TEXAS INSTRUMENTS

Technical Document

G23-GSM PROTOCOL STACK

CC

MESSAGE SEQUENCE CHARTS

Document Number:	6147.200.99.002
Version:	0.3
Status:	Draft
Approval Authority:	
Creation Date:	1997-Mar-22
Last changed:	2015-Mar-08 by XGUTTEFE
File Name:	cc.doc

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Change History

Date	Changed by	Approved by	Version	Status	Notes
1997-Mar-22	LE et al		0.1		1
2002-Jul-23	SBK		0.2		
2003-May-12	XGUTTEFE		0.3	Draft	

Notes:

1.   Initial version

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Table of Contents

List of Figures and Tables

List of References

[ISO 9000:2000]   International Organization for Standardization. Quality management sys-
                              tems - Fundamentals and vocabulary. December 2000

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1   Introduction

G23 is a software package implementing Layers 2 and 3 of the ETSI-defined GSM air interface signaling protocol, and as such represents the part of a GSM mobile station's protocol software which is both, platform and manufacturer independent. Therefore, G23 can be viewed as a building block providing standardized functionality through generic interfaces for easy integration.

The G23 suite of products consists of the following items:

- Layers 2 and 3 for speech & short message services,
- Layers 2 and 3 for fax & data services,
- Application Control Interface,
- Slim MMI [02.30] and
- Test and integration support tools.

This document describes the services offered by call control.

2   Overview of States

CC's functionality is distributed over 16 different states. The current state is stored by CC. The following states are implemented:

NULL (U0)	There is no call (in progress).
MM CONNECTION PENDING (U0.1) mobile	This state is used for the mobile originated call. The mobile station requests establishment of an MM connection.
WAIT FOR NW INFO (U0.3)	This state is used for CCBS. This state exists for a mobile originating call when the mobile station has responded to the prompt from the network to establish a CC connection and the mobile station is waiting for further information from the network.
CC EST. CONFIRMED (U0.5)	This state is used for CCBS. It exists for a mobile originating call when the mobile station has sent the acknowledgement that the mobile station has received all the CC information that is needed.
RECALL PRESENT (U0.6)	This state is used for CCBS. This state exists for a mobile originating call when the mobile station has received a recall request but has not yet responded.
CALL INITIATED (U1) call	This state is used for the mobile originated call. The MM connection is established and the mobile station requests establishment by the network.
MO CALL PROCEEDING (U3) mobile	This state is used for the mobile originated call. The mobile station has received a response from the network that the network has all necessary information to establish the call.
CALL DELIVERED (U4) mobile it	This state is used for the mobile originated call. The mobile station has received the message from the network, that it is alerting the called party.
CALL PRESENT (U6) mobile but	This state is used for the mobile terminated call. The mobile station has received the initial message from the network but has not yet responded.

TEXAS INSTRUMENTS

CALL RECEIVED (U7) mobile

sponse

This state is used for the mobile terminated call. The

station has switched on the alerting but has sent no re-

to the network.

CONNECT REQUEST (U8) mobile

from

This state is used for the mobile terminated call. The

station has answered and is awaiting acknowledgement

the network.

MT CALL CONFIRMED (U9) mobile

sary

This state is used for the mobile terminated call. The

station has answered and declared that it has all neces-

call establishment information.

ACTIVE (U10)

Call establishment is finished and the call is active.

ACTIVE PENDING (U10.1)

An error has occurred and the connection tries a call re-establishment.

DISCONNECT REQUEST (U11)

The mobile station requests call disconnection.

DISCONNECT INDICATION (U12)

The other party requests call disconnection.

RELEASE REQUEST (U19) the

network (local end release).

The mobile station requests release of the connection to

MO MODIFY (U26) mode

The mobile station has requested a new connection

(e.g. data instead of speech). It waits for an answer from the network.

MO MODIFY PENDING (U26.1) call

The call is interrupted during in-call modification and a

re-establishment is processed.

3 Protocol

3.1 Configuration

```
MMI                     CC                    MM                    Um
 |                       |                     |                     |
 | MNCC CONFIGURE REQ    |                     |                     |
 *=====================>*                      |                     |
 |                     (CC 1)                   |                     |
 |                       |                     |                     |
```
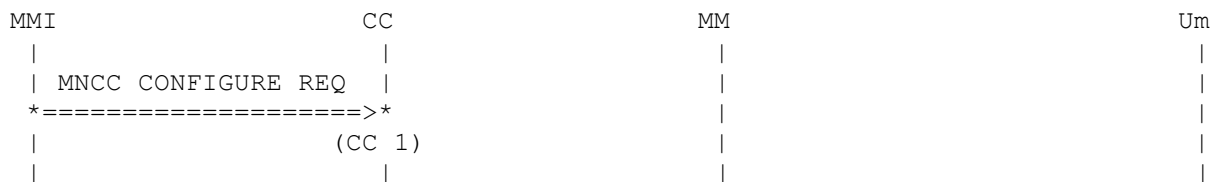
(CC 1)

MMI sets the CC configuration. This is used to define a subaddress. The subaddress is stored.

3.2 Call Establishment

3.2.1 Mobile Originated Call
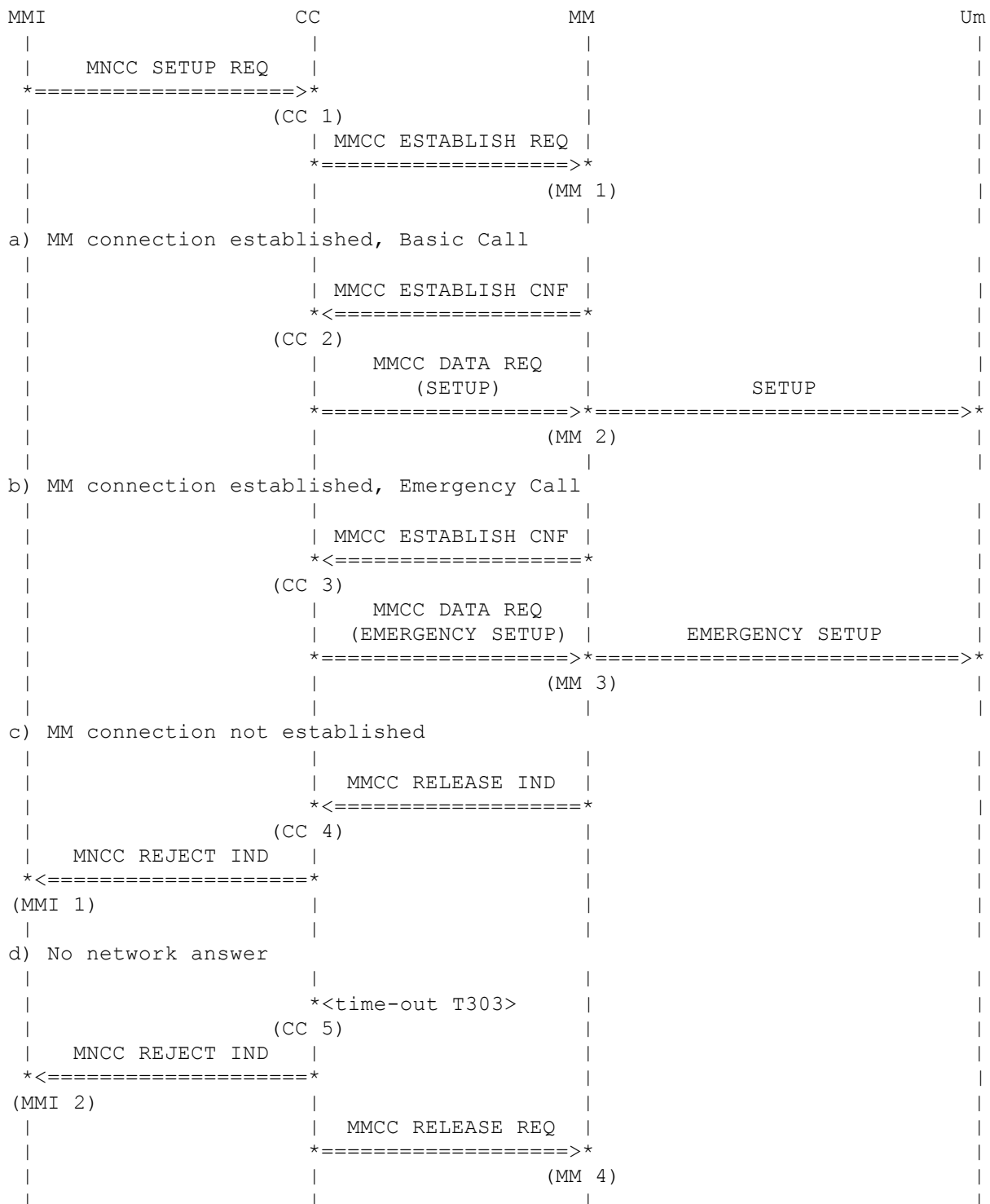
```
MMI                         CC                      MM                                  Um
 |                          |                       |                                   |
 |     MNCC SETUP REQ       |                       |                                   |
 *=====================>*                           |                                   |
 |                       (CC 1)                     |                                   |
 |                          | MMCC ESTABLISH REQ |                                      |
 |                          *==================>*                                       |
 |                          |                     (MM 1)                                |
 |                          |                       |                                   |
a) MM connection established, Basic Call
 |                          |                       |                                   |
 |                          | MMCC ESTABLISH CNF |                                      |
 |                          *<==================*                                       |
 |                       (CC 2)                     |                                   |
 |                          |    MMCC DATA REQ   |                                      |
 |                          |       (SETUP)      |            SETUP                     |
 |                          *==================>*============================>*          |
 |                          |                     (MM 2)                                |
 |                          |                       |                                   |
b) MM connection established, Emergency Call
 |                          |                       |                                   |
 |                          | MMCC ESTABLISH CNF |                                      |
 |                          *<==================*                                       |
 |                       (CC 3)                     |                                   |
 |                          |    MMCC DATA REQ   |                                      |
 |                          |  (EMERGENCY SETUP) |      EMERGENCY SETUP                 |
 |                          *==================>*============================>*          |
 |                          |                     (MM 3)                                |
 |                          |                       |                                   |
c) MM connection not established
 |                          |                       |                                   |
 |                          |  MMCC RELEASE IND  |                                      |
 |                          *<==================*                                       |
 |                       (CC 4)                     |                                   |
 |    MNCC REJECT IND       |                       |                                   |
 *<====================*                            |                                   |
(MMI 1)                     |                       |                                   |
 |                          |                       |                                   |
d) No network answer
 |                          |                       |                                   |
 |                          *<time-out T303>        |                                   |
 |                       (CC 5)                     |                                   |
 |    MNCC REJECT IND       |                       |                                   |
 *<====================*                            |                                   |
(MMI 2)                     |                       |                                   |
 |                          |  MMCC RELEASE REQ  |                                      |
 |                          *==================>*                                       |
 |                          |                     (MM 4)                                |
 |                          |                       |                                   |
```

