ETSI/TC SMG
Released by : ETSI/PT 12
Release date: February 1992

RELEASE NOTE

Recommendation GSM 03.09

Handover Procedures

Previously distributed version : 3.2.0 (Updated Release 1/90)
New Released version February 92 : 3.2.1 (Release 92, Phase 1)

1. Reason for changes

Only pagenumbering/layout/etc. has been changed since the previously distributed version.

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ETSI-GSM
Technical
Specification

GSM 03.09

Version 3.2.1

UDC: 621.396.21

Key words: European Digital Cellular Telecommunications System, Global System for Mobile Communications (GSM)

European digital cellular telecommunication system (phase 1);

Handover Procedures

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PREFATORY NOTE

ETSI has constituted stable and consistent documents which give specifications for the implementation of the European Cellular Telecommunications System. Historically, these documents have been identified as "GSM recommendations".

Some of these recommendations may subsequently become Interim European Telecommunications Standards (I-ETSs) or European Telecommunications Standards (ETSs), whilst some continue with the status of ETSI-GSM Technical Specifications. These ETSI-GSM Technical Specifications are for editorial reasons still referred to as GSM recommendations in some current GSM documents.

The numbering and version control system is the same for ETSI-GSM Technical Specifications as for "GSM recommendations".

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1. SCOPE

This recommendation contains a detailed description of handover procedures to be used in PLMNs.

The following cases are considered:

i) handover between radio channels of the same base station. This capability is used in the following situations:

- when the radio channel carrying the call is subject to interference or other disturbances;

- when a radio channel or channel equipment carrying a call has to be taken out of service for maintenance or other reasons.

ii) handover between base stations of the same MSC in order to ensure continuity of the connection when an MS moves from one BS area to another.

iii) handover between bases stations of different MSCs of the same PLMN in order to ensure continuity of the connection when an MS moves from a BS area of one MSC to a BS area of another MSC.

The same procedures can be used on the radio path for all three cases.

Cases i) and ii) involve only one MSC.

Note 1: Case i) may not involve the MSC if the BS contains switching facilities.

Case iii) involves more than one MSC. For this case two procedures are defined requiring the use of the mobile application part:

a) basic handover procedure where the call is handed over from the controlling MSC (MSC-A) to another MSC (MSC-B).

b) subsequent handover procedure where the call is handed over from MSC-B to MSC-A or from MSC-B to a third MSC (MSC-B').

The procedures in the mobile application part for supporting handover are specified in recommendation GSM 09.02.

In the following, the controlling MSC will be referred to as MSC-A also when the handover only involves this MSC (cases i) and ii) above). For case iii), the controlling MSC (MSC-A) is the MSC on which the call was originally established.

All MSCs shall be capable of acting as MSC-A and MSC-B.

The splitting of functions between BS and MSC is given in the 08 series of GSM recommendations.

Inter-MSC hand-over will impose a few limitations for the first operational system. After inter-MSC hand-over:

- ciphering cannot be initiated
- channel assignment cannot be performed
  - alternate services (in-call modification) is not supported
  - call reestablishment is not supported

2. FUNCTIONAL COMPOSITION OF MSCs AND INTERFACES FOR HANDOVER

2.1. MSC-A

For handover the controlling MSC can be regarded as being composed of functional units as shown in figure 1.

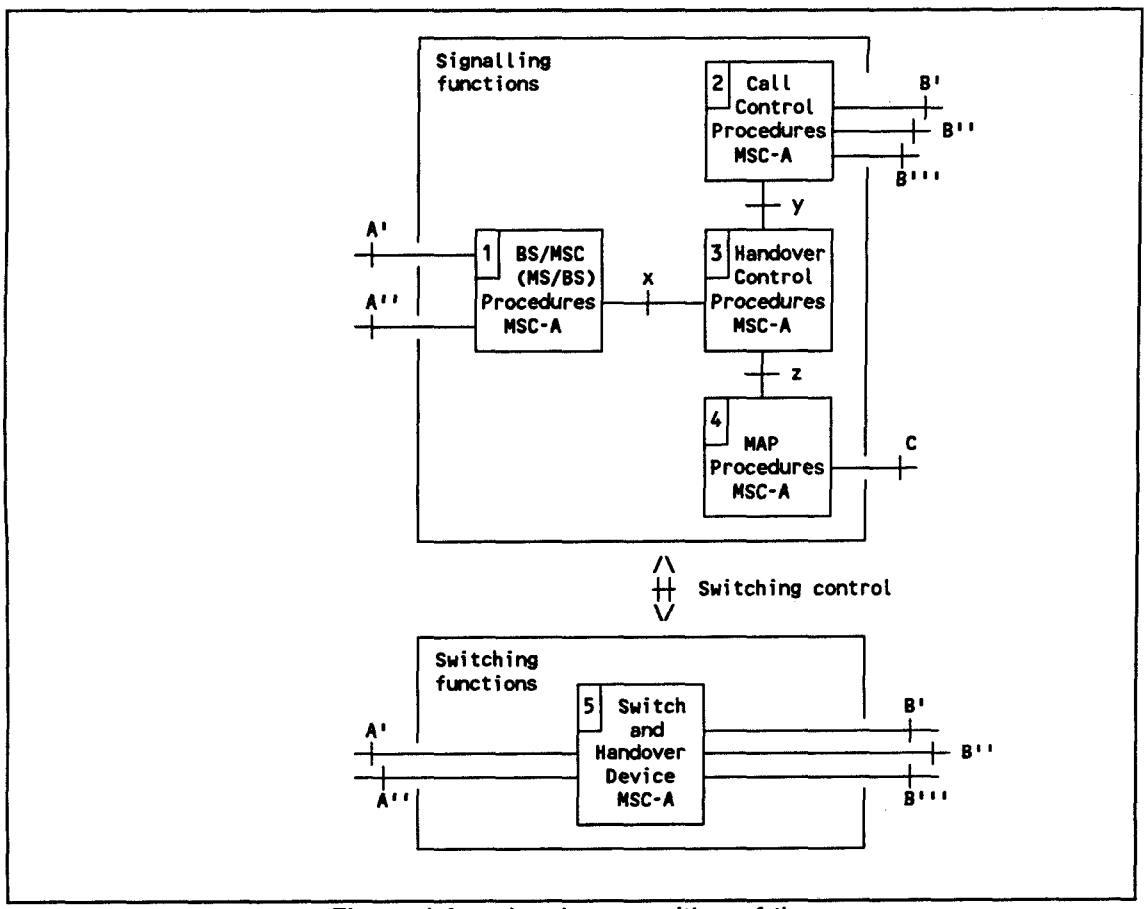


Figure 1 functional composition of the controlling MSC (MSC-A) for supporting handover.

Signalling functions

1) the BS/MSC (MS/BS) procedures MSC-A for signalling between the MSC and the BS and between the MSC and the MS. The functional unit interfaces the BSs through interfaces A' (to the previous BS) and, for case ii), also through interface A" (to the new BS). Interworking with other functional units takes place through the internal interface x.

2) the call control procedures MSC-A for normal call control functions (interface B') and for signalling and call control of connections to other MSCs (interfaces B" and B"'). Interfaces B" and B"' apply only to handover case iii) where interface B"' is required for subsequent handover.

3) the handover control procedures MSC-A for overall control of the handover including interworking with other functional units (interfaces x, y and z).

4) the MAP procedures MSC-A for information exchange with other MSCs and location registers. This function is required for handover case iii). The external interface is interface C and the internal interface to the handover control functions is interface z. Interface C represents the interface to all entities with which MSC-A is communicating during handover (other MSCs, location registers).

Switching functions

5) the switch and handover device MSC-A for connecting the new path. This function is additional to normal switching functions in the MSC. The handover device has interfaces to the previous BS (interface A') and the new BS (interface A") for handover case ii). Interface B' represents the original connection with the fixed network and interface B" represents the new connection to an MSC-B for handover between MSCs (case iii)). Interface B"' represents the connection to a third MSC (MSC-B') for subsequent handover from MSC-B to MSC-B'. The connections which can exist in the handover device are shown in Figure 2.

The connection via interface A' is released after completion of a successful handover (figure 2 a) and b)).

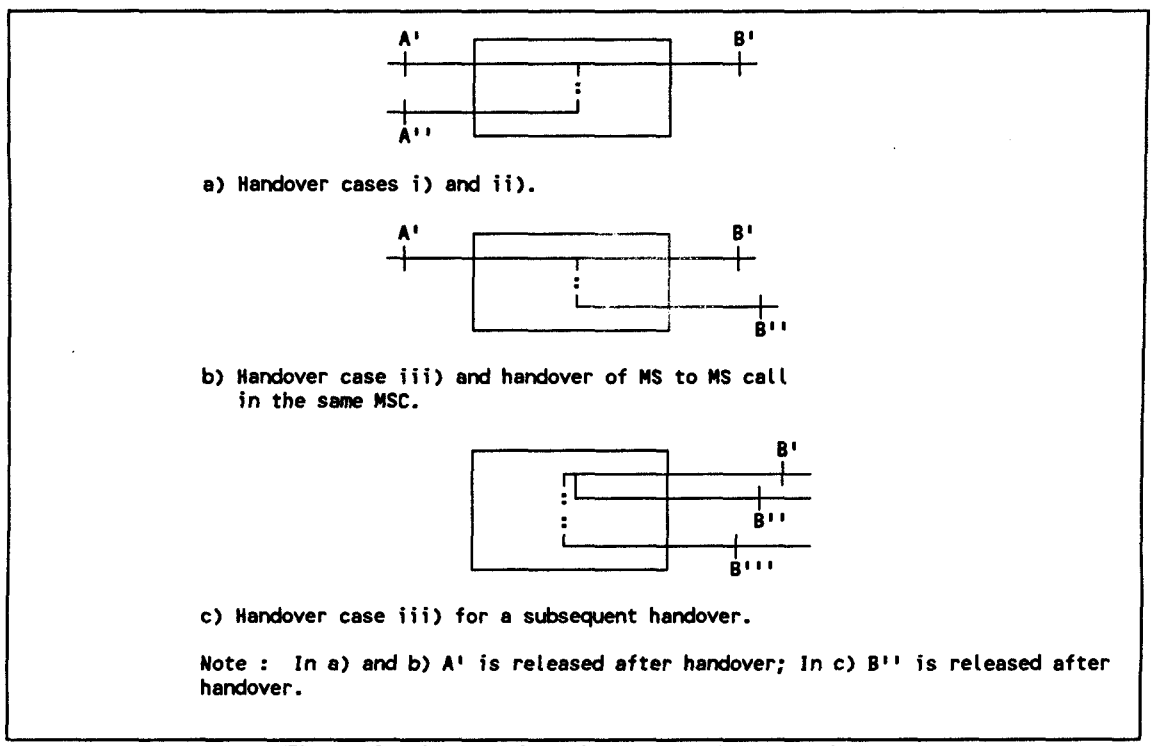
For MS to MS calls in the same MSC the configuration in Figure 2b) applies. Then interface B" is not to another MSC but internal to MSC-A.

The handover device can either be a three-party bridge or a switching facility without three-party connection capabilities. For a three-party bridge configuration the states of the handover device are as shown in Table 1. The three-party configuration exists in the intermediate state. This type of handover device may reduce the interruption time. However, this may require noise reduction if one of the radio channels is unterminated at some time in the intermediate state.

For a handover device consisting of a simple switch there will be no intermediate state.

Table 1 - States of the handover device

Case	Initial Connection	Intermediate Connection	Resulting Connection	
			Successful Procedure	Unsuccessful Procedure
Fig 2a)	B' to A'	B' to A' and A''	B' to A''	B' to A'
Fig 2b)	B' to A'	B' to A' and B''	B' to B''	B' to A'
Fig 2c)	B' to B''	B' to B''and B'' '	B' to B'''	B' to B''



a) Handover cases i) and ii).

b) Handover case iii) and handover of MS to MS call in the same MSC.

c) Handover case iii) for a subsequent handover.

