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New presentation - see History box

Contents

Foreword

This European Telecommunication Standard (ETS) has been produced by the Special Mobile Group (SMG) Technical Committee (TC) of the European Telecommunications Standards Institute (ETSI).

This ETS defines the stage 2 of the Call Forwarding (CF) supplementary services for the European digital cellular telecommunications system (Phase 2).

This ETS corresponds to GSM Technical Specification (GSM-TS) GSM 03.82 version 4.7.1.

The specification from which this ETS has been derived was originally based on CEPT documentation, hence the presentation of this ETS may not be entirely in accordance with the ETSI/PNE rules.

Reference is made within this ETS to GSM-TSs (NOTE).

NOTE: TC-SMG has produced documents which give the technical specifications for the implementation of the European digital cellular telecommunications system. Historically, these documents have been identified as GSM Technical Specifications (GSM-TSs). These TSs may have subsequently become I-ETSs (Phase 1), or ETSs (Phase 2), whilst others may become ETSI Technical Reports (ETRs). GSM-TSs are, for editorial reasons, still referred to in current GSM ETSs.

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0 General

0.1 Scope

This specification gives the stage 2 description of the call forwarding supplementary services.

The group of supplementary services call offering supplementary services is divided into 4 different supplementary services:

- Call forwarding unconditional (CFU) (section 1);

- Call forwarding on mobile subscriber busy (CFB) (section 2);

- Call forwarding on no reply (CFNRy) (section 3);

- Call forwarding on mobile subscriber not reachable (CFNRc) (section 4).

0.2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1]   GSM 01.04 (ETR 100): "European digital cellular telecommunications system (Phase 2); "Abbreviations and acronyms".

[2]   GSM 02.04 (ETS 300 503): "European digital cellular telecommunications system (Phase 2; General on supplementary services".

[3]   GSM 02.82 (ETS 300 515): "European digital cellular telecommunications system (Phase 2); Call Forwarding (CF) supplementary services - Stage 1".

[3]   GSM 03.11 (ETS 300 529): "European digital cellular telecommunications system (Phase 2); Technical realization of supplementary services".

[4]   GSM 03.15 (ETS 300 533): "European digital cellular telecommunications system (Phase 2); Technical realization of operator determined barring".

0.3 Definitions and abbreviations

Abbreviations used in this specification are listed in GSM 01.04.

0.4 The forwarded-to number

As indicated in TS GSM 02.82 the forwarded-to numbers are stored in the international format. The transfer from the HLR to other network entities and storage in the VLR shall also be in the international format.

0.5 Cross phase compatibility

For the following supplementary services, a number of changes exist between this specification and the phase 1 specification:

- Call forwarding unconditional;

- Call forwarding on mobile subscriber busy;

- Call forwarding on no reply;

- Call forwarding on mobile subscriber not reachable.

The main body of this specification assumes that all network entities comply with this version of the service. In each case an additional sub-section (section x.6) defines the additional requirements for when one or more network entities or the MS complies with the phase 1 specifications for the supplementary service procedures.

1 Call forwarding unconditional (CFU)

1.1 Handling of call forwarding unconditional

1.1.1 Registration

At the beginning of registration subscription to the basic service, provision of the supplementary service and sufficiency of registration information has to be checked (see figure 1.2).

The following information has to be registered in the network:

1) the forwarded-to number (possibly including a sub-address);

2) information as to whether all calls or all calls of a specific basic service group should be forwarded.

The basic service group code

If the registration request received by the HLR does not contain any basic service group code, the registration shall be performed for all subscribed basic service groups for which CFU is provided, see figure 1.2.

The forwarded-to number

If the forwarded-to number is a number in the HPLMN country, it may be entered by the served mobile subscriber in three different formats, independent of his actual location, according to the schemes:

1) national (significant) number;

2) (trunk) prefix plus national (significant) number;

3) international prefix, country code, national (significant) number.

The received number may have to be converted to an international number before further processing (see figure 1.2).

The network may also validate the forwarded-to number before accepting the call forwarding registration request.

Supplementary Service interaction

Possible interaction situations between CFU and other call forwarding and barring supplementary services must then be checked. This is described in figure 1.2. Also see technical specifications GSM 02.04 and 02.82. For interaction between CFU and other supplementary services (ie not call barring or call forwarding services), the reader is referred to the respective technical specification for those supplementary services.

Notifications to the subscriber

When the mobile subscriber registers CFU, the network shall attempt to register and activate the service. The network will return notification of acceptance of the request. This notification will include the forwarded-to number and possibly the basic service group code to which CFU is registered.

If the system cannot accept a registration request, the network sends a notification that CFU registration was not successful to the served mobile subscriber.

The information flow for registration of CFU is shown in figure 1.1.

```
      MS                 MSC                VLR                HLR

      Register CFU
      ─────────────────>
                         Register CFU
                         ─────────────────>
                                            Register CFU
                                            ─────────────────>
                                                               CFU1
                                            Acknowledge
                                            <─────────────────
                         Acknowledge
                         <─────────────────
      Release complete
      <─────────────────
            \Facility
```
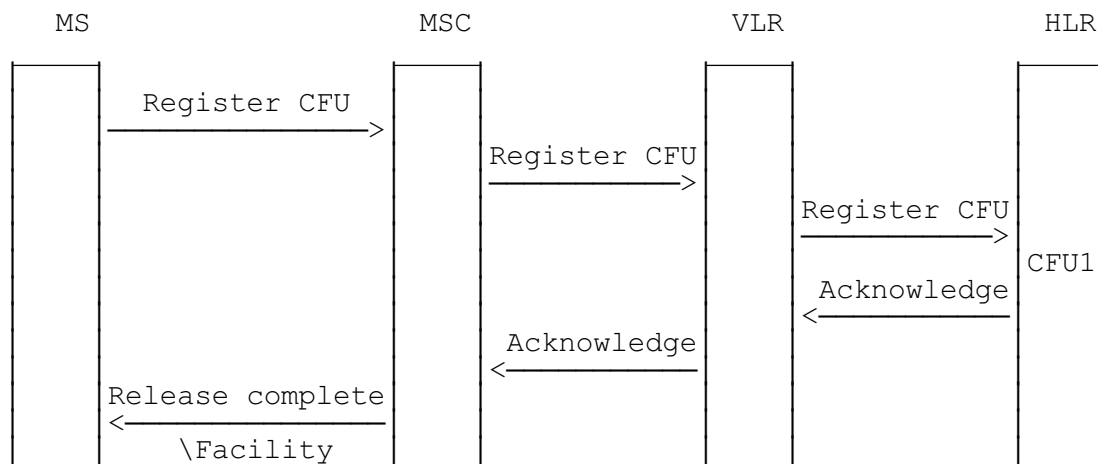
Figure 1.1: Registration of call forwarding unconditional

Process CFU1   382_12(1)

idle

register CFU

BS included in request — no → set BS = all BS

yes

CFU provided — no → 2

yes

subset of required BS provided — no → 2

yes

valid ftn — no → 2

Not, e.g.:
- special service number;
- own number.

yes

number type — national → convert to international (from HPLMN)

international

BAIC active — yes → 2

no

BAOC active — yes → 2

no → 1

2 → (circle)

2

ftn in HPLMN country — yes →

no

set error

1 → BOIC/ BOIC-exHC active — yes →

no

make any operative BIC-Roam and CCF services quiescent

set result

acknowledge

idle

BS: Basic Service group.
ftn: forwarded-to number.
CCF: "Conditional" Call Forwarding.
BAOC: Barring of All Outgoing Calls.
BOIC: Barring of Outgoing International Calls.
BOIC-exHC: Barring of Outgoing International Calls
            - except those directed to HPLMN Country.
BAIC: Barring of All Incoming Calls.
BIC-Roam: Barring of Incoming Calls when Roaming
            outside the home PLMN country.

Figure 1.2: CFU1 Call forwarding unconditional registration process

1.1.2 Erasure

A previous registration can be erased in either of the following three ways:

- the subscriber can specifically erase a previous registration (to a basic service group) with an appropriate control procedure;

- the subscriber can register information for CFU (to a basic service group), thus causing previous registrations of CFU to be overridden (in the network this shall be handled as an erasure immediately followed by a registration);

- all information is erased as a result of withdrawal of the supplementary service (administrative handling).

The basic service group code

If the erasure request received by the HLR does not contain any basic service group code, the erasure request applies for all basic service groups for which CFU is registered. See figure 1.4.

Supplementary Service interaction

Possible interaction situations between CFU and other supplementary services must then be checked. This is shown in figure 1.4. Also see technical specifications GSM 02.04 and 02.82. For interaction between CFU and other supplementary services (ie not call barring or call forwarding services), the reader is referred to the respective technical specification for those supplementary services.

Notifications to the subscriber

When the mobile subscriber erases CFU, the network shall attempt to erase (and thus deactivate) the service. The network shall send an indication of acceptance or rejection of the erasure request to the served mobile station.

The information flow for erasure of CFU is shown in figure 1.3.

```
        MS                    MSC                  VLR                  HLR
   ┌──────┐              ┌──────┐             ┌──────┐             ┌──────┐
   │      │   Erase CFU  │      │             │      │             │      │
   │      ├─────────────>│      │  Erase CFU  │      │             │      │
   │      │              │      ├────────────>│      │  Erase CFU  │      │
   │      │              │      │             │      ├────────────>│      │
   │      │              │      │             │      │             │ CFU2 │
   │      │              │      │             │      │ Acknowledge │      │
   │      │Release complete│    │ Acknowledge │      │<────────────┤      │
   │      │<─────────────┤      │<────────────┤      │             │      │
   │      │   \Facility  │      │             │      │             │      │
   └──────┘              └──────┘             └──────┘             └──────┘
```
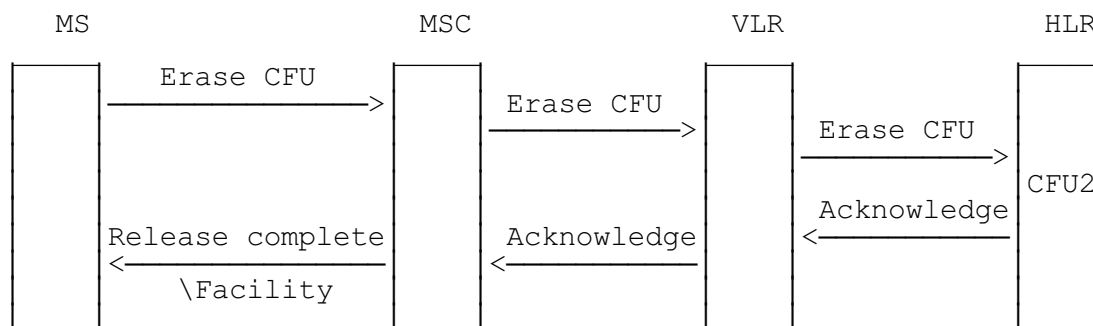
Figure 1.3: Erasure of call forwarding unconditional

Process CFU2   382_14(1)

idle

erase
CFU

BS
included
in request → no

yes

set BS =
all BS

CFU
provided
no ←   → yes

make any
quiescent BIC-Roam
and CCF services
operative

set
error

set
result

acknowledge

idle

BS: Basic Service group.
CCF: "Conditional" Call Forwarding.
BIC-Roam: Barring of Incoming Calls when Roaming
              outside the home PLMN country.
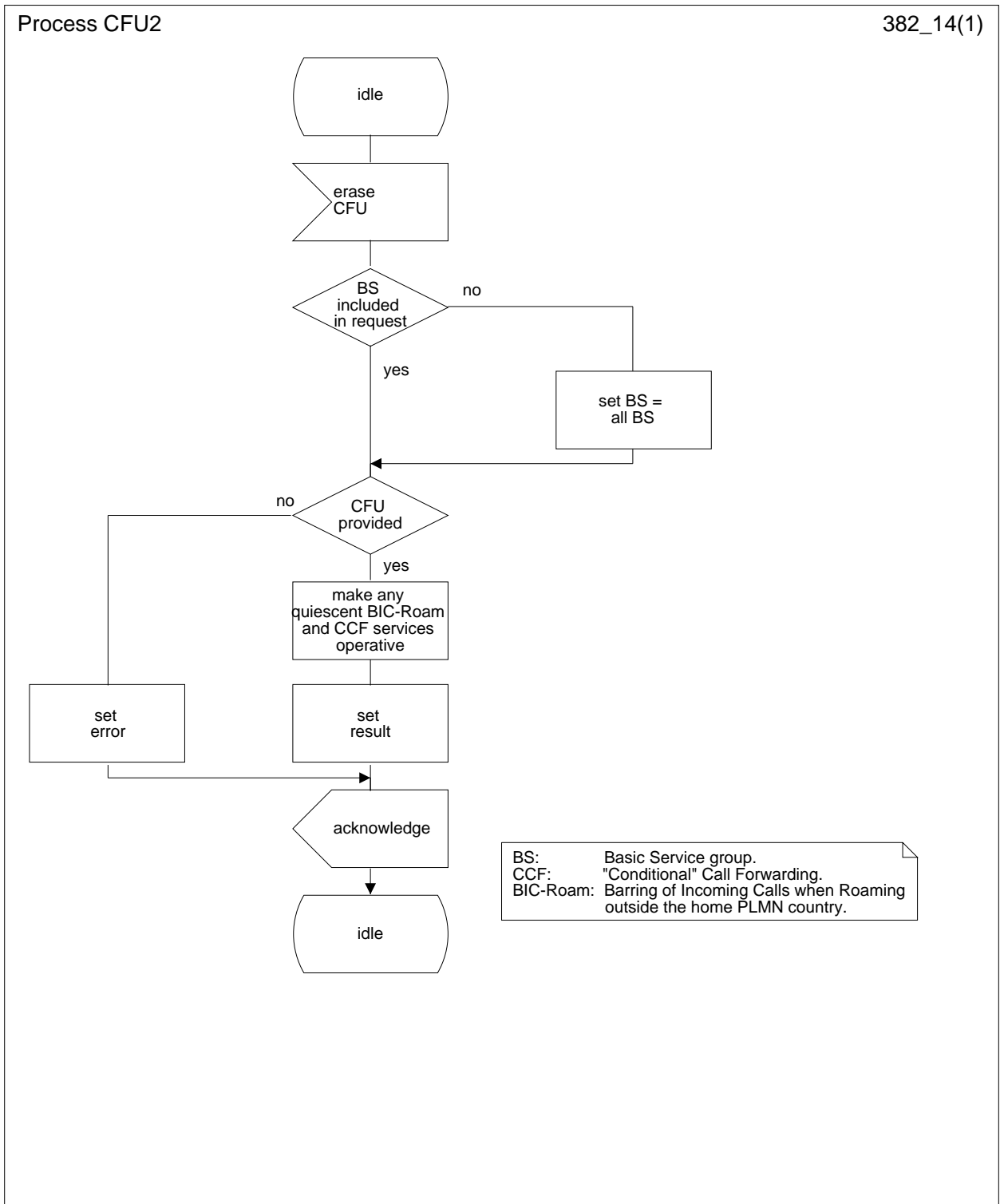
Figure 1.4: CFU2 Call forwarding unconditional erasure process

1.1.3　　　　　Activation

The network initially checks subscription to the basic service and registration status of the supplementary service, see figure 1.6.

Possible interaction situations between CFU and other supplementary services must then be checked. The SDL diagrams in figure 1.6 shows the function to be performed in the HLR in order to deal with the interactions between CFU and the call restriction and conditional call forwarding services. Also see TS GSM 02.04 and 02.82. For interaction between CFU and other supplementary services (ie not call barring or call forwarding services), the reader is referred to the respective technical specification for those supplementary services.

The Basic Service Group Code

If the activation request received by the HLR doesn't contain any basic service group code, the activation request shall apply to all subscribed basic service groups against which a CFU forwarded-to number is registered. If a forwarded-to number is not registered against even a subset of the required basic service group, the request will be rejected.

Note that according to TS GSM 02.04, a request for activation shall still be accepted although the CFU supplementary service was already active for all basic service groups.

Notification to the subscriber

The network will return notification of acceptance, partial acceptance or rejection of the request to the mobile station.

The information flow for activation of CFU is shown in figure 1.5.
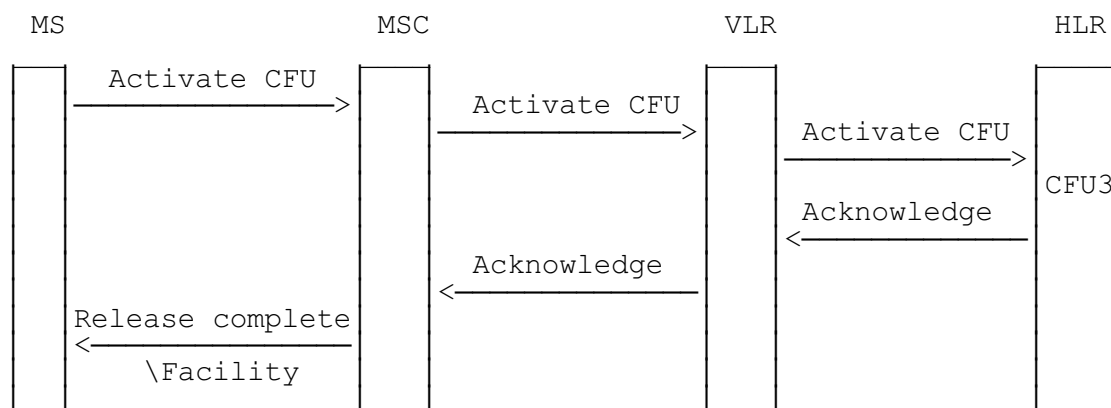
Figure 1.5: Activation of call forwarding unconditional

Process CFU3   382_16(1)

idle

activate
CFU

CFU
registered
for required   no
BS

yes

BAIC   yes
active

no

BAOC   yes
active

no

BOIC/   yes
BOIC-exHC
active

no

yes   ftn in
HPLMN
country

make any
operative BIC-Roam   no
and CCF services
quiescent

set   set   set
result   error   error

acknowledge

CCF:	"Conditional" Call Forwarding.
BS:	Basic Service group.
ftn:	forwarded-to number.
BAIC:	Barring of All Incoming Calls.
BAOC:	Barring of All Outgoing Calls.
BOIC:	Barring of Outgoing International Calls.
BOIC-exHC:	Barring of Outgoing International Calls - except those directed to HPLMN Country.

idle

Figure 1.6: CFU3 Call forwarding unconditional activation process

1.1.4 Deactivation

The previous activation can be deactivated in either of the following three ways:

-   The subscriber can specifically deactivate a previous activation (to a basic service group) with an appropriate control procedure;

-   the subscriber can register information for CFU (to a basic service group), thus causing previous registrations and activations of CFU to be overridden (this shall be handled in the same way as an erasure (implying deactivation) immediately followed by a registration (implying activation));

-   the service is deactivated as a result of withdrawal of the supplementary service (administrative handling).

Possible interaction situations between CFU and other supplementary services must be checked. The SDL diagram in figure 1.8 shows the function to be performed in the HLR in order to deal with the possible interactions between CFU and the conditional call forwarding services.

The Basic Service Group Code

The CFU deactivation request may specify a basic service group for which deactivation is required. If the deactivation request received by the HLR doesn't contain any basic service group code, the deactivation request shall apply to all basic services for which CFU is active, see figure 1.8.

If the deactivation request received by the HLR contains a basic service group code, only information related to the specified basic service group(s) is affected. Note that according to TS GSM 02.04, a request for deactivation shall still be accepted even if the CFU supplementary service was already deactive for all basic service groups.

The user shall receive a notification of acceptance or rejection of the CFU deactivation request.

The information flow for deactivation of call forwarding unconditional is shown in figure 1.7.

```
     MS                  MSC                 VLR                 HLR
 ┌───────┐           ┌───────┐           ┌───────┐           ┌───────┐
 │       │Deactivate CFU     │           │       │           │       │
 │       ├───────────>       │Deactivate CFU     │           │       │
 │       │           │       ├───────────>       │Deactivate CFU     │
 │       │           │       │           │       ├───────────>       │
 │       │           │       │           │       │           │ CFU4  │
 │       │           │       │           │       │ Acknowledge       │
 │       │           │       │Acknowledge│       <───────────┤       │
 │Release complete   │       <───────────┤       │           │       │
 <───────────────────┤       │           │       │           │       │
 │      \Facility     │       │           │       │           │       │
 └───────┘           └───────┘           └───────┘           └───────┘
```
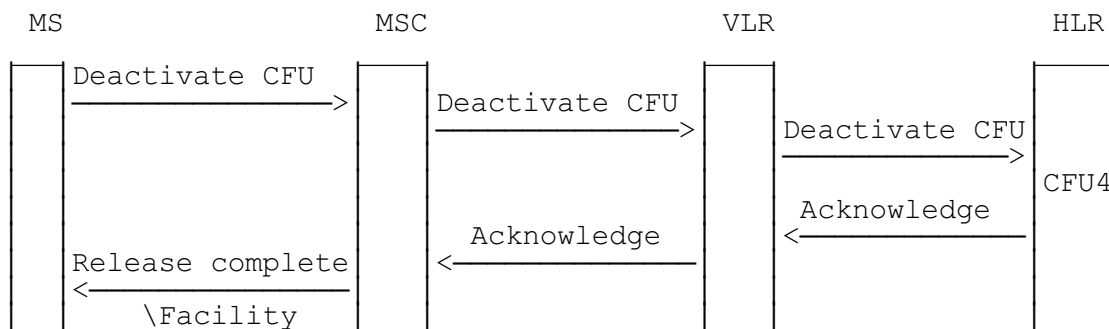
Figure 1.7: Deactivation of call forwarding unconditional

Process CFU4   382_18(1)

idle

deactivate
CFU

BS
included
in request   no

yes

set BS =
all BS

CFU
active for
subset BS   no

yes

BIC-Roam or
conditional
forwarding
quiescent   no

yes

make
quiescent
services
operative

set
error

set
result

acknowledge

BS: Basic Service group.
BIC-Roam: Barring of Incoming Calls when
           Roaming outside the home PLMN country.

idle
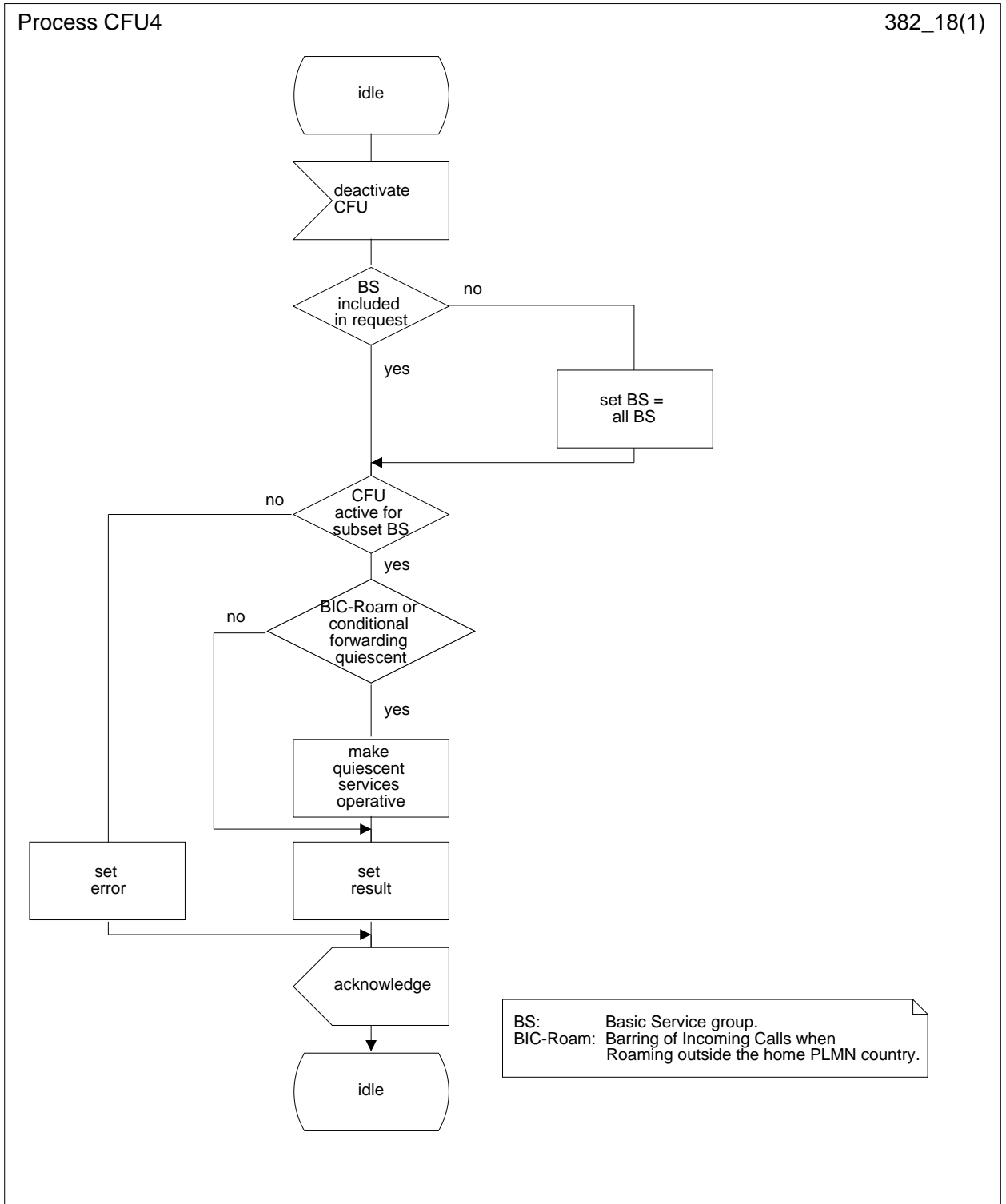
Figure 1.8: CFU4 Call forwarding unconditional deactivation process

1.1.5 Interrogation

Data request

The data request procedure enables the mobile subscriber to obtain information about the data stored in the PLMN. Interrogation of CFU is handled by the HLR which returns the required information or error to the MS, see figure 1.9.

```
     MS                   MSC                   VLR                   HLR
      |                    |                     |                     |
      | Interrogate CFU    |                     |                     |
      |------------------->|                     |                     |
      |                    | Interrogate CFU     |                     |
      |                    |-------------------->|                     |
      |                    |                     | Interrogate CFU     |
      |                    |                     |-------------------->|
      |                    |                     |     Acknowledge     |
      |                    |                     |<--------------------|
      |                    |     Acknowledge     |                     |
      |                    |<--------------------|                     |
      | Release complete   |                     |                     |
      |<-------------------|                     |                     |
      |     \Facility      |                     |                     |
      |                    |                     |                     |
```
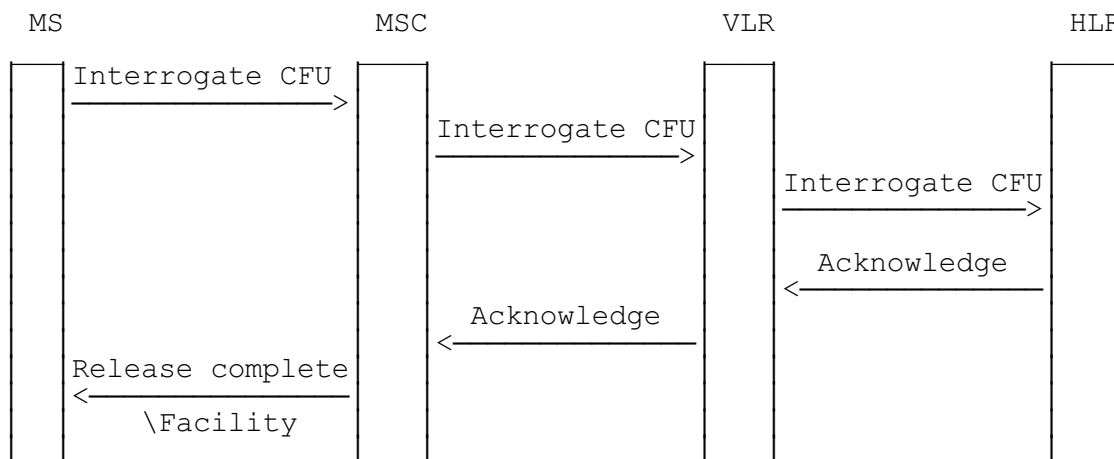
Figure 1.9: Interrogation of call forwarding unconditional

1.2 Functions and information flows

The following Mobile Additional Function has been identified for the PLMN:

MAF007
>   Call forwarding unconditional authorizations examination
>   The ability of a PLMN component to determine the authorizations relating to CFU.
>   See figure 1.10.
>   Location: HLR.