(CC 1)

MMI starts a mobile originated call. The kind of connection (basic or emergency call) and a few other parameters are stored by CC. CC is able to start a call only if it is in U0 NULL state.

(MM 1)

CC needs an MM connection to the network for the mobile originated call. The connection establishment is requested. Timer T303 is started to supervise the network answer. CC enters U0.1 MO CALL PENDING state.

(CC 2)

MM signals to CC that the MM connection establishment was successful.

(MM 2)

The kind of connection was a basic call. CC builds a SETUP message and sends it to the network. The timer is not stopped and CC enters U1 CALL INIT state.

(CC 3)

MM sends CC the confirmation that the MM connection establishment was successful.

(MM 3)

The kind of connection was an emergency call. CC builds an EMERGENCY SETUP message and sends it to the network. The timer is not stopped and CC enters U1 CALL INIT state.

(CC 4)

MM connection establishment has failed.

(MMI 1)

MMI is informed about the failed establishment. CC re-enters U0 NULL state. Timer T303 is stopped.

(CC 5)

The timer T303 times-out. The MM connection has not been established in time.

(MMI 2)

MMI is informed about the failed establishment. CC re-enters U0 NULL state.

(MM 4)

MM is informed that establishment is aborted.

3.2.2 Response to the SETUP message

CC is in U1 CALL INIT state. It is a mobile originated call.

```
MMI                      CC                      MM                      Um
 |                        |                       |                       |
a) Normal Case
 |                        |                       |                       |
 |                        |    MMCC DATA IND       |                       |
 |                        |  (CALL PROCEEDING)     |   CALL PROCEEDING      |
 |                        *<==================*<===========================*
 |                (CC 1)                           |                       |
 |MNCC CALL PROCEED IND|                           |                       |
 *<===================*                            |                       |
(MMI 1)                  |                          |                       |
 |                        |                       |                       |
b) Network rejects SETUP message
 |                        |                       |                       |
 |                        |    MMCC DATA IND       |                       |
 |                        |  (RELEASE COMPLETE)    |   RELEASE COMPLETE     |
 |                        *<==================*<===========================*
 |                (CC 2)                           |                       |
 |    MNCC RELEASE IND   |                         |                       |
 *<===================*                            |                       |
(MMI 2)                  |                          |                       |
 |                        |    MMCC RELEASE REQ    |                       |
 |                        *==================>*                            |
 |                        |                 (MM 1)                         |
 |                        |                       |                       |
 |                        |                       |                       |
c) Network answers with CONNECT message
 |                        |                       |                       |
 |                        |    MMCC DATA IND       |                       |
 |                        |     (CONNECT)          |      CONNECT           |
 |                        *<==================*<===========================*
 |                (CC 3)                           |                       |
 |    MNCC SETUP CNF     |                         |                       |
 *<===================*                            |                       |
(MMI 3)                  |                          |                       |
 |                        |    MMCC DATA REQ       |                       |
 |                        |   (CONNECT_ACK)        |   CONNECT_ACK          |
 |                        *==================>*===========================>*
 |                        |                 (MM 2)                         |
 |                        |                       |                       |
d) Network answers with ALERT message
 |                        |                       |                       |
 |                        |    MMCC DATA IND       |                       |
 |                        |      (ALERT)           |      ALERT             |
 |                        *<==================*<===========================*
 |                (CC 4)                           |                       |
 |    MNCC ALERT IND     |                         |                       |
 *<===================*                            |                       |
(MMI 4)                  |                          |                       |
 |                        |                 (MM 3)                         |
 |                        |                       |                       |
```

(CC 1)

The network has accepted the previous mobile station SETUP message and sends a CALL PROCEEDING message to indicate the call establishment progress. Timer T303 is stopped.

(MMI 1)

MMI is informed about the CALL PROCEEDING message by CC. If the progress indicator included in the message is not equal to 1 (one) or 2 (two) or 64 (sixty-four) and such a value has not been received with a prior PROGRESS message, then timer T310 is started. This matches if the called party is not inside an ISDN or PLMN or call queuing is applied within the network. If this is so, no time limit is given for the reception of an ALERTING message. CC enters the U3 CALL PROCEEDING state.

(CC 2)

The network rejects the SETUP message. CC receives a RELEASE COMPLETE message. Timer T303 is stopped.

(MMI 2)

MMI is informed about call rejection.

(MM 1)

The MM connection is released locally. CC re-enters U0 NULL state.

(CC 3)

It is possible that the network answers with a CONNECT message directly. This possibility is used for future extensions of the standard. The mobile station is able to handle the message in this state. Timer T303 is stopped.

(MMI 3)

MMI is informed about the successful establishment.

(MM 2)

CC sends a CONNECT ACKNOWLEDGE message to the network. CC enters the U10 ACTIVE state.

(CC 4)

It is possible that the network answers with an ALERTING message directly. This possibility is used for future extensions of the standard. The mobile station is able to handle this message in this state. Timer T303 is stopped.

(MMI 4)

MMI is informed that the called party has switched alerting on. CC enters the U4 CALL DELIVERED state.

3.2.3 Change of PLMN/ISDN

CC is in call establishment or call release.

```
MMI                        CC                 MM                              Um
 |                          |                  |                              |
 |                          |  MMCC DATA IND    |                              |
 |                          |   (PROGRESS)      |         PROGRESS             |
 |                        *<==================*<============================*
 |                    (CC 1)                   |                              |
 |   MNCC PROGRESS IND   |                      |                              |
 *<====================*                        |                              |
(MMI 1)                   |                      |                              |
 |                        |                      |                              |
```
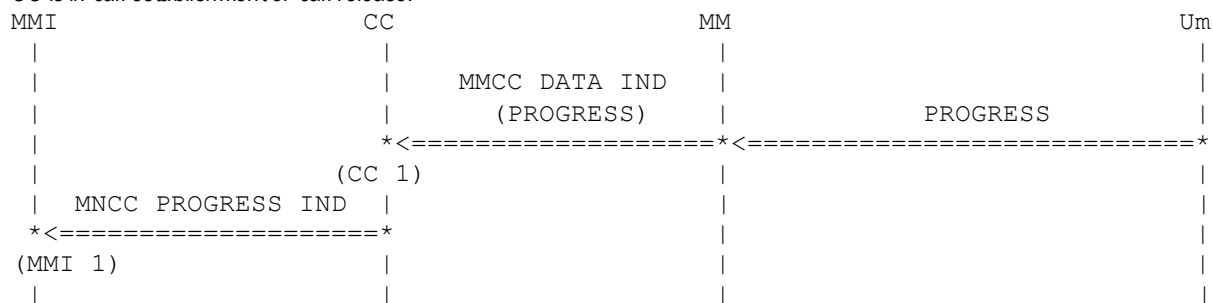
(CC 1)

The network has switched the PLMN or IDSN environment. CC is informed about this. If a timer is running, it will be stopped.