Note : In a) and b) A' is released after handover; In c) B'' is released after handover.

Figure 2 - Connections in the handover device

2.2. MSC-B

The functional composition of an MSC acting as MSC-B is essentially the same as that of MSC-A. However, there are some differences. The functional units are as follows (see figure 3):

Signalling functions

1) the BS/MSC (MS/BS) procedures MSC-B for signalling between the MSC and the new BS and between the MSC and the MS (interface A").

2) the call control procedures MSC-B for normal call control functions and for signalling between MSC-A and MSC-B.

3) the handover control procedures MSC-B for control of the handover in MSC-B.

4) the MAP procedures MSC-B for information exchange with MSC-A and the VLR of MSC-B.

Switching functions

5) the switch MSC-B for connecting the circuit from MSC-A (interface B") to the circuit to the BS (interface A").

MSC-B will also require a handover device for subsequent handovers to BSs (or to another channel of the same BS) in the MSC area of MSC-B. Subsequent handovers to other MSCs will not require switching in MSC-B, see below.

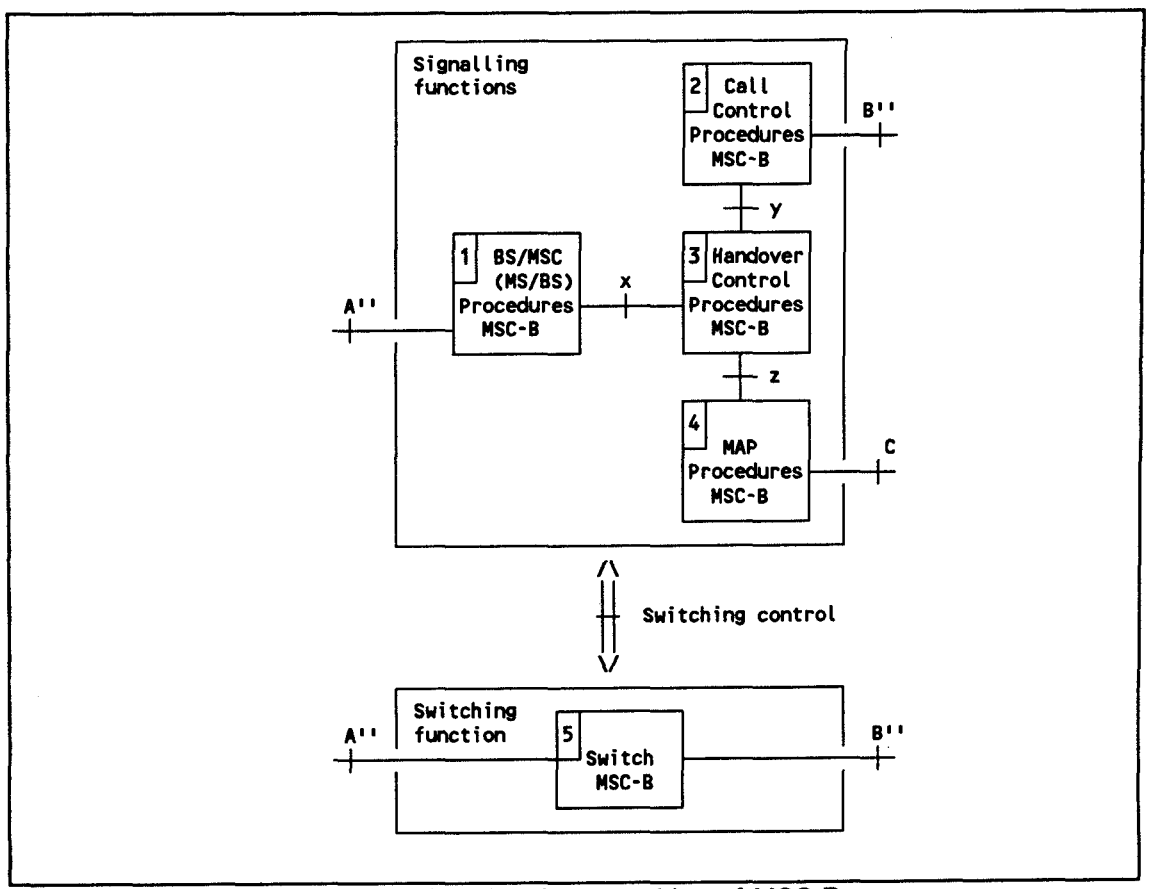


Figure 3 Functional composition of MSC-B for supporting handover.

3. INITIATION

Handover is stimulated by the network based on radio subsystem criteria (RF level, quality, distance) as well as network directed criteria (e.g. current traffic loading per cell, maintenance requests, etc.).

Neighbouring cell measurements to search for alternative BSs are done by the MS. These measurements are reported by the MS to the serving BS on a regular basis. When the network realises a need for handover, the procedures given in recommendation GSM 08.08 are followed.

The handover decision is taken by the network, taking into account both the measurement results from the MS and network directed criteria.

4. GENERAL DESCRIPTION OF THE PROCEDURES FOR HANDOVER TO ANOTHER MSC

4.1. Basic handover procedure

The procedure which takes place after initiation, i.e. after the identity of the new BS has been determined, is shown in figure 4 for a successful handover. The procedure makes use of messages of the Mobile Application Part (MAP) of recommendation GSM 09.02.

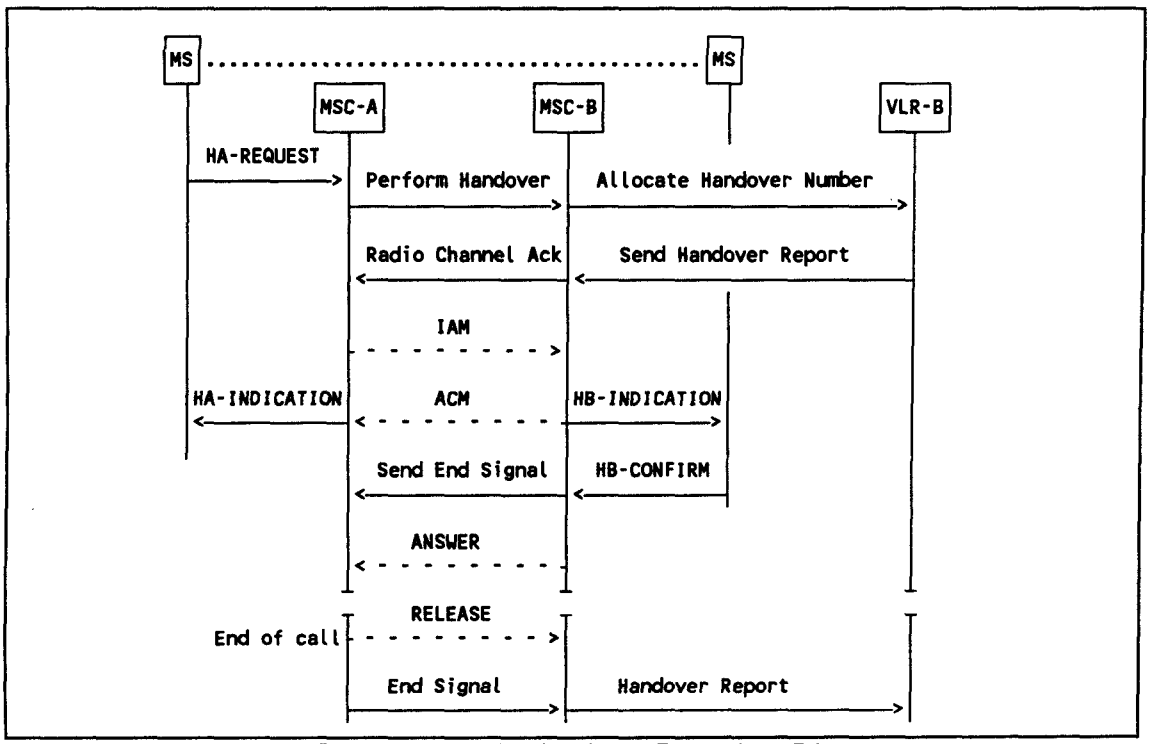


Figure 4 - Basic Handover Procedure.PA

First MSC-A sends a perform handover message to MSC-B. The message will contain all parameters needed by MSC-B for allocating a radio channel, see recommendation GSM 09.02. The message will also identify the BS to which the call is to be handed over. MSC-B will return the radio channel acknowledge message after having either allocated a handover number or retrieved it from its associated VLR (exchange of the messages allocate handover number and send handover report) - see note 1. The roaming number is to be used for routing the call from MSC-A to MSC-B. If a traffic channel is available in MSC-B the radio channel acknowledge message will contain the identity of the new radio channel and the mobile station roaming number. Other parameters may also be included, see recommendation GSM 09.02.

Note 1: For completeness, the case where the handover number is retrieved from the VLR is included in the remainder of this recommendation. If the handover number is allocated by MSC-B, then the operation

between MSC-B and its associated VLR is not required. The implementation of either of these solutions is a national matter.

If there is no free traffic channel in MSC-B, this will be indicated to MSC-A and MSC-A will terminate the handover procedure. The existing connection to the MS will not be cleared.

When the radio channel acknowledge message has been received, MSC-A establishes a connection between MSC-A and MSC-B by signalling procedures supported by the network to which MSC-A is connected, see note 2. In figure 4 this is illustrated by the messages IAM (Initiated Address Message) and ACM (Address Complete Message) of Signalling System no 7. MSC-B initiates the handover procedure on the radio path when the ACM is sent and MSC-A initiates the handover procedure when ACM is received (illustrated by HB- and HA-INDICATION, respectively).

Note 2: Dedicated circuits can be used for establishment of connections to be used for inter-MSC handover. The network case is described in the remainder of this recommendation.

The connection is through-connected in MSC-A by use of a handover device. The through-connection is done and the old radio channel is released when the send end signal message is received from MSC-B. MSC-B sends this message when it receives an acknowledgement from the MS (HB-CONFIRM).

In order not to conflict with the PSTN/ISDN signalling system(s) used between MSC-A and MSC-B, MSC-B must generate an answer signal when HB-CONFIRM is received.

If the connection between MSC-A and MSC-B cannot be established (e.g. an unsuccessful backward message is received instead of ACM), MSC-A terminates the procedure without clearing the radio path.

MSC-A will have the overall call control until the call is cleared by the fixed subscriber or the MS and there is no further call control functions to be performed (e.g. servicing waiting calls). MSC-A then releases the connection to MSC-B and also sends an end signal message which terminates the MAP procedure. When receiving this message MSC-B will release all call control functions and send the message handover report to its VLR.

MSC-A may terminate the procedure at any time by sending the MAP message handover cancellation to MSC-B. If establishment of the physical connection between MSC-A and MSC-B has been initiated, the physical connection must also be cleared by procedures defined for the signalling system used between MSC-A and the fixed network. The VLR of MSC-B is also informed by using the handover report message.

The handover cancellation message is sent when MSC-A detects clearing or interruption of the radio path before the call has been established on MSC-B. The message is also sent in order to terminate the MAP procedure in MSC-B when it is not possible to establish a connection between MSC-A and MSC-B.

4.2. Procedure for subsequent handover

When an MS, after the call has been handed over from MSC-A to MSC-B, leaves the area of MSC-B during the same call, subsequent handover is necessary in order to continue the connection.

The following cases are identified:

i) the MS moves back to the area of MSC-A;

ii) the MS moves into the area of a third MSC (MSC-B').

In both cases the call is redirected in MSC-A using the handover device; the connection between MSC-A and MSC-B can be released after a successful subsequent handover has been performed.

4.2.1. Description of subsequent handover procedure I): MSC-B to MSC-A

The procedure which takes place after the initiation procedure has indicated that a handover has to be made back to MSC-A, is shown in figure 5 in the case of successful handover.

