returned through speech circuit. Transmitter is disconnected on continuity check successfully completed. On reception of continuity tone in subsequent exchange, continuity check loop is canceled, if ever been through-connected. Also, if there were some national number digits that were held, same are cleared. In case that the outgoing continuity check fails, and in order to satisfy continuity check requests, following is performed:

- continuity check transmitter is removed and another attempt of seizure by another circuit is performed,
- continuity check failure message is sent to subsequent exchange (figure 18).

Another speech circuit continuity check is executed on the outgoing circuit where it failed 1 - 10 seconds after recognition of continuity check failure, in case of procedure started using IAM. Next continuity check is initiated by the side that detected the failure using continuity check request message.

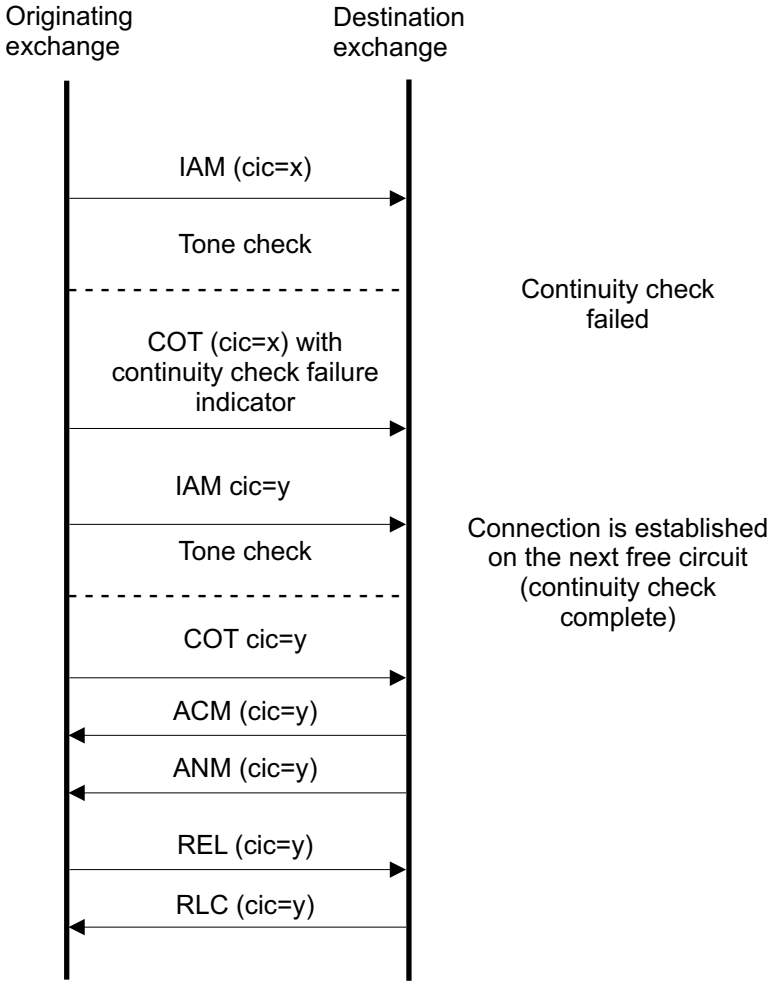

Figure 18: *Automatic repeat attempt in continuity check failure circumstances*

If the repeated continuity check works for this call, speech circuit is returned into *idle* state using the sequence of REL/RLC messages. If it fails, operator receives the alarm that the continuity check failed and check is than repeated in 1 - 3 minute intervals. Repeated continuity check is completed only after continuity being recognized.

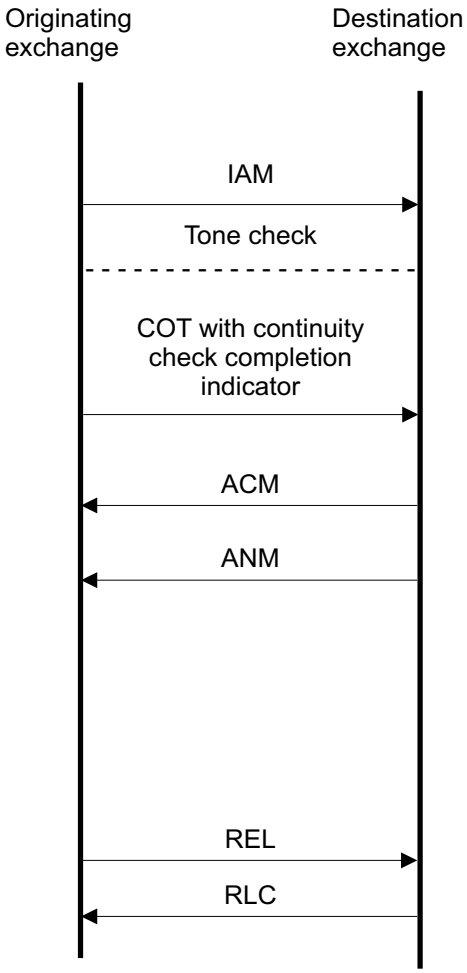

Figure 19: *Call with successful continuity check*

2.14.3 Continuity check on free circuit

When the continuity check is performed using test calls, procedure for one circuit testing is used. Circuit must be in state *idle* on procedure starting.