The information flow for call forwarding unconditional is shown in figure 1.11.

Process MAF007   382_1A(1)

idle

initiate
handling
of CFU

active
for this
BS — no

yes

number
of forwardings — yes
reached

no

increment counter
get forwarded-to number
set forwarding cause=CFU

notification
to calling — yes
subscriber

no

set
error

set indicator =
'notify calling
subscriber'

set indicator =
'set up
normal call'

continue
call
handling

idle

BS : Basic Service group.
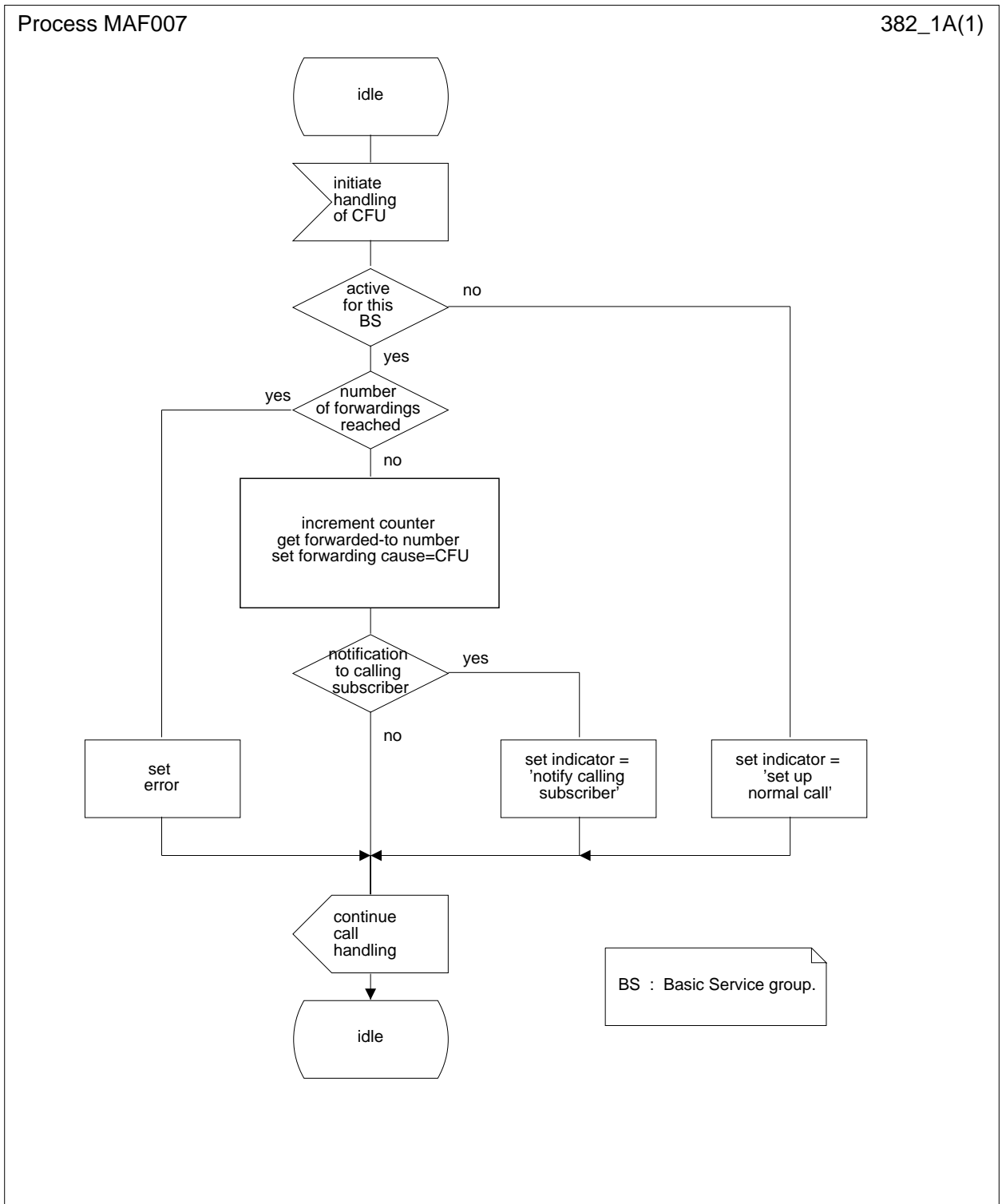
Figure 1.10: MAF007 Call forwarding unconditional authorisations examination (HLR)

```
MSa/TEa            GMSC              HLRb      MSCb            LEc

  |       Set-up     |                |         |              |
  |----------------->|                |         |              |
  |                  |  Info request  |         |              |
  |                  |--------------->|         |              |
  |                  |    Info ack    | MAF007  |              |
  |                  |<---------------|         |              |
  |                  |      Set-up    |         |              |
  |             OR1:N|------------------------->|              |
  |                  |      Set-up    |  |   |  |              |
  |             OR1:Y|------------------------------------->   |
  |    Notification  |                |  |   |  |              |
  |<-----------------|OR2:Y           |  |   |  |              |
  |                  |                |  |   |  |              |
```

```
MSa/TEa            GMSC              HLRb    MSCb  HLRc    SCc

  |      Set-up      |                |       |     |      |
  |----------------->|                |       |     |      |
  |                  |  Info request  |       |     |      |
  |                  |--------------->|       |     |      |
  |                  |   Info ack     | MAF007|     |      |
  |                  |<---------------|       |     |      |
  |                  |     Set-up     |       |     |      |
  |            OR1:N |--------------------->  |     |      |
  |                  | Information request |  |     |      |
  |            OR1:Y |------------------------------>      |
  |                  | Information acknowledge |  |        |
  |                  |<-----------------------------|      |
  |                  |     Set-up     |  |  | |  |  |      |
  |                  |------------------------------------>|
  |    Notification  |                |  |  | |  |  |      |
  |<-----------------|OR2:Y           |  |  | |  |  |      |
  |                  |                |  |  | |  |  |      |
```
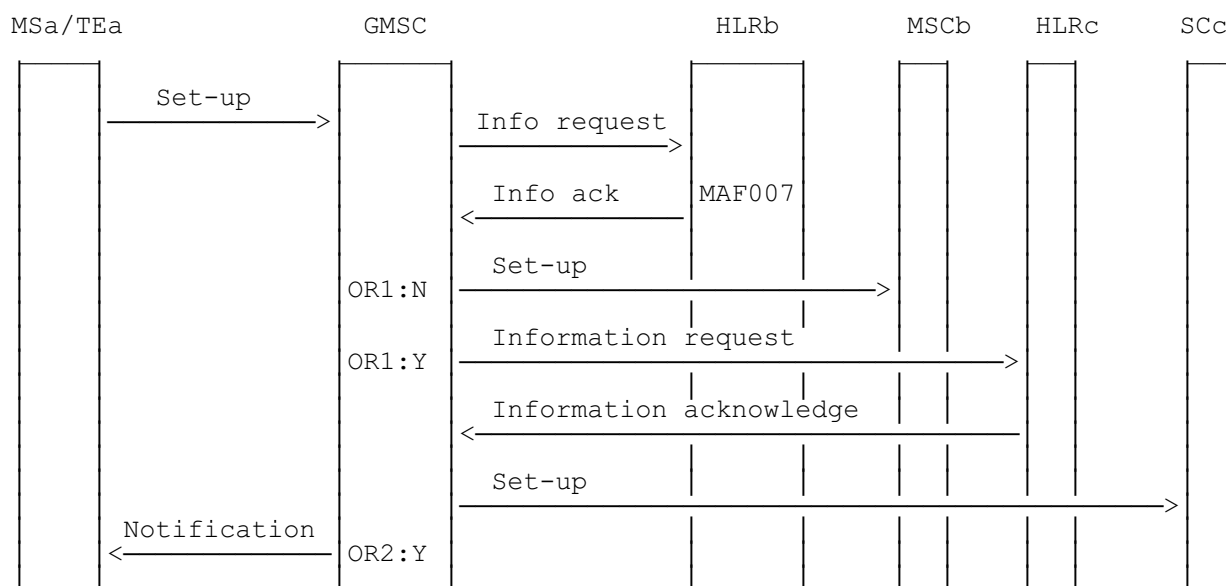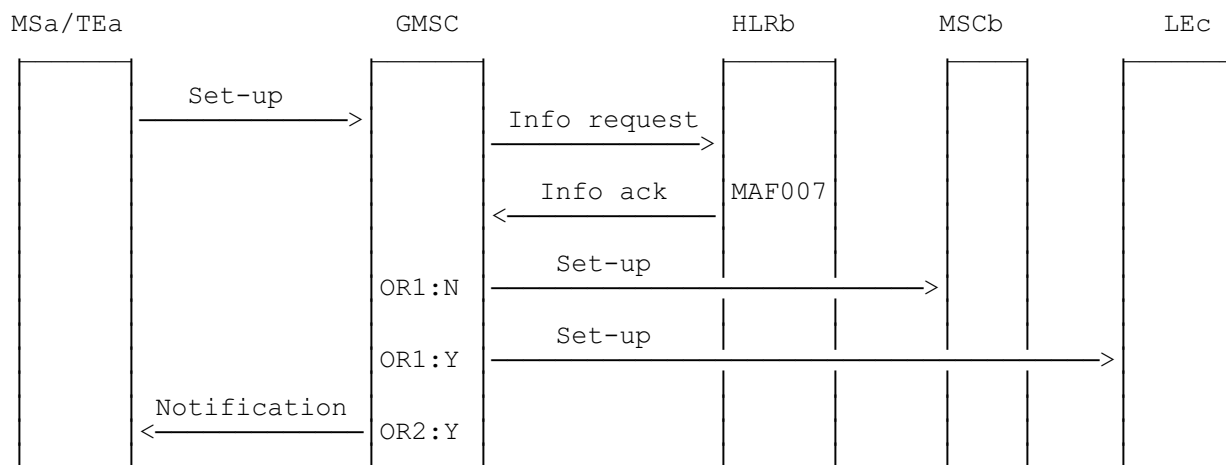
NOTE: info: information   Y: Yes
         req: request   N: No
         ack: acknowledge
         OR1: Forwarding requested
         OR2: Notification to calling subscriber required

Figure 1.11: Information flow for call forwarding unconditional

1.3 Information stored in the HLR

The following logical states are applicable for CFU (refer to TS GSM 03.11 for an explanation of the notation):

Provisioning State	Registration State	Activation State	HLR Induction State
(Not Provisioned,	Not Registered,	Not Active,	Not Induced)
(Provisioned,	Not Registered,	Not Active,	Not Induced)
(Provisioned,	Registered,	Not Active,	Not Induced)
(Provisioned,	Registered,	Active and Quiescent,	Not Induced)
(Provisioned,	Registered,	Active and Operative,	Not Induced)

The registration and activation state may be different for each applicable elementary basic service group.

The provisioning state shall be on a per subscriber basis, and hence the same for all basic service groups.

The HLR shall store:

-       the state of CFU (which shall be one of the valid states listed above) for each applicable elementary basic service group;

-       the subscription option "notification to the calling party" on a per subscriber basis;
        This subscription option takes one of the following values:
        -       no notification;
        -       notification.

-       the registration parameter "forwarded-to number" (possibly including a forwarded-to sub-address) for each applicable elementary basic service group.

Note that the value "Active and Quiescent" of the activation state is required in case of interaction with Operator Determined Barring (see TS GSM 03.15).

1.4 State transition model

The following figure shows the successful cases of transition between the applicable logical states of CFU. The state changes are either caused by actions of the service provider, the mobile user or the network.

Note that error cases are not shown in the diagram as they normally do not cause a state change. Additionally, some successful requests may not cause a state change. Hence, they are not shown in the diagram.

The diagram only shows operations on an elementary basic service group.
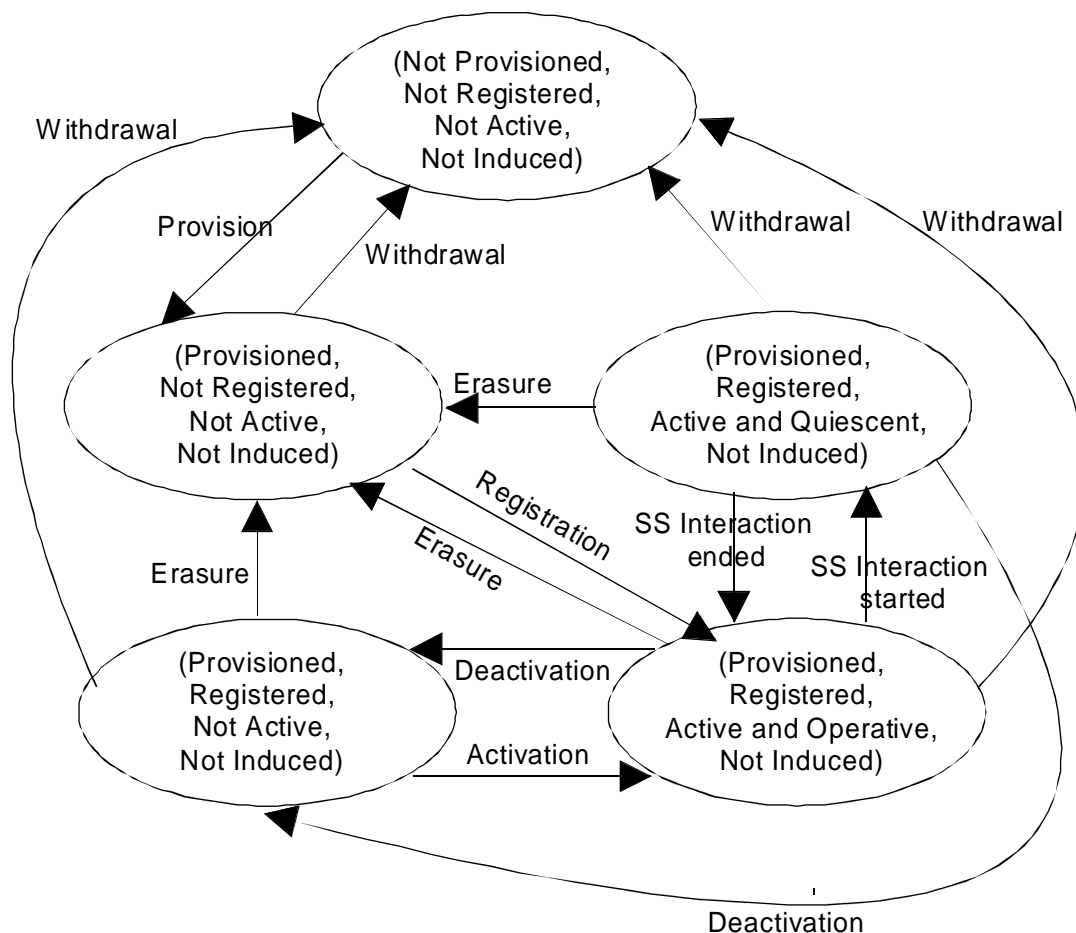
Figure 1.12: State transition model for CFU

1.5 Transfer of information from HLR to VLR

If the provisioning state for CFU is "Provisioned" then, when the subscriber registers on a VLR, the HLR shall send that VLR information about the logical state of CFU for all relevant elementary basic service groups.

If the logical state of CFU is changed while a subscriber is registered on a VLR then for the affected basic service groups, the HLR shall inform the VLR of the new logical state of CFU.

1.6 Information stored in the VLR

For CFU the VLR shall store the service state information received from the HLR for all relevant elementary basic service groups.

1.7 Handover

Handover will have no impact on the control procedure and the operation of the service.

1.8 Cross phase compatibility

1.8.1 MS, MSC, VLR or HLR only support phase 1 control of SS by the subscriber

In response to a CFU interrogation request, if the MS or any network element involved is of phase 1, only information concerning basic service groups for which the activation state has the value "Active and Operative" will be returned. This means, for example, that the subscriber will not be aware that the forwarded to number is registered if CFU is deactivated. A subaddress (if registered) will not be included in the response.

Note that if any network element involved is of phase 1, CFU Registration requests which use a subaddress and all CFU Activation and Deactivation requests will be rejected, as these are not specified in phase 1.

1.8.2 HLR only supports phase 1 updating of subscriber information

The VLR shall ignore the subscription option "notification to the calling party" and the registration parameter "forwarded to number" when received from a phase 1 HLR.

If the VLR receives the SS-Status parameter from a phase 1 HLR it shall act if it has received the SS-Status parameter with the values shown in the following:

1)   Activated   => A bit = 1, Q bit = 0;

2)   Deactivated   => A bit = 0, Q bit = 0 or 1

1.8.3 VLR only supports phase 1 updating of subscriber information

When passing CFU information to a phase 1 VLR, the HLR shall send the service state information in a form which the VLR can accept, based on the logical state held in the HLR, as follows:

1)   (Provisioned, Not Registered, Not Active, Not Induced)
                      => Erased, Deactivated;

2)   (Provisioned, Registered, Not Active, Not Induced)
                      => Registered, Deactivated;

3)   (Provisioned, Registered, Active and Operative, Not Induced)
                      => Registered, Activated;

4)   (Provisioned, Registered, Active and Quiescent, Not Induced)
                      => Registered, Deactivated.

The HLR shall not pass a subaddress to a phase 1 VLR.

1.8.4 GMSC only supports phase 1 call handling

When a call is forwarded unconditionally, the HLR shall not pass the subaddress to a phase 1 GMSC. Calls shall be forwarded without the subaddress.

2 Call forwarding on mobile subscriber busy

2.1 Handling of call forwarding on mobile subscriber busy

2.1.1 Registration

The same rules apply for the registration of Call Forwarding on Mobile Subscriber Busy as were described for Call Forwarding Unconditional in section 1.1.1 above, with the exception of the checking of interaction with other supplementary services. Basic registration of information is illustrated in figure 2.2.

Supplementary Service Interaction

Possible interaction situations between CFB and other supplementary services must then be checked. This is described in figure 2.2. Also see TS GSM 02.04 and 02.82. For interaction between CFB and other supplementary services (ie not call barring or call forwarding services), the reader is referred to the respective technical specification for those supplementary services.

The information flow for registration of CFB is shown in figure 2.1.

```
    MS                MSC               VLR               HLR

       Register CFB
      ─────────────────>
                          Register CFB
                         ────────────────>
                                            Register CFB
                                           ────────────────>
                                                              CFB1
                                              Acknowledge
                                           <────────────────
                            Acknowledge
                         <────────────────
      Release complete
      <─────────────────
          \Facility
```
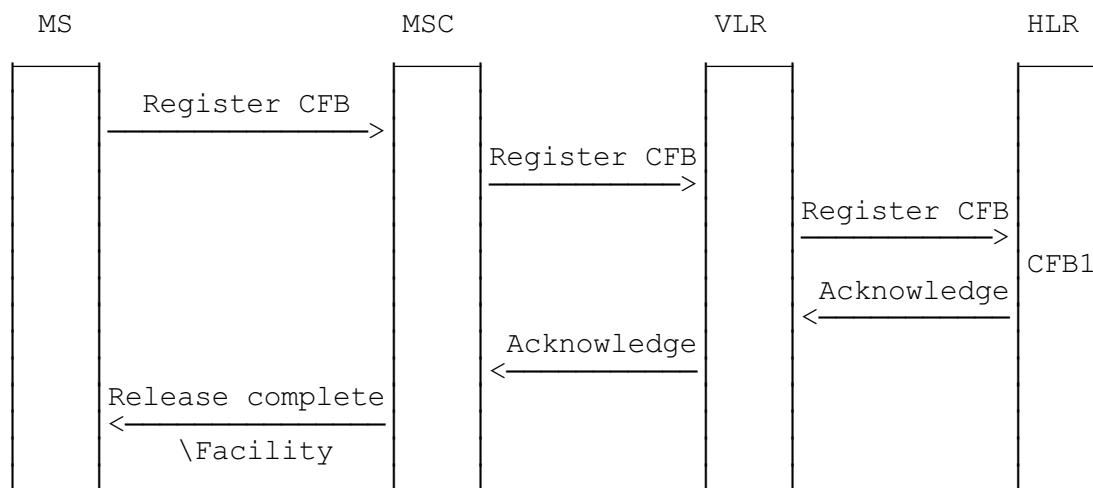
Figure 2.1: Registration of call forwarding on mobile subscriber busy

Process CFB1   382_22(1)

idle

register
CFB

BS included in request → no → set BS = all BS

BS included in request → yes

CFB provided → no

CFB provided → yes

subset of required BS provided → no

subset of required BS provided → yes

valid ftn → no

Not, e.g.:
- special service number;
- own number.

valid ftn → yes

number type → national

number type → international → covert to international (from HPLMN)

BAIC active → yes

BAIC active → no

BIC-Roam active → yes → roaming outside HPLMN country → no

BIC-Roam active → no

roaming outside HPLMN country → yes

BAOC active → yes

BAOC active → no

2   1   2

2

1

BOIC active → yes

BOIC active → no

BOIC-exHC active → yes

BOIC-exHC active → no

ftn in VPLMN country → yes

ftn in VPLMN country → yes

ftn in VPLMN country → no

ftn in HPLMN country → yes

ftn in HPLMN country → no

CFU active → yes

CFU active → no

set error

set result

set error

acknowledge

idle

BS: Basic Service group.
ftn: forwarded-to number.
BAOC: Barring of All Outgoing Calls.
BOIC: Barring of Outgoing International Calls.
BOIC-exHC: Barring of Outgoing International Calls
            except those directed to HPLMN Country.
BAIC: Barring of All Incoming Calls.
BIC-Roam: Barring of Incoming Calls when Roaming
            outside the home PLMN country.

Figure 2.2: CFB1 Call forwarding on mobile subscriber busy registration process

2.1.2　　　　Erasure

The same rules apply for the erasure of CFB as were described for CFU in section 1.1.2 above. However, no checks for interaction with other supplementary services are required for erasure of CFB, see figure 2.4.

The information flow for registration of CFB is shown in figure 2.3.

```
      MS                    MSC                   VLR                   HLR

   ┌──────┐              ┌──────┐              ┌──────┐              ┌──────┐
   │      │   Erase CFB  │      │              │      │              │      │
   │      │─────────────>│      │              │      │              │      │
   │      │              │      │   Erase CFB  │      │              │      │
   │      │              │      │─────────────>│      │              │      │
   │      │              │      │              │      │   Erase CFB  │      │
   │      │              │      │              │      │─────────────>│      │
   │      │              │      │              │      │              │ CFB2 │
   │      │              │      │              │      │  Acknowledge │      │
   │      │              │      │              │      │<─────────────│      │
   │      │              │      │  Acknowledge │      │              │      │
   │      │              │      │<─────────────│      │              │      │
   │      │Release complete      │              │      │              │      │
   │      │<─────────────│      │              │      │              │      │
   │      │   \Facility  │      │              │      │              │      │
   └──────┘              └──────┘              └──────┘              └──────┘
```
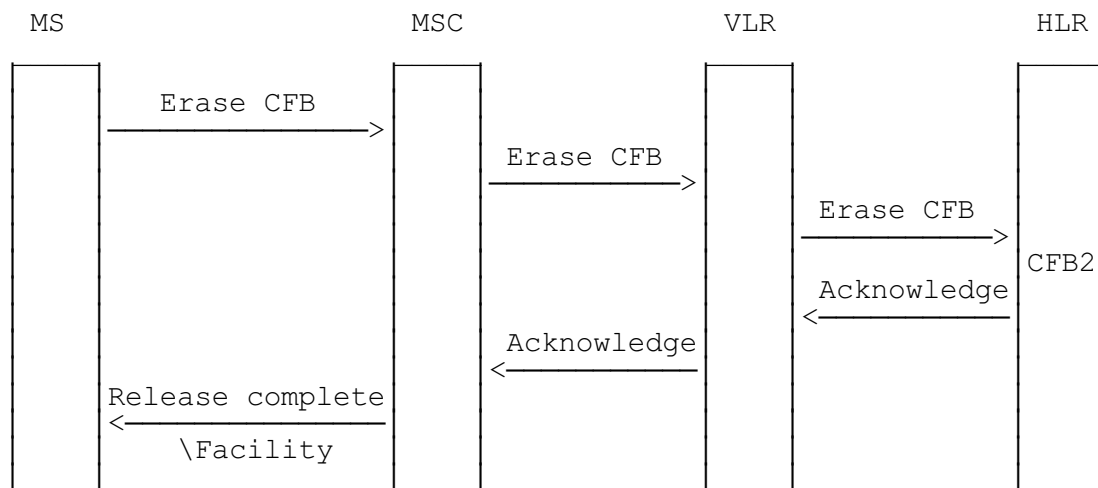
Figure 2.3: Erasure of call forwarding on mobile subscriber busy

Process CFB2   382_24(1)

idle

erase
CFB

BS
included
in request — no

yes

set BS =
all BS

CFB
provided

no — yes

set
error

set
result

acknowledge

idle

BS: Basic Service group.
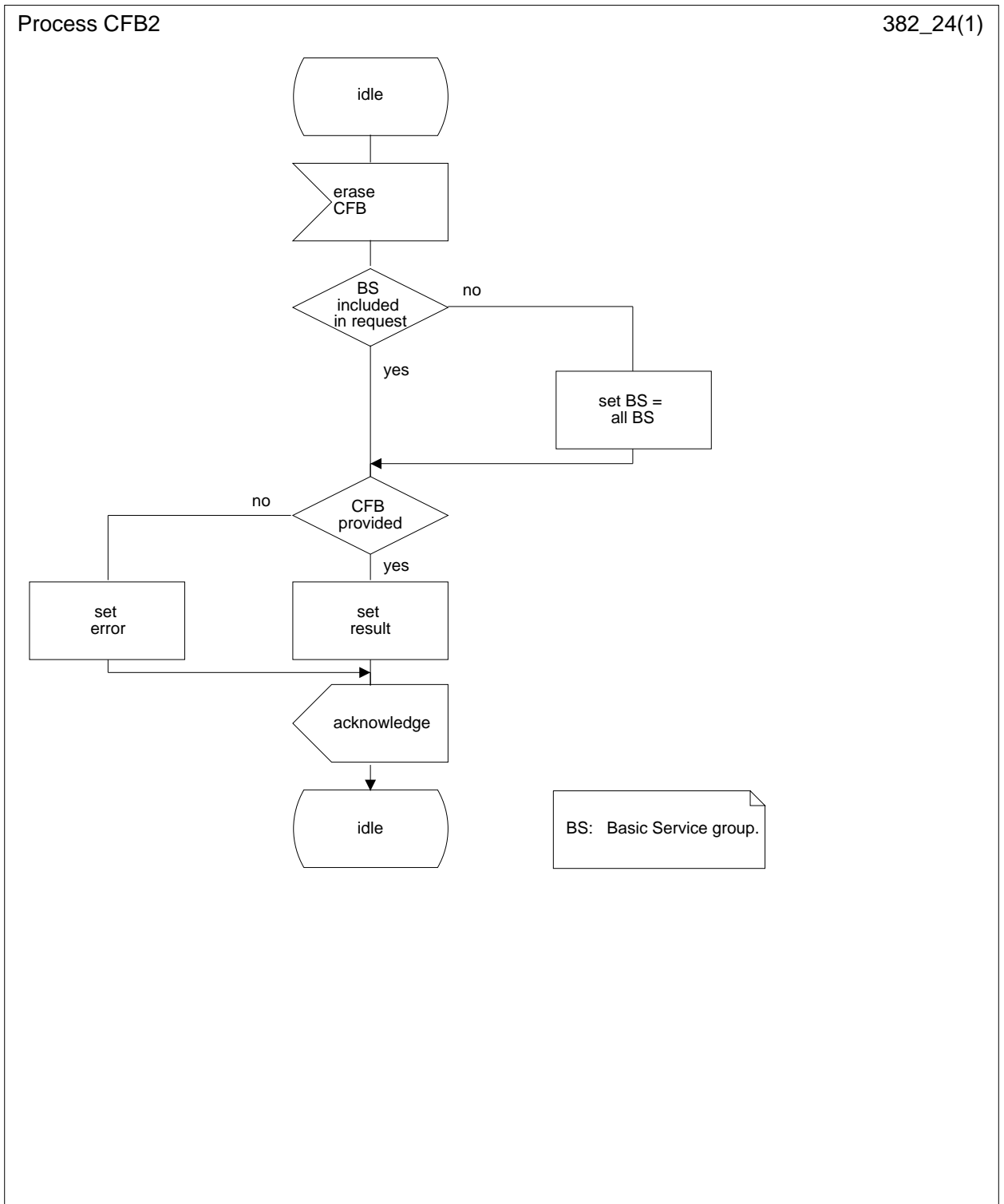
Figure 2.4: CFB2 Call forwarding on mobile subscriber busy erasure process

2.1.3   Activation

The same rules apply for the activation of CFB as were described for CFU in section 1.1.3 above, with the exception of the checking of interaction with other supplementary services. Basic activation of CFNRc is illustrated in figure 2.6.