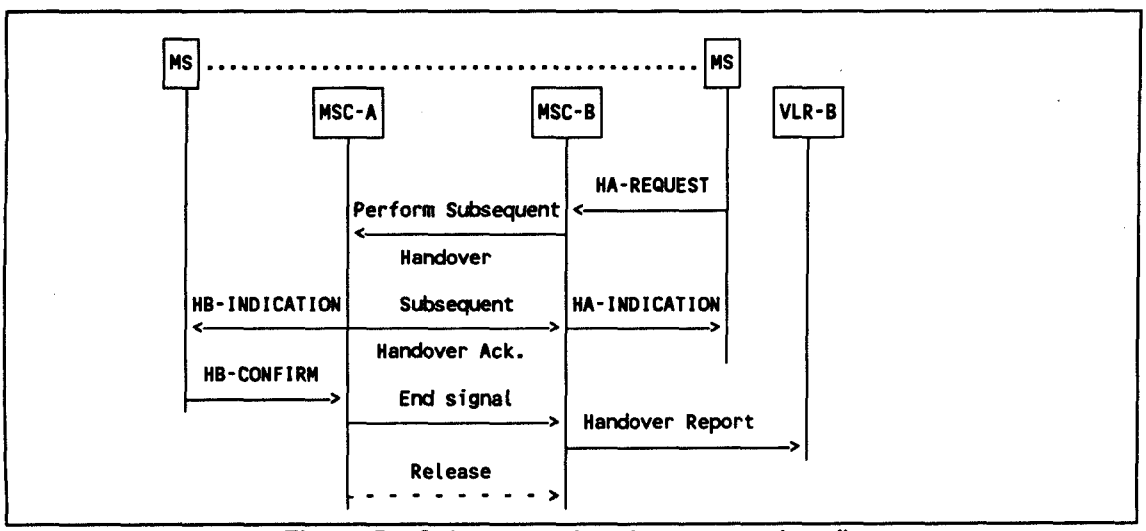


Figure 5 - Subsequent handover procedure i):
successful handover from MSC-B to MSC-A.

The procedure is as follows:

MSC-B sends the perform subsequent handover message to MSC-A indicating that the new MSC is MSC-A. Because MSC-A is the call controlling MSC, this MSC needs no roaming number for routing purposes; MSC-A can directly search for a free radio channel at the desired BS.

When a radio channel can be assigned in time, MSC-A will return the subsequent handover acknowledgement message containing the new radio channel number and possibly other information to MSC-B. If a radio channel cannot be assigned, a no

channel available indication will be given to MSC-B and MSC-B has to maintain the connection with the MS as long as possible.

If a radio channel has been reserved in MSC-A, both MSC-A and MSC-B can start the handover procedure on the radio path (in figure 5 indicated by the interworking messages HB-INDICATION and HA-INDICATION respectively).

After handover MSC-A has to release the connection with MSC-B by the procedures relevant to the PSTN/ISDN signalling system(s) used between MSC-A and MSC-B.

MSC-A must also terminate the MAP procedure for the basic handover between MSC-A and MSC-B. This is done by MSC-A by sending the end signal message to MSC-B. When receiving this signal, MSC-B sends the handover report message to its VLR.

4.2.2.Description of the subsequent handover procedure II): MSC-B to MSC-B'

The procedure which takes place after the initiation procedure has indicated that the call has to be handed over to MSC-B', is shown in figure 6 in the case of successful handover.

The procedure consists of two parts:

- a subsequent handover as described in section 4.2.1 between MSC-A and MSC-B, and

- a basic handover procedure as described in section 4.1 between MSC-A and MSC-B'.

MSC-B sends the perform subsequent handover message to MSC-A indicating a new MSC which is not MSC-A. The message contains the identity of MSC-B' and of the new BS. MSC-A starts then a basic handover procedure towards MSC-B'.

When MSC-A receives the ACM from MSC-B', MSC-A informs MSC-B that MSC-B' has started the handover procedure on the radio path by sending the subsequent handover acknowledgement message to MSC-B containing the new radio channel number. Now MSC-B can start the procedure on the radio path.

For MSC-A the handover is completed when it has received the send end signal message form MSC-B'. The connection between MSC-A and MSC-B is released by normal clearing procedures applicable for the PSTN/ISDN signalling system(s) on the connection between MSC-A and MSC-B. MSC-A also sends the end signal message to MSC-B in order to terminate the original handover procedure between MSC-A and MSC-B. Receiving this message, MSC-B releases the radio path.

In case no radio channel can be allocated in time or the connection between MSC-A and MSC-B' cannot be established, MSC-A informs MSC-B by a congestion message. MSC-B has then to maintain the existing connection with the MS as long as possible. When necessary, MSC-A sends the handover cancellation message to MSC-B'.

When the MS again passes the MSC boundary, MSC-B' is considered as an MSC-B so that the subsequent handover procedures given above are applicable for any series of handover between MSCs.

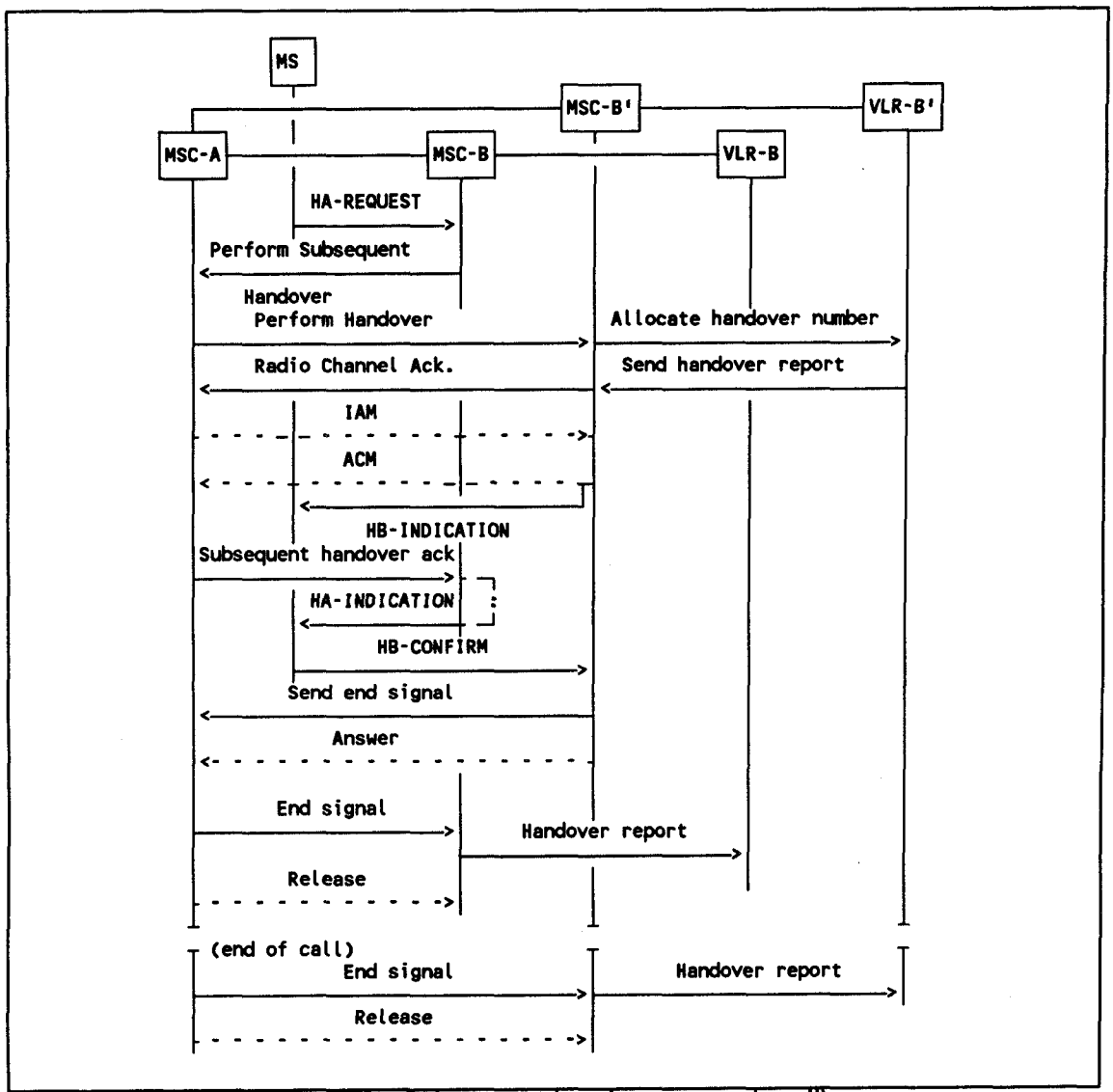


Figure 6 - Subsequent handover *procedure ii)*:
Successful handover from MSC-B to MSC-B'.

5. DETAILED PROCEDURES IN MSC-A

5.1. BS/MSC (MS/BS) procedures MSC-A (functional unit 1)

The handover procedures in this functional unit consist of:

i) signalling between the MS and the MSC;

ii) signalling between the BS and the MSC for access management.

Signals sent to and received from functional unit 3 (handover control procedures MSC-A) are indicated in section 5.3 below.

5.2. Call control procedures MSC-A (functional unit 2)

Related to handover the call control procedures in MSC-A can be divided into two functional entities:

- the first entity is the call control procedure as part of the normal interworking between the PSTN/ISDN and the PLMN; for an MS originating call MSC-A is the originating exchange, for an MS terminating call MSC-A is the destination exchange.

- the second entity is the call control procedure for the connection between MSC-A and MSC-B in case of a handover from MSC-A to MSC-B. For this call control procedure the following applies:

Call set-up

The connection to MSC-B is set up by procedures relevant to the signalling system used in the PSTN/ISDN to which MSC-A is connected. The call is set up by using the MS roaming number received from MSC-B as part of the MAP procedure.

The call set-up direction will always be from MSC-A to MSC-B, i.e. also when the call was originally established by the MS. Functional unit 2 should therefore keep information on call set-up direction in order to be able to interpret correctly any clearing signals (see below).

The unit should indicate the address complete condition to functional unit 3 and through-connect without awaiting the answer signal from MSC-B. This applies also to signalling systems where address complete signals are not supported. In such cases an artificial address complete is established by functional unit 2.

Call clearing

The call clearing consists of two parts: after inter-MSC handover, clearing of the MS-BS connection and clearing of the inter-MSC connection.

The MAP is used to transfer information between MSC-B and MSC-A in order to maintain full call control with MSC-A. MSC-A determines, based on information received from MSC-B, the appropriate signals (according to recommendation GSM 04.08) to be sent to the MS, and sends this information to MSC-B.

MSC-A shall initiate inter-MSC connection release and send the end signal to release any resource attached to the call.

The clearing of the connection is by procedures relevant to the signalling system in the PSTN/ISDN to which MSC-A is connected.

When the Signalling System no 7 ISDN User Part is used, the normal symmetric release procedures apply on both the connection to the fixed network and to MSC-B.

When a signalling system is used without a symmetric release possibility, some notice should be given to the clear-forward and clear-back procedures.

For MS terminating calls the following conditions apply on clear-forward and clear-back:

- when a clear-forward signal is received on interface B' (see figure 1), MSC-A clears the circuit to MSC-B by normal clear-forward procedures.

- when a clear-back signal is received from MSC-B, MSC-A starts normal clear-back procedures towards the fixed network (interface B') and sends the clear-forward signal on interface B'' in order to clear the connection with MSC-B.

  Note : this case corresponds to a fault situation. O&M actions are for further study.

For MS originated calls the following applies:

- when MSC-A receives a clear-back signal from MSC-B, this signal must be interpreted as indicating a clear-forward condition. MSC-A then clears both the connection on interface B' (see figure 1) and to MSC-B by normal clear-forward procedures.

  Note : this case corresponds to a fault situation. O&M actions are for further study.