To initiate outgoing procedure, continuity check request message is sent to subsequent exchange and transmitter is through-connected onto outgoing speech circuit. On CCR message received, subsequent exchange through-connects the loop on the involved circuit. On reception of backward tone within specified time interval, transmitter on the outgoing side is released and circuit returns to state *idle*after sequence of REL/RLC messages (figure 21).

If backward tone is not received in specified time, same operations are performed as in continuity check failure circumstances during regular connection establishment (figure 20).

Had IAM been received by the circuit that CCR message was sent by (in case of collision on both way channels), continuity check test call is cleared, transmitter released and incoming call processed.

CCR message received after IAM was sent by a particular circuit is ignored and call establishment procedure is continued.

Speech channel continuity check is realized link by link, for each call.

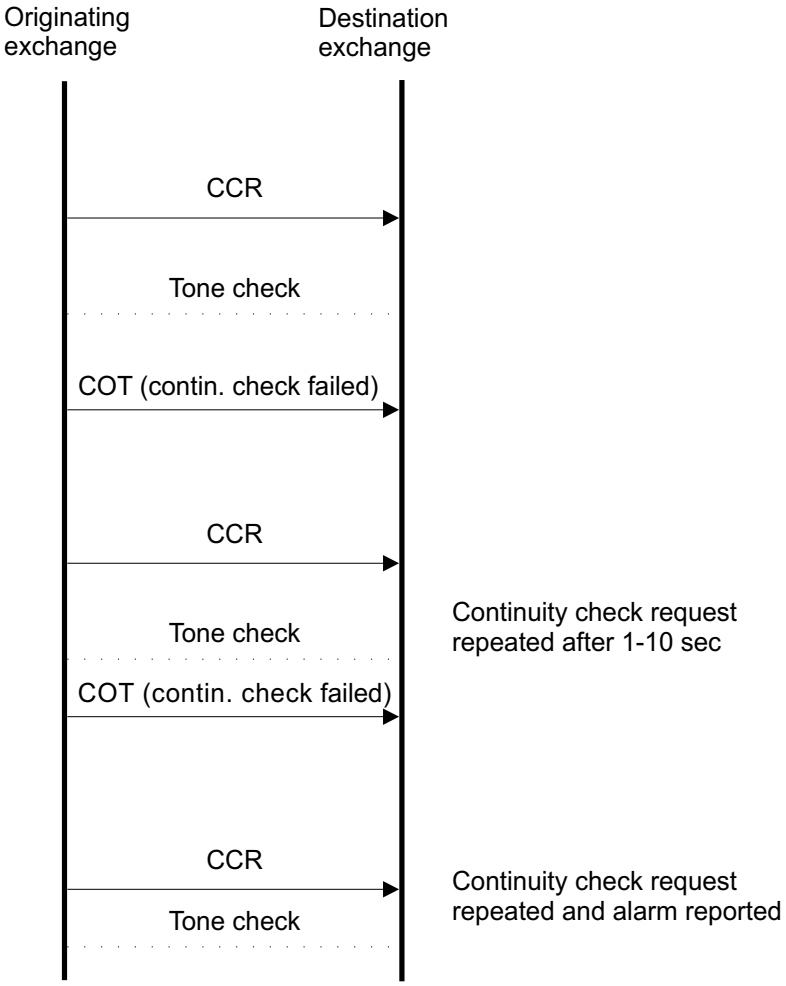

Figure 20: *Continuity check failed on free circuit*

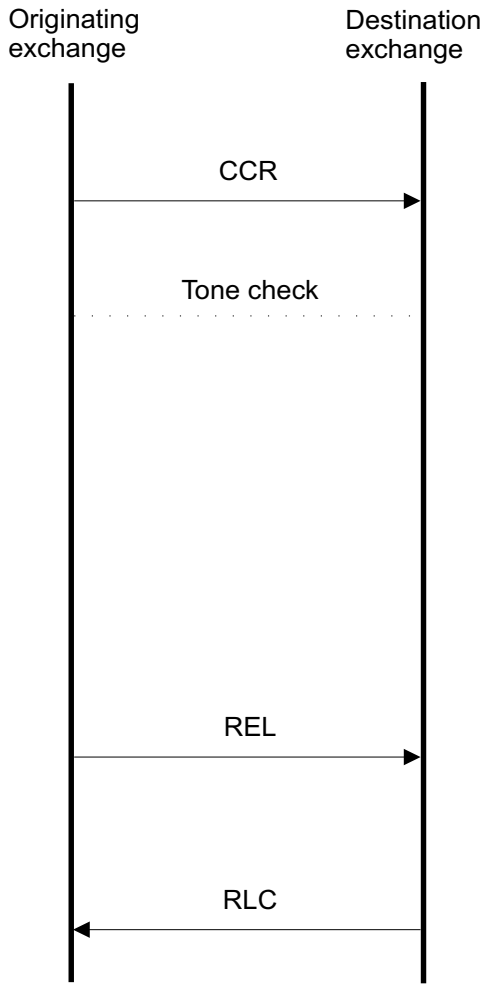

Figure 21: *Successful continuity check on free circuit*

2.15 Circuit reset procedure

In case of irregular state occurred, the circuit that is free or seized for a call must be reset, that is, released on both ends, so that it gets available for new calls.

2.15.1 Circuit reset

Reset circuit message - RSC

Message is sent to release the circuit not free for any reason. It is also sent during the call as a response to received unexpected messages (e.g. SUS received after IAM). If the circuit is remote blocked on the reception end, RSC message reception causes blocking state to be removed. Message has no other parameters, except the message type.

Circuit reset procedure

If it is required to reset a small number of circuits, RSC message is sent separately for each circuit that the interference was reported at.

On reception of RSC message, following is performed:

- after circuit release, RLC message is sent as a response, if the incoming or outgoing call is in the phase of set-up;
- RLC is sent as a response, if the circuit is free;
- had BLO message been previously sent, or circuit cannot be released, BLO message is sent as a response. If an outgoing or incoming connection is in process, it is cleared, circuits are released (or blocked) and REL or RLC message is sent. If the circuit remains blocked, BLO is sent and should be confirmed by a remote exchange. If BLA message is not received, procedure described in trunk blocking chapter (2.12.4) will be repeated;
- had BLO message been received previously, established connections are cleared and unblocked and circuits are released. If the outgoing connection is in process still, REL is sent as a response, and RLC in all other cases;