Supplementary Service Interaction

Possible interaction situations between CFB and other supplementary services must then be checked. This is described in figure 2.6. Also see TS GSM 02.04 and 02.82. For interaction between CFB and other supplementary services (ie not call barring or call forwarding services), the reader is referred to the respective technical specification for those supplementary services.

The information flow for activation of call forwarding on MS busy is shown in figure 2.5.

```
       MS                  MSC                 VLR                 HLR

        |   Activate CFB    |                   |                   |
        |------------------>|   Activate CFB    |                   |
        |                   |------------------>|   Activate CFB    |
        |                   |                   |------------------>|
        |                   |                   |                   | CFB3
        |                   |                   |   Acknowledge     |
        |                   |                   |<------------------|
        |                   |   Acknowledge     |                   |
        | Release complete  |<------------------|                   |
        |<------------------|                   |                   |
        |     \Facility     |                   |                   |
        |                   |                   |                   |
```
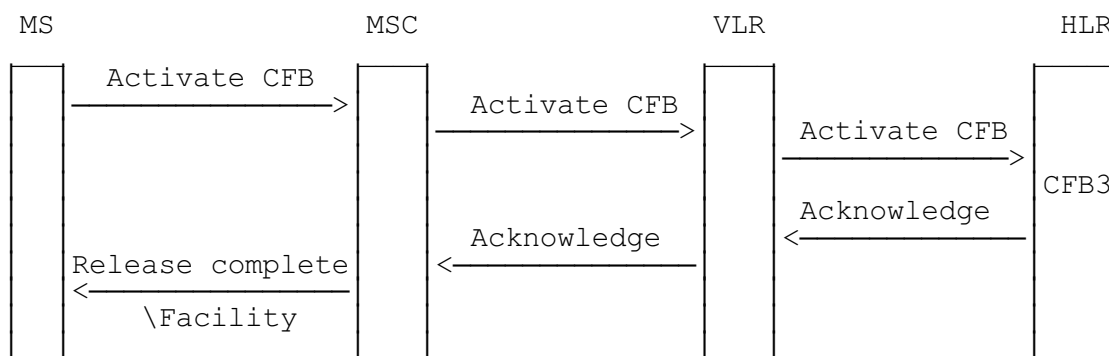
Figure 2.5: Activation of call forwarding on MS busy
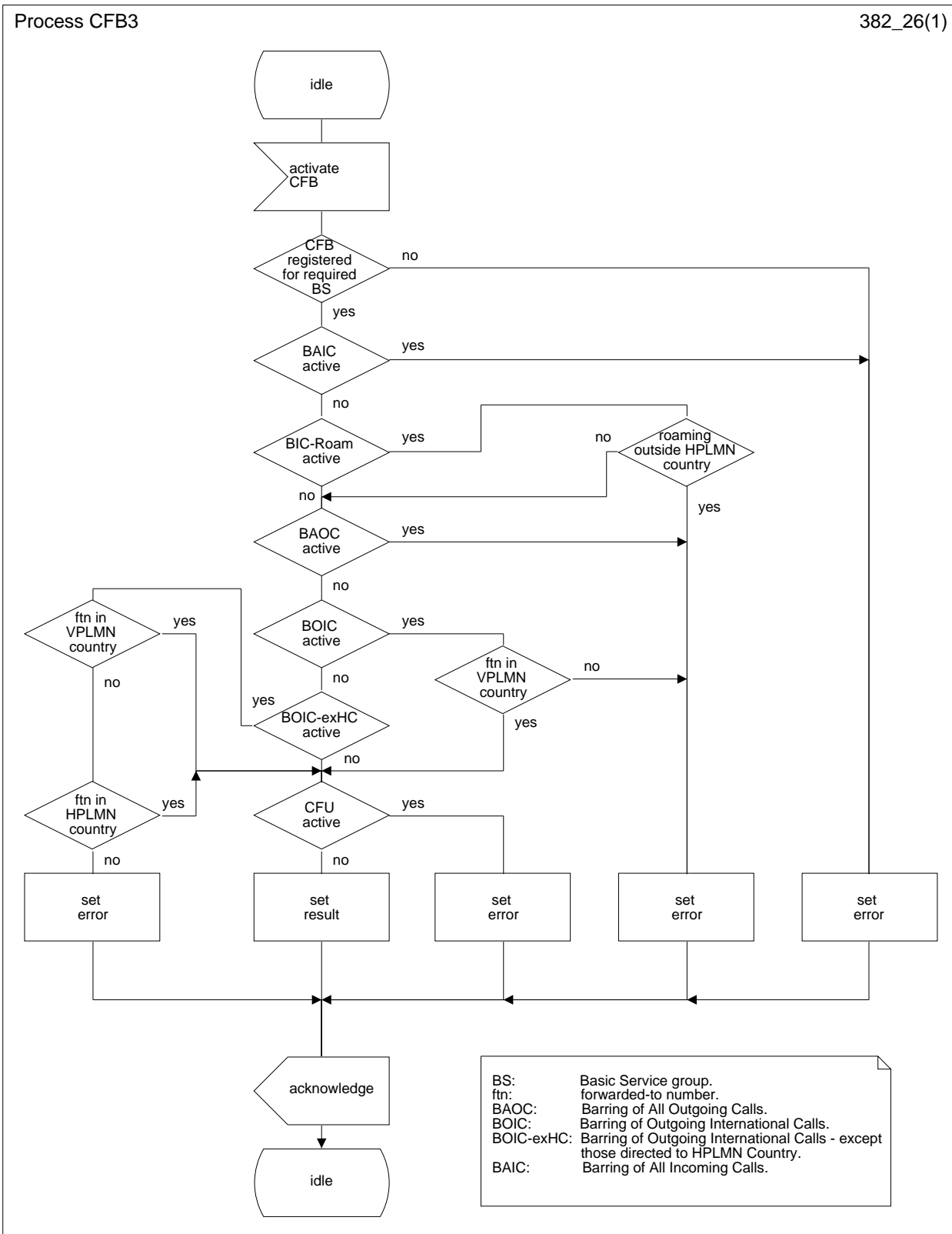
Figure 2.6: CFB3 Call forwarding on mobile subscriber busy activation process

2.1.4   Deactivation

The same rules apply for the deactivation of CFB as were described for CFU in section 1.1.4 above, see figure 2.8.

The information flow for deactivation of call forwarding on mobile subscriber busy is shown in figure 2.7.
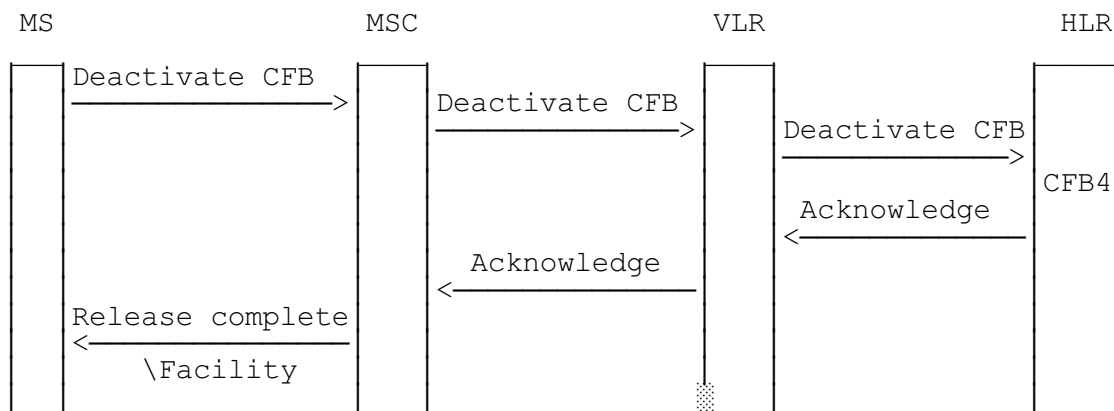
Figure 2.7: Deactivation of call forwarding on mobile subscriber busy

Process CFB4   382_28(1)

idle

deactivate
CFB

BS
included
in request   no

yes

set BS =
all BS

no   CFB
active for
subset BS

yes

set
error

set
result

acknowledge

idle

BS: Basic Service group.
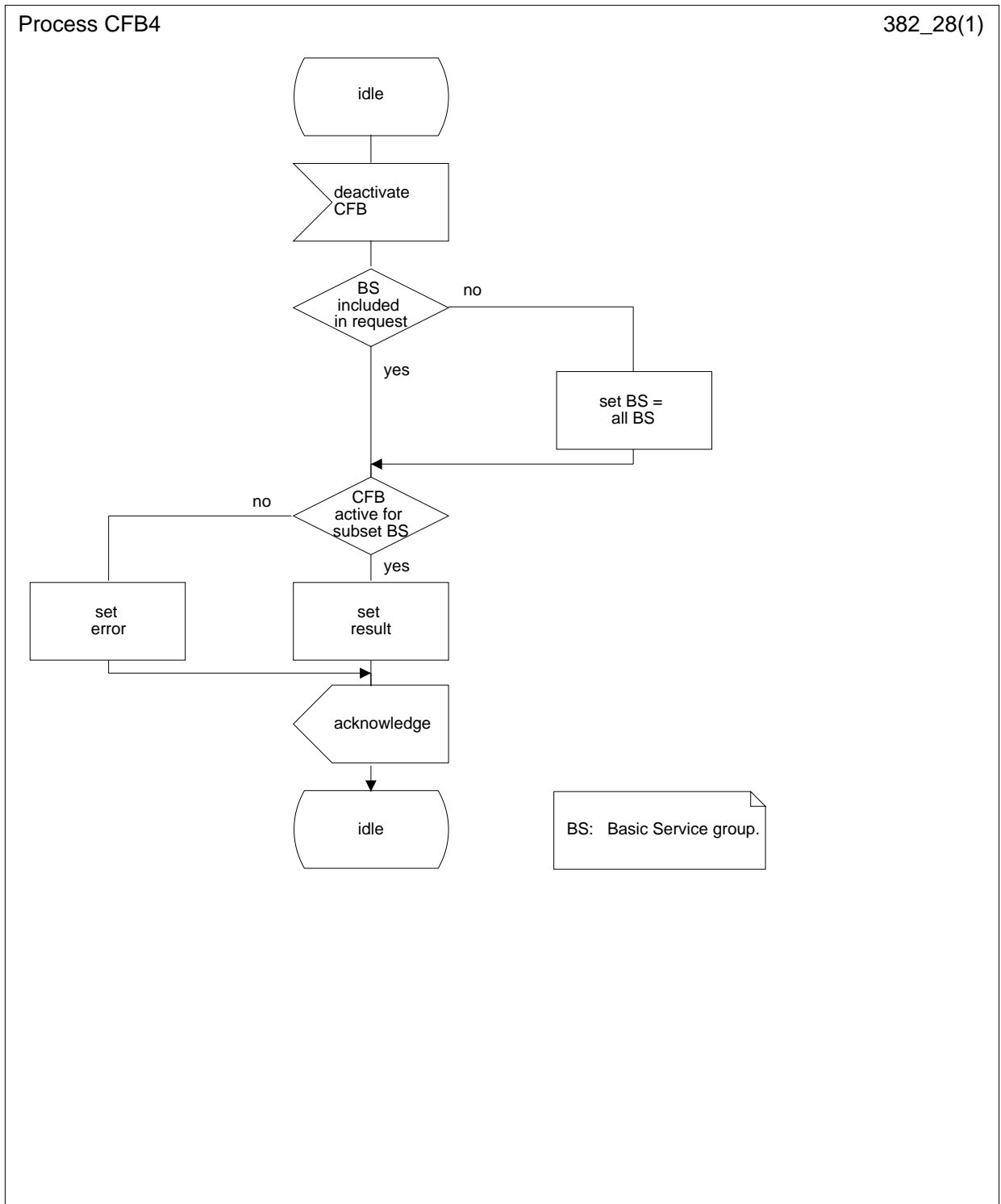
Figure 2.8: CFB4 Call forwarding on mobile subscriber busy deactivation process

2.1.5 Interrogation

Data request

The data request procedure enables the mobile subscriber to obtain information about the data stored in the PLMN. Interrogation of CFB is handled by the VLR which returns the required information or error to the MS, see figure 2.9.

```
        MS                    MSC                    VLR                    HLR

         ┌─┐                  ┌─┐                    ┌─┐                    ┌─┐
         │ │ Interrogate CFB  │ │                    │ │                    │ │
         │ │─────────────────>│ │                    │ │                    │ │
         │ │                  │ │ Interrogate CFB    │ │                    │ │
         │ │                  │ │───────────────────>│ │                    │ │
         │ │                  │ │    Acknowledge     │ │                    │ │
         │ │                  │ │<───────────────────│ │                    │ │
         │ │ Release complete │ │                    │ │                    │ │
         │ │<─────────────────│ │                    │ │                    │ │
         │ │      \Facility    │ │                    │ │                    │ │
         └─┘                  └─┘                    └─┘                    └─┘
```
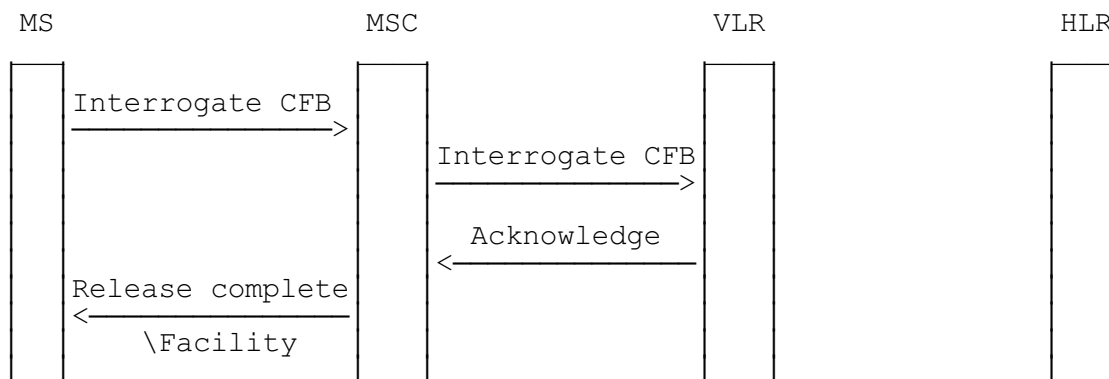
Figure 2.9: Interrogation of call forwarding on mobile subscriber busy

2.2 Functions and information flows

The following Mobile Additional Function has been identified for the PLMN:

MAF008

> Call forwarding on mobile subscriber busy authorizations examination
> The ability of a PLMN component to determine the authorizations relating to call forwarding on mobile subscriber busy. See figure 2.10.
> Location: VLR.

The information flows for forwarding to fixed terminal and to mobile station are shown in figures 2.11 & 2.12 and 2.13 & 2.14 respectively.

Process MAF008   382_2A(1)

idle

initiate
handling
of CFB

active
for this BS — no

yes

number
of forwardings — yes
reached

no

increment counter
get forwarded-to number
set forwarding cause=CFB

UDUB — UDUB
or
NDUB

NDUB

notification
to forwarding — yes
subscriber

no

set indicator =
'notify forwarding
subscriber'

notification
to calling — yes
subscriber

no

set error

set indicator =
'notify calling
subscriber'

set indicator =
'normal call
busy'

continue
call
handling

idle

NDUB:	Network Determined User Busy.
UDUB:	User Determined User Busy.
BS:	Basic Serice group.

Figure 2.10: MAF008 Call forwarding on mobile subscriber busy authorisations examination (VLR)
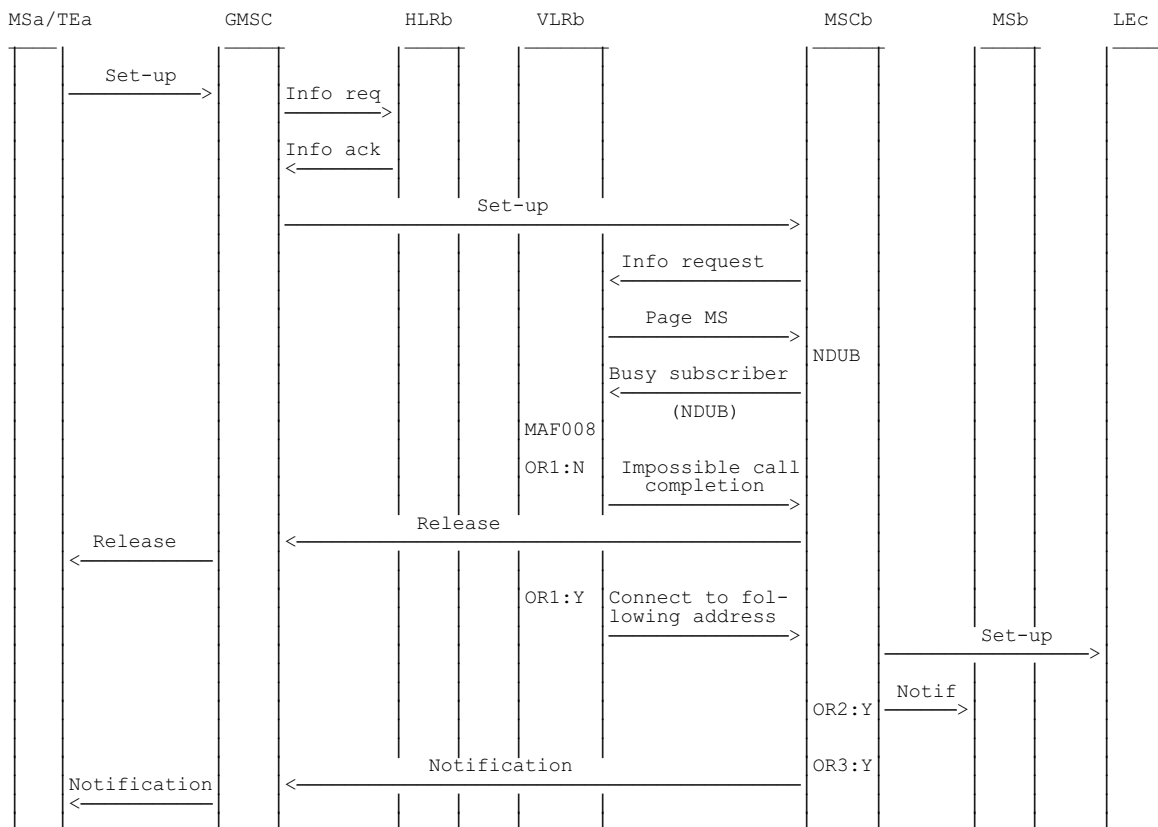
```
MSa/TEa      GMSC      HLRb    VLRb                    MSCb         MSb        LEc

  |   Set-up   |        |       |                       |           |          |
  |----------->|        |       |                       |           |          |
  |            | Info req|      |                       |           |          |
  |            |-------->|      |                       |           |          |
  |            | Info ack|      |                       |           |          |
  |            |<--------|      |                       |           |          |
  |            |       Set-up   |                       |           |          |
  |            |------------------------------------->  |           |          |
  |            |        |       |     Info request      |           |          |
  |            |        |       |<----------------------|           |          |
  |            |        |       |       Page MS         |           |          |
  |            |        |       |---------------------->|           |          |
  |            |        |       |                      NDUB         |          |
  |            |        |       |    Busy subscriber    |           |          |
  |            |        |       |<----------------------|           |          |
  |            |        |       |         (NDUB)        |           |          |
  |            |        |   MAF008                      |           |          |
  |            |        |       |                       |           |          |
  |            |        |   OR1:N  Impossible call      |           |          |
  |            |        |          completion           |           |          |
  |            |        |       |---------------------->|           |          |
  |            |     Release    |                       |           |          |
  |            |<-------------------------------------  |           |          |
  |  Release   |        |       |                       |           |          |
  |<-----------|        |       |                       |           |          |
  |            |        |   OR1:Y  Connect to fol-      |           |          |
  |            |        |          lowing address       |           |          |
  |            |        |       |---------------------->|           |          |
  |            |        |       |                       |   Set-up  |          |
  |            |        |       |                       |---------------------->|
  |            |        |       |                      OR2:Y  Notif |          |
  |            |        |       |                       |---------->|          |
  |            |        |       |                      OR3:Y        |          |
  |            |     Notification|                      |           |          |
  |            |<-------------------------------------  |           |          |
  | Notification|       |       |                       |           |          |
  |<-----------|        |       |                       |           |          |
```

NOTE: NDUB: Network Determined User Busy
           info: information   Y: Yes
           req: request   N: No
           ack: acknowledge
           notif: notification
           OR1:   Call to be forwarded
           OR2:   Notification to forwarding subscriber required
           OR3:   Notification to calling subscriber required

**Figure 2.11: Information flow for call forwarding on mobile subscriber busy
(to fixed terminal) (NDUB)**
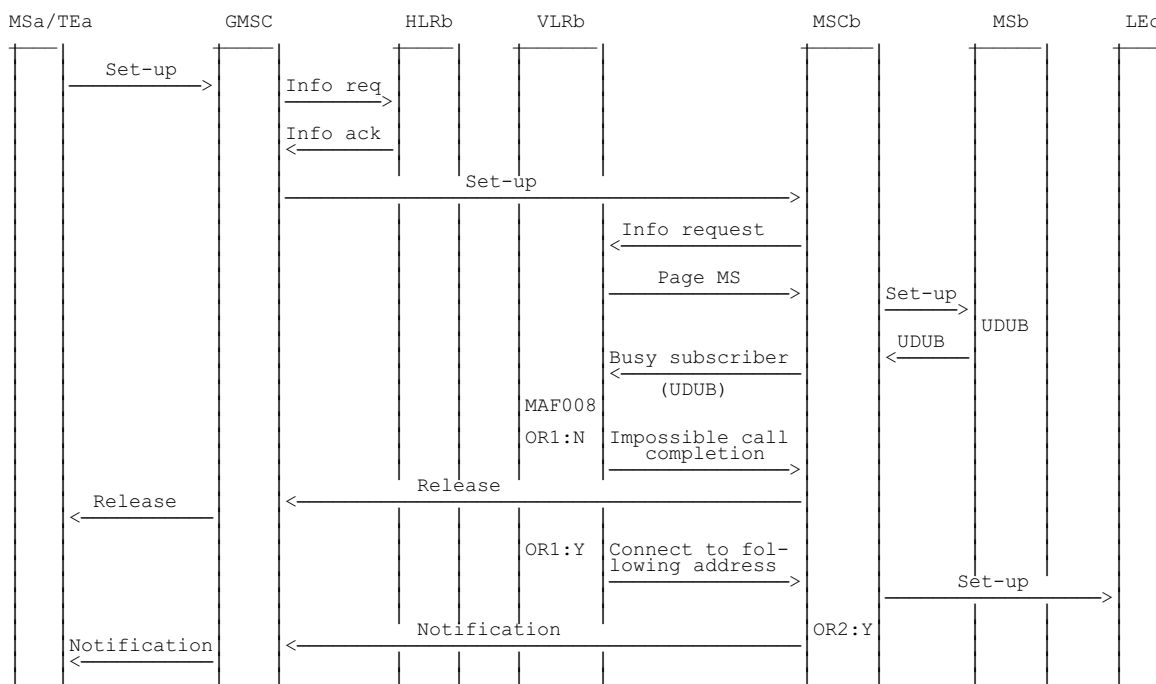
NOTE: UDUB: User Determined User Busy
          info: information   Y: Yes
          req: request   N: No
          ack: acknowledge
          notif: notification
          OR1: Call to be forwarded
          OR2: Notification to calling subscriber required

**Figure 2.12: Information flow for call forwarding on mobile subscriber busy
(to fixed terminal) (UDUB)**
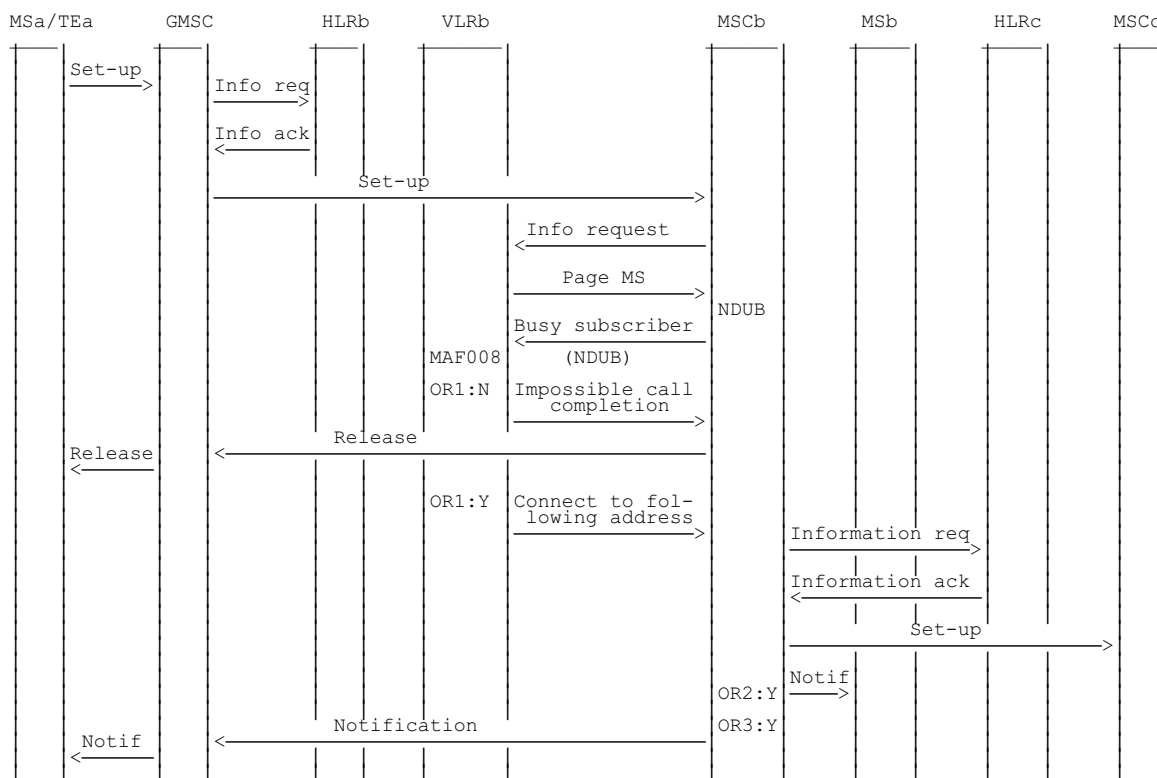
NOTE: NDUB: Network Determined User Busy
info: information Y: Yes
req: request N: No
ack: acknowledge
notif: notification
OR1: Call to be forwarded
OR2: Notification to forwarding subscriber required
OR3: Notification to calling subscriber required