- when MSC-A receives a clear-back signal on interface B', MSC-A should distinguish between national and international connections:

  ■ for international connections where the Q.118 supervision is done in the ISC, MSC-A sends a clear-forward signal on both interface B' to the fixed network and interface B" to MSC-B;

  ■ for national connections or for international connections where the Q.118 supervision is not done in the ISC, a timer is started according to national practice for clear-back supervision and MSC-A proceeds as follows:

  i) if a clear-back signal is received from MSC-B, MSC-A interprets this as indicating a clear-forward condition and proceeds by clearing the connections on interface B' and to MSC-B by normal clear-forward procedures.

  ii) if the timer expires, MSC-A proceeds by normal clear-forward of the connections on interface B' and to MSC-B.

5.3. Handover control procedures MSC-A (functional unit 3)

The procedures of functional unit 3 are given in terms of SDL diagrams in figure 7. For all signals sent to or received from another functional unit the source or sink of the signal is indicated (e.g. from 4, to 2, etc.).

Note: there is no state 2 in the SDL diagrams.

The procedures of functional unit 3 include:

i) initiation (states 1 and 3). The initiation condition is shown by the signal HA-REQUEST.

The diagram also includes queuing when there is no channel available. Calls for which handover has been initiated should be queued with priority higher than normal calls. They should have lower priority than emergency calls.

ii) handover of calls within the area of MSC-A, i.e. handover cases i) and ii) (states 1,3 and 4). MSC-A controls the procedures on both the previous and the new radio channel. Both signals HA-INDICATION and HB-INDICATION are required. The handover procedure is completed when HB-CONFIRM is received. If this signal is not received, the radio path and the connection on interface B' are either released or the original connection is maintained, depending on national choice.

For handover devices with three-party capabilities the handover device is first set up so that all interfaces A', A" and B' are connected (illustrated by the signal set up handover device). This is done when HA-INDICATION is sent. The device is connected in its final position (i.e. A" to B' for case ii)) (illustrated by the signal connect handover device) when HB-CONFIRM is received.

iii) handover to MSC-B (states 1, 5, 6 and 7). This procedure is the one described in section 4.1. For handover devices with three-party capabilities the handover device is set-up when MSC-A sends the HA-INDICATION, i.e. the interfaces A', B' and B" are then connected. The device is connected in its final position (i.e. B' to B") when the successful procedure indication is received from functional unit 4.

iv) subsequent handover to MSC-A (states 7 and 9). The procedure is described in section 4.2. When a handover to MSC-A indication is received from functional unit 4, the handover device is set up so that interfaces B', B" and A' are connected (for handover devices with three-party capabilities). When HB-CONFIRM is received, the device is connected in its final position (i.e. B' to A').

If HB-CONFIRM is not received (expiry of timer T104), the handover device releases interface A' and returns to a position where B' and B" are connected. A congestion indication is returned via functional unit 4 to MSC-B.

v) subsequent handover to a third MSC (MSC-B') (states 7 and 8). The procedure is described in section 4.2. The handover device is set up in its initial position, (i.e. interconnection of interfaces B', B" and B"') when the connection to MSC-B' has been established (indicated by the signal connection established from functional unit 2). MSC-B is informed via functional unit 4 (send acknowledge) that the connection has been established and that the procedure on the radio path can be initiated. The device is connected in its final position (i.e. B' to B"') when a successful procedure indication is received from functional unit 4. MSC-B is informed that all procedures in MSC-B can be terminated (illustrated by the send end signal indication). The device returns to the state where B' and B" are connected if the subsequent handover procedure fails.

Timers in MSC-A

The procedures are supervised by timers in order to avoid a deadlock when responses are not received or the procedures fail. The following timers are defined:

T101: this timer supervises the queuing time for a free channel. If T101 expires, a no channel indication is generated. T101 is set by O&M.

T102: this timer supervises the time for handover completion for handover between BSs in MSC-A. If T102 expires, the radio path and the connection on interface B' are released. T102 is set by O&M.

T103: this timer supervises the time between issuing a HA-INDICATION in MSC-A and receiving a successful procedure indication from MSC-B. If T103 expires, the handover procedure is cancelled and the call may continue on the old channel. T103 is set by O&M

T104: this timer supervises the time between sending of HB-INDICATION and receiving the HB-CONFIRM for a subsequent handover from MSC-B to MSC-A. If the timer expires, the new radio channel is released and the existing handover device connection to MSC-B is maintained. T104 is set by O&M

5.4. MAP procedures in MSC-A (functional unit 4)

The MAP procedures for handover are defined in recommendation

GSM 09.02. They include:

- procedures for basic handover
- procedures for subsequent handover

These procedures are as outlined in section 4.

6. DETAILED PROCEDURES IN MSC-B

6.1. BS/MSC (MS/BS) procedures MSC-B (functional unit 1)

The handover procedures in this functional unit consist of :

i) signalling between the MS and the MSC.

ii) signalling between the BS and the MSC for access management.

Signals exchanged with functional unit 3 are indicated in section 6.3 below.

6.2. Call control procedures MSC-B (functional unit 2)

These procedures relate to the call control in MSC-B of the "handover" connection with MSC-A. For these procedures the following apply:

Call set-up

The connection is set up by MSC-A. MSC-B should provide, if possible, the following backward signals:

- signals indicating unsuccessful call set-up and, if possible, the cause of call failure;
- address complete signal;
- answer signal (see note).

Note: The answer signal is not related to answering by the MS and it has no meaning in the handover procedure between MSC-A and MSC-B. But after successful handover this signal is needed for bringing the connection in the answered state in the intermediate PSTN/ISDN exchanges.

There will be no indication that the call applies to a handover. This information has to be derived from the MS roaming number received during call set-up in relation to the earlier radio channel request/radio channel acknowledgement procedure between MSC-A and MSC-B (MAP-procedure).

When the connection has been established, an indication should be given to functional unit 3 (illustrated by the signal connection established in figure 8).

Call clearing

The call clearing consists of two parts after inter-MSC handover: clearing of the BS-MS connection and clearing of the inter-MSC connection.

The MAP is used to transfer information between MSC-A and MSC-B in order to make it possible for MSC-B to send the appropriate signals, specified in recommendation GSM 04.08, and still leave the call control to MSC-A.

MSC-A initiates release of the connection between MSC-A and MSC-B.

MSC-B is only allowed to initiate inter-MSC connection release after the end signal is received.

When the Signalling System no 7 ISDN User Part is used, the normal symmetric release procedures apply.

When a signalling system is used without a symmetric release possibility, the following applies:

- when MSC-B receives a clear-forward signal from MSC-A, it shall release the radio path;

- in fault situation eg. machine malfunction or loss of the connection on interface A, MSC-B may send a clear-back signal to MSC-A

6.3 Handover control procedures MSC-B (functional unit 3)

The procedures of functional unit 3 are given in form of SDL diagrams in figure 8. For all signals sent to or received from another functional unit the source or sink of the signal is indicated (eg. from 4, to 2, etc)

Note: There is no state 5 in the SDL-diagrams.

The procedure in functional unit 3 include:

i) handover from MSC-A (states 1,2,3 and 4).
This case includes initiation by MSC-A (indicated by the allocate radio channel signal received from functional unit 4), and allocation and establishment of the new radio channel. The procedure is outlined in section 4.1.

ii) subsequent handover within the area controlled by MSC-B (states 4, 6 and 7).
This procedure is essentially the same as that of ii) of section 5.3.

iii) subsequent handover to another MSC (MSC-A or MSC-B') (states 4, 8 and 9)
The initiation procedure is essentially the same as that of i) of section 5.3. The HA-INDICATION is now generated by MSC-B after a subsequent handover accepted indication is received from MSC-A (via functional unit 4). The procedure is terminated in MSC-B when MSC-B receives a terminate procedure indication from functional unit 4.

Timers in MSC-B

The following procedures are supervised by timers in order to avoid a deadlock when responses are not received or the procedures fails.

The following timers are defined:

T201: this timer is the same as T101 (section 5.3)

T202: this timer is the same as T102 (section 5.3)

T204: this timer is the same as T104 (section 5.3)

T210: this timer is used to supervise the time for establishing a connection from MSC-A to MSC-B after an allocate radio channel request has been received. When T210 expires, the allocated channel in MSC-B is released T210 is set by O&M.

T211: this timer is used to control the time between requesting a subsequent handover and receiving the response from MSC-A. If T211 expires, the existing connection with the MS is maintained. T211 is set by O&M.

6.4 MAP procedures MSC-B (functional unit 4)

The MAP procedures for handover are defined in recommendation GSM 09.02. They include:

- procedures for basic handover
- procedures for subsequent handover
- procedures for obtaining and releasing the handover number from the VLR.

These procedures are outlined in section 4.

7. Authentication

Authentication will not be performed after handover.

8. Handling of Supplementary Services

8.1 General

MAP procedures for supporting such functions are contained in recommendation GSM 09.02.

MSC-A will maintain call control until all operations, ie. the existing call and any supplementary service operation, have been terminated. At this instant MSC-B is informed by the end signal message of MAP that all functions in MSC-B can be released.

The following should be observed:

i) If a reply to a MAP message is pending when ACM is received or a MAP message is received after the receipt of ACM, MSC-A should return a negative result message to MSC-B indicating that the call state is indeterminate.

ii) If a call control message is ready to be sent to the MS after receipt of ACM, MSC-A should postpone the transmission of the message until handover has been completed.