- on RSC message received after IAM message sending, and message backwards not yet received, circuit is released and connection set-up attempt is repeated automatically by another circuit, if available (figure 22);
- if RSC message is received after RSC message was sent, RLC message is sent as a response and circuit returns into traffic;
- corresponding messages are sent to connected circuits for their release (e.g REL message).

If RSC message was sent after acknowledgement reception (RLC message), circuit is released and a response is sent as usual. For example, RLC is sent as a response to message REL, and BLA is a response to BLO.

Circuit in the connection are released with appropriate messages. If there is no acknowledgement for RSC message reception after 15-60 seconds, RSC message will be sent again. If the acknowledgement for RSC message reception is not received in 5-15 minutes after first RSC message was sent, alarm is reported. RSC message sending is continued in 5-15 minute intervals, until RLC is received as an answer or the operator performing some actions.

2.15.2 Circuit group reset

Circuit group reset message GRS

Message is sent to release a circuit group that remained busy for some reason. If any of circuits in the marked group on the reception end is remote blocked, message reception should cancel blocking state. Message contains a mandatory parameter of variable length - *range and status*.

Group reset acknowledgment GRA

Message is sent as a response to GRS message and indicates that the requested circuit group is reset (released for new calls). This message also indicates blocking state for each circuit, which is necessary for maintenance. Message contains two mandatory variable parameters *range and status* and *circuit state indicator*.

Circuit group reset procedure

If it comes to the problem on a larger number of circuits or all circuits GRS message is used to connect the circuits into traffic.

Following actions should be performed after reception of GRS message:

- releasing the circuits the message refers to;
- sending corresponding circuit group blocking message if CGB message was previously sent, for hardware irregularity;
- sending GRA message as a response, with circuit state indicator bits (of circuits not blocked for maintenance) set to 0 (are available for operation or blocked because of electronic equipment error), and state indicator bits for circuits blocked for maintenance are set to 1;
- had BLO or CGB message been previously received, circuits are unblocked and returned to traffic;
- if GRS message is received after GRS or RSC message sending, all circuits are returned to traffic, both those it was received for and those for which GRS or RSC message was sent for;
- corresponding messages or circuit release are sent to connected circuits.