**Figure 2.13: Information flow for call forwarding on mobile subscriber busy
(to mobile station) (NDUB)**
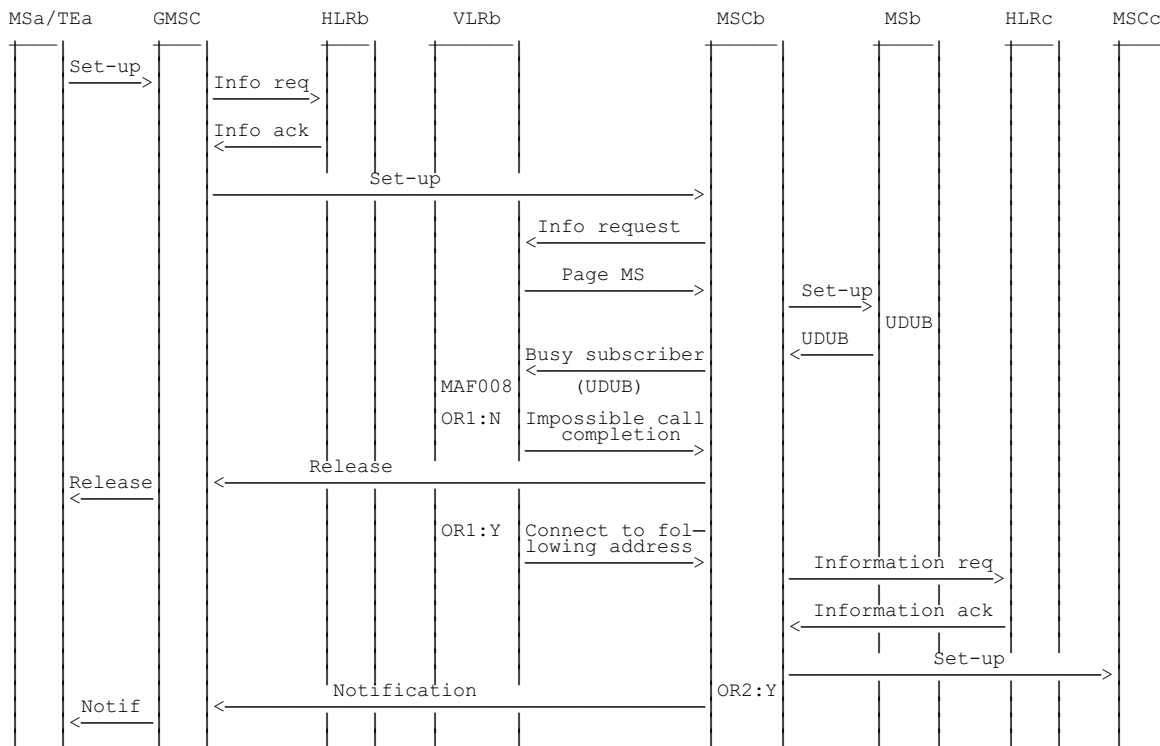
```
MSa/TEa   GMSC      HLRb      VLRb                MSCb        MSb       HLRc      MSCc

    Set-up
    ─────────>
              Info req
              ─────────>
              Info ack
              <─────────
                   Set-up
              ────────────────────────────────────>
                             Info request
                             <───────────────────
                              Page MS
                             ───────────────────>
                                                    Set-up
                                                   ─────────>
                                                    UDUB      UDUB
                                                   <─────────
                             Busy subscriber
                             <───────────────────
                   MAF008     (UDUB)
                   OR1:N     Impossible call
                              completion
                             ───────────────────>
    Release        Release
    <──────────────────────────────────────────
                   OR1:Y     Connect to fol-
                             lowing address
                             ───────────────────>
                                                    Information req
                                                   ────────────────────────────>
                                                    Information ack
                                                   <────────────────────────────
                                                              Set-up
                                                   ──────────────────────────────────────>
    Notif          Notification              OR2:Y
    <──────────────────────────────────────────
```

```
NOTE:     UDUB:  User Determined User Busy
          info:  information          Y: Yes
          req:   request              N: No
          ack:   acknowledge
          notif: notification
          OR1:   Call to be forwarded
          OR2:   Notification to calling subscriber required
```

**Figure 2.14: Information flow for call forwarding on mobile subscriber busy
(to mobile station) (UDUB)**

2.3 Information stored in the HLR

The following logical states are applicable for CFB (refer to TS GSM 03.11 for an explanation of the notation):

Provisioning State	Registration State	Activation State	HLR Induction State
(Not Provisioned,	Not Registered,	Not Active,	Not Induced)
(Provisioned,	Not Registered,	Not Active,	Not Induced)
(Provisioned,	Registered,	Not Active,	Not Induced)
(Provisioned,	Registered,	Active and Quiescent,	Not Induced)
(Provisioned,	Registered,	Active and Operative,	Not Induced)

The registration and activation state may be different for each applicable elementary basic service group.

The provisioning state shall be on a per subscriber basis, and hence the same for all basic service groups.

The HLR shall store:

- the state of CFB (which shall be one of the valid states listed above) for each applicable elementary basic service group;

- the subscription option "notification to the calling party" on a per subscriber basis;
  This subscription option takes one of the following values:
  - no notification;
  - notification.

- the subscription option "notification to the forwarding party" on a per subscriber basis;
  This subscription option takes one of the following values:
  - no notification;
  - notification.

- the registration parameter "forwarded-to number" (possibly including a forwarded-to sub-address) for each applicable elementary basic service group.

2.4   State transition model

The following figure shows the successful cases of transition between the applicable logical states of CFB. The state changes are either caused by actions of the service provider, the mobile user or the network.

Note that error cases are not shown in the diagram as they normally do not cause a state change. Additionally, some successful requests may not cause a state change. Hence, they are not shown in the diagram. The diagram only shows operations on an elementary basic service group.
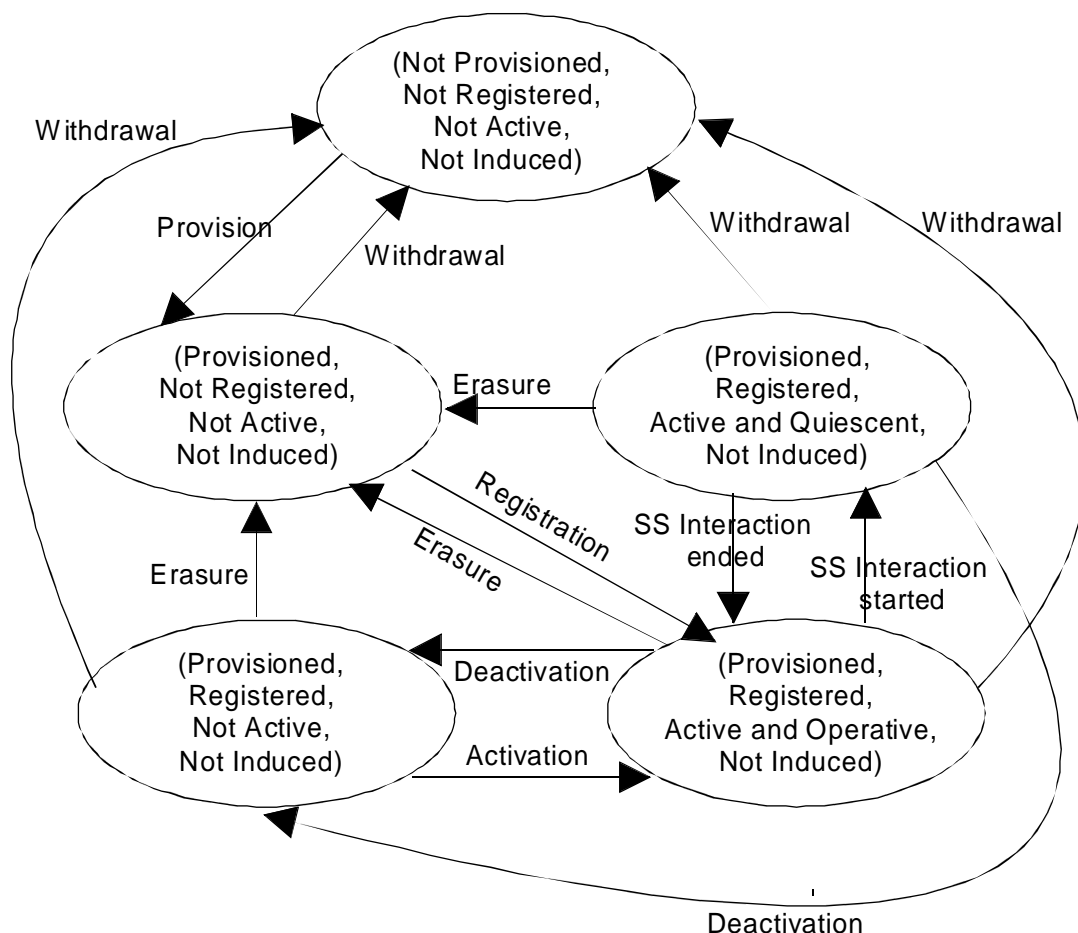
Figure 2.15: State transition model for CFB

2.5   Transfer of information from HLR to VLR

If the provisioning state for CFB is "Provisioned" then, when the subscriber registers on a VLR, the HLR shall send that VLR information about the logical state of CFB for all relevant elementary basic service groups and information about the subscription options "notification to the calling party" and "notification to the forwarding party".

If the registration state for CFB is "Registered" then, when the subscriber registers on a VLR, the HLR shall send that VLR the registration parameter "forwarded-to number" for all relevant elementary basic service groups.

If the logical state or the registration parameter "forwarded-to number" of CFB is changed while a subscriber is registered on a VLR then for the affected basic service groups, the HLR shall inform the VLR respectively of the new logical state or the new registration parameter of CFB.

2.6 Information stored in the VLR

For CFB the VLR shall store the service state information and the subscription options received from the HLR.

2.7 Handover

Handover will have no impact on the control procedure and the operation of the service.

2.8 Cross phase compatibility

2.8.1 MS, MSC, VLR or HLR only support phase 1 control of SS by the subscriber

In response to a CFB interrogation request, if the MS or any network element involved is of phase 1, only information concerning basic service groups for which the activation state has the value "Active and Operative" will be returned. This means that the subscriber will not be aware that the forwarded to number is registered if CFB is deactivated or active (quiescent). A subaddress (if registered) will not be included.

Note that if any network element involved is of phase 1, CFB Registration requests which use a subaddress and all CFB Activation and Deactivation requests will be rejected, as these are not specified in phase 1.

2.8.2 HLR only supports phase 1 updating of subscriber information

If the VLR receives the SS-Status parameter from a phase 1 HLR it shall act if it has received the SS-Status parameter with the values shown in the following:

1) Registered, Activated => P bit =1, R bit = 1, A bit = 1, Q bit = 0;

2) Registered, Deactivated => P bit =1, R bit = 1, A bit = 0, Q bit = 0 or 1;

3) Erased => P bit =1, R bit = 0, A bit = 0, Q bit = 0 or 1.

2.8.3 VLR only supports phase 1 updating of subscriber information

When passing CFB information to a phase 1 VLR, the HLR shall send the service state information in a form which the VLR can accept, based on the logical state held in the HLR, as follows:

1) (Provisioned, Not Registered, Not Active, Not Induced)
=> Erased, Deactivated;

2) (Provisioned, Registered, Not Active, Not Induced)
=> Registered, Deactivated;

3) (Provisioned, Registered, Active and Operative, Not Induced)
=> Registered, Activated;

4) (Provisioned, Registered, Active and Quiescent, Not Induced)
=> Registered, Deactivated.

The HLR shall not pass a subaddress to a phase 1 VLR.

2.8.4 VLR only supports phase 1 call handling

When a call is forwarded on busy, as the HLR does not pass the subaddress to the VLR, calls shall be forwarded without the subaddress.

3 Call forwarding on no reply

3.1 Handling of call forwarding on no reply

3.1.1 Registration

The same rules apply for the registration of Call Forwarding on No Reply as were described for Call Forwarding Unconditional in section 1.1.1 above, with the exceptions described below. Basic registration of information is illustrated in figure 3.2.

The No Reply Condition Timer

If a value for the no reply condition timer is not included in the registration request received from the MS, then the previous value set by the mobile user or the network operator applies.

Supplementary Service Interaction

Possible interaction situations between CFNRy and other supplementary services must then be checked. This is described in figure 3.2. Also see TS GSM 02.04 and 02.82. For interaction between CFNRy and other supplementary services (ie not call barring or call forwarding services), the reader is referred to the respective technical specification for those supplementary services.

The information flow for registration of call forwarding on no reply is shown in figure 3.1.

```
     MS                  MSC                 VLR                 HLR

      │                   │                   │                   │
      │  Register CFNRy   │                   │                   │
      │──────────────────>│                   │                   │
      │                   │  Register CFNRy   │                   │
      │                   │──────────────────>│                   │
      │                   │                   │  Register CFNRy   │
      │                   │                   │──────────────────>│
      │                   │                   │                   │  CFNRy1
      │                   │                   │    Acknowledge    │
      │                   │                   │<──────────────────│
      │                   │    Acknowledge    │                   │
      │                   │<──────────────────│                   │
      │ Release complete  │                   │                   │
      │<──────────────────│                   │                   │
      │     \Facility     │                   │                   │
      │                   │                   │                   │
```
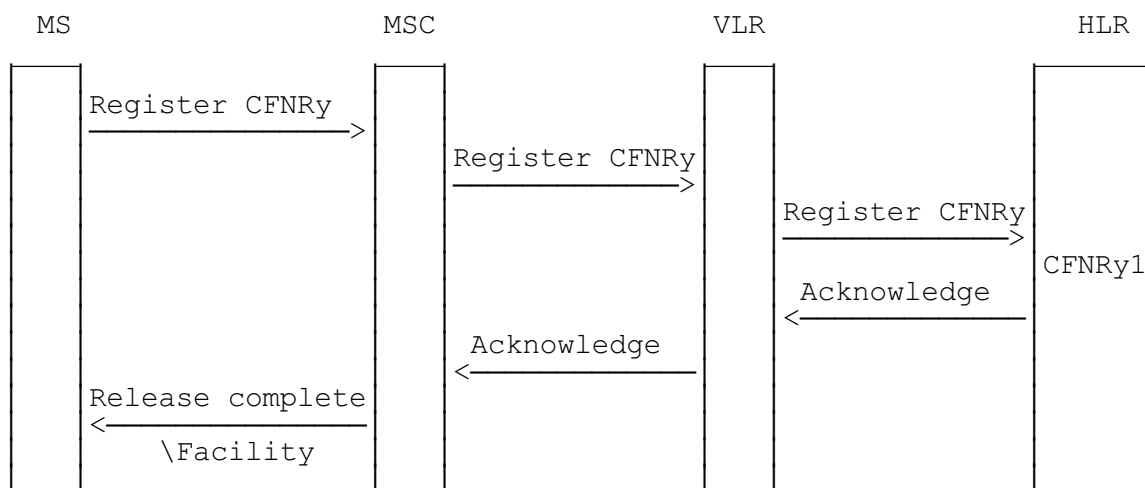
Figure 3.1: Registration of call forwarding on no reply

Process CFNRy1   382_32(1)

idle

register
CFNRy

BS
included in
request — no → set BS =
all BS

yes

no ← CFNRy
provided

yes

no ← subset of
required BS
provided

yes

Not, e.g.:
- special service number;
- own number.

no ← valid
ftn

yes

number
type — national → covert to
international
(from HPLMN)

international

yes ← BAIC
active

no

BIC-
Roam
active — yes → roaming
outside HPLMN
country

no ← no

yes

yes ← BAOC
active

no

2   1   2

BOIC
active — yes

no

yes ← BOIC-exHC
active

no

ftn
in VPLMN
country — yes →   ← yes — ftn
in VPLMN
country

no   no

ftn
in HPLMN
country — yes →

no

yes ← CFU
active

no

set
error   set
result   set
error

acknowledge

idle

BS:	Basic Service group.
ftn:	forwarded-to number.
BAOC:	Barring of All Outgoing Calls.
BOIC:	Barring of Outgoing International Calls.
BOIC-exHC:	Barring of Outgoing International Calls except those directed to HPLMN Country.
BAIC:	Barring of All Incoming Calls.
BIC-Roam:	Barring of Incoming Calls when Roaming outside the home PLMN country.

Figure 3.2: CFNRy1 Call forwarding on no reply registration process

3.1.2 Erasure

The same rules apply for the erasure of Call Forwarding on No Reply as were described for Call Forwarding Unconditional in section 1.1.2 above. However, no checks for interaction with other supplementary services are required for erasure of CFNRy, see figures 3.3 and 3.4.

```
     MS                    MSC                   VLR                   HLR

      |                     |                     |                     |
      |   Erase CFNRy       |                     |                     |
      |-------------------->|                     |                     |
      |                     |   Erase CFNRy       |                     |
      |                     |-------------------->|                     |
      |                     |                     |   Erase CFNRy       |
      |                     |                     |-------------------->|
      |                     |                     |                     | CFNRy2
      |                     |                     |     Acknowledge     |
      |                     |                     |<--------------------|
      |                     |     Acknowledge     |                     |
      |                     |<--------------------|                     |
      |  Release complete   |                     |                     |
      |<--------------------|                     |                     |
      |       \Facility     |                     |                     |
      |                     |                     |                     |
```
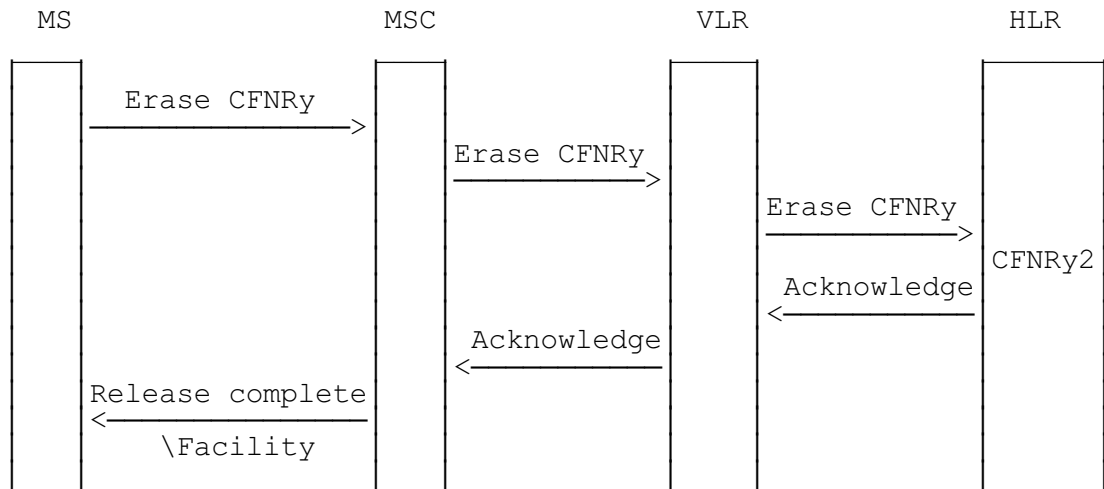
Figure 3.3: Erasure of call forwarding on no reply

Process CFNRy2   382_34(1)

idle

erase
CFNRy

BS
included
in request ———— no ————┐
      │   │
     yes   set BS =
      │   all BS
      │   │
      ◄───────────────────┘

      CFNRy
no —— provided
  │   │
  │   yes
  │   │
set   set
error   result
  │   │
  └────────►
           │
     acknowledge
           │
         idle   ┌─────────────────────┐
                       │ BS: Basic Service group. │
                       └─────────────────────┘
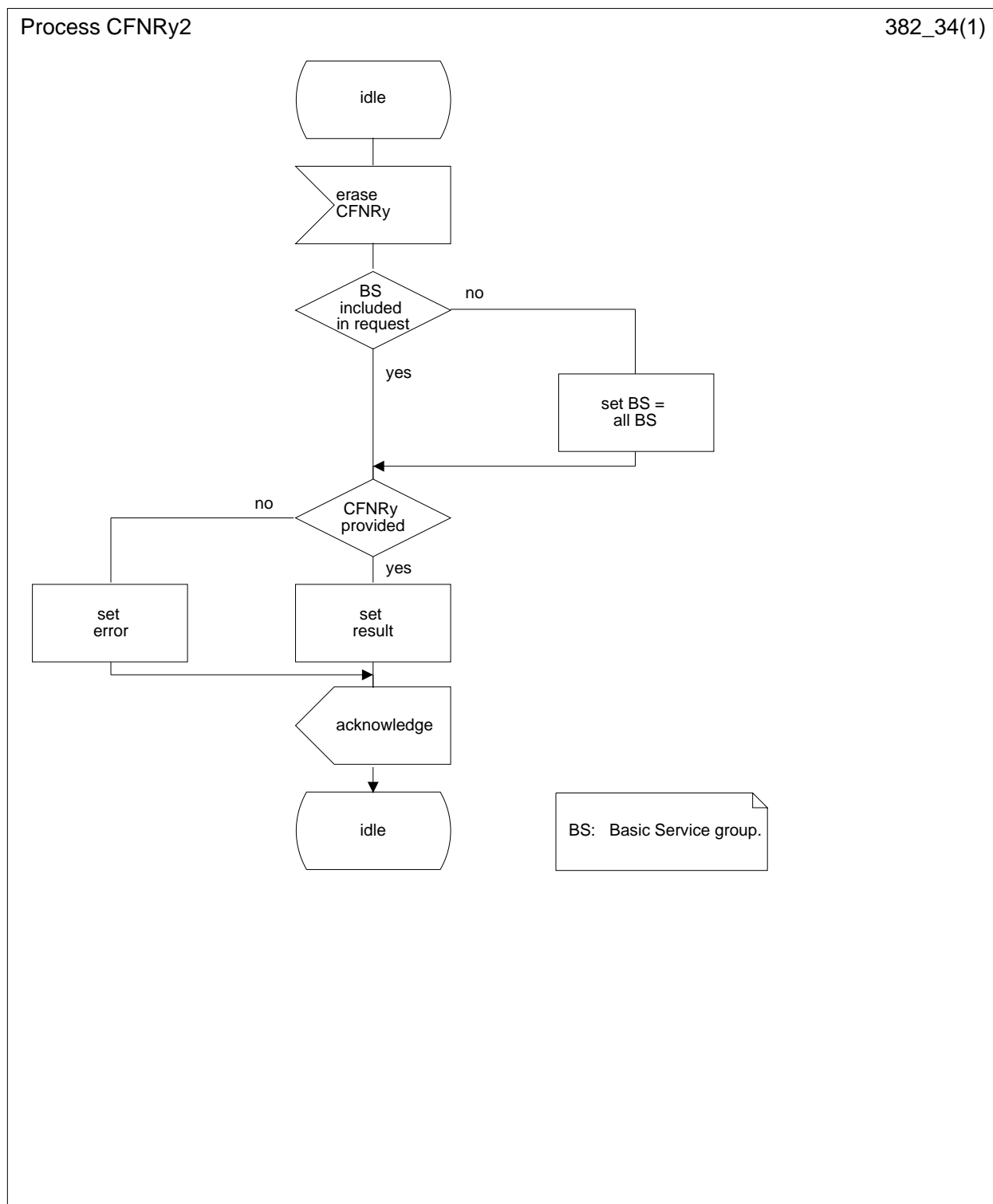
Figure 3.4: CFNRy2 Call forwarding on no reply erasure process

3.1.3 Activation

The same rules apply for the activation of Call Forwarding on No Reply as were described for Call Forwarding Unconditional in section 1.1.3 above, with the exception of the checking of interaction with other supplementary services. Basic activation of CFNRy is illustrated in figure 3.6.

Supplementary Service Interaction

Possible interaction situations between CFNRy and other supplementary services must then be checked. This is described in figure 3.6. Also see TS GSM 02.04 and 02.82. For interaction between CFNRy and other supplementary services (ie not call barring or call forwarding services), the reader is referred to the respective technical specification for those supplementary services.

The information flow for activation of CFNRy is shown in figure 3.5.

```
     MS              MSC              VLR              HLR

 ┌─┐ ┌─┐            ┌─┐ ┌─┐          ┌─┐              ┌─┐
 │ │ │ │Activate CFNRy│ │            │ │              │ │
 │ │ │ │──────────────>│ │Activate CFNRy│            │ │
 │ │ │ │            │ │ │ │──────────────>│Activate CFNRy│
 │ │ │ │            │ │ │ │            │ │──────────────>│
 │ │ │ │            │ │ │ │            │ │          │CFNRy3│
 │ │ │ │            │ │ │ │            │ │Acknowledge│ │
 │ │ │ │            │ │ │ │            │ │<──────────│ │
 │ │ │ │Release complete│ │Acknowledge│ │            │ │
 │ │ │ │<──────────────│ │<──────────│ │            │ │
 │ │ │ │   \Facility │ │ │ │          │ │            │ │
 └─┘ └─┘            └─┘ └─┘          └─┘              └─┘
```
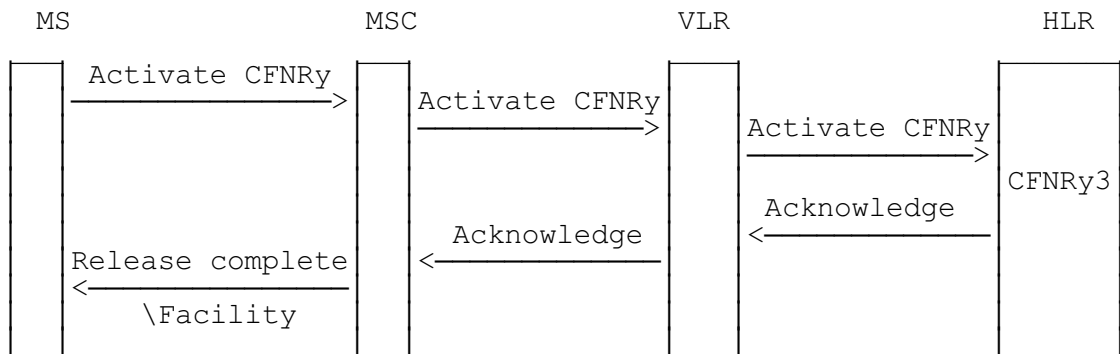
Figure 3.5: Activation of call forwarding on no reply

Process CFNRy3   382_36(1)

idle

activate
CFNRy

CFNRy
registered
for required   —— no
BS

yes

BAIC
active   —— yes

no

BIC-Roam   no   roaming
active   —— yes   outside HPLMN
                                                country

no

BAOC   yes
active   —— yes

no

ftn in
VPLMN   —— yes
country   BOIC
                         active   —— yes
no
                                                ftn in
yes   VPLMN   —— no
                         no   country

                         BOIC-exHC   yes
ftn in   yes   active
HPLMN   ——
country   no

no   CFU
             active   —— yes

             no

set   set   set   set   set
error   result   error   error   error

acknowledge

BS:	Basic Service group.
ftn:	forwarded-to number.
BAOC:	Barring of All Outgoing Calls.
BOIC:	Barring of Outgoing International Calls.
BOIC-exHC:	Barring of Outgoing International Calls except those directed to HPLMN Country.
BAIC:	Barring of All Incoming Calls.