(MMI 1)

MMI is informed about the change of network type.

TEXAS INSTRUMENTS

3.2.4 Alerting during mobile originated call

CC is in U3 CALL PROCEEDING state. It is a mobile originated call.

```
MMI                     CC                  MM                            Um
 |                       |                   |                             |
 |                       |    MMCC DATA IND   |                             |
 |                       |     (ALERTING)     |         ALERTING            |
 |                      *<==================*<===========================*
 |              (CC 1)   |                   |                             |
 |     MNCC ALERT IND    |                   |                             |
 *<==================*                   |                             |
(MMI 1)                  |                   |                             |
 |                       |                   |                             |
```

(CC 1)

The network indicates that the called party has switched on the alert with the ALERTING message. CC stops timer T310.

(MMI 1)

MMI is informed about the alerting and CC enters U4 CALL DELIVERED state.

3.2.5 Completion of mobile originated call

CC is in U4 CALL DELIVERED state. It is a mobile originated call.

```
MMI                     CC                      MM                              Um
 |                       |                       |                               |
 |                       |     MMCC DATA IND      |                               |
 |                       |      (CONNECT)         |           CONNECT             |
 |                      *<=====================*<=============================*
 |                       (CC 1)                  |                               |
 |     MNCC SETUP CNF     |                       |                               |
 *<===================*                          |                               |
 (MMI 1)                 |                       |                               |
 |                       |     MMCC DATA REQ      |                               |
 |                       |      (CONNECT ACK)     |      CONNECT ACKNOWLEDGE       |
 |                      *==================>*=============================>*
 |                       |            (MM 1)     |                               |
 |                       |                       |                               |
```

(CC 1)
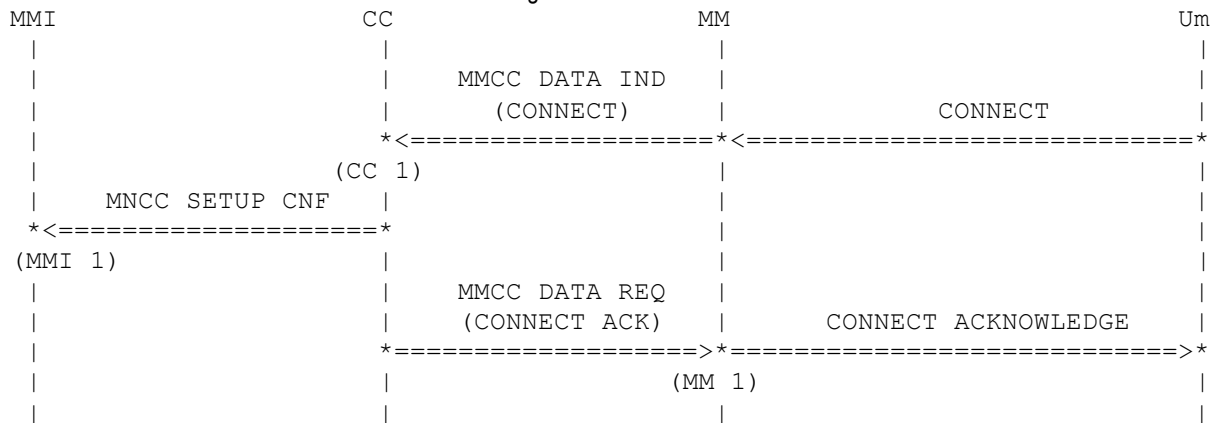
The network sends a CONNECT message.

(MMI 1)

MMI is informed about the successful call establishment.

(MM 1)

As confirmation, CC sends a CONNECT ACKNOWLEDGE message to the network. CC enters U10 ACTIVE state.

TEXAS
INSTRUMENTS

3.2.6 Disconnection of mobile originated call

```
MMI                      CC                   MM                              Um
 |                        |                    |                              |
 |                        |    MMCC DATA IND    |                              |
 |                        |     (DISCONNECT)    |            DISCONNECT        |
 |                        *<==================*<============================*
 |             (CC 1)                           |                              |
 |  MNCC DISCONNECT IND  |                       |                              |
 *<===================*                        |                              |
(MMI 1)                  |                       |                              |
 |                        |    MMCC DATA REQ     |                              |
 |                        |      (RELEASE)       |             RELEASE          |
 |                        *==================>*============================>*
 |                        |               (MM 1)                              |
 |                        |                     |                              |
```
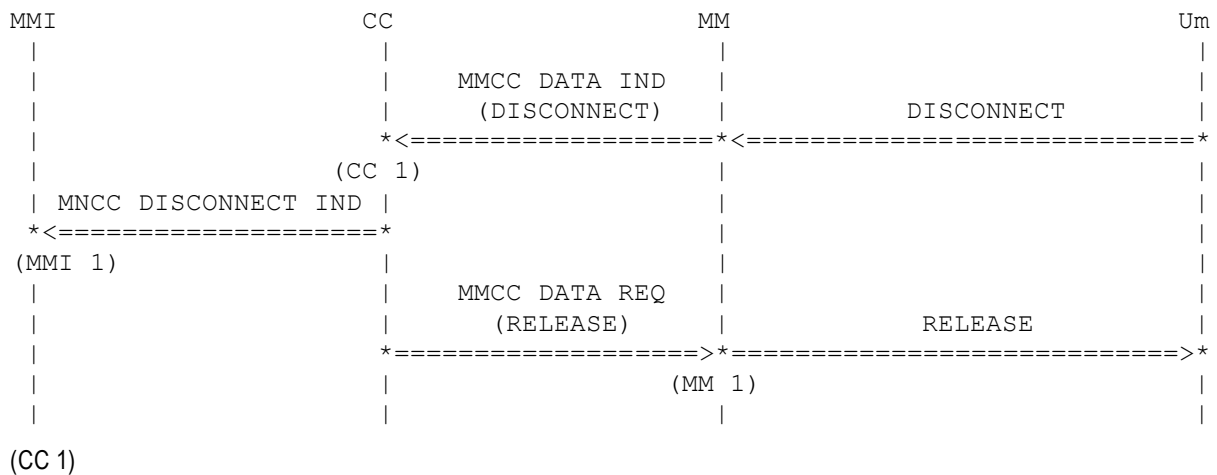
(CC 1)

The network decides that it or the called party is not able to accept the call. The network starts call release. It sends a DISCONNECT message to the mobile station.

(MMI 1)

MMI is informed about the call establishment abort.

(MM 1)

CC requests the local end release from the network. Therefore, the RELEASE message is sent to the network.