8.2 Conditions related to specific services.

These conditions are given in recommendation GSM 03.11

Figure 7 (Sheet 1 of 8) Handover control procedure in MSC-A

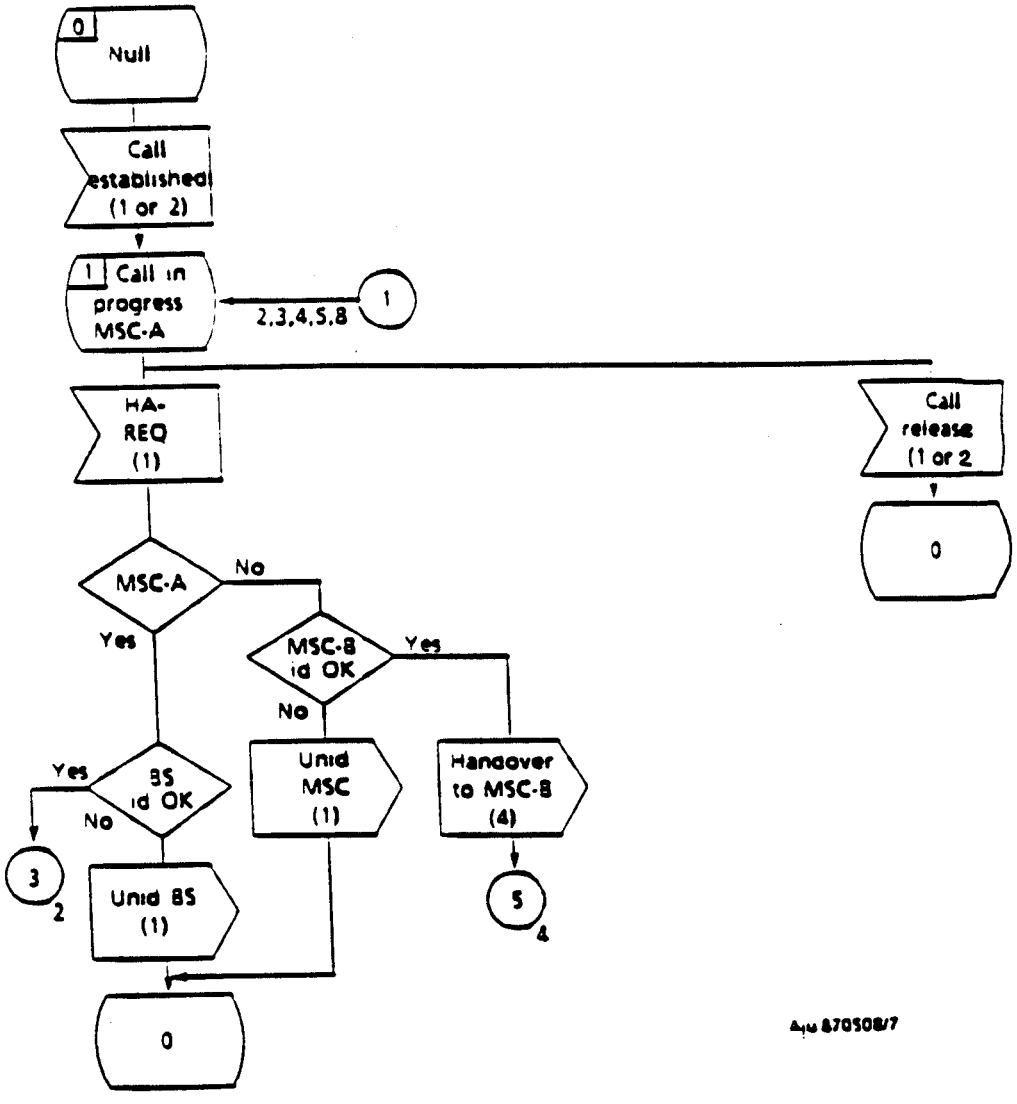


Figure 7 (Sheet 1 of 8) Handover control procedure in MSC-A

Figure 7 (Sheet 2 of 8) Handover control procedure in MSC-A

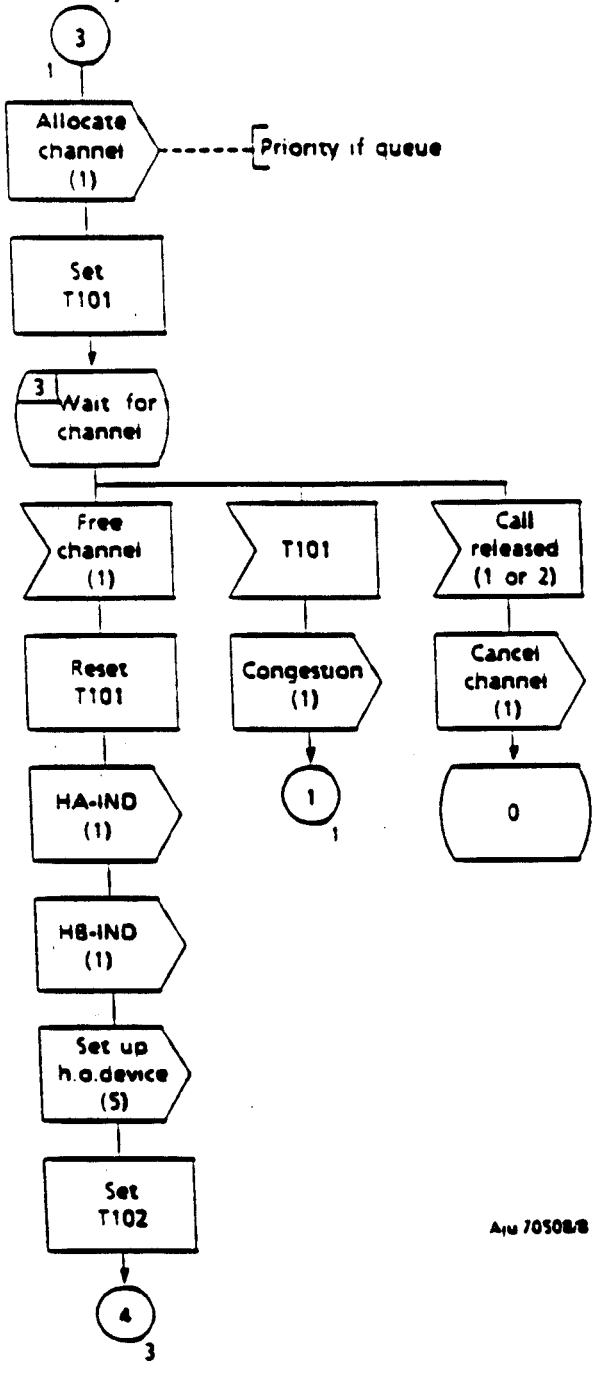


Figure 7 (Sheet 2 of 8) Handover control procedure in MSC-A

Figure 7 (Sheet 3 of 8) Handover control procedure in MSC-A

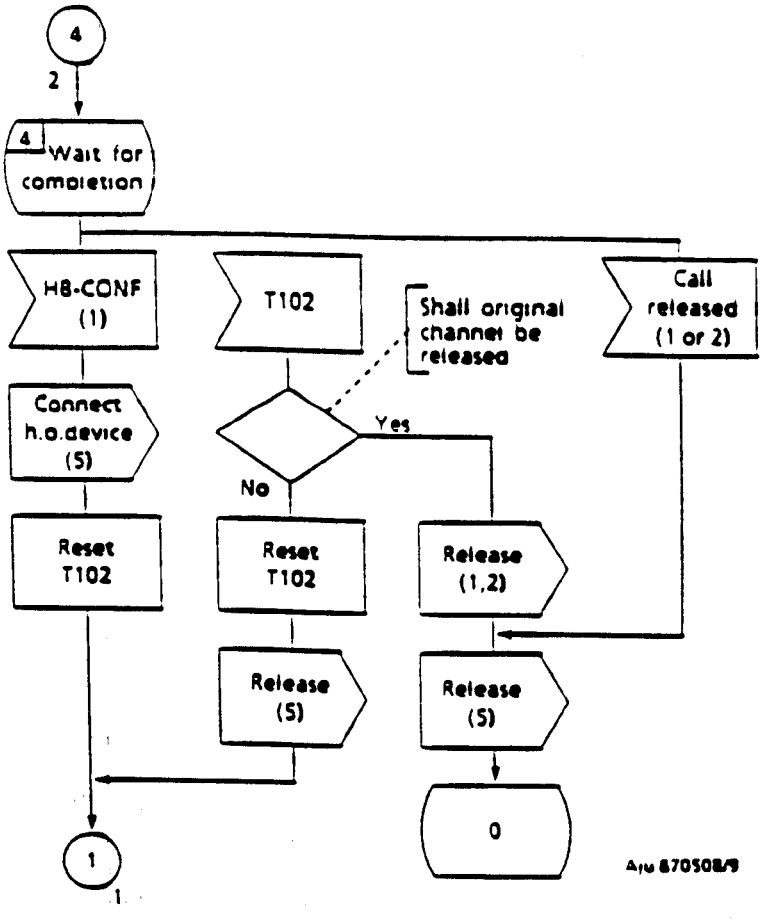


Figure 7 (Sheet 3 of 8) Handover control procedure in MSC-A

Figure 7 (Sheet 4 of 8) Handover control procedure in MSC-A