idle

Figure 3.6: CFNRy3 Call forwarding on no reply activation process

3.1.4 Deactivation

The same rules apply for the deactivation of CFNRy as were described for CFU in section 1.1.4 above, see figure 3.7 and 3.8.

```
     MS              MSC              VLR              HLR
    ┌┐│            │┌┐             ┌┐│             ┌┐│
    │││Deactivate CFNRy││            │││            │││
    ││├────────────────>│Deactivate CFNRy││           │││
    │││            │││├────────────────>│DeactivateCFNRy││
    │││            │││            │││├────────────────>│││
    │││            │││            │││   Acknowledge   │││CFNRy4
    │││            │││            │││<────────────────┤││
    │││            │││  Acknowledge  │││            │││
    │││            │││<──────────────┤││            │││
    │││Release complete│││            │││            │││
    │││<────────────────┤││            │││            │││
    │││  \Facility   │││            │││            │││
    └┘│            │└┘             └┘│             └┘│
```
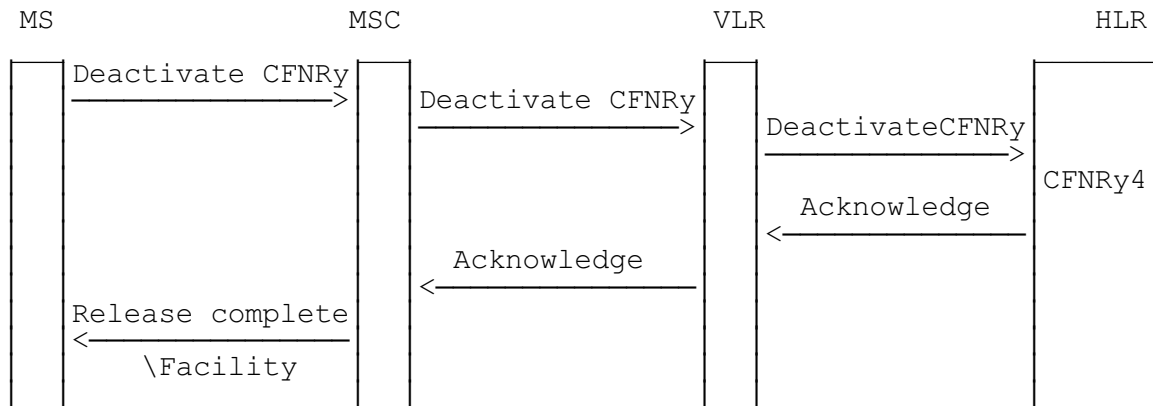
Figure 3.7: Deactivation of call forwarding on no reply

Process CFNRy4   382_38(1)

idle

deactivate
CFNRy

BS
included
in request → no → set BS =
all BS

yes

CFNRy
active for
subset BS

no   yes

set
error   set
                                result

acknowledge

idle

BS: Basic Service group.
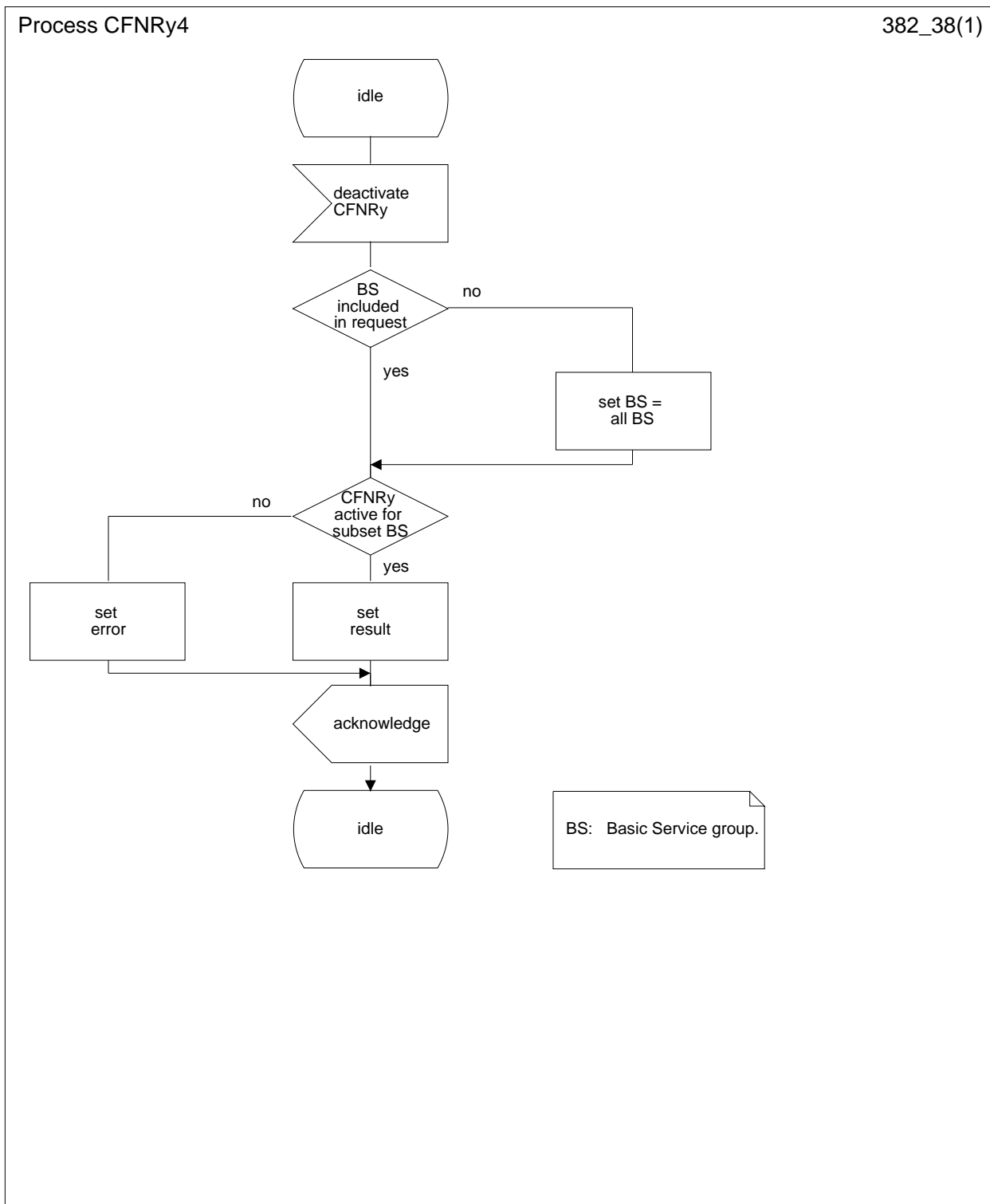
Figure 3.8: CFNRy4 Call forwarding on no reply deactivation process

3.1.5 Interrogation

Data request

The data request procedure enables the mobile subscriber to obtain information about the data stored in the PLMN. Interrogation of CFNRy is handled by the VLR which returns the required information or error to the MS, see figure 3.9.

```
    MS                    MSC                   VLR                   HLR

    │ │   Interrogate CFNRy │ │                  │ │                  │ │
    │ │────────────────────>│ │                  │ │                  │ │
    │ │                     │ │  Interrogate CFNRy│ │                  │ │
    │ │                     │ │──────────────────>│ │                  │ │
    │ │                     │ │    Acknowledge    │ │                  │ │
    │ │   Release complete  │ │<──────────────────│ │                  │ │
    │ │<────────────────────│ │                  │ │                  │ │
    │ │       \Facility     │ │                  │ │                  │ │
    │ │                     │ │                  │ │                  │ │
```
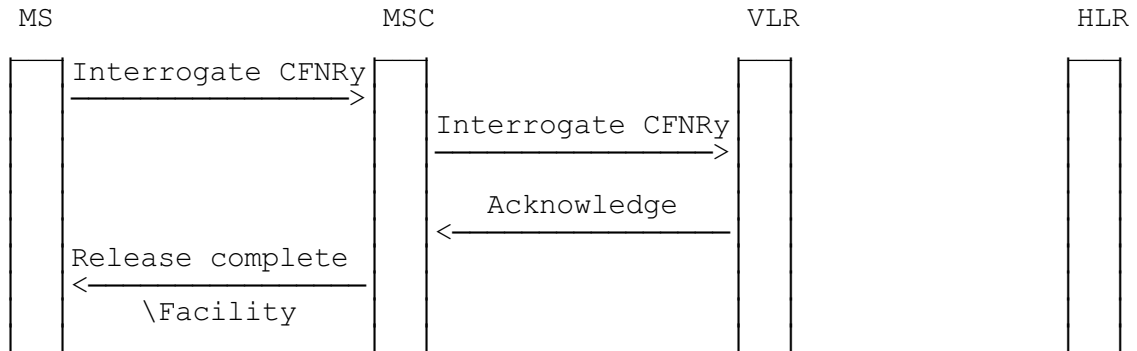
Figure 3.9: Interrogation of call forwarding on no reply

3.2 Functions and information flows

The following Mobile Additional Function has been identified for the PLMN:

MAF009

> Call forwarding on no reply authorizations examination
> The ability of a PLMN component to determine the authorizations relating to call forwarding on no reply. See figure 3.10.
> Location: VLR.

The information flows for forwarding to fixed terminal and to mobile station are shown in figures 3.11 and 3.12 respectively.

Process MAF009 382_3A(1)

idle

initiate
handling
of CFNRy

active
for this
BS — no

yes

number
of forwardings
reached — yes

no

increment counter
get forwarded-to number
set forwarding cause=CFNRy
set no reply condition timer

notification
to forwarding
subscriber — yes

no

set indicator =
'notify forwarding
subscriber'

notification
to calling
subscriber — yes

set
error

no

set indicator =
'notify calling
subscriber'

set indicator =
'set up
normal call'

continue
call
handling

BS : Basic Service group.

idle

Figure 3.10: MAF008 Call forwarding on no reply authorisations examination (VLR)
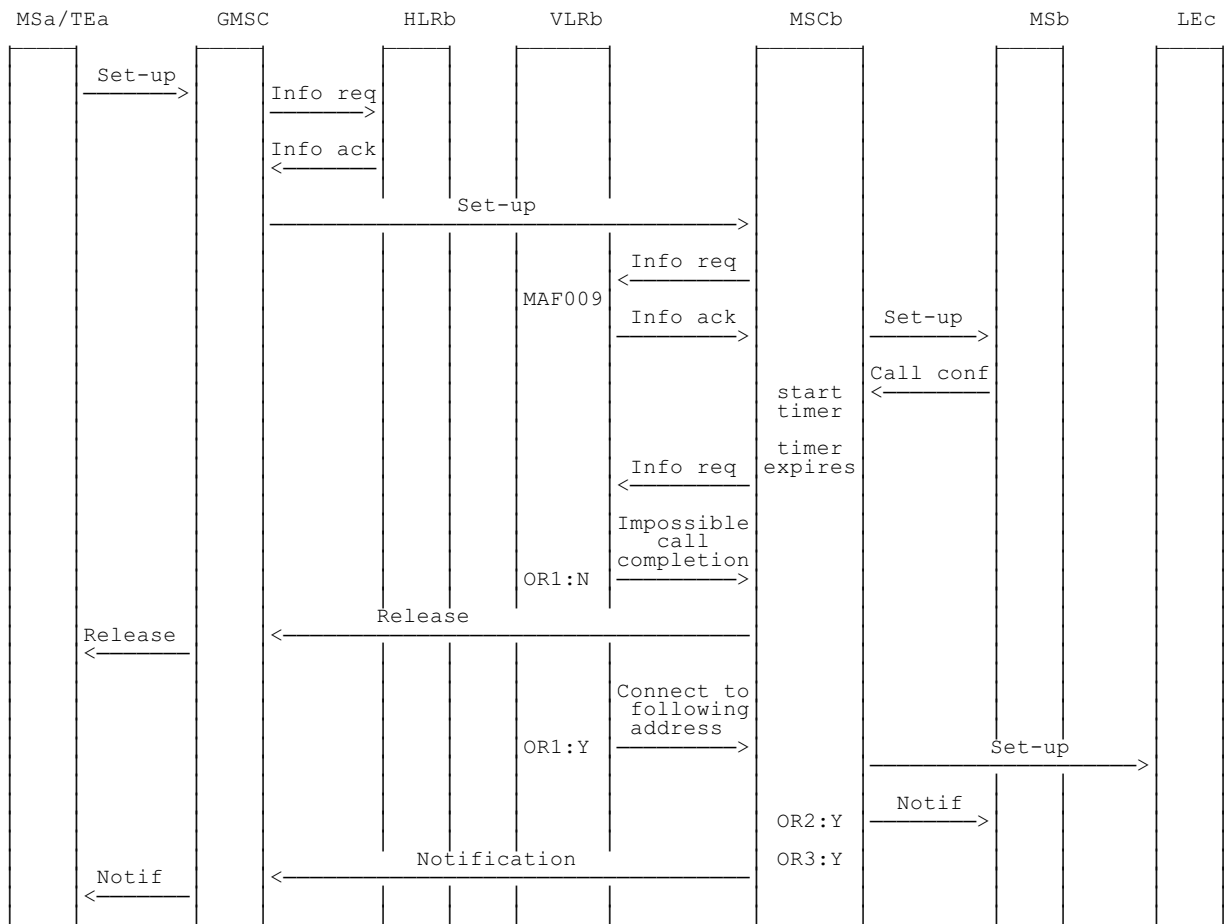
```
MSa/TEa        GMSC        HLRb     VLRb                    MSCb                 MSb          LEc

    Set-up
   ────────>
              Info req
             ────────>
              Info ack
             <────────
                         Set-up
             ──────────────────────────────────────────>
                                      Info req
                                    <────────
                         MAF009                                    Set-up
                                      Info ack                  ──────────>
                                    ────────>
                                                                  Call conf
                                                   start       <──────────
                                                   timer

                                                   timer
                                      Info req     expires
                                    <────────
                                    Impossible
                                       call
                                    completion
                         OR1:N      ────────>
              Release
             <──────────────────────────────────────────
    Release
   <────────
                                    Connect to
                                     following
                                      address
                         OR1:Y      ────────>
                                                                                 Set-up
                                                                      ──────────────────────>
                                                                  Notif
                                                   OR2:Y        ──────────>
                         Notification
              <────────────────────────────────────────    OR3:Y
    Notif
   <────────
```

NOTE: info: information   Y: Yes
           req: request   N: No
           ack: acknowledge
           notif: notification
           conf: confirmation
           OR1:   Call to be forwarded
           OR2:   Notification to forwarding subscriber required
           OR3:   Notification to calling subscriber required

**Figure 3.11: Information flow for call forwarding on no reply
(to fixed terminal)**
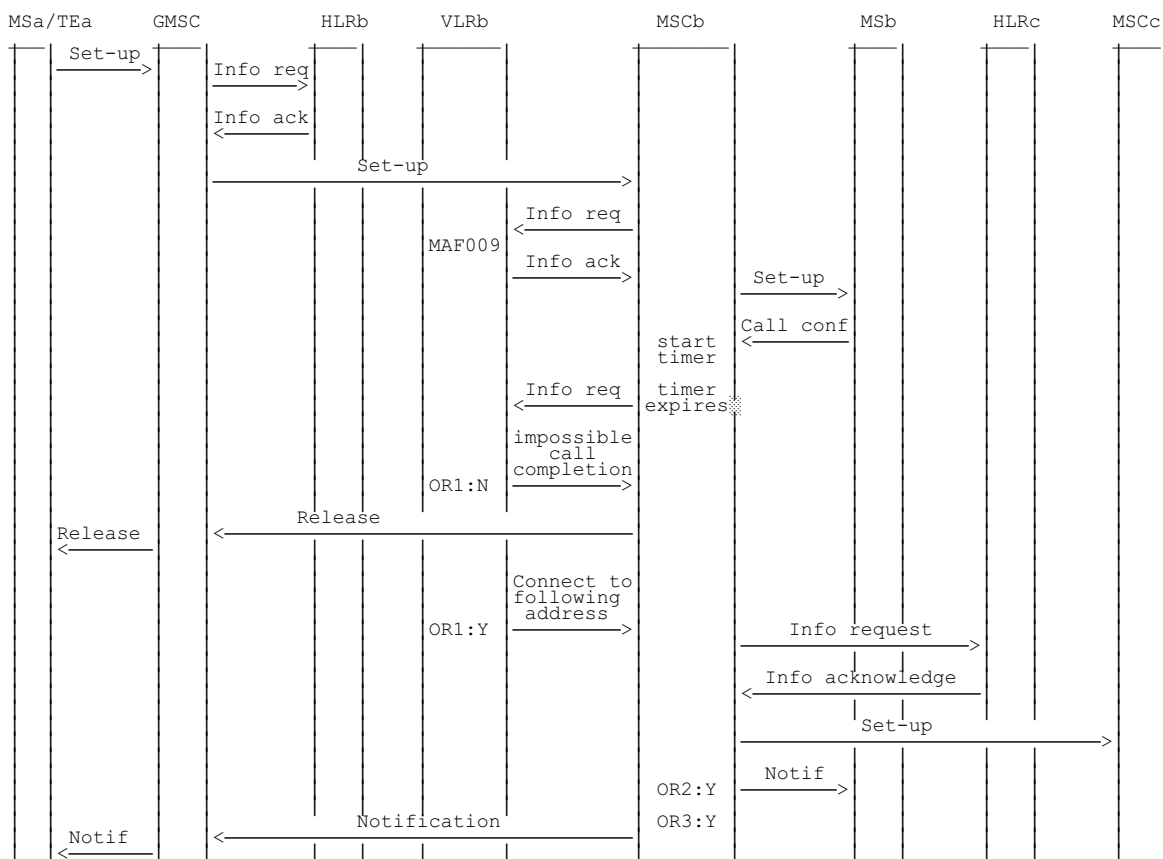
```
MSa/TEa    GMSC         HLRb    VLRb              MSCb          MSb      HLRc     MSCc
  |    Set-up  |           |       |               |            |        |        |
  |----------->|  Info req |       |               |            |        |        |
  |            |---------->|       |               |            |        |        |
  |            |  Info ack |       |               |            |        |        |
  |            |<----------|       |               |            |        |        |
  |            |       Set-up      |               |            |        |        |
  |            |------------------------------------>|          |        |        |
  |            |           |       |   Info req     |           |        |        |
  |            |           |       |<---------------|           |        |        |
  |            |           |  MAF009  Info ack      |           |        |        |
  |            |           |       |--------------->|           |        |        |
  |            |           |       |               | Set-up    |        |        |
  |            |           |       |               |---------->|         |        |
  |            |           |       |               | Call conf |        |        |
  |            |           |       |               |<----------|        |        |
  |            |           |       |               | start     |         |        |
  |            |           |       |               | timer     |         |        |
  |            |           |       |   Info req    | timer      |        |        |
  |            |           |       |<--------------| expires    |        |        |
  |            |           |       | impossible    |           |        |        |
  |            |           |       |   call        |           |        |        |
  |            |           |  OR1:N completion      |           |        |        |
  |            |           |       |--------------->|           |        |        |
  | Release    |  Release  |       |               |           |        |        |
  |<-----------|<----------------------------------|           |        |        |
  |            |           |       | Connect to    |           |        |        |
  |            |           |       | following     |           |        |        |
  |            |           |       | address       |           |        |        |
  |            |           |  OR1:Y|--------------->|           |        |        |
  |            |           |       |               | Info request        |        |
  |            |           |       |               |---------->|         |        |
  |            |           |       |               | Info acknowledge    |        |
  |            |           |       |               |<----------|        |        |
  |            |           |       |               |    Set-up          |         |
  |            |           |       |               |------------------------------>|
  |            |           |       |               | Notif     |        |        |
  |            |           |       |          OR2:Y|---------->|         |        |
  |            |           |  Notification    OR3:Y|           |        |        |
  | Notif      |<----------------------------------|           |        |        |
  |<-----------|           |       |               |           |        |        |
```

NOTE:	info:	information	Y: Yes	
	req:	request	N: no	
	ack:	acknowledge		
	notif:	notification		
	conf:	confirmation		
	OR1:	Call to be forwarded		
	OR2:	Notification to forwarding subscriber required		
	OR3:	Notification to calling subscriber required		

Figure 3.12: Information flow for call forwarding on no reply
(to mobile station)

3.3 Information stored in the HLR

The following logical states are applicable for CFNRy (refer to TS GSM 03.11 for an explanation of the notation):

Provisioning State	Registration State	Activation State	HLR Induction State
(Not Provisioned,	Not Registered,	Not Active,	Not Induced)
(Provisioned,	Not Registered,	Not Active,	Not Induced)
(Provisioned,	Registered,	Not Active,	Not Induced)
(Provisioned,	Registered,	Active and Quiescent,	Not Induced)
(Provisioned,	Registered,	Active and Operative,	Not Induced)

The registration and activation state may be different for each applicable elementary basic service group.

The provisioning state shall be on a per subscriber basis, and hence the same for all basic service groups.

The HLR shall store:

- the state of CFNRy (which shall be one of the valid states listed above) for each applicable elementary basic service group;

- the subscription option "notification to the calling party" on a per subscriber basis;
  This subscription option takes one of the following values:
    - no notification;
    - notification.

- the subscription option "notification to the forwarding party" on a per subscriber basis;
  This subscription option takes one of the following values:
    - no notification;
    - notification.

- the registration parameter "forwarded-to number" (possibly including a forwarded-to sub-address) for each applicable elementary basic service group;

- the registration parameter "no reply condition timer" for each applicable elementary basic service group.
  This parameter may take values in the range 5 - 30 seconds in steps of 5 seconds.

3.4 State transition model

The following figure shows the successful cases of transition between the applicable logical states of CFNRy. The state changes are either caused by actions of the service provider, the mobile user or the network.

Note that error cases are not shown in the diagram as they normally do not cause a state change. Additionally, some successful requests may not cause a state change. Hence, they are not shown in the diagram. The diagram only shows operations on an elementary basic service group.
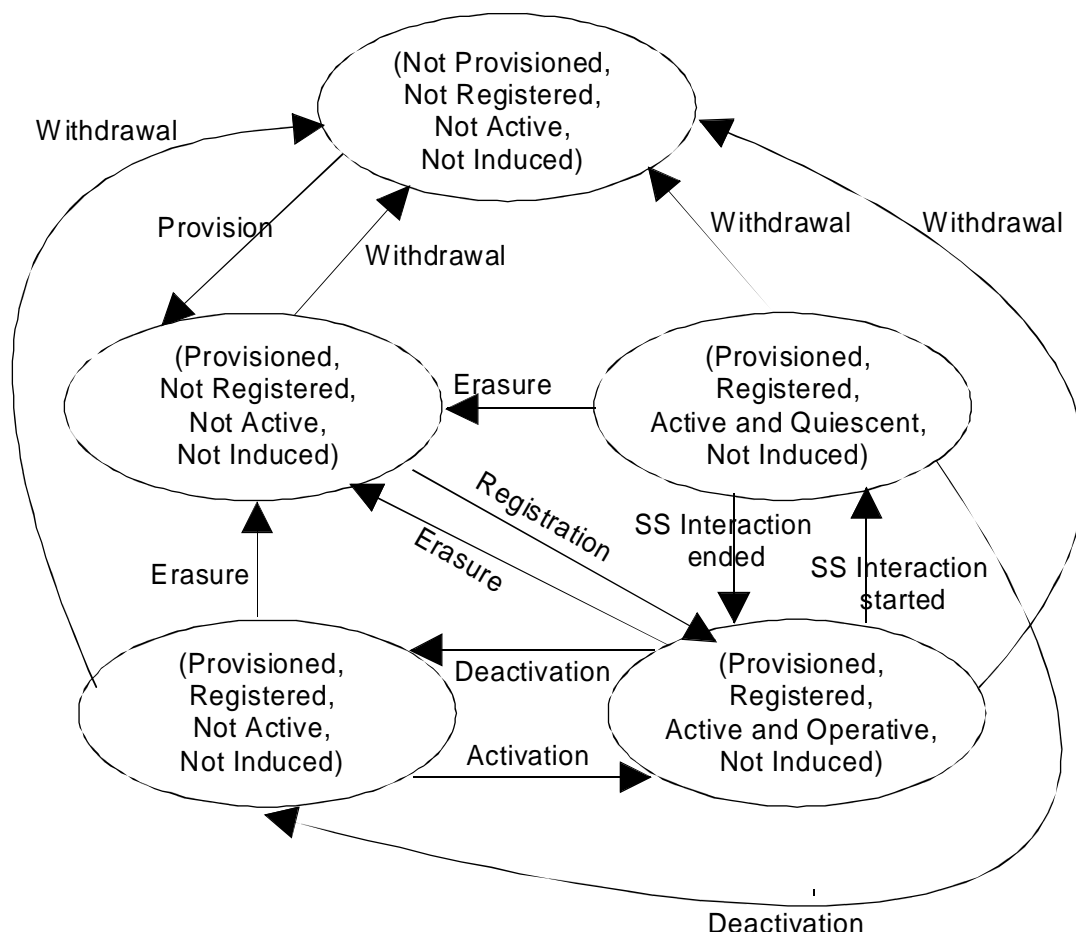
Figure 3.13: State transition model for CFNRy

3.5 Transfer of information from HLR to VLR

If the provisioning state for CFNRy is "Provisioned" then, when the subscriber registers on a VLR, the HLR shall send that VLR information about the logical state of CFNRy for all relevant elementary basic service groups and information about the subscription options "notification to the calling party" and "notification to the forwarding party".

If the registration state for CFNRy is "Registered" then, when the subscriber registers on a VLR, the HLR shall send that VLR the registration parameter "forwarded-to number" and "no reply condition timer" for all relevant elementary basic service groups.

If the logical state, the registration parameter "forwarded-to number" or the registration parameter "no reply condition timer" of CFNRy is changed while a subscriber is registered on a VLR then for the affected basic service groups, the HLR shall inform the VLR respectively of the new logical state or the new registration parameter of CFNRy.

3.6   Information stored in the VLR

For CFNRy the VLR shall store the service state information and the subscription options received from the HLR.

3.7   Handover

Handover will have no impact on the control procedure and the operation of the service.

3.8   Cross phase compatibility

3.8.1   MS, MSC, VLR or HLR only support phase 1 control of SS by the subscriber

In response to a CFNRy interrogation request, if the MS or any network element involved is of phase 1, only information concerning basic service groups for which the activation state has the value "Active and Operative" will be returned. This means that the subscriber will not be aware that the forwarded to number is registered if CFNRy is deactivated or active (quiescent). A subaddress (if registered) will not be included.

Note that if any network element involved is of phase 1, CFNRy Registration requests which use a subaddress and all CFNRy Activation and Deactivation requests will be rejected, as these are not specified in phase 1.

3.8.2   HLR only supports phase 1 updating of subscriber information

If the VLR receives the SS-Status parameter from a phase 1 HLR it shall act if it has received the SS-Status parameter with the values shown in the following:

1)   Registered, Activated   => P bit =1, R bit = 1, A bit = 1, Q bit = 0;

2)   Registered, Deactivated   => P bit =1, R bit = 1, A bit = 0, Q bit = 0 or 1;

3)   Erased   => P bit =1, R bit = 0, A bit = 0, Q bit = 0 or 1.

3.8.3   VLR only supports phase 1 updating of subscriber information

When passing CFNRy information to a phase 1 VLR, the HLR shall send the service state information in a form which the VLR can accept, based on the logical state held in the HLR, as follows:

1)   (Provisioned, Not Registered, Not Active, Not Induced)
                        => Erased, Deactivated;

2)   (Provisioned, Registered, Not Active, Not Induced)
                        => Registered, Deactivated;

3)   (Provisioned, Registered, Active and Operative, Not Induced)
                        => Registered, Activated;

4)   (Provisioned, Registered, Active and Quiescent, Not Induced)
                        => Registered, Deactivated.

The HLR shall not pass a subaddress to a phase 1 VLR.

3.8.4   VLR only supports phase 1 call handling

When a call is forwarded on no reply, as the HLR does not pass the subaddress to the VLR, calls shall be forwarded without the subaddress.

4 Call forwarding on mobile subscriber not reachable

4.1 Handling of call forwarding on mobile subscriber not reachable

4.1.1 Registration

The same rules apply for the registration of Call Forwarding on Mobile Subscriber Not Reachable as were described for Call Forwarding Unconditional in section 1.1.1 above, with the exception of the checking of interaction with other supplementary services. Basic registration of information is illustrated in figure 4.2.

Supplementary Service Interaction

Possible interaction situations between CFNRc and other supplementary services must then be checked. This is described in figure 4.2. Also see TS GSM 02.04 and 02.82. For interaction between CFNRc and other supplementary services (ie not call barring or call forwarding services), the reader is referred to the respective technical specification for those supplementary services.