3.2.7 Mobile terminated call

```
MMI                      CC                    MM                              Um
 |                        |                     |                               |
 |                        | MMCC ESTABLISH IND  |                               |
 |                        |      (SETUP)        |          SETUP                |
 |                        *<=================*<===========================*
 |                      (CC 1)                  |                               |
 |                        |                     |                               |
a) normal case
 |                        |                     |                               |
 |     MNCC SETUP IND     |                     |                               |
 *<==================*    |                     |                               |
(MMI 1)                   |                     |                               |
 |                        | MMCC DATA REQ       |                               |
 |                        | (CALL CONFIRM)      |       CALL CONFIRM            |
 |                        *=================>*===========================>*
 |                        |                (MM 1)                              |
 |                        |                     |                               |
b) TI flag set
 |                        |                     |                               |
 |                        | MMCC RELEASE REQ    |                               |
 |                        *==================>*                                 |
 |                        |                (MM 2)                              |
 |                        |                     |                               |
c) TI is reserved value
 |                        |                     |                               |
 |                        | MMCC DATA REQ       |                               |
 |                        |     (STATUS)        |          STATUS               |
 |                        *=================>*===========================>*
 |                        |                (MM 3)                              |
 |                        | MMCC RELEASE REQ    |                               |
 |                        *==================>*                                 |
 |                        |                (MM 4)                              |
 |                        |                     |                               |
d) mandatory info element error
 |                        |                     |                               |
 |                        | MMCC DATA REQ       |                               |
 |                        | (RELEASE COMPLETE)  |    RELEASE COMPLETE           |
 |                        *=================>*===========================>*
 |                        |                (MM 5)                              |
 |                        | MMCC RELEASE REQ    |                               |
 |                        *==================>*                                 |
 |                        |                (MM 6)                              |
 |                        |                     |                               |
e) optional or content error
 |                        |                     |                               |
 |                        | MMCC DATA REQ       |                               |
 |                        |     (STATUS)        |          STATUS               |
 |                        *=================>*===========================>*
 |                        |                (MM 7)                              |
 |     MNCC SETUP IND     |                     |                               |
 *<==================*    |                     |                               |
(MMI 2)                   |                     |                               |
 |                        | MMCC DATA REQ       |                               |
 |                        | (CALL CONFIRM)      |       CALL CONFIRM            |
 |                        *=================>*===========================>*
 |                        |                (MM 8)                              |
 |                        |                     |                               |
```

TEXAS INSTRUMENTS

```
MMI                      CC                       MM                        Um
 |                       |                        |                         |
f) all transactions in use
 |                       |                        |                         |
 |                       |      MMCC DATA REQ      |                         |
 |                       |   (RELEASE COMPLETE)    |     RELEASE COMPLETE    |
 |                       *==================>*=============================>*
 |                       |                      (MM 9)                       |
 |                       |    MMCC RELEASE REQ    |                         |
 |                       *==================>*                              |
 |                       |                      (MM 10)                      |
 |                       |                        |                         |
g) compatibility check failed
 |                       |                        |                         |
 |                       |      MMCC DATA REQ      |                         |
 |                       |   (RELEASE COMPLETE)    |     RELEASE COMPLETE    |
 |                       *==================>*=============================>*
 |                       |                      (MM 11)                      |
 |                       |    MMCC RELEASE REQ    |                         |
 |                       *==================>*                              |
 |                       |                      (MM 12)                      |
 |                       |                        |                         |
```

(CC 1)

CC receives the SETUP message with the primitive MMCC ESTABLISH IND from MM. The primitive indicates that the transaction identifier was not in use earlier. CC starts some tests including the compatibility check.

(MMI 1)

The tests are successful. MMI is informed.

(MM 1)

CC sends a CALL CONFIRM message to the network and enters U9 CALL CONFIRMED state.

(MM 2)

One of tests processed by CC checks the transaction identifier flag. If the flag is set, this is a network failure, which will disturb the transaction identifier control in CC. CC ignores the message and releases the MM connection locally. CC remains in U0 NULL state.

(MM 3)

If the reserved transaction identifier value is used by the network, this is a failure. The network is informed by the STATUS message and the cause "invalid ti value". The SETUP message is ignored.

(MM 4)

CC releases the MM connection locally and remains in U0 NULL state.

(MM 5)

The incoming SETUP message contains mandatory information element errors. CC rejects the call with a RELEASE COMPLETE message.

(MM 6)

CC releases the MM connection locally and remains in U0 NULL state.

(MM 7)

The incoming SETUP message contains optional information or content errors. The network is informed with a STATUS message. The erroneous information elements are cleared. CC starts the tests for the remaining information elements.

(MMI 2)

The tests are successful. MMI is informed.

(MM8)

CC sends a CALL CONFIRM message to the network and enters U9 CALL CONFIRMED state.

(MM 9)

All parallel transactions are in use. A new one is rejected with a RELEASE COMPLETE message and the cause "no circuit available".

(MM 10)

CC releases the MM connection locally and remains in U0 NULL state.

(MM 11)

The compatibility check has failed. The network is informed with a RELEASE COMPLETE message.

(MM 12)

The MM connection is released locally and CC remains in U0 NULL state.

3.2.8 Test of incoming SETUP message

CC carries out three tests:

- Subaddress Check

- Compatibility Check

- Repeat Indicator Check.

The call is accepted only if all tests are passed. Otherwise, the release is carried out.

3.2.8.1 Subaddress Check

If a subaddress is defined for the mobile station and the called party information element of the incoming SETUP message contains a subaddress, the subaddress check is carried out. In this case, a failure is detected if both subaddresses are unequal (result FAILED). If no subaddress is defined, no test is carried out (result PASSED).

This leads to the rejection of the incoming call with the cause "no route to destination".

3.2.8.2 Compatibility Check

The compatibility check is used to test the incoming bearer capabilities (up to two) against the capabilities of the mobile. The check is processed for each incoming bearer capability. The mobile station capabilities are stored in the permanent memory configuration area. It defines which of the possible data configurations are supported by the mobile station:

Non Transparent Asynchronous (BS 21-BS26)
If supported, the incoming bearer capabilities are checked against:

- info transfer capability: AUDIO or DIGITAL UNRESTRICTED
- connection element   NON TRANSPARENT or BOTH, NON TRANSPARENT PREFERRED
- sync/async flag   ASYNCHRONOUS
- signaling access protocol SAP I.440/I.450

Transparent Asynchronous (BS 21-BS26)
If supported, the incoming bearer capabilities are checked against:

- info transfer capability: AUDIO or DIGITAL UNRESTRICTED
- connection element   TRANSPARENT or BOTH, TRANSPARENT PREFERRED
- sync/async flag   ASYNCHRONOUS
- signaling access protocol SAP I.440/I.450

Non Transparent Synchronous (BS 31-BS34)
If supported, the incoming bearer capabilities are checked against:

- info transfer capability: AUDIO or DIGITAL UNRESTRICTED
- connection element   NON TRANSPARENT or BOTH, NON TRANSPARENT PREFERRED
- sync/async flag   SYNCHRONOUS
- signaling access protocol SAP I.440/I.450

Transparent Synchronous (BS 31-BS34)
If supported, the incoming bearer capabilities are checked against:

- info transfer capability: AUDIO or DIGITAL UNRESTRICTED

TEXAS INSTRUMENTS

- connection element   TRANSPARENT or BOTH, TRANSPARENT PREFERRED
- sync/async flag   SYNCHRONOUS
- singling access protocol   SAP I.440/I.450

Transparent Facsimile group 3 (TS 61 / 62)
If supported, the incoming bearer capabilities are checked against:

- info transfer capability: FAX 3
- connection element   TRANSPARENT
- sync/async flag   SYNCHRONOUS

3.2.8.3   Repeat Indicator Check

The repeat indicator check is used to check the repeat indicator of the incoming SETUP message. The content must be REPEAT SEQUENTIAL or REPEAT CIRCULAR if two bearer capabilities are sent with the SETUP message. It must be omitted if none or one bearer capability is sent with the SETUP message.

3.2.8.4   End of Test Phase

The incoming SETUP message tests lead to one of these results: PASSED, FAILED or NEGOTIATION.
PASSED
The compatibility check has passed and a CALL CONFIRM is sent to the network without bearer ca-pabilities.
FAILED
The compatibility check has failed and a RELEASE COMPLETE message is sent to the network.
NEGOTIATION
The compatibility check result is negotiation. This means that the mobile station responds with a CALL CONFIRM message which includes bearer capabilities. The following table defines the way of negotia-tion:

Parameter	Value	Settings
connection element	Both, transparent preferred	connection element = transparent structure = unstructured user Layer 2 protocol = not available
connection element	Both, non-transparent pre-ferred	Connection element = non-transparent structure = SDU
radio channel re-quirement	half rate preferred full rate preferred	Use value according capabilities of the mobile
intermediate rate	-	Set to 8 kBit/s if radio channel requirement indicates halfrate channel set to 8 kBit/s if radio channel requirement indicates fullrate channel, connection element is non transparent, NIRR is set to 1 and user rate is not equal to 9.6 kBit/s set to 8 kBit/s if radio channel requirement indicates fullrate channel, connection element is transparent and user rate is not equal to 9.6 kBit/s set to 16 kBit/s if radio channel requirement indicates fullrate channel, connection element is transparent and user rate is equal to 9.6 kBit/s. set to stored value if radio channel require-ment is dual.