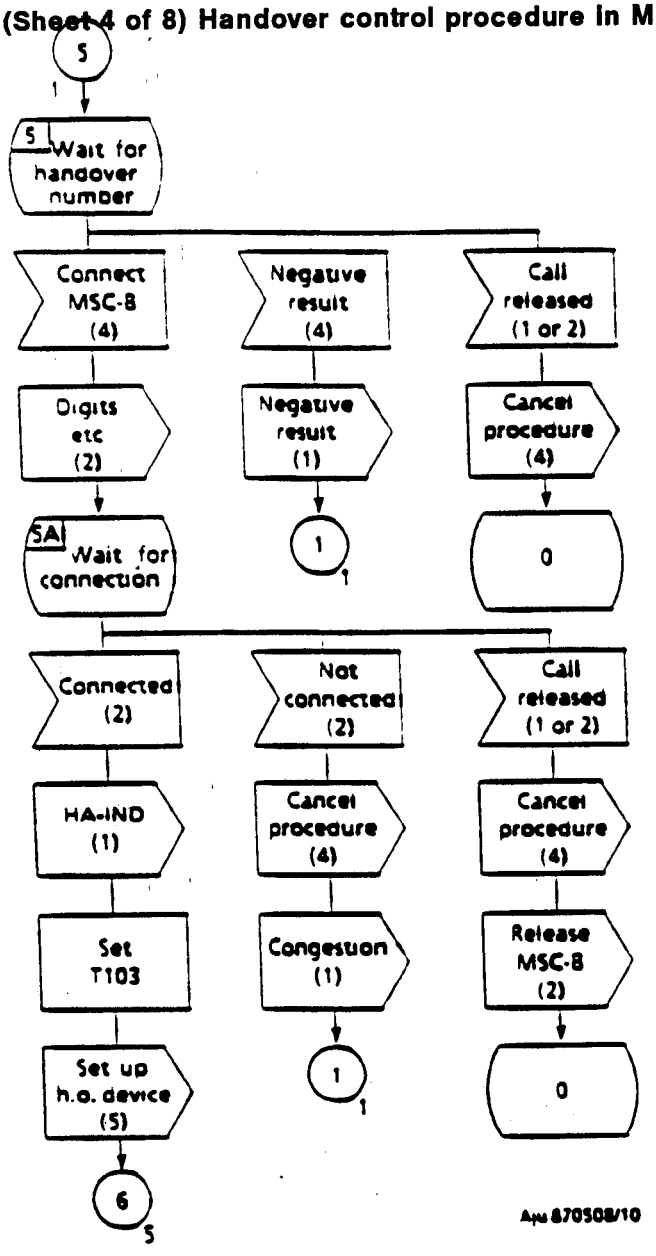


Figure 7 (Sheet 4 of 8) Handover control procedure in MSC-A

Figure 7 (Sheet 5 of 8) Handover control procedure in MSC-A

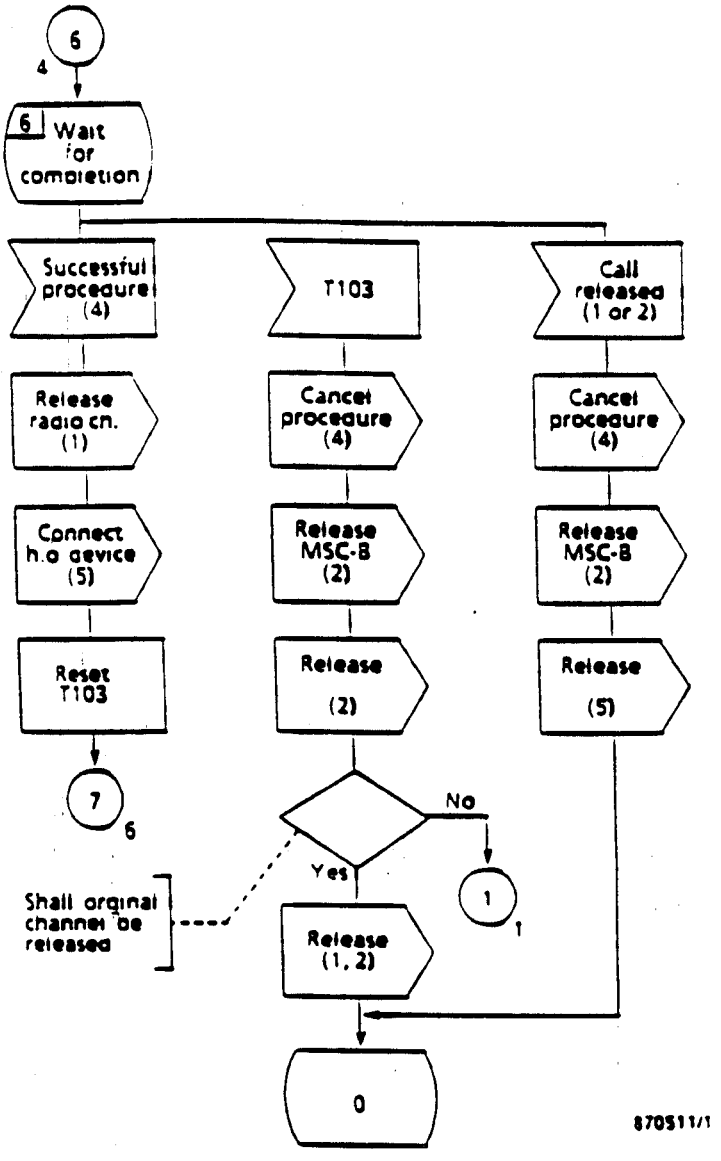


Figure 7 (Sheet 5 of 8) Handover control procedure in MSC-A

Figure 7 (Sheet 6 of 8) Handover control procedure in MSC-A

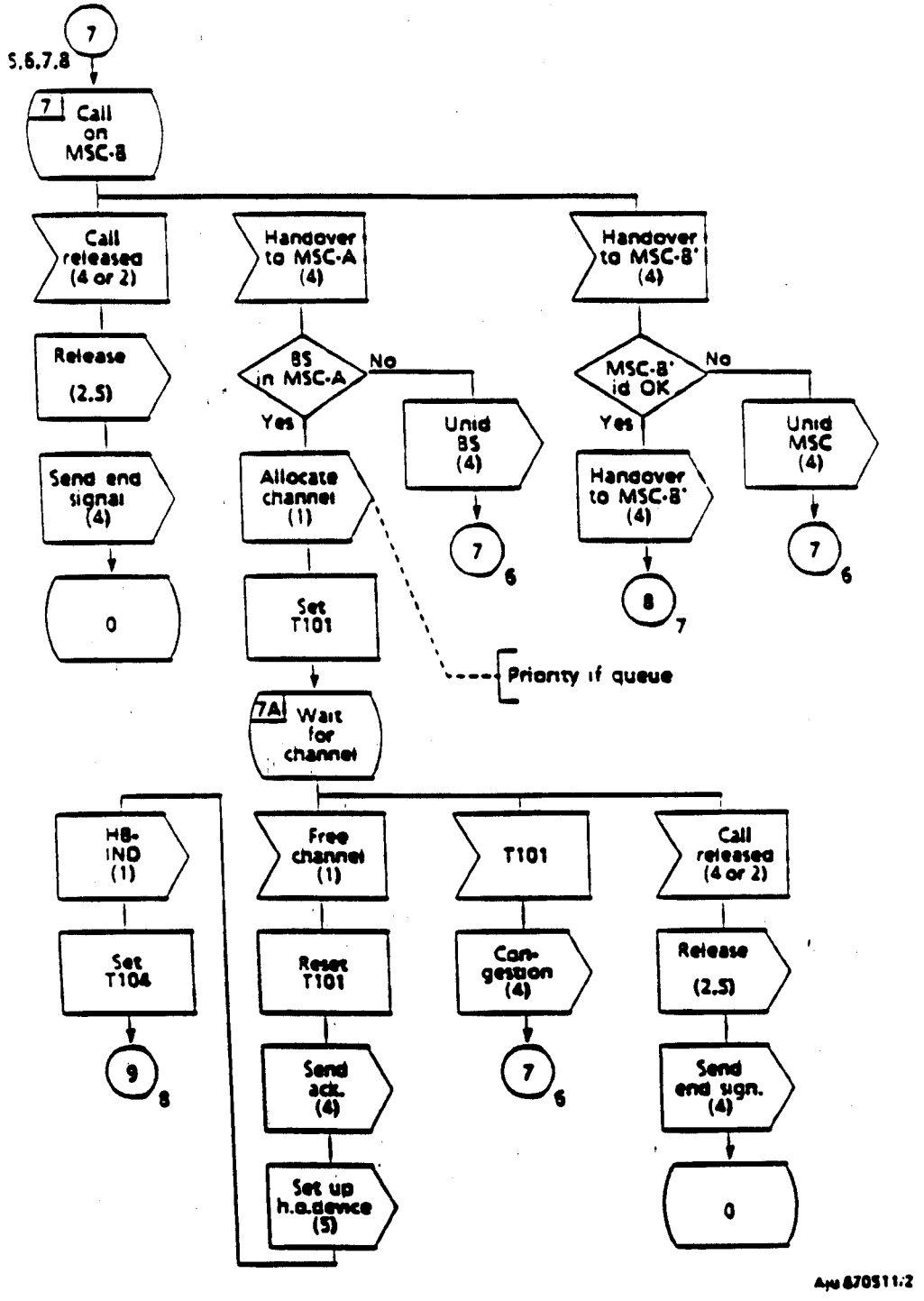


Figure 7 (Sheet 6 of 8) Handover control procedure in MSC-A

Figure 7 (Sheet 7 of 8) Handover control procedure in MSC-A

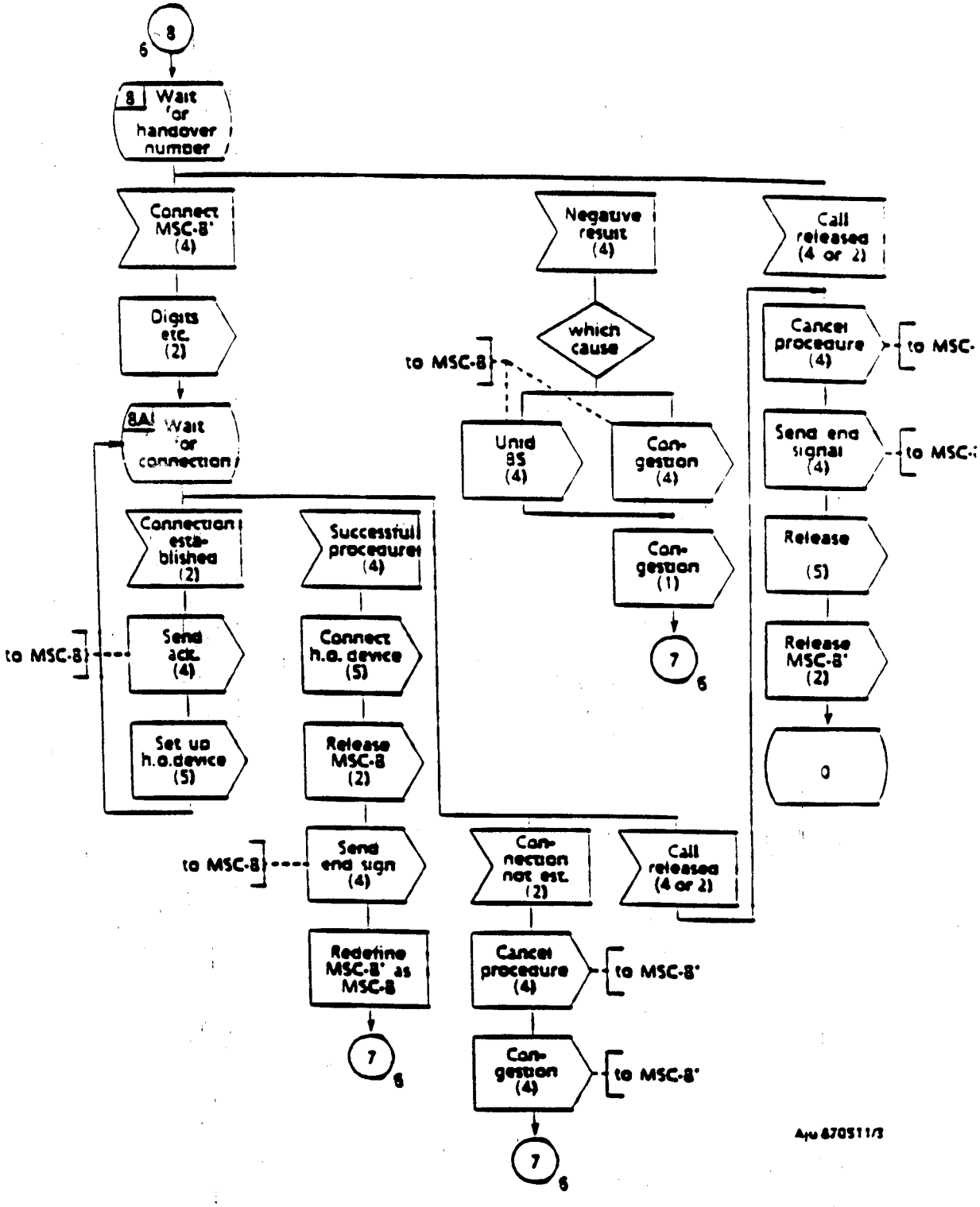


Figure 7 (Sheet 7 of 8) Handover control procedure in MSC-A