The information flow for registration of call forwarding on mobile subscriber not reachable is shown in figure 4.1.
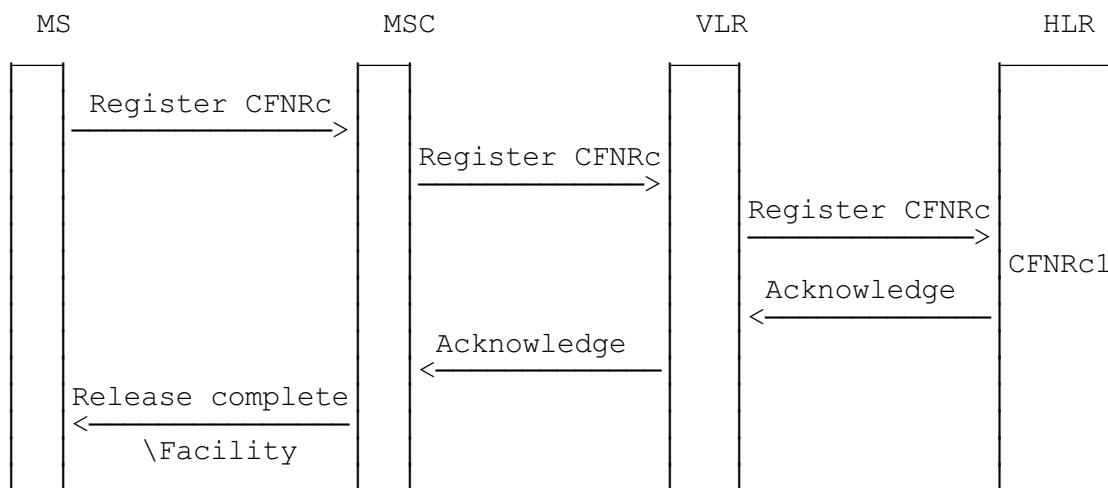
Figure 4.1: Registration of call forwarding on mobile subscriber not reachable
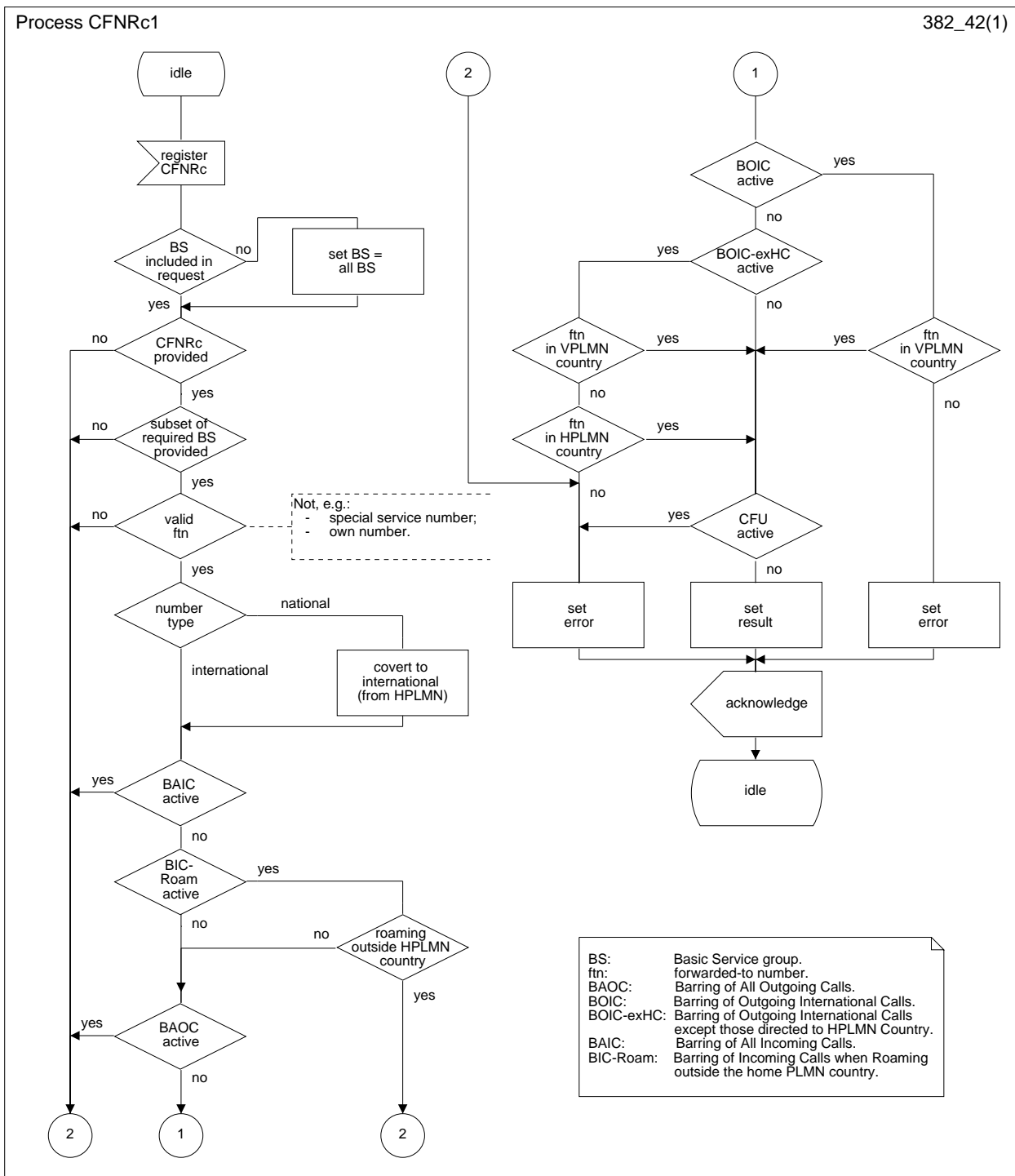
Figure 4.2: CFNRc1 Call forwarding on mobile subscriber not reachable registration process

4.1.2 Erasure

The same rules apply for the erasure of CFNRc as were described for CFU in section 1.1.2 above. However, no checks for interaction with other supplementary services are required for erasure of CFNRc, see figure 4.4.

The information flow for registration of CFNRc is shown in figure 4.3.

```
      MS                    MSC                  VLR                  HLR

       |                     |                    |                    |
       |   Erase CFNRc       |                    |                    |
       |────────────────────>|                    |                    |
       |                     |   Erase CFNRc      |                    |
       |                     |───────────────────>|                    |
       |                     |                    |   Erase CFNRc      |
       |                     |                    |───────────────────>|
       |                     |                    |                    | CFNRc2
       |                     |                    |   Acknowledge      |
       |                     |                    |<───────────────────|
       |                     |   Acknowledge      |                    |
       |                     |<───────────────────|                    |
       |   Release complete  |                    |                    |
       |<────────────────────|                    |                    |
       |      \Facility      |                    |                    |
       |                     |                    |                    |
```
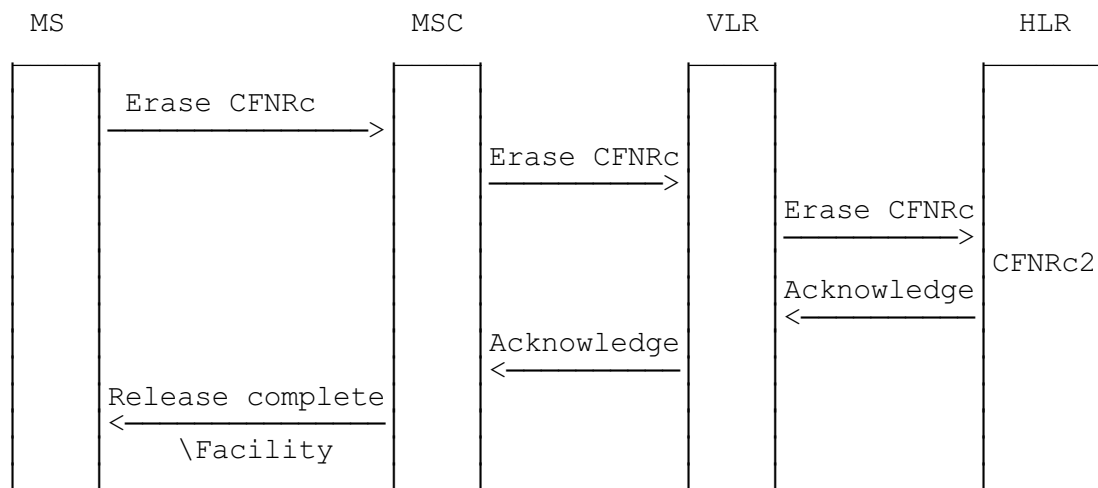
Figure 4.3: Erasure of call forwarding on mobile subscriber not reachable

Process CFNRc2 382_44(1)

idle

erase
CFNRc

BS
included
in request — no

yes

set BS =
all BS

CFNRc
provided
no — yes

set
error

set
result

acknowledge

idle

BS: Basic Service group.
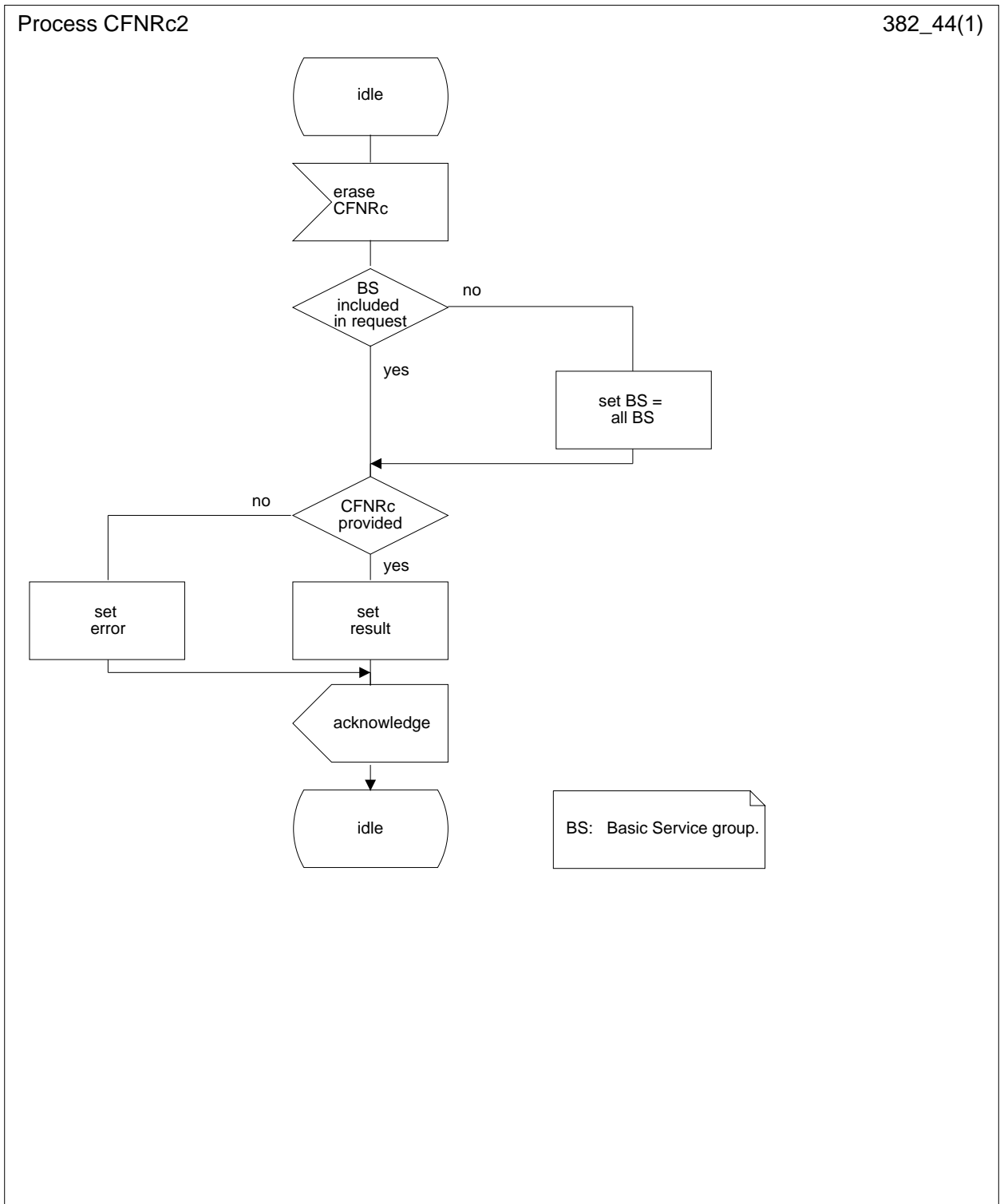
Figure 4.4: CFNRc2 Call forwarding on mobile subscriber not reachable erasure process

4.1.3   Activation

The same rules apply for the activation of CFNRc as were described for CFU in section 1.1.3 above, with the exception of the checking of interaction with other supplementary services. Basic activation of CFNRc is illustrated in figure 4.6.

<u>Supplementary Service Interaction</u>

Possible interaction situations between CFNRc and other supplementary services must then be checked. This is described in figure 4.6. Also see TS GSM 02.04 and 02.82. For interaction between CFNRc and other supplementary services (ie not call barring or call forwarding services), the reader is referred to the respective technical specification for those supplementary services.

The information flow for activation of call forwarding on MS not reachable is shown in figure 4.5.

```
    MS                 MSC               VLR               HLR
 ┌──┐               ┌──┐              ┌──┐              ┌──┐
 │  │ Activate CFNRc│  │              │  │              │  │
 │  │──────────────>│  │ Activate CFNRc│  │              │  │
 │  │               │  │──────────────>│  │ Activate CFNRc│  │
 │  │               │  │              │  │──────────────>│  │
 │  │               │  │              │  │              │  │ CFNRc3
 │  │               │  │              │  │  Acknowledge │  │
 │  │Release complete│  │  Acknowledge │  │<─────────────│  │
 │  │<──────────────│  │<─────────────│  │              │  │
 │  │    \Facility  │  │              │  │              │  │
 └──┘               └──┘              └──┘              └──┘
```
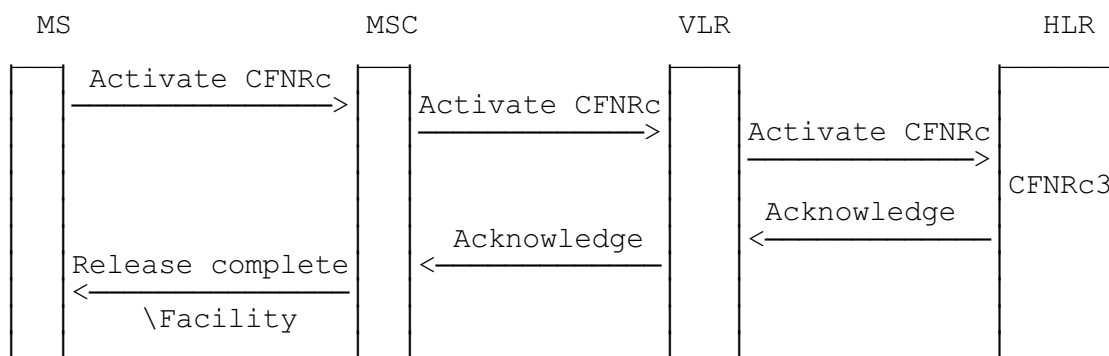
Figure 4.5: Activation of call forwarding on MS not reachable
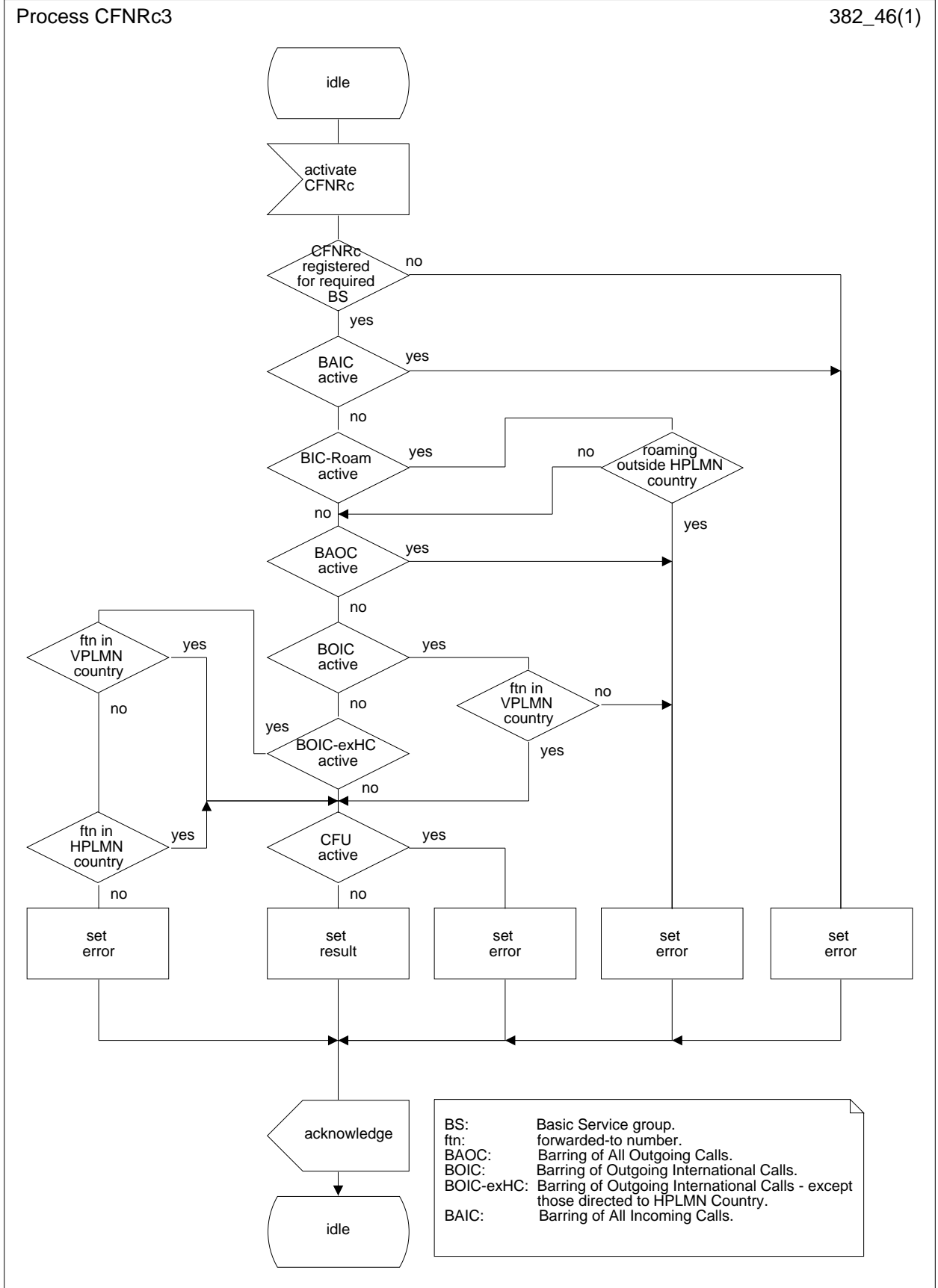
Figure 4.6: CFNRc3 Call forwarding on mobile subscriber not reachable activation process

4.1.4 Deactivation

The same rules apply for the deactivation of CFNRc as were described for CFU in section 1.1.4 above, see figure 4.8.

The information flow for deactivation of call forwarding on mobile subscriber not reachable is shown in figure 4.7.
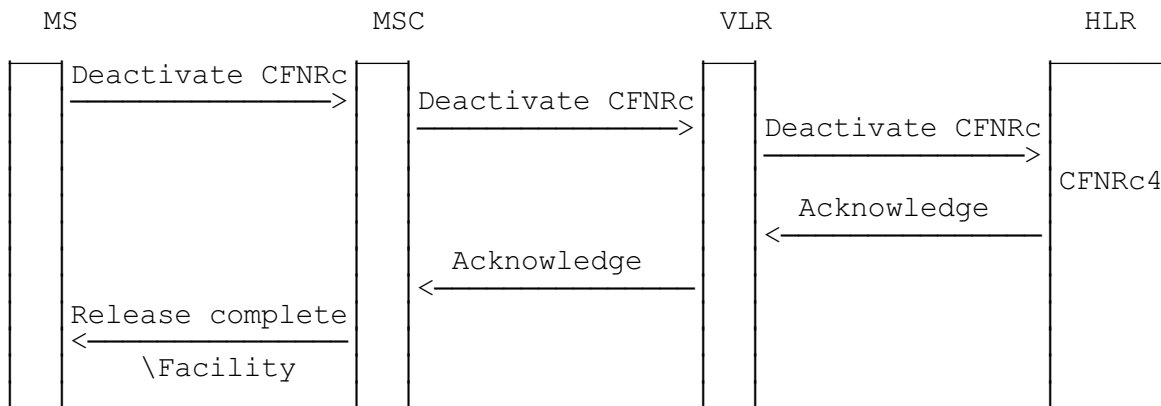
Figure 4.7: Deactivation of call forwarding on mobile subscriber not reachable

Process CFNRc4   382_48(1)

idle

deactivate
CFNRc

BS
included
in request ──── no

yes

set BS =
all BS

CFNRc
active for
subset BS

no ────

yes

set
error

set
result

acknowledge

idle

BS: Basic Service group.
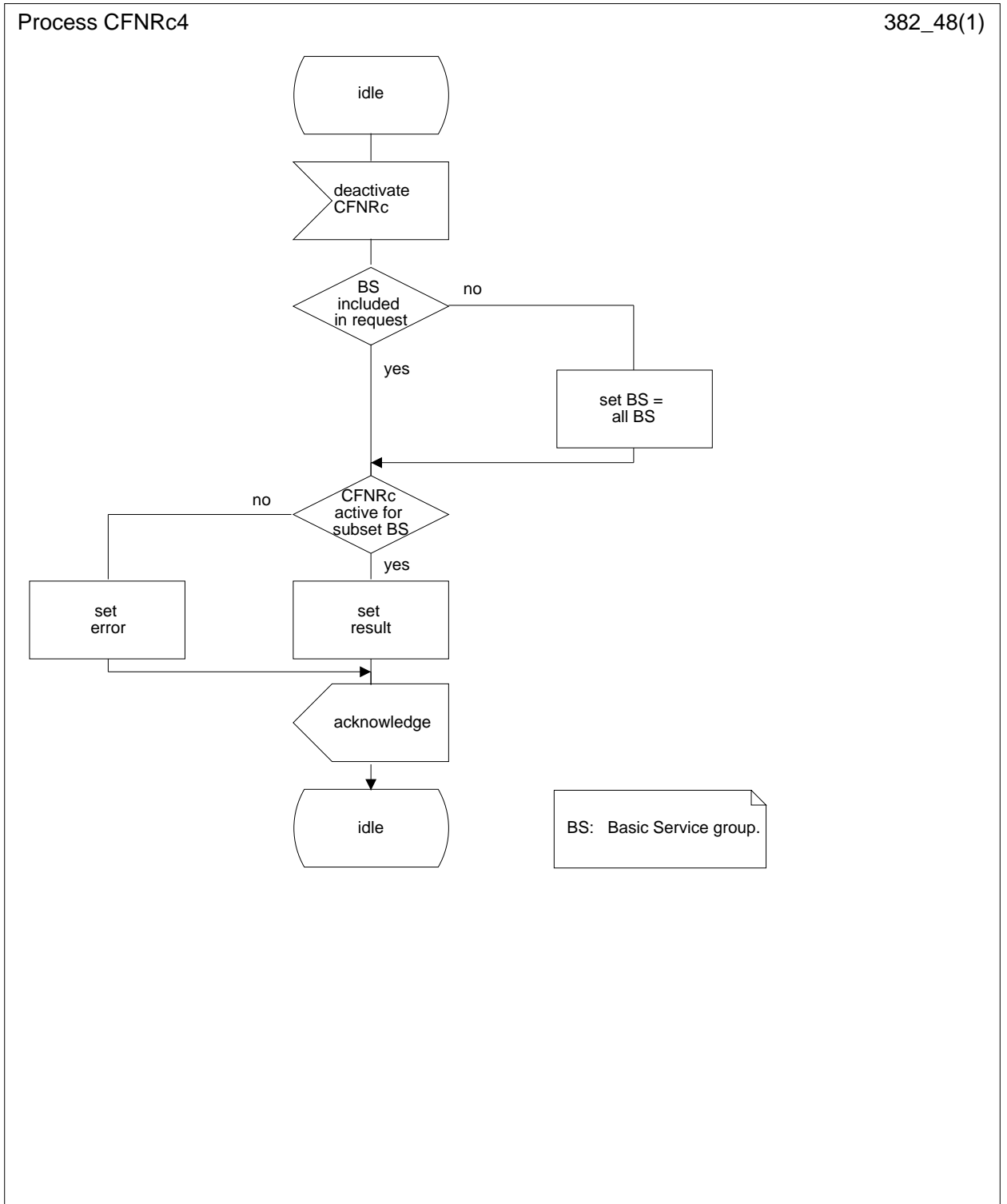
Figure 4.8: CFNRc4 Call forwarding on mobile subscriber not reachable deactivation process

4.1.5 Interrogation

Data request

The data request procedure enables the mobile subscriber to obtain information about the data stored in the PLMN. Interrogation of CFNRc is handled by the VLR which returns the required information or error to the MS, see figure 4.9.

```
     MS                   MSC                   VLR                   HLR

      │                    │                     │                     │
      │ Interrogate CFNRc  │                     │                     │
      │───────────────────>│                     │                     │
      │                    │ Interrogate CFNRc   │                     │
      │                    │────────────────────>│                     │
      │                    │     Acknowledge     │                     │
      │                    │<────────────────────│                     │
      │ Release complete   │                     │                     │
      │<───────────────────│                     │                     │
      │     \Facility      │                     │                     │
      │                    │                     │                     │
```
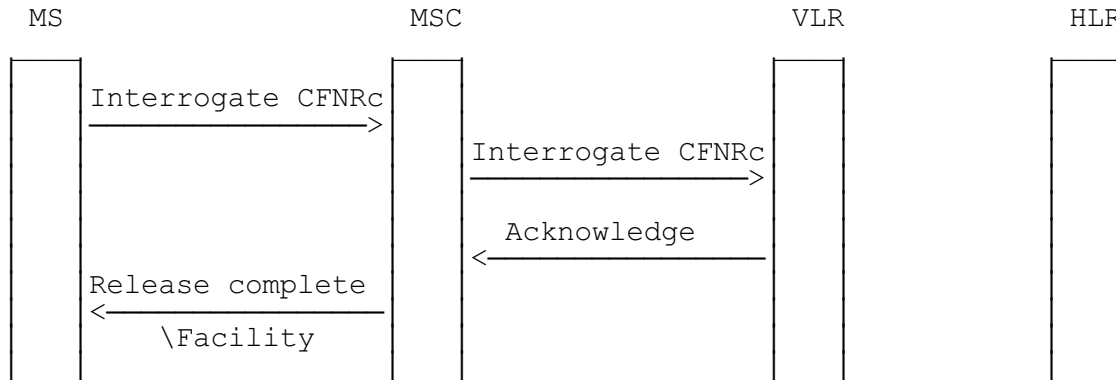
Figure 4.9: Interrogation of call forwarding on mobile subscriber not reachable

4.2 Functions and information flows

4.2.1 Call re-routed from VLR

The following Mobile Additional Function has been identified for the PLMN:

MAF010

> Examination of call forwarding on mobile subscriber not reachable authorizations
> The ability of a PLMN component to determine the authorizations relating to call forwarding on mobile subscriber not reachable in case the mobile subscriber is not reachable in the VLR, in case of no paging response or radio congestion. See figure 4.10.
> Location: VLR.

The information flows for forwarding to fixed terminal and to mobile station are shown in figures 4.11 and 4.12 respectively. These flows represent the case where the mobile subscriber is not reachable in the VLR, and that this fact was not detected at interrogation from the HLR. This situation occurs if the MSC requests the VLR to provide information for a mobile terminating call towards a subscriber who is detached in the VLR.

Figures 4.13 and 4.14 show the information flows in case of no paging response.

Figures 4.15 and 4.16 show the information flows in case of radio congestion.

4.2.2 Call re-routed from HLR

The following Mobile Additional Function has been identified for the PLMN:

MAF010

> Examination of call forwarding on mobile subscriber not reachable authorizations
> The ability of a PLMN component to determine the authorizations relating to call forwarding on mobile subscriber not reachable in case the mobile subscriber is deregistered or purged in the HLR or not reachable in the VLR. See figure 4.10.
> Location: HLR.