3.2.9 Alerting during Mobile Terminated Call

CC is in U9 CALL CONFIRMED state. It is a mobile terminated call.

```
MMI                        CC                    MM                             Um
 |                          |                     |                              |
 |     MNCC ALERT REQ       |                     |                              |
 *=====================>*                         |                              |
 |                      (CC 1)                     |                              |
 |                          |    MMCC DATA REQ     |                              |
 |                          |     (ALERTING)       |            ALERTING         |
 |                          *==================>*============================>*
 |                          |                  (MM 1)                           |
 |                          |                     |                              |
```

(CC 1)
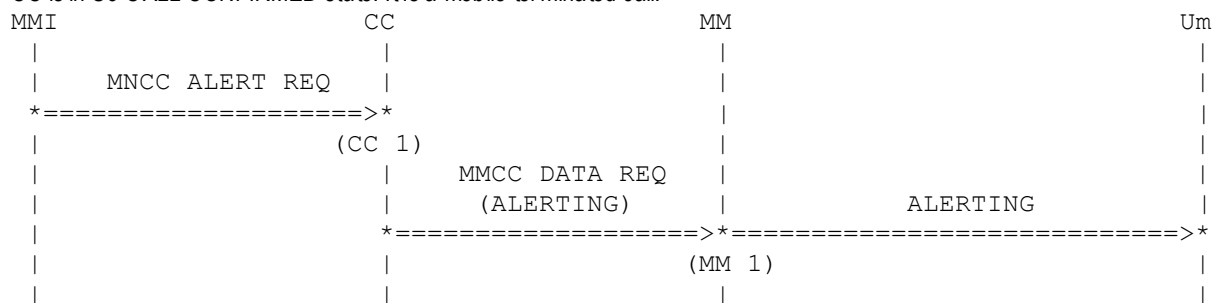
MMI indicates that alerting has been switched on.

(MM 1)

CC sends an ALERTING message to the network and CC enters U7 CALL REVEIVED state.

3.2.10 Confirmation of Mobile Terminated Call

CC is in U9 CALL CONFIRMED or U7 CALL RECEIVED state. It is a mobile terminated call.

```
MMI                           CC                        MM                              Um
 |                            |                         |                               |
 |      MNCC SETUP RES        |                         |                               |
 *=====================>*                               |                               |
 |                         (CC 1)                        |                               |
 |                            |        MMCC DATA REQ     |                               |
 |                            |          (CONNECT)       |              CONNECT          |
 |                            *==================>*============================>*
 |                            |                       (MM 1)                     |
 |                            |                         |                               |
```

(CC 1)
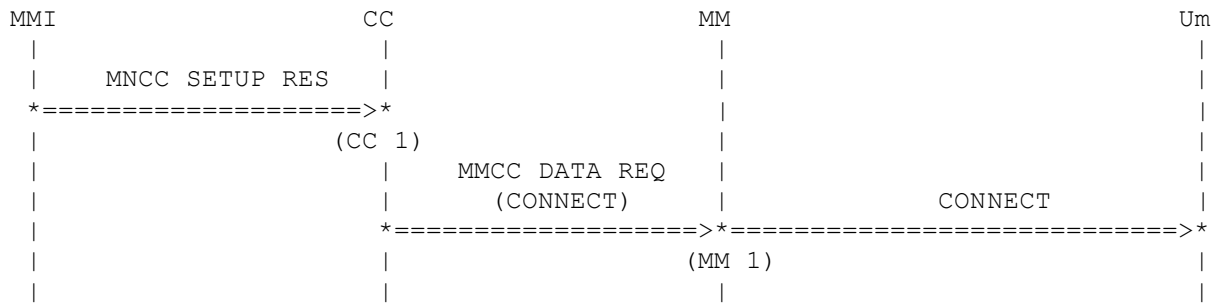
MMI indicates that the mobile user has accepted the call.

(MM 1)

CC sends a CONNECT message to the network. The timer T313 is started, which supervises the network answer. CC enters U9 CONNECT REQUEST state.

3.2.11 End of Establishment Phase

CC is in U8 CONNECT REQUEST state. It is a mobile terminated call.

```
MMI                      CC                      MM                      Um
 |                       |                       |                       |
a) normal case
 |                       |                       |                       |
 |                       |    MMCC DATA IND       |                       |
 |                       |    (CONNECT ACK)       |        CONNECT ACK     |
 |                       *<==================*<===========================*
 |                    (CC 1)                 |                       |
 |MNCC SETUP COMPL IND |                       |                       |
 *<==================*                       |                       |
(MMI 1)                 |                       |                       |
 |                       |                       |                       |
b) no answer by the network
 |                       |                       |                       |
 |                    *<time-out T313>          |                       |
 |                    (CC 2)                     |                       |
 |                       |    MMCC DATA REQ       |                       |
 |                       |    (DISCONNECT)        |        DISCONNECT      |
 |                       *==================>*===========================>*
 |                       |                    (MM 1)                  |
 |MNCC SETUP COMPL IND |                       |                       |
 *<==================*                       |                       |
(MMI 2)                 |                       |                       |
 |                       |                       |                       |
```
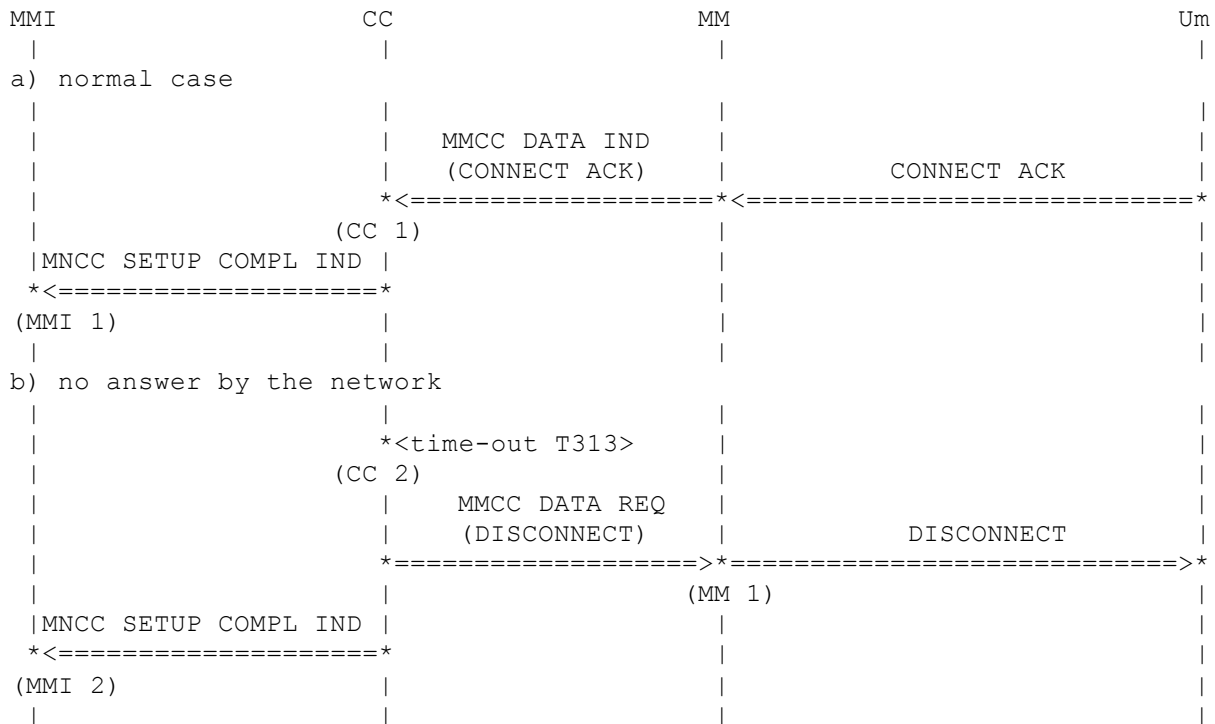
(CC 1)

The network confirms the successful connection establishment.

(MMI 1)

CC signals the successful establishment to MMI. T313 is stopped and CC enters U10 ACTIVE state.

(CC 2)

If no CONNECT ACK message is received, timer T313 times-out.

(MM 1)

CC stops call establishment and sends a DISCONNECT message to the network with the cause "recovery on timer expiration".

(MMI 2)

MMI is informed and CC enters U11 DISCONNECT REQUEST state.