Figure 7 (Sheet 8 of 8) Handover control procedure in MSC-A

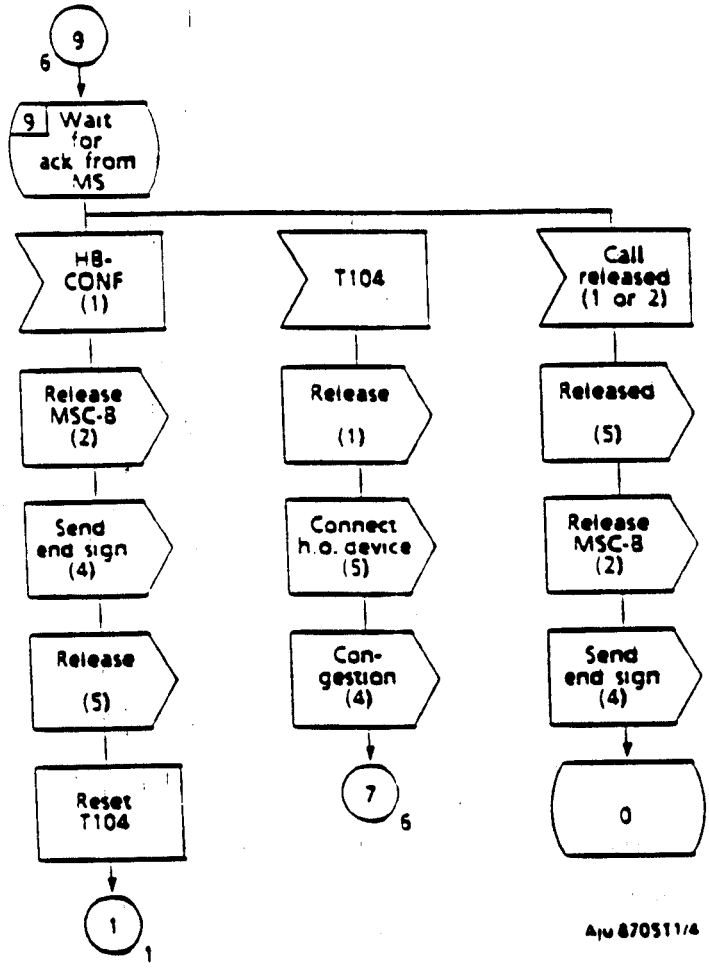


Figure 7 (Sheet 8 of 8) Handover control procedure in MSC-A

Figure 8 (Sheet 1 of 7) Handover control procedure in MSC-B

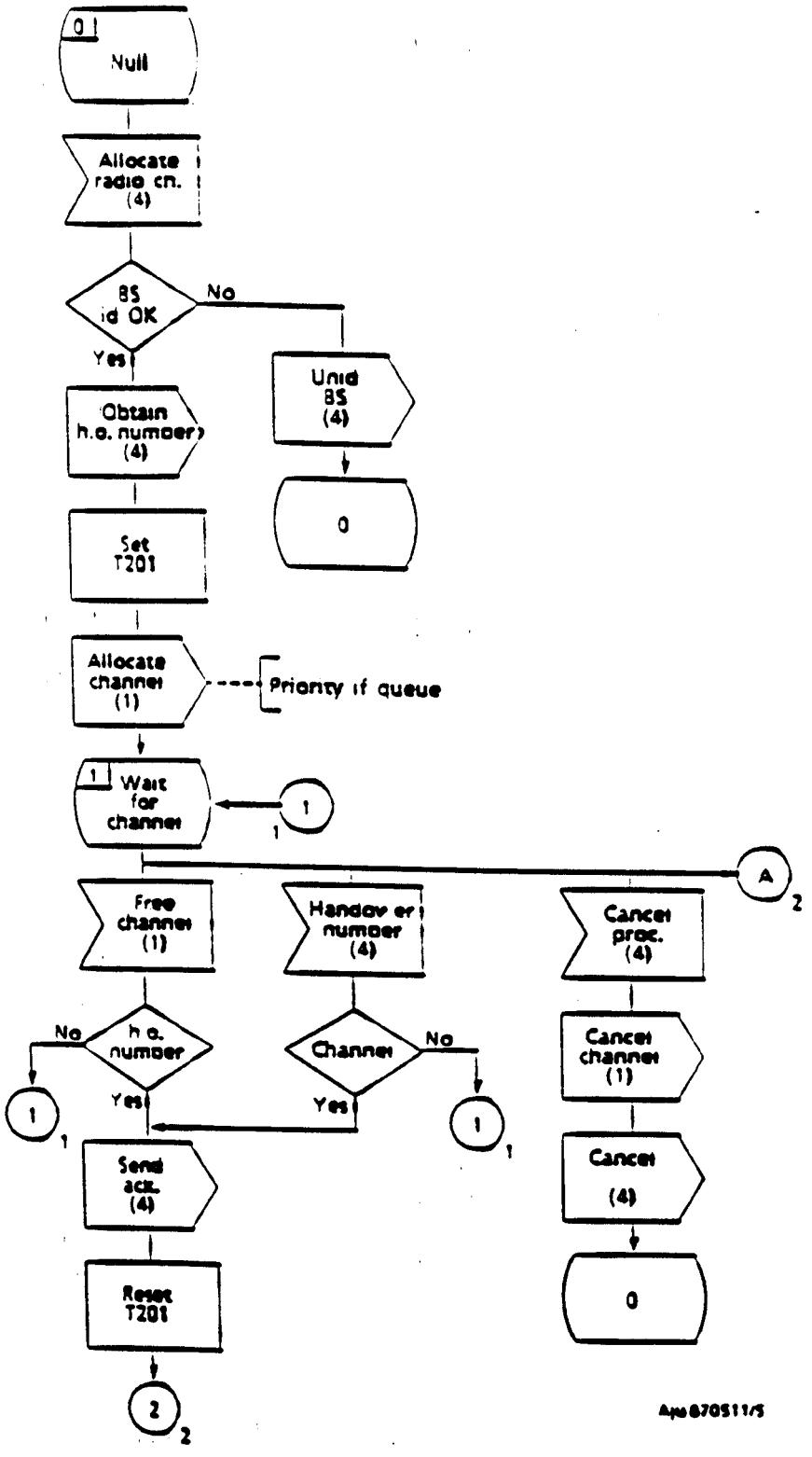


Figure 8 (Sheet 1 of 7) Handover control procedure in MSC-B

Figure 8 (Sheet 2 of 7) Handover control procedure in MSC-B

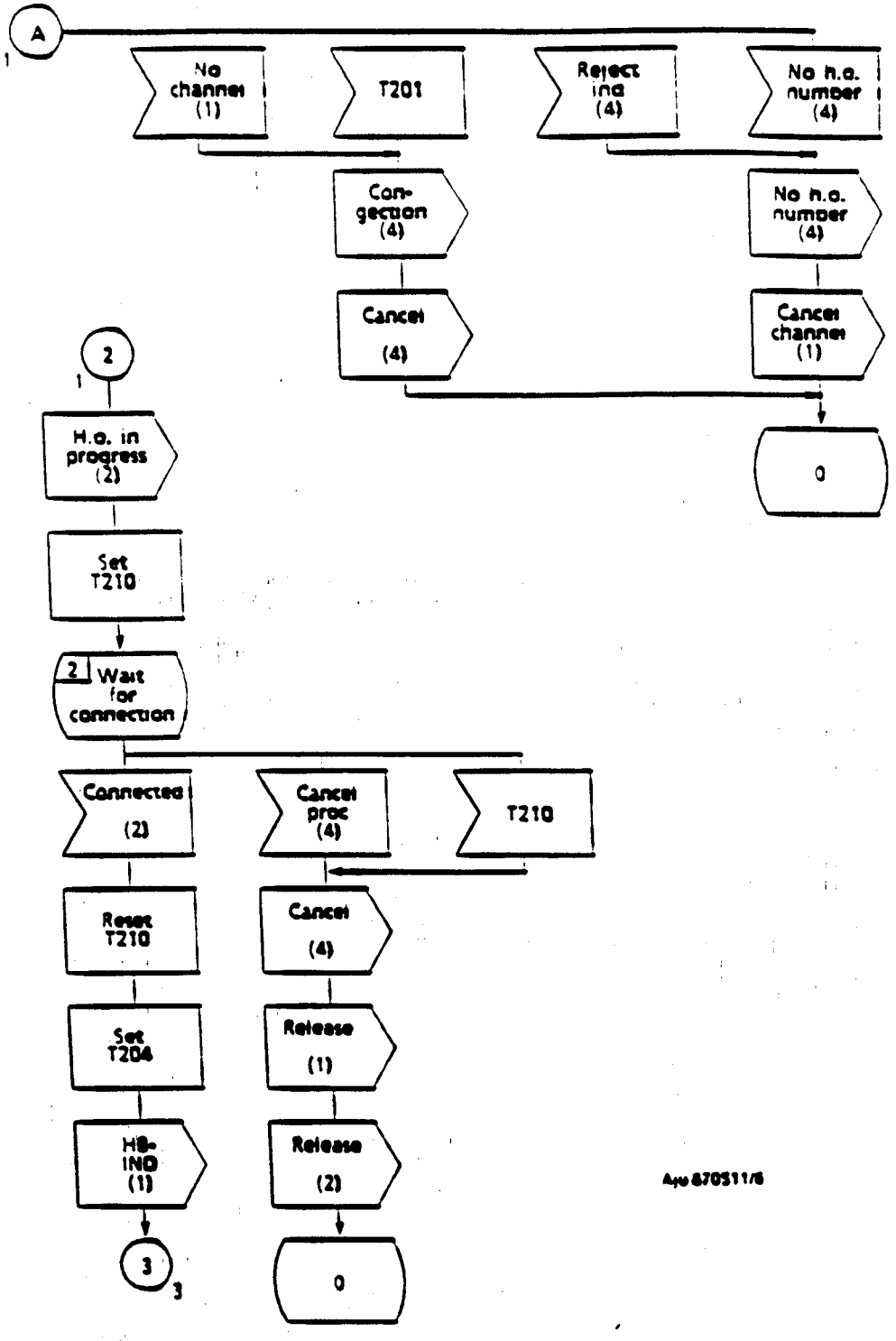


Figure 8 (Sheet 2 of 7) Handover control procedure in MSC-B

Figure 8 (Sheet 3 of 7) Handover control procedure in MSC-B

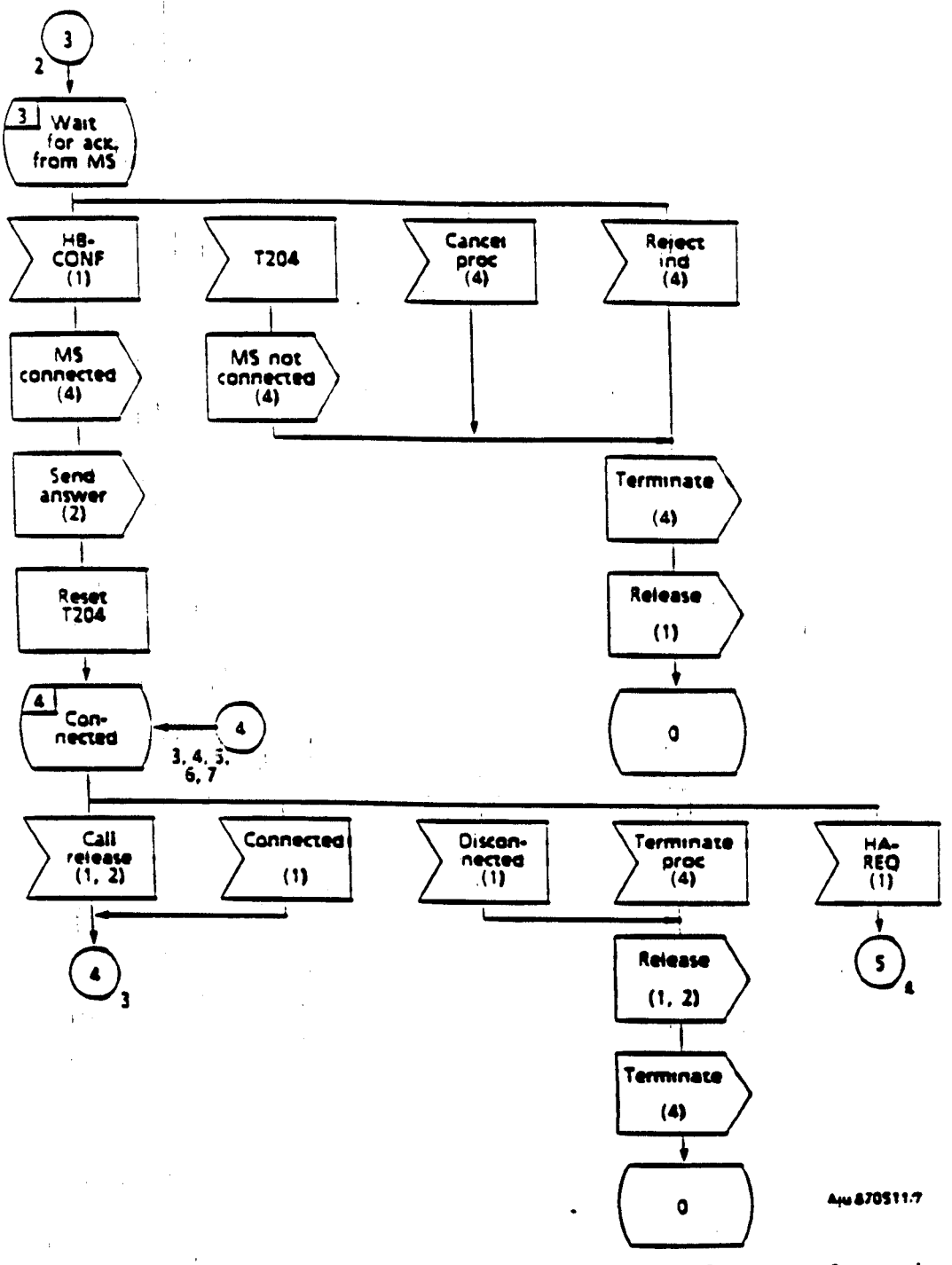


Figure 8 (Sheet 3 of 7) Handover control procedure in MSC-B