Having GRS message sent, after reception of GRA message, circuits are released for new calls. Had CGB messages been received, response message is as usual.

Had GRA message not been received in 15-60 seconds, GRS sending is repeated twice. If GRA message was not received in 5-15 minutes after first GRS was sent, alarm is reported. GRS message sending will be continued in 5-15 minute intervals all until GRA is received or the operator has reacted.

Regular GRA message should correspond with original GRS message in range and CIC contained in label. CIC in both message labels must belong to circuits controlled by ISDN user part.

2.15.3 Circuit group reset irregular procedures

When GRS message is received indicating to reset of more than allowed number of circuits, message is ignored.

If GRA is received that is not a regular response to send GRS, message is ignored.

On reception of GRS message requiring reset of circuit group not controlled by ISDN user part, or GRA message containing circuit identification codes not controlled by ISDN user part, message is ignored.

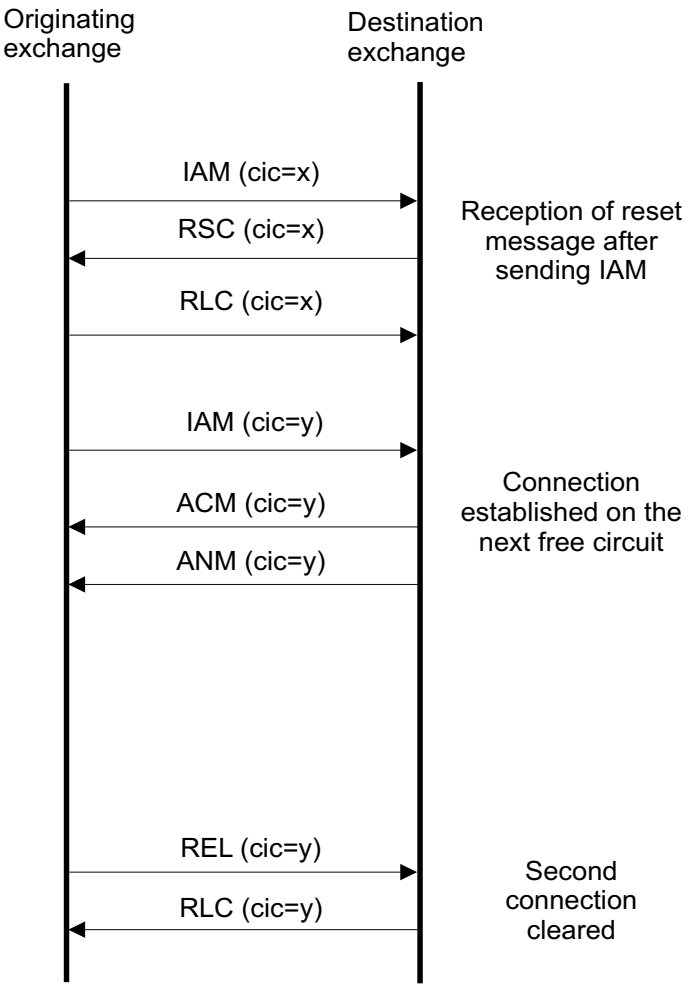

Figure 22: *Automatic repeat attempt on reception of reset message*

2.16 Reception of unexpected signalling information

2.16.1 General notes

MTP avoids disposition errors or repeating the messages with a high level of safety. However, undetected errors or exchange malfunction may cause the information in signalling messages irregular or inappropriate.

Ambiguous information or messages might be also received as a result of different level of the same network signalling protocol. The exchange using an advanced protocol version may send certain information to the exchange with less enhanced version of protocol, so the information remain apart of protocol defined in the exchange.

Procedures mentioned do not include procedures for circuit blocking, circuit group blocking and circuit group reset.

Following are considered message format errors:

- Message length less than the number of octets necessary for fixed mandatory part, mandatory variable part pointers and an optional parameter beginning pointer.
- mandatory variable part pointer or optional part pointer pointing to the out of the message end.
- Length indicator of mandatory variable part or optional parameters causing the total message length being exceeded.

Had message format error been detected, message is ignored.