3.2.12 TCH Assignment

```
MMI                     CC                    MM                          Um
 |                      |                      |                          |
 |                      |     MMCC SYNC IND    |                          |
 |                      *<===================*                           |
 |                    (CC 1)                   |                          |
 |      MNCC SYNC IND   |                      |                          |
 *<===================*                        |                          |
(MMI 1)                 |                      |                          |
 |                      |                      |                          |
```
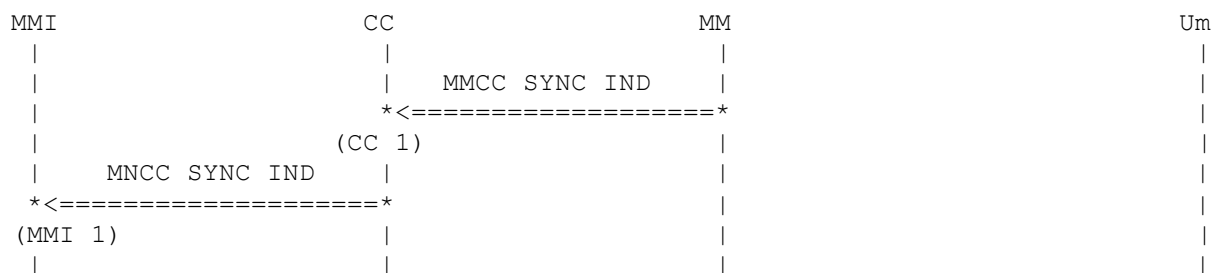
(CC 1)

It is a network decision to assign a traffic channel (TCH). This happens in radio resource. MM informs CC about assignment of a TCH.

(MMI 1)

CC sets an internal flag that the TCH is assigned and informs MMI. TCH assignment is important for the behavior of CC during call disconnection phase.

3.2.13 Advice of Charge Information

```
MMI                      CC                    MM                              Um
 |                        |                     |                               |
 |                        |                     |                               |
 |                        | MMCC DATA/EST IND    |                               |
 |                        |   (MT MESSAGE)       |          MT MESSAGE           |
 |                        *<==================*<============================*
 |                      (CC 1)                   |                               |
 |   MNCC MT PRIMITIVE  |                        |                               |
 *<==================*                           |                               |
(MMI 1)                  |                        |                               |
 |                        |                     |                               |
a) no support of Advice of Charge
 |                        |                     |                               |
 |   MNCC FACILITY IND  |                        |                               |
 *<==================*                           |                               |
(MMI 1)                  |                        |                               |
 |                        |                     |                               |
b) support of Advice of Charge
 |                        |                     |                               |
 |   MNCC FACILITY IND  |                        |                               |
 *<==================*                           |                               |
(MMI 1)                  |                        |                               |
 |                        |    MMCC DATA REQ     |                               |
 |                        |  (Return Result AoC)|          FACILITY             |
 |                        *==================>*============================>*
 |                        |                  (MM 1)                             |
 |                        |                     |                               |
```

(CC 1)

The network sends one of these messages: ALERTING, CALL PROCEEDING, CONNECT, DISCONNECT, FACILITY, RELEASE, RELEASE COMPLETE or SETUP. The message contains an invoke component for advice of charge information.

The content of the message (not the advice of charge information) is forwarded to the MMI.

(MMI 1)

The content of the facility information element is forwarded to MMI.

(MM 1)

CC checks the AoC flag in the MS support record of the permanent configuration data. If the flag indicates support of advice of charge, a return result component for advice of charge is coded and filled in a facility message. The message is sent to the network.

3.2.14 Call Completion to Busy Subscriber Call Establishment

```
MMI                      CC                      MM                       Um
 |                        |                        |                        |
 |                        |                        | RR_DATA_IND            |
 |                        |                        | (CM SERVICE PROMPT)    |
 |                        |                        *<======================*
 |                        | MMCC_PROMPT_IND        |                        |
 |                        *<==================*    |                        |
 | MMCC_PROMPT_IND        |                        |                        |
 *<==================*    |                        |                        |
 |                       (CC 1)                    |                        |
a)Normal case, CC assigns ti and sends initial CM message
 |                        |                        |                        |
 | MNCC_PROMPT_RSP        |                        |                        |
 *==================>*    |                        |                        |
 |                        | MMCC_PROMPT_RSP        |                        |
 |                        *==================>*    |                        |
 |                       (CC 2)                    |                        |
 |                        | MMCC_DATA_REQ          |                        |
 |                        | (START CC)             |                        |
 |                        *==================>*    |                        |
 |                        |                        | RR_DATA_REQ            |
 |                        |                        | (START CC)             |
 |                        |                        *======================>*
 |                        |                        |                        |
After sending START CC, CC enters state "WAIT FOR NETWORK INFO" (U0.3)
b) Out of transaction identifiers, rejection if request
 |                        |                        |                        |
 | MNCC_PROMPT_REJ        |                        |                        |
 *==================>*    |                        |                        |
 |                       (CC 3)                    |                        |
 |                        | MMCC_PROMPT_REJ        |                        |
 |                        *==================>*    |                        |
 |                        |                        | RR_DATA_REQ            |
 |                        |                        | (MM_STATUS)            |
 |                        |                        *======================>*
c) a) succeeded, network sends CC ESTABLISHMENT message
 |                        |                        |                        |
 |                        |                        | RR_DATA_IND            |
 |                        |                        | (CC ESTABLISHMENT)     |
 |                        |                        *<======================*
 |                        | MMCC_DATA_IND          |                        |
 |                        | (CC ESTABLISHMENT)     |                        |
 |                        *<==================*    |                        |
 |                        |                        |                        |
 |                        | MMCC_DATA_REQ          |                        |
 |                        | (CC EST. CONFIRMED)|   |                        |
 |                        *==================>*    |                        |
 |                        |                        | RR_DATA_REQ            |
 |                        |                        | CC ESTABLISHMENT CONFIRMED |
 |                        |                        *======================>*
 |                       (CC 4)                    |                        |
After sending CC EST. CONFIRMED, CC enters state "CC EST. CONFIRMED" (U0.5)
d) a) succeeded, network sent CC EST. with incompatible capabilities etc.
 |                        |                        |                        |
 |                        |                        | RR_DATA_IND            |
 |                        |                        | (CC ESTABLISHMENT)     |
 |                        |                        *<======================*
```

TEXAS INSTRUMENTS

```
|                     | MMCC_DATA_IND        |                              |
|                     | (CC ESTABLISHMENT)   |                              |
|                     *<==================*  |                              |
|                     |                   |  |                              |
|                     | MMCC_DATA_REQ     |  |                              |
|                     | (RELEASE COMPLETE)|  |                              |
|                     *==================>*  |                              |
|                     |                      | RR_DATA_REQ                  |
|                     |                      | (RELEASE COMPLETE)           |
|                     |                      *============================>*
| MNCC_RELEASE_IND    |                      |                              |
*<==================*  |                      |                              |
|                     | MMCC_RELEASE_REQ     |                              |
|                     *==================>*  |                              |
|                   (CC 5)                    |                              |
e) c) succeeded, network sends RECALL and user accepts within time
|                     |                      |                              |
|                     |                      | RR_DATA_IND                  |
|                     |                      | (RECALL)                     |
|                     |                      *<============================*
|                     | MMCC_DATA_IND        |                              |
|                     | (RECALL)             |                              |
|                     *<==================*  |                              |
| MNCC_RECALL_IND     |                      |                              |
*<==================*  |                      |                              |
After receiving RECALL, CC is in the state "RECALL PRESENT" (U0.6)
|                   (CC 6)                    |                              |
| MNCC_SETUP_REQ      |                      |                              |
| (CCBS indicated)    |                      |                              |
*==================>*  |                      |                              |
|                   (CC 7)                    |                              |
|                     | MMCC_DATA_REQ        |                              |
|                     | (SETUP)              |                              |
|                     *==================>*  |                              |
|                     |                      | RR_DATA_REQ                  |
|                     |                      | (SETUP)                      |
|                     |                      *============================>*
After sending SETUP, CC enters state "CALL INITIATED" (U1)
f) c) succeeded, network sends RECALL and user rejects this
|                     |                      |                              |
|                     |                      | RR_DATA_IND                  |
|                     |                      | (RECALL)                     |
|                     |                      *<============================*
|                     | MMCC_DATA_IND        |                              |
|                     | (RECALL)             |                              |
|                     *<==================*  |                              |
| MNCC_RECALL_IND     |                      |                              |
*<==================*  |                      |                              |
|                     |                      |                              |
| MNCC_REJECT_REQ     |                      |                              |
*==================>*  |                      |                              |
|                     | MMCC_DATA_REQ        |                              |
|                     | (RELEASE COMPLETE)   |                              |
|                     *==================>*  |                              |
|                     |                      | RR_DATA_REQ                  |
|                     |                      | (RELEASE COMPLETE)           |
|                     |                      *============================>*
|                     | MMCC_RELEASE_REQ     |                              |
|                     *==================>*  |                              |
|                   (CC 8)                    |                              |
```

```
g) c) succeeded, network sends RECALL and user doesn't answer in time
   |                         |                         |                                     |
   |                         |                         |  RR_DATA_IND                        |
   |                         |                         |  (RECALL)                           |
   |                         |                         *<============================*
   |                         |  MMCC_DATA_IND          |                                     |
   |                         |  (RECALL)               |                                     |
   |                         *<==================*     |                                     |
   |  MNCC_RECALL_IND        |                         |                                     |
  *<====================*    |                         |                                     |
   |                         |                         |                                     |
   |                         |                         |  RR_DATA_IND                        |
   |                         |                         |  (RELEASE COMPLETE)                 |
   |                         |                         *<============================*
   |                         |  MMCC_RELEASE_REQ       |                                     |
   |                         *==================>*     |                                     |
   |                     (CC 9)                        |                                     |
```

(CC 1)

The ACI is informed by MNCC_PROMPT_IND about the necessity to allocate a mobile originated transaction identifier.