Figure 8 (Sheet 4 of 7) Handover control procedure in MSC-B

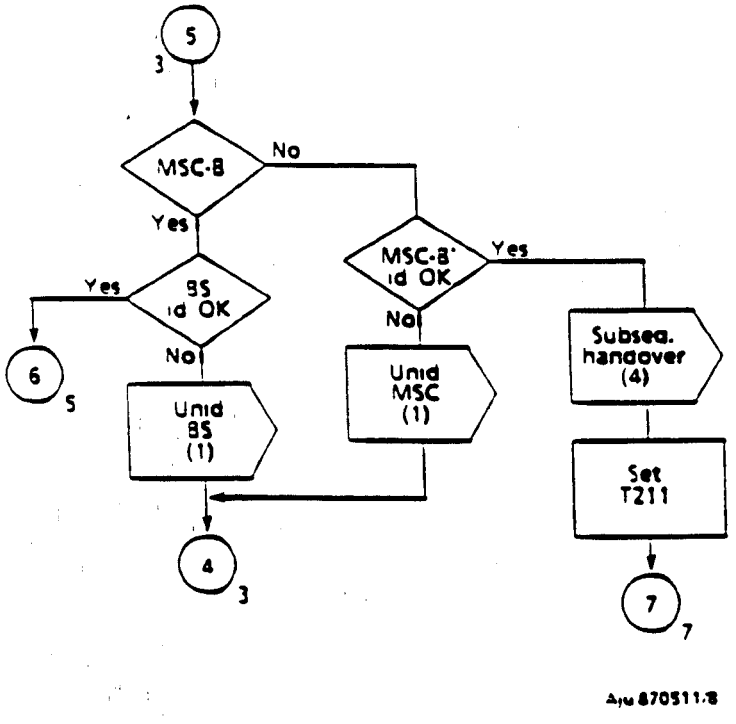


Figure 8 (Sheet 4 of 7) Handover control procedure in MSC-B

Figure 8 (Sheet 5 of 7) Handover control procedure in MSC-B

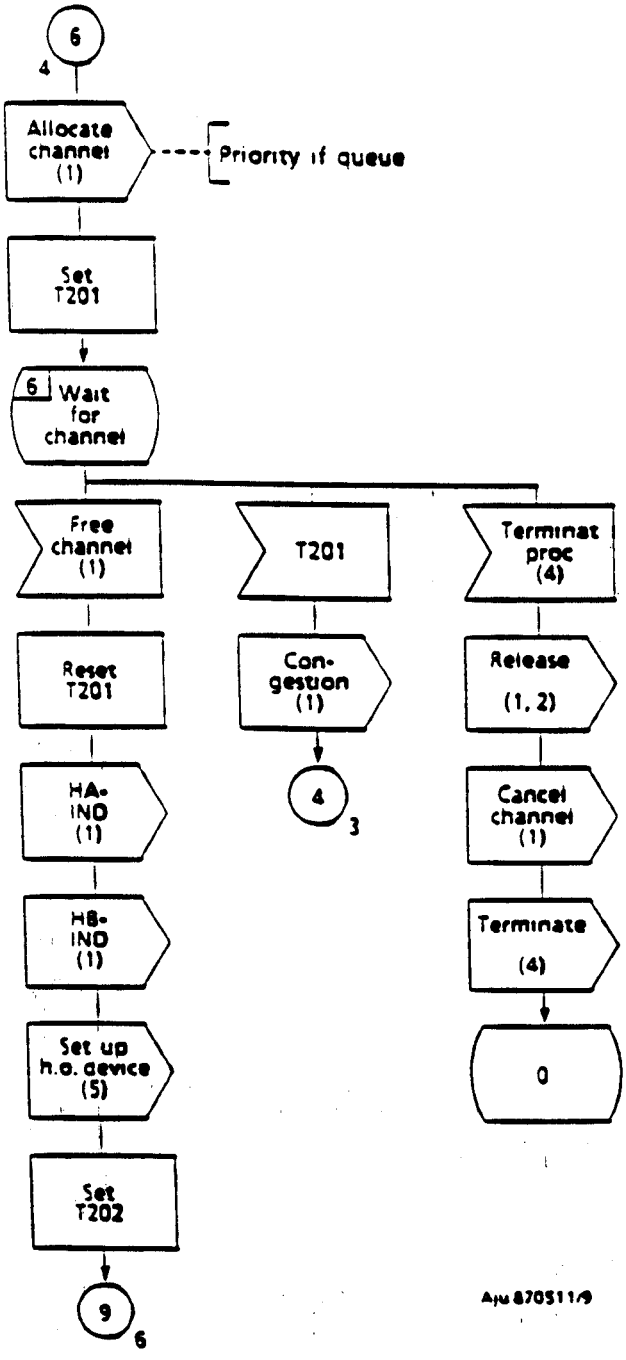


Figure 8 (Sheet 5 of 7) Handover control procedure in MSC-B

Figure 8 (Sheet 6 of 7) Handover control procedure in MSC-B

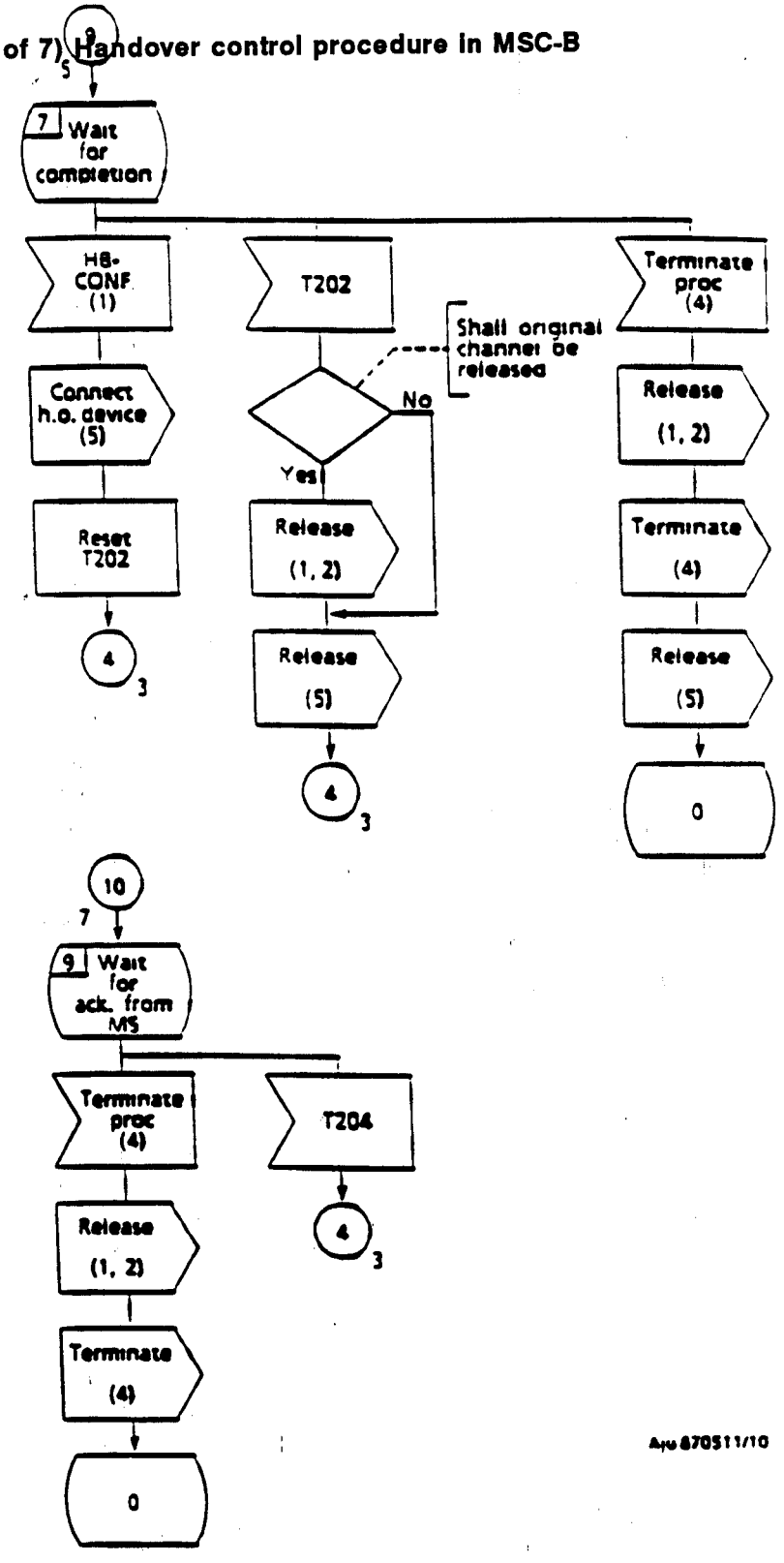


Figure 8 (Sheet 6 of 7) Handover control procedure in MSC-B

Figure 8 (Sheet 7 of 7) Handover control procedure in MSC-B

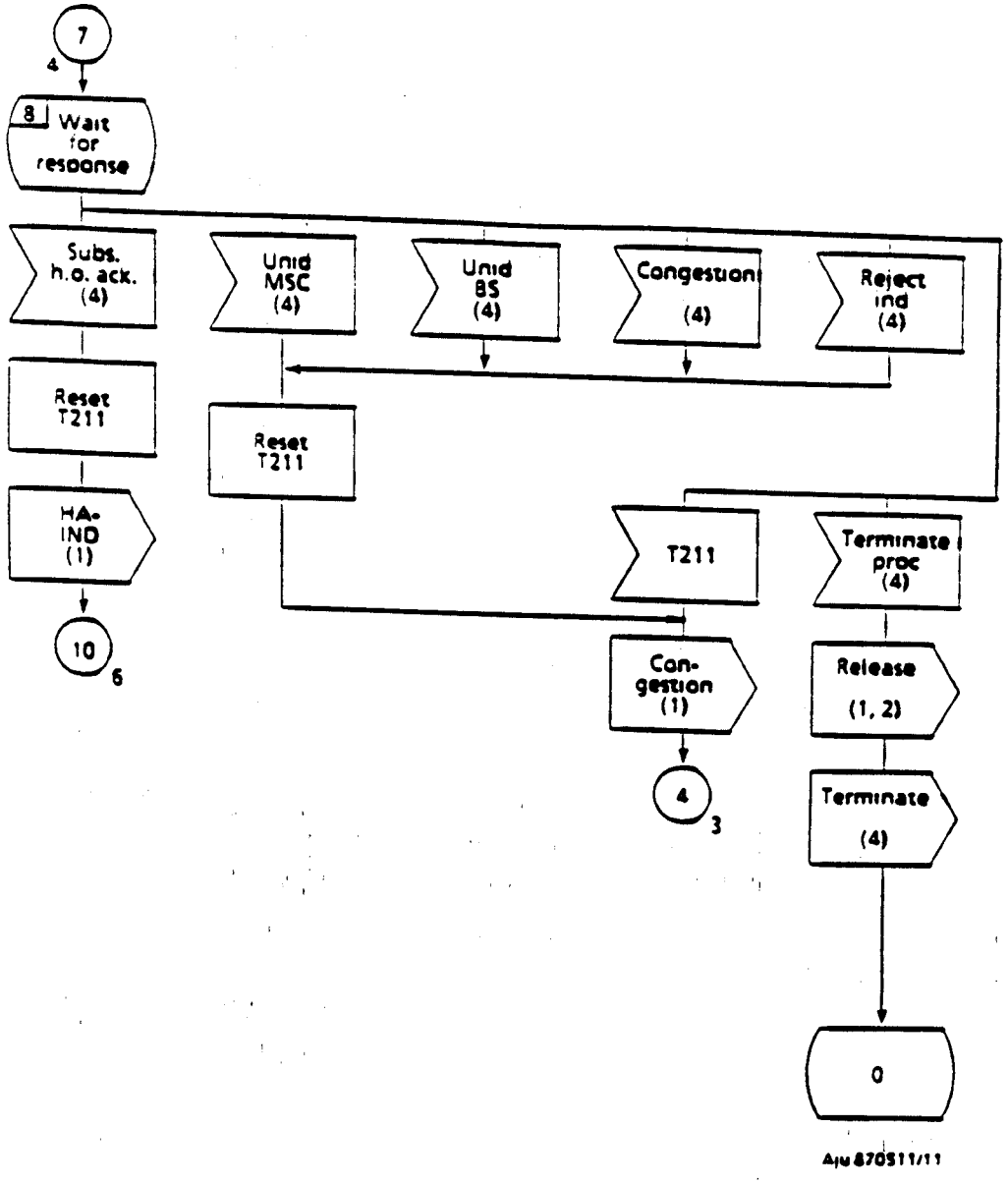


Figure 8 (Sheet 7 of 7) Handover control procedure in MSC-B