2.16.2 Processing of unexpected messages

Unexpected messages are those with a message type supported by SRCE system, but is not expected to be received in a particular call processing state. To solve such problems, following procedure is applied:

- REL message received for circuit in *idle* state is confirmed with RLC message;
- RLC message received for circuits in *idle* state is ignored;
- If RLC message is received for *busy* circuit for which REL message hasn't been sent, circuit is released and REL message sent;
- Had any other unexpected signalling message been received in *idle* state, RSC message is sent;
- If any other unexpected signalling message was received for circuit seized with a call and on reception of backward messages necessary for call establishment (ACM, CON...), unexpected signalling message is ignored;

If any other unexpected signalling message was received for the circuit seized by a call, before the reception of backward messages necessary for call establishment (ACM, CON...), RSC message is sent. If circuit is seized with an outgoing call, call is automatically repeated by another circuit (figure 23);

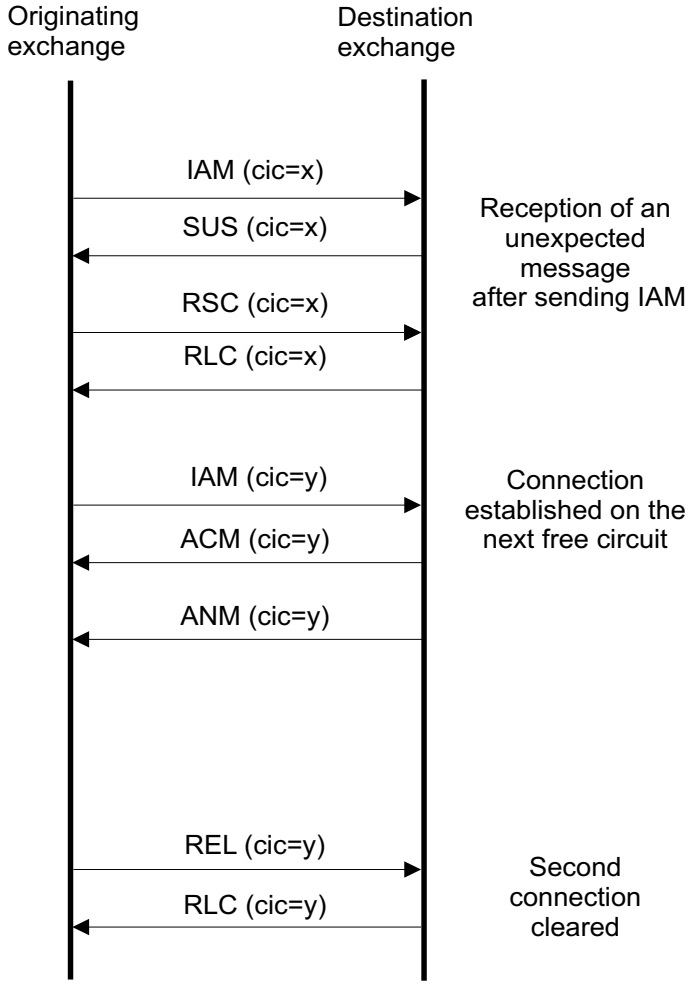

Figure 23: *Automatic repeat attempt in unexpected message reception circumstances*

2.17 Unrecognized signalling information reception (compatibility procedure

2.17.1 General notes

Had No.7 signalling system been up-graded, some of network exchanges may receive some unrecognized signalling information. Following are considered unrecognized signalling information: unrecognized message, unrecognized parameter or unrecognized parameter value. In case of unrecognized signalling information reception, compatibility procedure is started to provide a "predictable" network operation.

ISDN user part in SRCE system guarantees version compatibility, starting from 1992 year version. This practically means that any two versions may be indirectly connected with all following features satisfied:

- Protocol compatibility - a call between two ISDN user parts won't fail for reasons of protocol requests that cannot be satisfied.
- Compatibility of services and functions - this feature relates to originating and destination exchange. Services and functions implemented at the originating and destination exchange, but maybe not yet in transit exchanges, are supported, meaning that transit exchanges transfer all required parameters and requests.
- Control of resources and management compatibility - if a correct processing is not possible for any reason, system provides acknowledgements backwards relating to the problems that arise.
- Compatibility mechanism enables connecting of different versions of ISDN user parts or, two networks with mutually different functional levels, or connection of networks using different subsets of the same ISDN user part. Mechanism is based on forward sending of compatibility information. These information are sent in parameter containing message compatibility information and parameter with parameter compatibility information. All parameters that were not included in *Blue Book Recommendations 1988* are implemented using optional parts of ISUP messages.
- SRCE covers messages and parameters listed in table 4 and table 5, and these will be correctly recognized. Messages and parameters not included in this tables are subject to compatibility mechanisms.

Compatibility information contain different information for different exchange types. There are two exchange types: type A and type B. A type exchanges are:

- originating exchanges, where call is established, as considered by national public network;
- destination exchanges, to which a call is sent as considered by national public network;

- exchanges with interworking between ISDN user part and other signalling systems.