(CC 2)

CC ist informed about the newly allocated tranaction identifier by MNCC_PROMPT_RSP, MM by MMCC_PROMPT_RSP.

(CC 3)

CC is informed about the impossibility to allocate a new mobile originated transaction identifier by MNCC_PROMPT_REJ, MM by MMCC_PROMPT_REJ.

(CC 4)

The network sent the CC ESTABLISHMENT message. The mobile station has successfully performed the recall alignment procedure and responded by a CC-ESTABLISHMENT CONFIRMED message.

(CC 5)

The network sent a CC ESTABLISHMENT message with incompatible parameters. The connection is released, upper and lower layers are informed about connection release.

(CC 6)

The network sent the RECALL message. The user has to be informed about an incoming CCBS recall, the mobile is alerting in a special way. Relevant parametes delivered by the CC ESTABLISHMENT and RECALL message are delivered to the ACI. The CCBS recall may be accepted or rejected by the user now. If ACM => ACMmax, the RECALL shall be refused without user notification. The decision wether ACM >= ACMmax is not met in CC, this is done in upper layers.

(CC 7)

Because the SETUP message was delivered by the network packed into the CC ESTABLISHMENT message, the SETUP message is already built and stored in the CC entity, ready for sending. It is not built from the SETUP parameters delivered by MNCC_SETUP_REQ, these are ignored. Only the transaction identifier and the field prio set to PRIO_CCBS_CALL are neccessary to start the CCBS call. From this point on, the CCBS recall is more or less a normal mobile originated call.

(CC 8)

Upper layers are informed about the RECALL, the recall attempt is refused by MNCC_REJECT_REQ. No acknowledge is sent to upper layers about the connection release, the connection will be released by RELEASE COMPLETE.

(CC 9)

The user hasn't responded in time, a network timer expired, the connection was released by the network (RELEASE COMPLETE). Upper layers are informed by the primitive MNCC_RELEASE_IND.

3.3 Call Active

3.3.1 Mobile Terminating User Notification Procedure

```
MMI                       CC                MM                              Um
 |                         |                 |                               |
a) Notification for the mobile station
 |                         |                 |                               |
 |                         |    MMCC DATA IND |                               |
 |                         |     (NOTIFY)     |               NOTIFY          |
 |                        *<=================*<=============================*
 |                    (CC 1)                  |                               |
 |                         |                 |                               |
 |                         |                 |                               |
```

(CC 1)
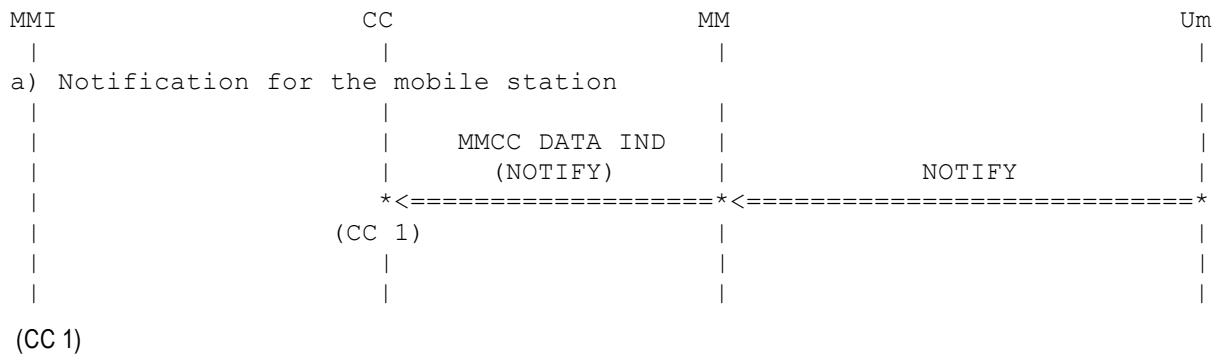
Mobile Terminating User Notification procedure allows the network to notify a mobile station of any appropriate call related event during Active\e state of the Call. Network sends a NOTIFY message to the MS. CC just ignores this message.

Texas Instruments

3.3.2 Facility

```
MMI                       CC                    MM                         Um
 |                        |                     |                          |
a) Facility for the mobile station
 |                        |                     |                          |
 |                        |    MMCC DATA IND     |                          |
 |                        |      (FACILITY)      |        FACILITY          |
 |                        *<==================*<==========================*
 |                 (CC 1)                       |                          |
 |   MNCC FACILITY IND    |                     |                          |
 *<==================*                          |                          |
(MMI 1)                   |                     |                          |
 |                        |                     |                          |
b) Facility for the network
 |                        |                     |                          |
 |   MNCC FACILITY REQ    |                     |                          |
 *==================>*                          |                          |
 |                 (CC 2)                       |                          |
 |                        |    MMCC DATA REQ     |                          |
 |                        |      (FACILITY)      |        FACILITY          |
 |                        *==================>*============================>*
 |                        |                  (MM 1)                         |
 |                        |                     |                          |
c) Facility for the mobile station with other messages
 |                        |                     |                          |
 |                        |    MMCC DATA IND     |                          |
 |                        |    (XX-MESSAGE)      |       XX-MESSAGE         |
 |                        *<==================*<==========================*
 |                 (CC 3)                       |                          |
 |     MNCC XX IND        |                     |                          |
 *<==================*                          |                          |
(MMI 2)                   |                     |                          |
 |   MNCC FACILITY IND    |                     |                          |
 *<==================*                          |                          |
(MMI 3)                   |                     |                          |
 |                        |                     |                          |
```