The information flows for forwarding to fixed terminal and to mobile station are shown in figures 4.17 and 4.18 respectively. These flows represent the case where the call is re-routed from the HLR because information from the VLR indicates that the subscriber cannot be reached in the VLR. This situation occurs if the VLR detects at roaming number request time that the subscriber concerned is detached or that there is no roaming number available.

Figures 4.19 and 4.20 show the information flows for forwarding to fixed terminal and to mobile station respectively in case where the call is re-routed by the HLR because the subscriber is deregistered or purged in the HLR.

Process MAF010   382_4A(1)

idle

initiate
handling
of CFNRc

active
for this
BS ────── no ──────────────────────────┐

yes

number
yes ────── of forwardings
reached

no

increment counter
get forwarded-to number
set forwarding cause=CFNRc

notification
to calling ────── yes ──────┐
subscriber

no

set   set indicator =   set indicator =
error   'notify calling   'mobile subscriber
                            subscriber'   not reachable'

continue
call
handling   ┌─────────────────────────┐
                            │ BS : Basic Service group. │
                            └─────────────────────────┘
idle
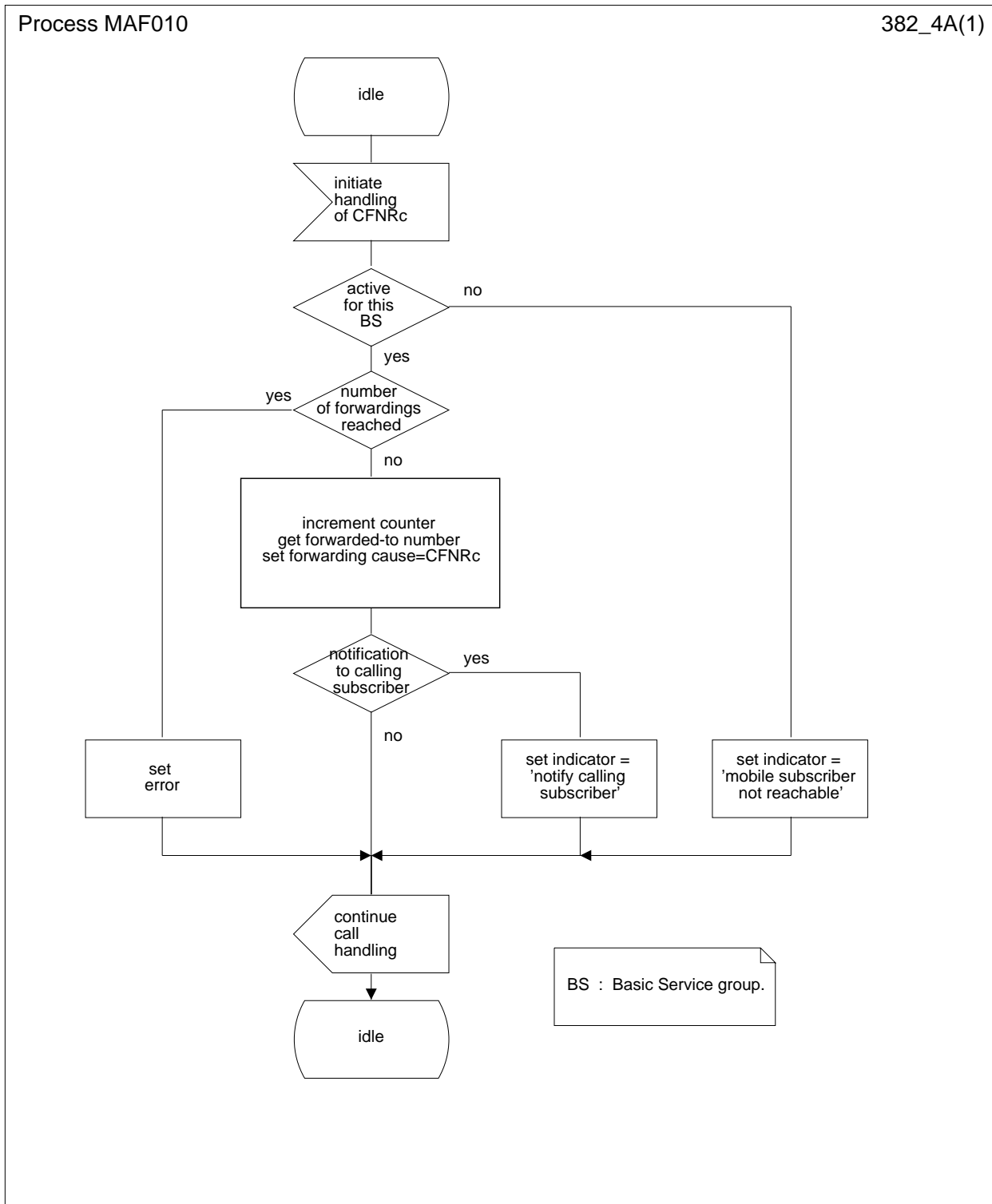
**Figure 4.10: MAF010 Call forwarding on mobile subscriber not reachable authorisations
examination (VLR and HLR)**
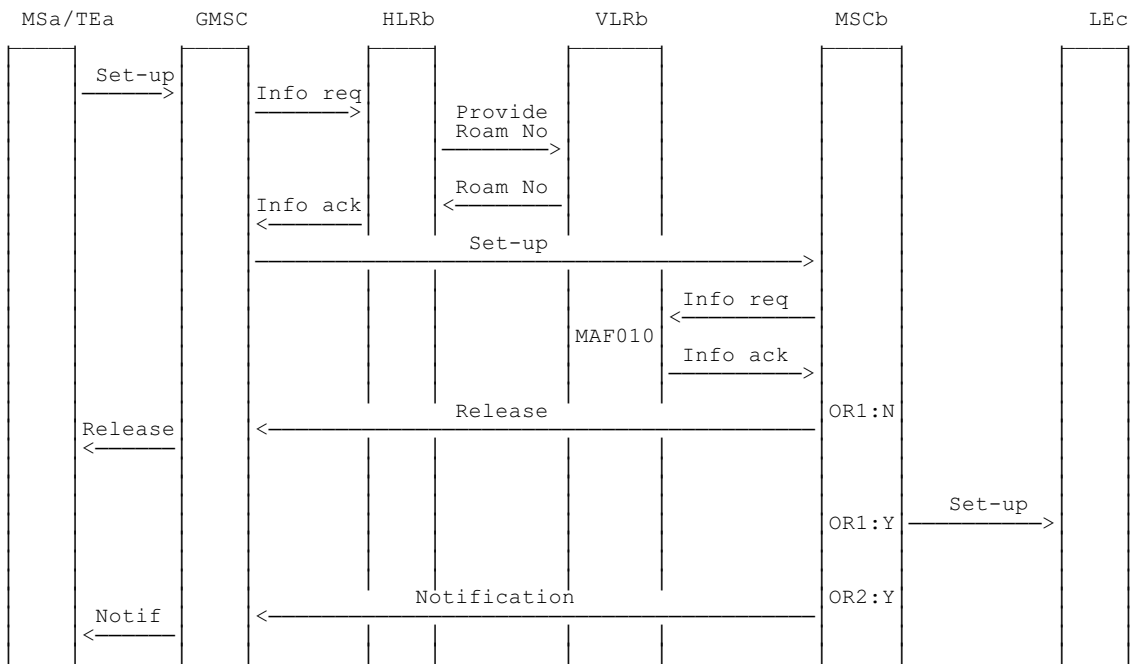
```
  MSa/TEa      GMSC         HLRb         VLRb          MSCb           LEc

    │      Set-up │            │            │             │             │
    ├──────────> │  Info req  │            │             │             │
    │            ├──────────> │  Provide   │             │             │
    │            │            │  Roam No   │             │             │
    │            │            ├──────────> │             │             │
    │            │            │  Roam No   │             │             │
    │            │  Info ack  │ <──────────┤             │             │
    │            │ <──────────┤            │             │             │
    │            │         Set-up          │             │             │
    │            ├─────────────────────────────────────> │             │
    │            │            │            │   Info req   │             │
    │            │            │            │ <────────────┤             │
    │            │            │            │   MAF010     │             │
    │            │            │            │   Info ack   │             │
    │            │            │            ├────────────> │             │
    │            │         Release         │             │ OR1:N       │
    │  Release   │ <───────────────────────────────────────┤           │
    │ <──────────┤            │            │             │             │
    │            │            │            │             │             │
    │            │            │            │             │ OR1:Y Set-up│
    │            │            │            │             ├─────────> │ │
    │            │        Notification     │             │ OR2:Y       │
    │  Notif     │ <───────────────────────────────────────┤           │
    │ <──────────┤            │            │             │             │
    │            │            │            │             │             │
```

NOTE: info: information   Y: Yes
         req: request   N: No
         ack: acknowledge
         notif: notification
         Roam No: roaming number
         OR1: Call to be forwarded
         OR2: Notification to calling subscriber required

Figure 4.11: Information flow for call forwarding on mobile subscriber not reachable in case of mobile subscriber not reachable in the VLR
(to fixed terminal)
(re-routing by VLR)

```
MSa/TEa      GMSC        HLRb        VLRb          MSCb          HLRc        MSCc

 │           │           │           │             │             │           │
 │  Set-up   │           │           │             │             │           │
 │──────────>│ Info req  │           │             │             │           │
 │           │──────────>│  Provide  │             │             │           │
 │           │           │  Roam No  │             │             │           │
 │           │           │──────────>│             │             │           │
 │           │ Info ack  │  Roam No  │             │             │           │
 │           │<──────────│<──────────│             │             │           │
 │           │           Set-up      │             │             │           │
 │           │──────────────────────────────────> │             │           │
 │           │           │           │       Info req            │           │
 │           │           │           │      <──────│             │           │
 │           │           │           │  MAF010     │             │           │
 │           │           │           │       Info ack            │           │
 │           │           │           │      ──────>│             │           │
 │           │           Release     │             │ OR1:N       │           │
 │ Release   │<──────────────────────────────────│ │             │           │
 │<──────────│           │           │             │ │             │           │
 │           │           │           │             │ OR1:Y  Info req         │
 │           │           │           │             │──────────────────>│     │
 │           │           │           │             │   Info ack        │     │
 │           │           │           │             │<──────────────────│     │
 │           │           │           │             │        Set-up           │
 │           │           │           │             │───────────────────────>│
 │           │           Notification│             │ OR2:Y       │           │
 │ Notif     │<──────────────────────────────────│ │             │           │
 │<──────────│           │           │             │             │           │
 │           │           │           │             │             │           │
```
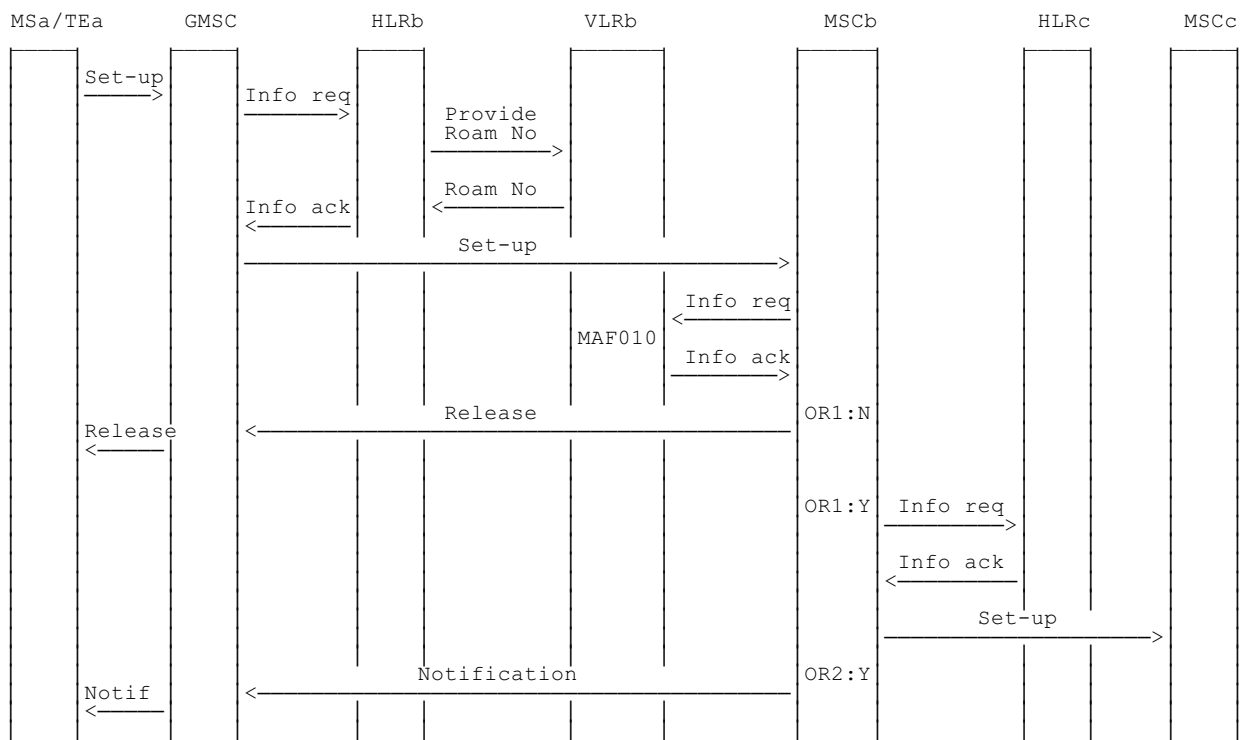
NOTE: info: information   Y: Yes
          req: request   N: No
          ack: acknowledge
          notif: notification
          Roam No: roaming number
          OR1: Call to be forwarded
          OR2: Notification to calling subscriber required

Figure 4.12: Information flow for call forwarding on mobile subscriber not reachable in case of
mobile subscriber not reachable in the VLR
(to mobile station)
(re-routing by VLR)

```
MSa/TEa       GMSC      HLRb      VLRb          MSCb          MSb       LEc

  |            |         |         |             |             |         |
  | Set-up     |         |         |             |             |         |
  |----------->|         |         |             |             |         |
  |            | Info req |         |             |             |         |
  |            |--------->|         |             |             |         |
  |            |         | Provide |             |             |         |
  |            |         | roam No |             |             |         |
  |            |         |-------->|             |             |         |
  |            |         | Roam No |             |             |         |
  |            | Info ack |<--------|             |             |         |
  |            |<---------|         |             |             |         |
  |            |         Set-up     |             |             |         |
  |            |---------------------------------->|             |         |
  |            |         |         | Info req    |             |         |
  |            |         |         |<------------|             |         |
  |            |         |         | Page MS     |             |         |
  |            |         |         |------------>|  Paging     |         |
  |            |         |         |             |------------>|         |
  |            |         |         |             | no          |         |
  |            |         |         | Absent      | response    |         |
  |            |         |         | subscriber  |             |         |
  |            |         |         |<------------|             |         |
  |            |         |  MAF010 | Impossible  |             |         |
  |            |         |  OR1:N  | call        |             |         |
  |            |         |         | completion  |             |         |
  |            |         |         |------------>|             |         |
  |            | Release |         |             |             |         |
  |            |<--------------------------------|             |         |
  | Release    |         |         |             |             |         |
  |<-----------|         |         |  OR1:Y  Connect to        |         |
  |            |         |         |         following         |         |
  |            |         |         |         address           |         |
  |            |         |         |------------>|             |         |
  |            |         |         |             |    Set-up   |         |
  |            |         |         |             |------------------->|
  |            |      Notification |             |  OR2:Y      |         |
  | Notif      |<--------------------------------|             |         |
  |<-----------|         |         |             |             |         |
  |            |         |         |             |             |         |
```

NOTE: info: information   Y: Yes
          req: request   N: No
          ack: acknowledge
          notif: notification
          roam: roaming
          OR1:   Call to be forwarded
          OR2:   Notification to calling subscriber required

Figure 4.13: Information flow for call forwarding on mobile subscriber not reachable in case of no paging response
(to fixed terminal)
(re-routing by VLR)

```
MSa/TEa    GMSC      HLRb      VLRb            MSCb        MSb    HLRc   MSCc
  |          |         |         |               |          |      |      |
  | Set-up   |         |         |               |          |      |      |
  |--------->| Info req|         |               |          |      |      |
  |          |-------->| Provide |               |          |      |      |
  |          |         | roam No |               |          |      |      |
  |          |         |-------->|               |          |      |      |
  |          |         | Roam No |               |          |      |      |
  |          | Info ack|<--------|               |          |      |      |
  |          |<--------|         |               |          |      |      |
  |          |        Set-up     |               |          |      |      |
  |          |------------------------------------>          |      |      |
  |          |         |         | Info req      |          |      |      |
  |          |         |         |<--------------|          |      |      |
  |          |         |         | Page MS       |  Paging  |      |      |
  |          |         |         |-------------->|--------->|      |      |
  |          |         |         |               |   no     |      |      |
  |          |         |         |               | response |      |      |
  |          |         |         |   Absent      |          |      |      |
  |          |         |         | subscriber    |          |      |      |
  |          |         |         |<--------------|          |      |      |
  |          |         |    MAF010|               |          |      |      |
  |          |         |    OR1:N | Impossible    |          |      |      |
  |          |         |         |    call       |          |      |      |
  |          |         |         | completion    |          |      |      |
  |          |         |         |-------------->|          |      |      |
  |          |         |  Release                |          |      |      |
  | Release  |<------------------------------------          |      |      |
  |<---------|         |         |               |          |      |      |
  |          |         |    OR1:Y | Connect to    |          |      |      |
  |          |         |         | following     |          |      |      |
  |          |         |         |  address      |          |      |      |
  |          |         |         |-------------->|          |      |      |
  |          |         |         |               | Info req |      |      |
  |          |         |         |               |--------------->|      |
  |          |         |         |               | Info ack |      |      |
  |          |         |         |               |<---------------|      |
  |          |         |         |               |     Set-up      |     |
  |          |         |         |               |---------------------->|
  |          |         |  Notification     OR2:Y  |          |      |      |
  | Notif    |<------------------------------------          |      |      |
  |<---------|         |         |               |          |      |      |
  |          |         |         |               |          |      |      |
```

NOTE: info: information   Y: Yes
           req: request   N: No
           ack: acknowledge
           notif: notification
           roam: roaming
           OR1:   Call to be forwarded
           OR2:   Notification to calling subscriber required

Figure 4.14: Information flow for call forwarding on mobile subscriber not reachable in case of no paging response
(to mobile station)
(re-routing by VLR)

```
 MSa/TEa      GMSC       HLRb        VLRb              MSCb         MSb        LEc

     │  Set-up  │          │           │                │            │          │
     ├─────────>│ Info req │           │                │            │          │
     │          ├─────────>│ Provide   │                │            │          │
     │          │          │ roam No   │                │            │          │
     │          │          ├──────────>│                │            │          │
     │          │ Info ack │ Roam No   │                │            │          │
     │          │<─────────┼───────────┤                │            │          │
     │          │          │   Set-up  │                │            │          │
     │          ├──────────┼───────────┼───────────────>│            │          │
     │          │          │           │    Info req    │            │          │
     │          │          │           │<───────────────┤            │          │
     │          │          │           │ Complete call  │            │          │
     │          │          │           ├───────────────>│ radio      │          │
     │          │          │           │    Radio       │ congestion │          │
     │          │          │           │  congestion    │            │          │
     │          │          │           │<───────────────┤            │          │
     │          │          │        MAF010              │            │          │
     │          │          │        OR1:N  Impossible   │            │          │
     │          │          │               call         │            │          │
     │          │          │               completion   │            │          │
     │          │          │           ├───────────────>│            │          │
     │          │  Release │           │                │            │          │
     │ Release  │<─────────┼───────────┼────────────────┤            │          │
     │<─────────┤          │           │                │            │          │
     │          │          │        OR1:Y  Connect to   │            │          │
     │          │          │               following    │            │          │
     │          │          │               address      │            │          │
     │          │          │           ├───────────────>│            │          │
     │          │          │           │                │   Set-up   │          │
     │          │          │           │                ├───────────>│          │
     │          │        Notification  │                │ OR2:Y      │          │
     │  Notif   │<─────────┼───────────┼────────────────┤            │          │
     │<─────────┤          │           │                │            │          │
     │          │          │           │                │            │          │
```

NOTE: info: information   Y: Yes
        req: request   N: No
        ack: acknowledge
        notif: notification
        roam: roaming
        OR1:   Call to be forwarded
        OR2:   Notification to calling subscriber required