B type exchanges are transit exchanges.
All unrecognized messages that may be received contain only parameters coded as optional parameters. No new message would include mandatory fixed or mandatory variable parameters.

2.17.2 Confusion message CFN

Message is sent as a response to any message different from CFN not recognized by SRCE or in case that a part of message (parameter or parameter value) is unrecognizable. It contains mandatory variable parameter *cause value(2.13.1)*.

2.17.3 Processing of unrecognized messages

Message compatibility information
Parameter informs the exchange receiving the message with the unrecognized parameter, what to do with the message. Information is contained in following indicators:

- Transit indicator (bit A in first parameter octet);
- Connection release indicator (bit B in first parameter octet);
- Acknowledgement sending indicator (bit C in first parameter octet);
- Message discard parameter (bit D in first parameter octet);
- Action indicator in situation when message cannot be forwarded (1, to discard the message or 0 to clear the connection, bit E in first parameter octet);
- Continue indicator (0-there is a following octet, 1-last octet, bit H in all parameter octets),
- Indicators with additional command (defined when required and stored from the second octet).

Unrecognized message processing procedure
On reception of an unrecognized message, it should be determined whether the message contains *parameter with message compatibility information*. If the unrecognized message does not contain *message compatibility parameter*, it is ignored and CFN message is sent. In case the unrecognized message contains *message compatibility parameter*, indicators found within the parameter are tested. Before further actions are performed, it is determined whether the call is outgoing, incoming or transit one:

- If it's transit (B type exchange) *transit indicator* is viewed. If it is set to 0, other indicators are ignored and the unrecognized message is forwarded further unchanged. In case of transit call and *transit indicator* equal to 1, other indicators are tested.

- If a call is not transit (A type exchange), all indicators, except the *transit indicator*, are always analized.

In case of other command indicators tested, procedure is following:

- If *connection release indicator* is set, call is released.
- If *connection release indicator* is not set and *message discard indicator* is, message is ignored.
- If no *connection release indicator* is set, but there is *acknowledgement sending indicator* set, CFN message is sent to the exchange that the unrecognized message was sent from.
- If no *connection release and message discard indicators* were set, message is forwarded unchanged.
- Had the message forwarding failed, the contents of *indicators of action for message forwarding not possible* are tested. There is a possibility of connection release or message discard. *Acknowledgement sending indicator* (CFN) is also tested.

Command indicators			***Required action***
B	C	D	
0	0	0	Transfer message
0	0	1	Discard message
0	1	0	Transfer message and don't send notification
0	1	1	Discard message and send notification
1	X	X	Release call
	Bit		B Connection release indicator
			0 Do not release the call
			1 Release call
	Bit		C Sending indicator
			0 Do not send notification
			1 Send notification
	Bit		D Message discard indicator
			0 Do not discard message, transfer it
			1 Discard message

Table 6: *Operations on reception of message compatibility information parameter*

2.17.4 Unrecognized parameter processing

Parameter compatibility information

Parameter contains following indicators for each unrecognized parameter included in compatibility procedure message:

- Transit indicator (bit *A* in the first octet of unrecognized parameter indicator);
- Connection release indicator (bit *B* in the first octet of unrecognized parameter indicator);
- Acknowledgement sending indicator (bit *C* in the first octet of unrecognized parameter indicator);
- message discard indicator (bit *D* in the first octet of unrecognized parameter indicator);
- parameter discard indicator (bit *E* in the first octet of unrecognized parameter indicator);
- Action indicator in case when parameter forwarding is not possible (00 to clear the connection, 01 to discard the message or 10 to discard the parameter, *GF* bits in the first octet of unrecognized parameter indicator);
- Continue indicator (0-there are following octets, 1-last octet, bit *H* in all parameter octets),
- Indicators with additional commands (defined when required and stored from the second octet of unrecognized parameter indicator).

Processing procedure of unrecognized parameter reception

On reception of an unrecognized message parameter, it is tested whether the message contains *parameter compatibility information*. If the received message does not contain *parameter compatibility information*, unrecognized parameter is ignored. If the received message contains *parameter compatibility information*, indicators found in this parameter are tested. Before any further actions are taken, it is determined whether the call is outgoing, incoming or transit:

- If it's transit (B type exchange) *transit indicator* is viewed. If it's set to 0, other indicators are ignored and the unrecognized parameter is forwarded further unchanged.
- If the call is transit (B type exchange) and *transit indicator* is set to 1, other indicators are tested.
- If the call isn't a transit one (A type exchange) all indicators, except *transit indicator*, are always analized.

In case all other unrecognized parameter indicators are tested, procedure is following:

- Had *connection release indicator* been set, call is released.