**Figure 4.15: Information flow for call forwarding on mobile subscriber not reachable in case of
radio congestion
(to fixed terminal)
(re-routing by VLR)**

```
MSa/TEa   GMSC      HLRb        VLRb              MSCb        MSb   HLRc   MSCc

  │  Set-up  │         │          │                │           │     │      │
  ├─────────>│ Info req│          │                │           │     │      │
  │          ├────────>│ Provide  │                │           │     │      │
  │          │         │ roam No  │                │           │     │      │
  │          │         ├─────────>│                │           │     │      │
  │          │         │ Roam No  │                │           │     │      │
  │          │ Info ack│<─────────┤                │           │     │      │
  │          │<────────┤          │                │           │     │      │
  │          │         │  Set-up  │                │           │     │      │
  │          ├────────────────────────────────────>│           │     │      │
  │          │         │          │   Info req     │           │     │      │
  │          │         │          │<───────────────┤           │     │      │
  │          │         │          │ Complete call  │           │     │      │
  │          │         │          ├───────────────>│ radio     │     │      │
  │          │         │          │                │ congestion│     │      │
  │          │         │          │    Radio       │           │     │      │
  │          │         │          │  congestion    │           │     │      │
  │          │         │       MAF010<─────────────┤           │     │      │
  │          │         │       OR1:N│ Impossible   │           │     │      │
  │          │         │          │    call        │           │     │      │
  │          │         │          │  completion    │           │     │      │
  │          │         │          ├───────────────>│           │     │      │
  │          │         │ Release  │                │           │     │      │
  │ Release  │<────────────────────────────────────┤           │     │      │
  │<─────────┤         │          │                │           │     │      │
  │          │         │       OR1:Y│ Connect to   │           │     │      │
  │          │         │          │  following     │           │     │      │
  │          │         │          │  address       │           │     │      │
  │          │         │          ├───────────────>│ Info req  │     │      │
  │          │         │          │                ├──────────>│     │      │
  │          │         │          │                │ Info ack  │     │      │
  │          │         │          │                │<──────────┤     │      │
  │          │         │          │                │   Set-up  │     │      │
  │          │         │          │                ├─────────────────────>│
  │          │         │ Notification             │ OR2:Y     │     │      │
  │ Notif    │<────────────────────────────────────┤           │     │      │
  │<─────────┤         │          │                │           │     │      │
```
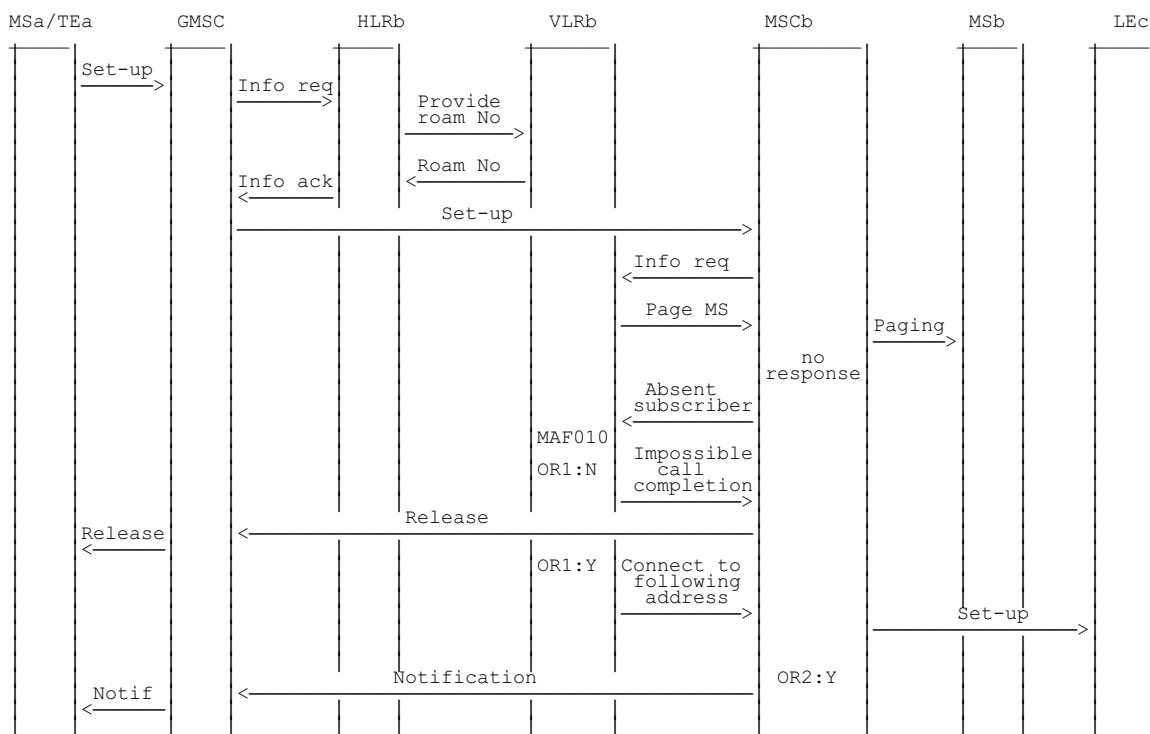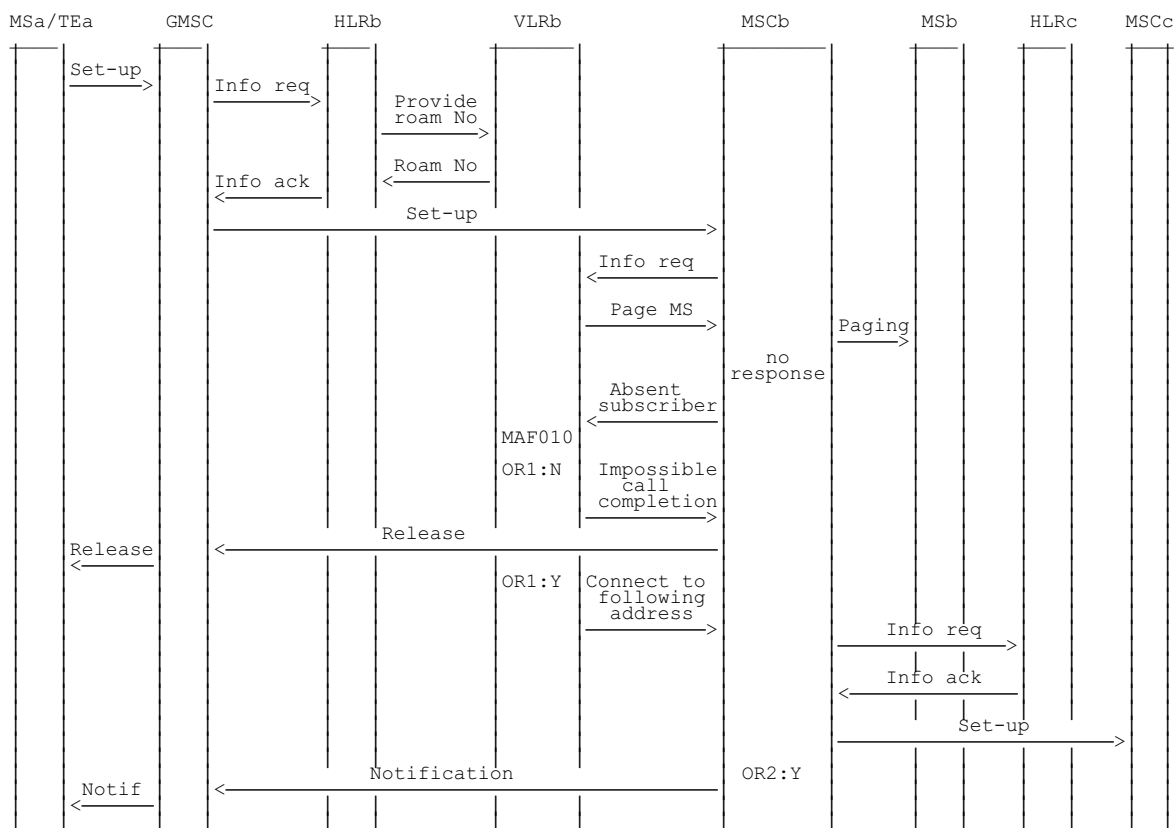
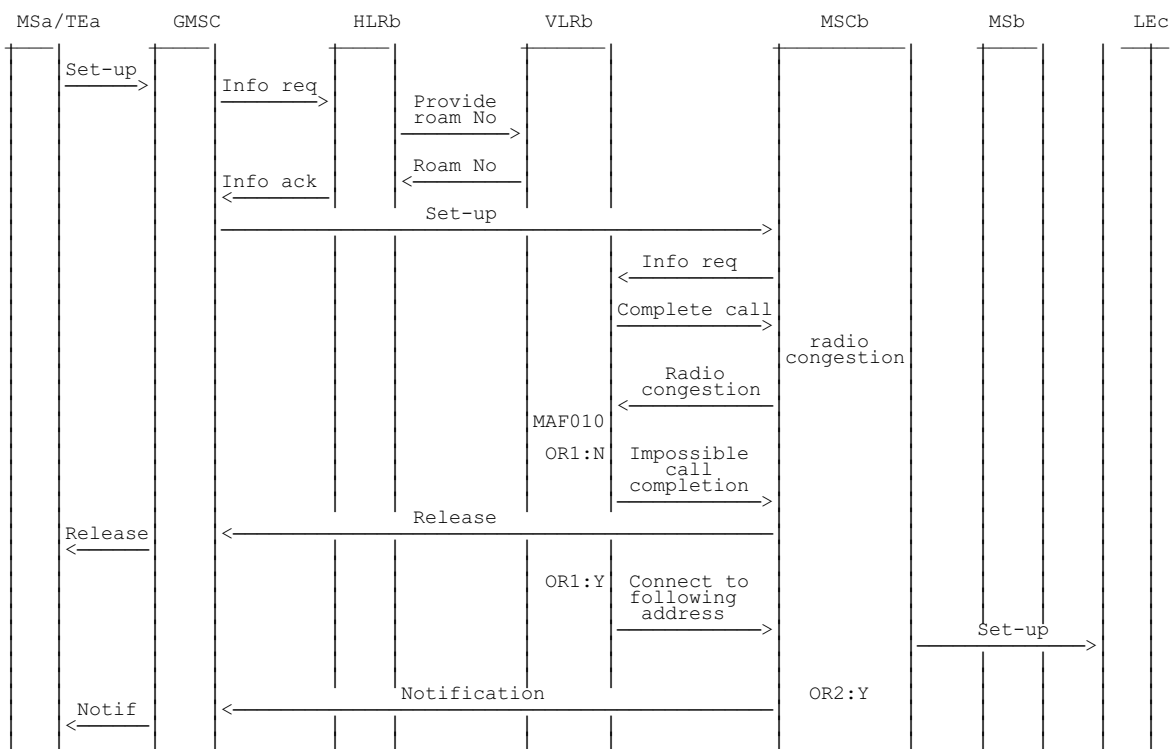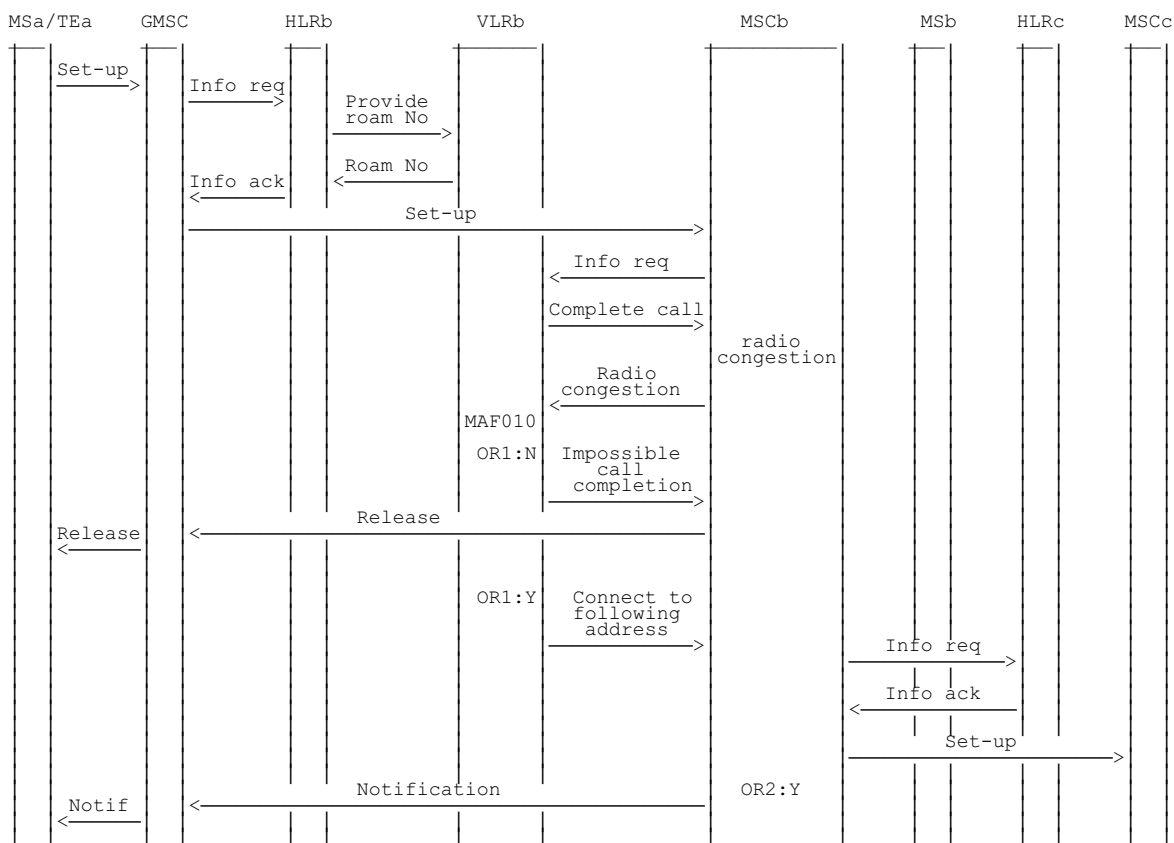   NOTE: info: information   Y: Yes
                  req: request   N: No
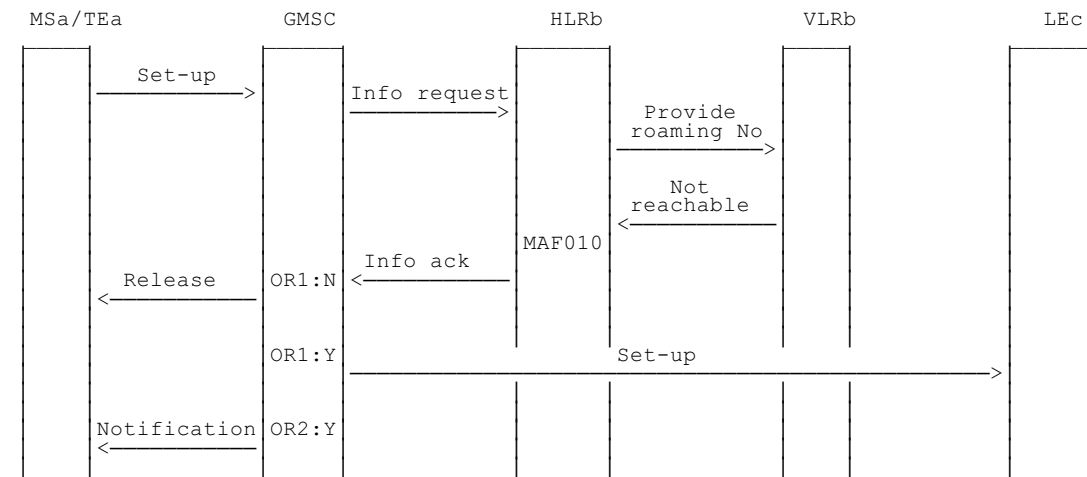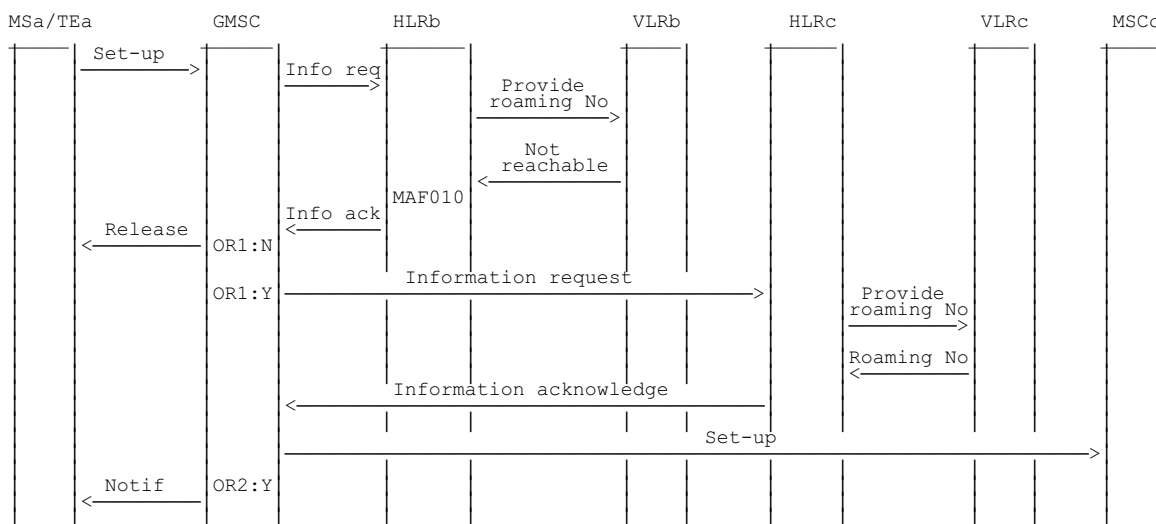   ack: acknowledge
                  notif: notification
                  roam: roaming
                  OR1:   Call to be forwarded
                  OR2:   Notification to calling subscriber required

Figure 4.16: Information flow for call forwarding on mobile subscriber not reachable in case of
radio congestion
(to mobile station)
(re-routing by VLR)

```
  MSa/TEa           GMSC             HLRb             VLRb              LEc
    ┌─┐             ┌─┐              ┌─┐              ┌─┐              ┌─┐
    │ │   Set-up    │ │              │ │              │ │              │ │
    │ ├──────────►  │ │ Info request │ │              │ │              │ │
    │ │             │ ├─────────────►│ │  Provide     │ │              │ │
    │ │             │ │              │ │ roaming No   │ │              │ │
    │ │             │ │              │ ├─────────────►│ │              │ │
    │ │             │ │              │ │    Not       │ │              │ │
    │ │             │ │              │ │  reachable   │ │              │ │
    │ │             │ │              │ │◄─────────────┤ │              │ │
    │ │             │ │              │ │ MAF010       │ │              │ │
    │ │   Release   │ │ OR1:N Info ack│ │             │ │              │ │
    │ │◄────────────┤ │◄─────────────┤ │              │ │              │ │
    │ │             │ │              │ │              │ │              │ │
    │ │             │ │ OR1:Y        │ │     Set-up   │ │              │ │
    │ │             │ ├──────────────────────────────────────────────►│ │
    │ │Notification │ │ OR2:Y        │ │              │ │              │ │
    │ │◄────────────┤ │              │ │              │ │              │ │
    └─┘             └─┘              └─┘              └─┘              └─┘
```

NOTE: info: information   Y: Yes
          ack: acknowledge   N: No
          OR1: Call to be forwarded
          OR2: Notification to calling subscriber required

**Figure 4.17: Information flow for call forwarding on mobile subscriber not reachable in case of
mobile subscriber not reachable in the VLR
(to fixed terminal)
(re-routing by HLR)**

```
MSa/TEa        GMSC          HLRb          VLRb          HLRc          VLRc          MSCc
   |             |             |             |             |             |             |
   |   Set-up    |             |             |             |             |             |
   |------------>|   Info req  |             |             |             |             |
   |             |------------>|             |             |             |             |
   |             |             |   Provide   |             |             |             |
   |             |             |  roaming No |             |             |             |
   |             |             |------------>|             |             |             |
   |             |             |    Not      |             |             |             |
   |             |             |  reachable  |             |             |             |
   |             |             |<------------|             |             |             |
   |             |   Info ack  | MAF010      |             |             |             |
   |  Release    |<------------|             |             |             |             |
   |<------------| OR1:N       |             |             |             |             |
   |             |             |             |             |             |             |
   |             | OR1:Y       Information request         |             |             |
   |             |---------------------------------------->|             |             |
   |             |             |             |             |   Provide   |             |
   |             |             |             |             |  roaming No |             |
   |             |             |             |             |------------>|             |
   |             |             |             |             |  Roaming No |             |
   |             |             |             |             |<------------|             |
   |             |      Information acknowledge            |             |             |
   |             |<----------------------------------------|             |             |
   |             |             |             |       Set-up              |             |
   |             |------------------------------------------------------------------->|
   |   Notif     | OR2:Y       |             |             |             |             |
   |<------------|             |             |             |             |             |
   |             |             |             |             |             |             |
```

NOTE: info: information   Y: Yes
         req: request   N: No
         ack: acknowledge
         notif: notification
         OR1: Call to be forwarded
         OR2: Notification to calling subscriber required

**Figure 4.18: Information flow for call forwarding on mobile subscriber not reachable in case of
mobile subscriber not reachable in the VLR
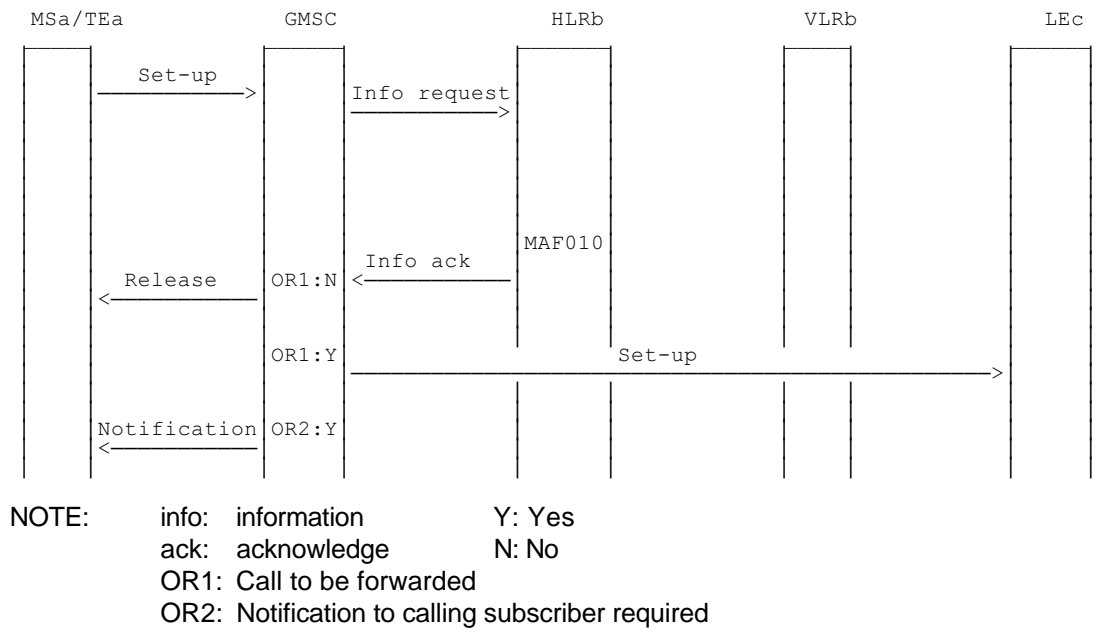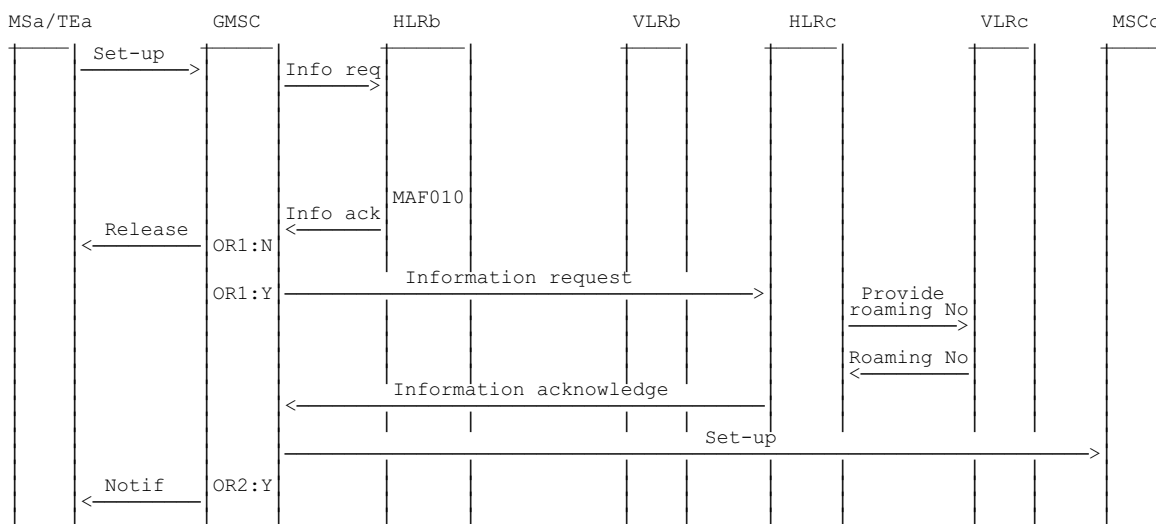(to mobile station)
(re-routing by HLR)**

```
  MSa/TEa           GMSC              HLRb              VLRb              LEc

    |                 |                 |                 |                 |
    |    Set-up       |                 |                 |                 |
    |---------------->| Info request    |                 |                 |
    |                 |---------------->|                 |                 |
    |                 |                 |                 |                 |
    |                 |                 |                 |                 |
    |                 |                 MAF010            |                 |
    |    Release      | OR1:N  Info ack |                 |                 |
    |<----------------|<----------------|                 |                 |
    |                 |                 |                 |                 |
    |                 | OR1:Y           |     Set-up      |                 |
    |                 |---------------------------------------------------->|
    |                 |                 |                 |                 |
    | Notification    | OR2:Y           |                 |                 |
    |<----------------|                 |                 |                 |
    |                 |                 |                 |                 |
```

NOTE: info: information   Y: Yes
          ack: acknowledge   N: No
          OR1: Call to be forwarded
          OR2: Notification to calling subscriber required

**Figure 4.19: Information flow for call forwarding on mobile subscriber not reachable in case of
mobile subscriber deregistered or purged
(to fixed terminal)
(re-routing by HLR)**

```
MSa/TEa        GMSC          HLRb          VLRb          HLRc          VLRc          MSCc
   |             |             |             |             |             |             |
   |   Set-up    |   Info req  |             |             |             |             |
   |------------>|------------>|             |             |             |             |
   |             |             |             |             |             |             |
   |             |             |             |             |             |             |
   |             |    MAF010   |             |             |             |             |
   |             |   Info ack  |             |             |             |             |
   |   Release   |<------------|             |             |             |             |
   |<------------| OR1:N       |             |             |             |             |
   |             |             |             |             |             |             |
   |             | OR1:Y   Information request             |             |             |
   |             |--------------------------------------->|   Provide   |             |
   |             |             |             |             | roaming No  |             |
   |             |             |             |             |------------>|             |
   |             |             |             |             |  Roaming No |             |
   |             |             |             |             |<------------|             |
   |             |       Information acknowledge           |             |             |
   |             |<---------------------------------------|             |             |
   |             |             |             |             |             |   Set-up    |
   |             |----------------------------------------------------------------->|
   |   Notif     | OR2:Y       |             |             |             |             |
   |<------------|             |             |             |             |             |
   |             |             |             |             |             |             |
```

NOTE: info: information   Y: Yes
          req: request   N: No
          ack: acknowledge
          notif: notification
          No: number
          OR1:   Call to be forwarded
          OR2:   Notification to calling subscriber required

**Figure 4.20: Information flow for call forwarding on mobile subscriber not reachable in case of
mobile subscriber deregistered or purged
(to mobile station)
(re-routing by HLR)**

4.3 Information stored in the HLR

The following logical states are applicable for CFNRc (refer to TS GSM 03.11 for an explanation of the notation):

Provisioning State	Registration State	Activation State	HLR Induction State
(Not Provisioned,	Not Registered,	Not Active,	Not Induced)
(Provisioned,	Not Registered,	Not Active,	Not Induced)
(Provisioned,	Registered,	Not Active,	Not Induced)
(Provisioned,	Registered,	Active and Quiescent,	Not Induced)
(Provisioned,	Registered,	Active and Operative,	Not Induced)

The registration and activation state may be different for each applicable elementary basic service group.

The provisioning state shall be on a per subscriber basis, and hence the same for all basic service groups.

The HLR shall store:

- the state of CFNRc (which shall be one of the valid states listed above) for each applicable elementary basic service group;

- the subscription option "notification to the calling party" on a per subscriber basis;
  This subscription option takes one of the following values:
  - no notification;
  - notification.

- the registration parameter "forwarded-to number" (possibly including a forwarded-to sub-address) for each applicable elementary basic service group;

4.4 State transition model

The following figure shows the successful cases of transition between the applicable logical states of CFNRc. The state changes are either caused by actions of the service provider, the mobile user or the network.

Note that error cases are not shown in the diagram as they normally do not cause a state change. Additionally, some successful requests may not cause a state change. Hence, they are not shown in the diagram.

The diagram only shows operations on an elementary basic service group.
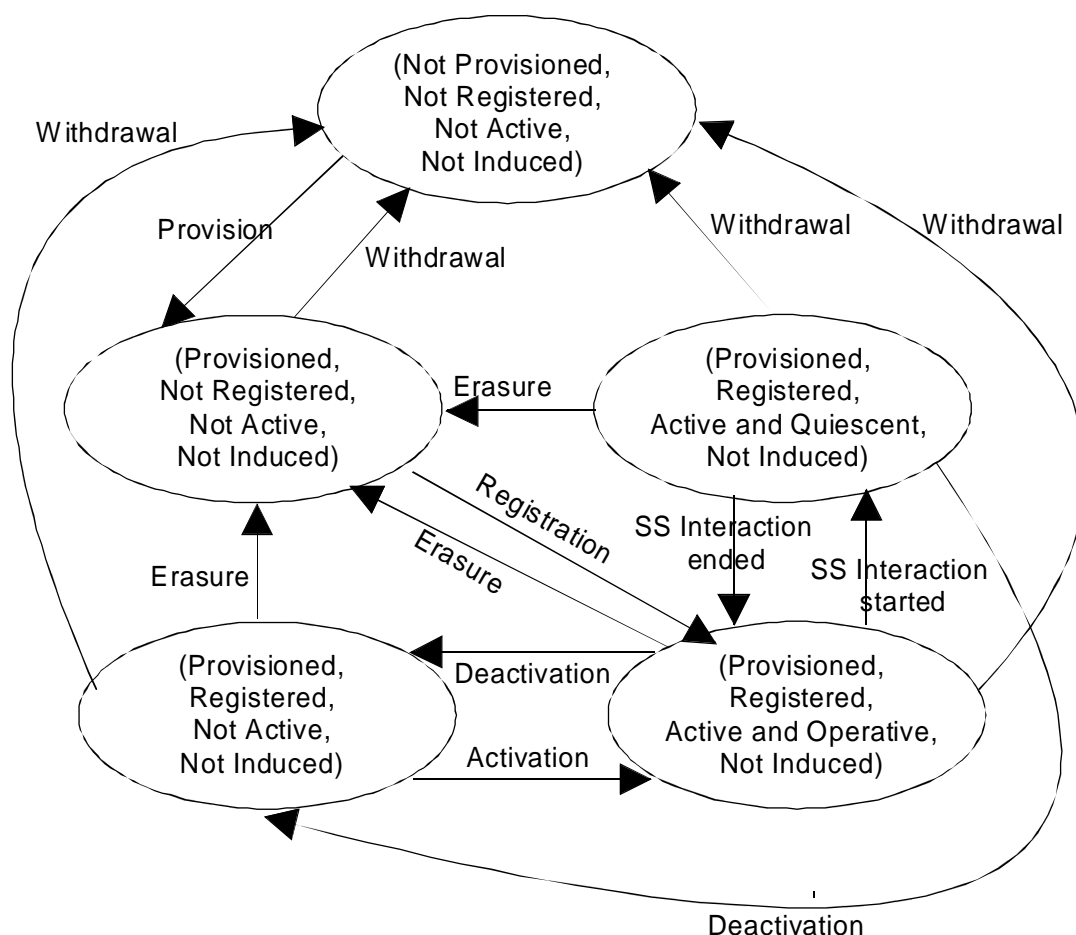
Figure 4.21: State transition model for CFNRc

4.5 Transfer of information from HLR to VLR

If the provisioning state for CFNRc is "Provisioned" then, when the subscriber registers on a VLR, the HLR shall send that VLR information about the logical state of CFNRc for all relevant elementary basic service groups and information about the subscription option "notification to the calling party".

If the registration state for CFNRc is "Registered" then, when the subscriber registers on a VLR, the HLR shall send that VLR the registration parameter "forwarded-to number" for all relevant elementary basic service groups.

If the logical state or the registration parameter "forwarded-to number" of CFNRc is changed while a subscriber is registered on a VLR then for the affected basic service groups, the HLR shall inform the VLR respectively of the new logical state or the new registration parameter of CFNRc.

4.6 Information stored in the VLR

For CFNRc the VLR shall store the service state information and the subscription options received from the HLR.

4.7 Handover

Handover will have no impact on the control procedure and the operation of the service.

4.8 Cross phase compatibility

4.8.1 MS, MSC, VLR or HLR only support phase 1 control of SS by the subscriber

In response to a CFNRc interrogation request, if the MS or any network element involved is of phase 1, only information concerning basic service groups for which the activation state has the value "Active and Operative" will be returned. This means that the subscriber will not be aware that the forwarded to number is registered if CFNRc is deactivated or active (quiescent). A subaddress (if registered) will not be included.

Note that if any network element involved is of phase 1, CFNRc Registration requests which use a subaddress and all CFNRc Activation and Deactivation requests will be rejected, as these are not specified in phase 1.

4.8.2 HLR only supports phase 1 updating of subscriber information

If the VLR receives the SS-Status parameter from a phase 1 HLR it shall act if it has received the SS-Status parameter with the values shown in the following:

1)   Registered, Activated   => P bit =1, R bit = 1, A bit = 1, Q bit = 0;

2)   Registered, Deactivated => P bit =1, R bit = 1, A bit = 0, Q bit = 0 or 1;

3)   Erased   => P bit =1, R bit = 0, A bit = 0, Q bit = 0 or 1.

4.8.3 VLR only supports phase 1 updating of subscriber information

When passing CFNRc information to a phase 1 VLR, the HLR shall send the service state information in a form which the VLR can accept, based on the logical state held in the HLR, as follows:

1)   (Provisioned, Not Registered, Not Active, Not Induced)
                        => Erased, Deactivated;

2)   (Provisioned, Registered, Not Active, Not Induced)
                        => Registered, Deactivated;

3)   (Provisioned, Registered, Active and Operative, Not Induced)
                        => Registered, Activated;

4)   (Provisioned, Registered, Active and Quiescent, Not Induced)
                        => Registered, Deactivated.

The HLR shall not pass a subaddress to a phase 1 VLR.

4.8.4 GMSC only supports phase 1 call handling

When a call is forwarded on not reachable at the GMSC, the HLR shall not pass the subaddress to a phase 1 GMSC. Calls shall be forwarded without the subaddress.

4.8.5 VLR only supports phase 1 call handling

When a call is forwarded on not reachable at the VMSC, as the HLR does not pass the subaddress to the VLR, calls shall be forwarded without the subaddress.

History

Document history	
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