- If *connection release indicator* is not and *message discard indicator* is set, message is ignored. This is performed in case the exchange sending the unrecognized information considers unacceptable to process the message further without these parameters.
- If no *connection release indicator* is set and there is *parameter discard indicator* set, parameter is ignored.
- If no *connection release indicator* is set, and *notification sending indicator* is set, CFN message is sent to the exchange the unrecognized parameter was sent from.
- Had *connection release and message/parameter discard indicators* not been set, parameter is forwarded unchanged.
- In case parameter forwarding fails, *indicators of action for message forwarding not possible* is tested. There is a possibility of connection release, message or parameter ignoring. In this case also *notification sending indicator* is tested.

Command indicators				***Required action***
B	C	D	E	
0	0	0	0	Transfer parameter
0	0	0	1	Discard parameter
0	0	1	0	Discard message
0	0	1	1	Discard message
0	1	0	0	Transfer parameter (don't send notification)
0	1	0	1	Discard parameter and send notification
0	1	1	0	Discard the message and send notification
0	1	1	1	Discard message and send notification
1	X	X	X	Release call
		Bit		B Connection release indicator
				0 Do not release the call
				1 Release call
		Bit		C Send notification indicator
				0 Don't send notification
				1 Send notification
		Bit		D Discard message indicator
				0 Don't discard message, transfer it
				1 Discard message
		Bit		E Discard parameter indicator
				0 Don't discard parameter, transfer it
				1 Discard parameter

Table 7: *Operations on reception of parameter compatibility information parameter*

In case a particular message is used for more than one compatibility procedure at the same time and compatibility information indicators are different in one parameter, indicators are set to most strict coding combination. Any unrecognized parameters received in CFN, FARJ or RLC message are ignored. If any unrecognized value of mandatory parameter is received in CFN or FARJ message, message will be ignored.

2.18 Fallback procedure

2.18.1 Parameters related to Fallback procedure

Transmission medium requirement

Parameter is mandatory and contained only in IAM message. Parameter coding mode is given in *Q.763 § 3.54*.

Transmission medium requirement prime

Parameter is optional and may be contained only in IAM. Parameter coding mode is described in *Q.763 § 3.55*.

Transmission medium used

Parameter is optional, containing one octet and may be included in messages in direction opposite to direction of connection establishment, ACM, ANM, CPG or CON. It is coded as *Transmission medium requirement prime* parameter.

User service information

Parameter is optional and may be contained only in IAM. Parameter coding process is defined in *Q.763 § 3.57*. Parameter contains information on transmission possibilities.

User service information prime

Parameter is optional and possibly contained only in IAM. It is coded same as the previous parameter mentioned.

2.18.2 Actions in direction of connection establishment

In the outgoing call establishment, parameter *transmission medium requirement* in IAM message is always coded as "*speech*" (0).

In transit call, when *transmission medium requirement* parameter value "64 kbit/s unrestricted preferred" was received, the parameter is forwarded unchanged. Other parameters forwarded are: *Transmission medium requirement prime* containing message type that would be used in case Fallback procedure, *user service information* containing a possibility of the information transmission in case of Fallback procedure and *user service information prime* including required possibility of the information transmission. During transmission of this information, it is not checked whether subsequent exchange supports Fallback procedure or not (see figures *D1-D6/Q764 Annex D*).

2.18.3 Actions in direction opposite to direction of connection establishment

In the incoming call, with analog subscriber called, Fallback procedure is applied. Parameter *Transmission medium used* is included in ACM and has the value of *transmission medium requirement prime* parameter received in IAM.

As concerning transit call, if parameter *transmission medium used* is received from subsequent exchange in ACM, CPG, CON or ANM message, it indicates the Fallback procedure applied and is forwarded unchanged. In case that *transmission medium used* parameter was not received in any of these messages, it is considered that the subsequent exchange does not support Fallback procedure and this parameter is sent in ANM or CON message, coded as "*speech*" (see figures *D1-D6/Q764 Annex D*).

2.19 Propagation delay determination procedure

2.19.1 Propagation delay counter

Parameter may be found only as an optional one in IAM. It contains propagation delay value in milliseconds. This value is accumulated during call establishing. Delay is contained in two octets.

2.19.2 Call history information parameter

Parameter contains propagation delay value in milliseconds for one call. This parameter is always an optional one and is sent in ANM, CPG or CON message, provided the exchange supports propagation delay procedure.

2.19.3 Procedure

Procedure of propagation delay determination should determine a total value of propagation delay in milliseconds for one call. Delay information accumulate during call establishment. Results are sent in parameter *call history information* (2.19.2).

In the outgoing call, parameter *propagation delay* is always included in IAM. Depending on selected route towards subsequent exchange, delay increases for delay value of a selected route. On reception of *call history information* in ANM or CON message, delay value is saved to the end of a call.

In transit call, after IAM was received, a route is selected to send IAM to subsequent exchange. Depending on selected route value, *propagation delay* parameter value increases for corresponding value. IAM message sent to subsequent exchange contains a new value of propagation delay.

Transit parameter *call history information* in transit call received in ANM or CON message is forwarded in the same messages, unchanged.

In the incoming call, received propagation delay value in IAM message is increased for delay value in the access to a called subscriber. This value is included in ANM message and is found in parameter *call history information*. Delay value is kept to the end of the call. It may be determined, based on called subscriber address received in IAM, that a call is further forwarded by signalling other than No.7 signalling, in which case same actions described for the incoming call are applied.

Had the call been received from the exchange not supporting the procedure of propagation delay specification, delay is set to 0 and further actions taken are those applied for the outgoing call.

If ANM or CON message are received without parameter *call history information*, there are no special actions. Messages are forwarded further without this parameter.

2.20 ISDN user part accessability control

On reception of *MTP-STATUS* command from level 3, with "unavailable remote user" note, relating to a remote signalling point, ISUP is marked unaccessible for that signalling point and ISUP accessibility testing procedure is started.

Testing procedure is started with UPT (*User Part Test Message*) message sending and initiating of time out T4 (5-15 minutes). During T4, response to UPT message is expected. Remote signalling point should respond to UPT message with message UPA (*User Part Available*) provided ISUP became available in the meantime.

On T4 expiry, UPT message sending is continued.

ISUP on a remote signalling point is considered available if a UPA message is received as an answer to UPT, or any other ISUP message. In both cases, T4 is stopped and traffic is reestablished.

MTP-STATUS command is ignored in case it was received from level 3 while T4 was still in effect.

2.21 Automatic congestion control

2.21.1 Automatic congestion level parameter

Automatic congestion level value may be:

- 0000 0000 reserve
- 0000 0001 first degree of congestion
- 0000 0010 second degree of congestion

This parameter may be contained only in REL message after the exchange has confirmed ISUP user part congestion.

2.21.2 Congestion control

Automatic congestion control is used in state of the exchange congestion. Two congestion levels are possible.

For both levels, parameter *automatic congestion level* is added in each REL message sent. This way congestion level in SRCE system is acknowledged for contiguous signalling points. On reception of this parameter in REL message, remote signalling points should decrease the traffic.

On congestion terminated, parameter *automatic congestion level* is no longer included in REL message and regular traffic is established.

On reception of REL message with parameter *automatic level congestion*, depending on congestion level received in parameter, traffic toward signalling point the message was received from is decreased.

Traffic is decreased with *call gapping*. If *congestion level 1* is received in REL message, approximately 50% of calls routed toward signalling point that has reported congestion on ISUP is discarded, and in case of *congestion level 2*, around 80% of calls is discarded.

On reception of REL message without parameter *automatic level congestion* from a contiguous signalling point , regular traffic is reestablished.

2.22 MTP-PAUSE/RESUME

On command *MTP-PAUSE* received from level 3 for particular signalling point, all circuits toward this point are blocked for new calls. Current calls are not released, except if messages cannot be sent to this destination.

On command *MTP-RESUME* received from level 3 for particular signalling point, the circuits already in state *idle* may be immediately used for new calls.

Provided that the signalling point that one of these commands is received for has no ISDN user part, there will be no further actions.

3 Abbreviations

ACM - Address Complete
ANM - Answer
BLO - Blocking
BLA - Blocking acknowledgment
CPG - Call progress
CGB - Circuit group blocking
CGBA - Circuit group blocking acknowledgment
CQM - Circuit group query message
CQR - Circuit group query response
GRS - Circuit group reset
GRA - Circuit group reset acknowledgment
CGU - Circuit group unblocking
CGUA - Circuit group unblocking acknowledgment
CRG - Charge information
CFN - Confusion
CON - Connect
COT - Continuity
CCR - Continuity check request
IDR - Identification request
IRS - Identification response
INF - Information
INR - Information request
ISDN - Integrated Services Digital Network
ISUP - ISDN User Part
IAM - Initial address message
MTP - Message Transfer Part
OPR - Operator message
REL - Release
RLC - Release complete
RSC - Reset circuit
RES - Resume
SGM - Segmentation
SAM - Subsequent address message
SUS - Suspend
UBL - Unblocking
UBA - Unblocking acknowledgment
UPA - User part available
UPT - User part test
VK - Time out