(CC 1)
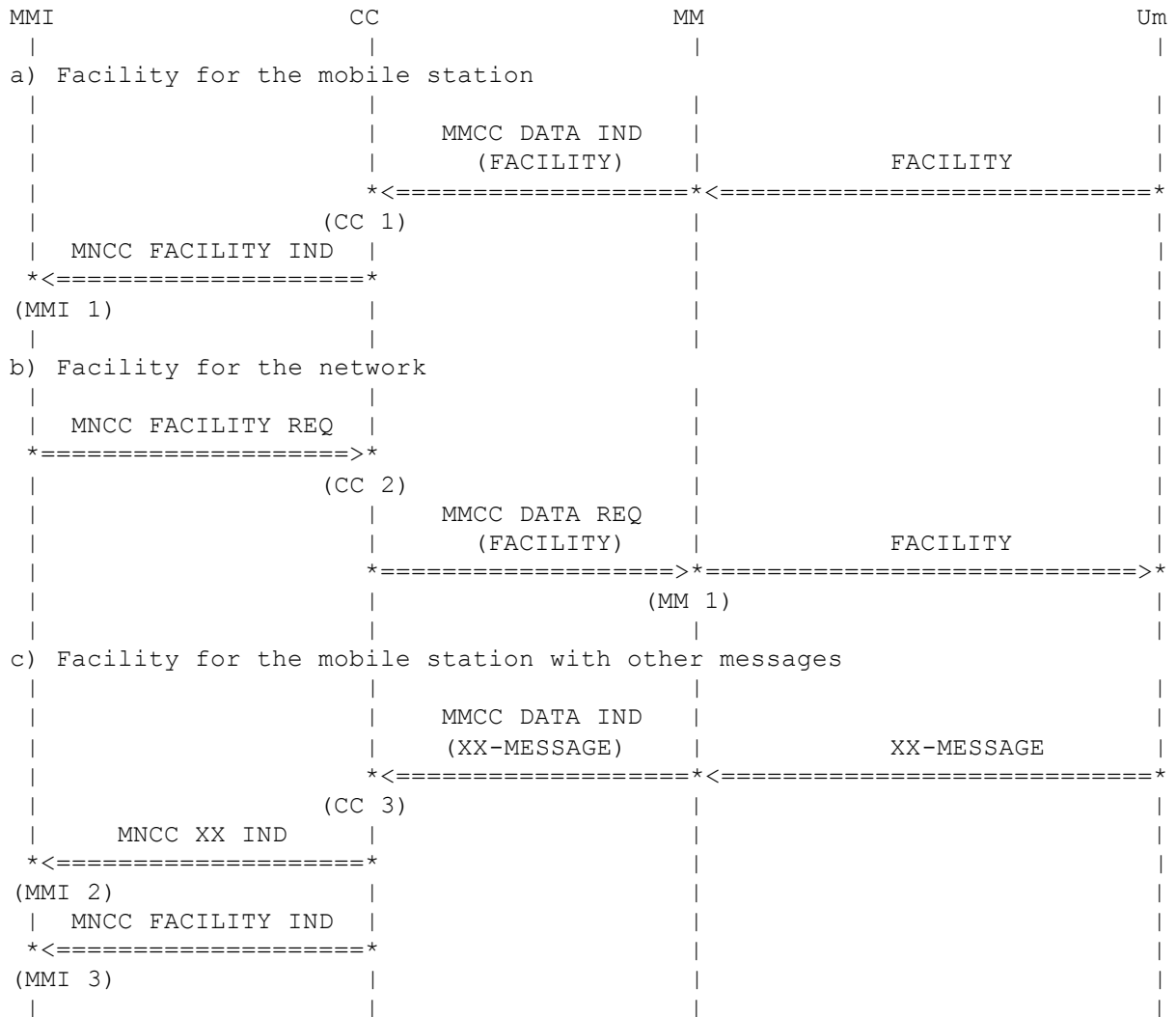
The network sends a facility information element with a FACILITY message to CC for a call dependent supplementary service.

(MMI 1)

CC decodes the facility information element and forwards the content to MMI.

(CC 2)

MMI will send a facility information element to the network.

(MM 1)

CC codes a FACILITY message and sends it to the network.

(CC 3)

A message unequal the FACILITY message is sent to CC, it contains a facility information element.

(MMI 2)

The normal processing for the message is done.

(MMI 3)

The facility information element is forwarded to the MMI. A context parameter shows MMI the used message of the infrastructure.

3.3.3 Dual Tone Multi Frequency (DTMF)

```
MMI                    CC                  MM              Um    Net     DTMF state
 |                      |                   |               |            of CC
 |                      |                   |               |
 |MNCC START DTMF REQ|                      |               |            IDLE
 *==================>*                      |               |
 |                   (CC 1)                 |               |
 |                      | MMCC DATA REQ |                   |
 |                      |  (START DTMF) |  START DTMF  | Tone on   SEND_REQ
 |                      *=============>*=============>*
 |                      |                    (MM 1)         |
 |                      | MMCC DATA IND |                   |
 |MNCC START DTMF CNF|(START DTMF ACK)|START DTMF ACK|            SENDING
 *<=================*<=============*<============*
 |                   (CC 2)                 |               |
 |                      | MMCC DATA REQ |                   |
 |                      |  (STOP DTMF)  |  STOP DTMF   | Tone off  IDLE
 |                      *=============>*=============>*
 |                      |                    (MM 2)         |
 |                      |                   |               |
```
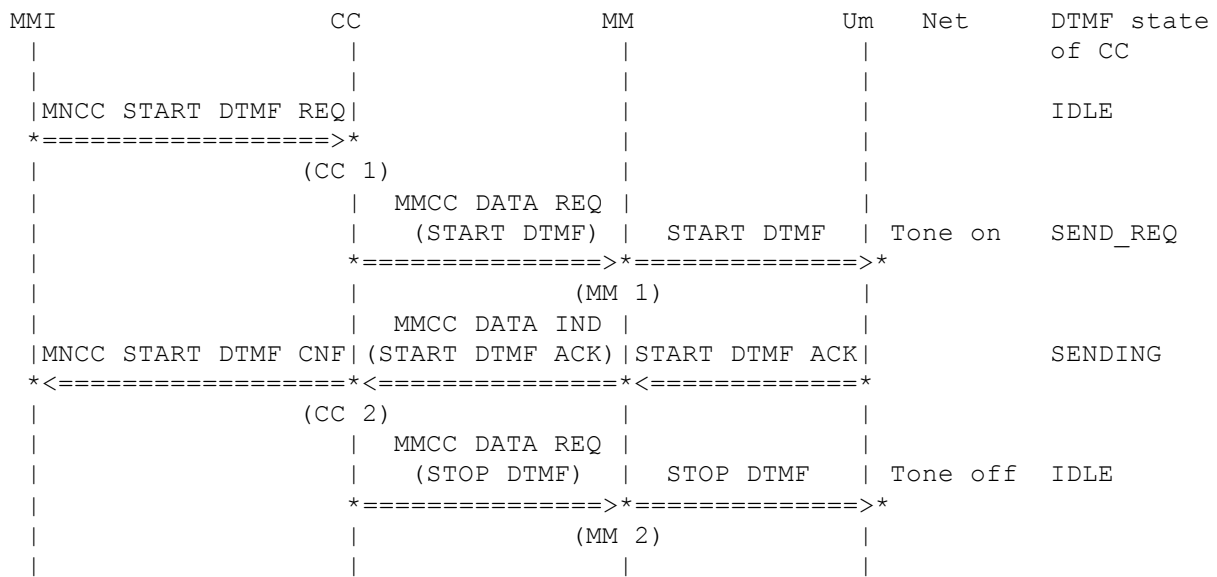
(CC 1)

MMI wants to send DTMF tones. The requests are stored in CC to an upper limit. The next DTMF tone is generated after the previous DTMF tone procedure has finished.

(MM 1)

CC sends a START DTMF message to the network. The network generates the corresponding tone.

(CC 2)

A network confirmation receives a message that tone generation has started. MMI is informed.

(MM 2)

CC sends a message to stop tone generation. The message delay is sufficient for the tone duration.

3.3.4 Dual Tone Multi Frequency (DTMF), lost tones due to DTMF buffer full condition

In the following MSC, it is assumed that the DTMF buffer has room for exactly two entries. This is configurable. Lost requests are marked by a "*". We are using manual DTMF mode only.

```
MMI                             CC                      MM
Um
  |                             |                       |
  |                             |                       |
  | MNCC_START_DTMF_REQ   | MMCC_DATA_REQ        |
  |                             |                       |
  |(DTMF_MODE_MAN_START)  | (START DTMF)         |     START DTMF
  |                             |                       |
  *=======================>*===================>*===========================
    >*
  |                        (CC 1)                       |
  |                             |                       |
  | MNCC_START_DTMF_REQ   |                       |
  |                             |                       |
  |(DTMF_MODE_MAN_STOP)   |                       |
  |                             |                       |
  *=======================>*                     |
    |                             |                       |
  |                        (CC 2)                       |
  |                             |                       |
  | MNCC_START_DTMF_REQ   |                       |
  |                             |                       |
  |(DTMF_MODE_MAN_START *)|                       |
  |                             |                       |
  *=======================>*                     |
    |                             |                       |
  | MNCC_START_DTMF_CNF   |                       |
  |                             |                       |
  |  (CAUSE_TEMP_FAIL)    |                       |
  |                             |                       |
  *<=====================*                       |
    |                             |                       |
  |                        (CC 3)                       |
  |                             |                       |
  | MNCC_START_DTMF_REQ   |                       |
  |                             |                       |
  |(DTMF_MODE_MAN_STOP *) |                       |
  |                             |                       |
  *=======================>*                     |
    |                             |                       |
  |                        (CC 4)                       |
  |                             |                       |
  |                             |   MMCC_DATA_IND     |
  |                             |                       |
  | MNCC_START_DTMF_CNF   | (START DTMF ACK)    |     START DTMF ACKNOWLEDGE
  |                             |                       |
  *<=====================*<=================*<==========================
    =*
  |                        (CC 5)                       |
  |                             |                       |
  |                             | MMCC_DATA_REQ       |
  |                             |                       |
  |                             | (STOP DTMF)         |     STOP DTMF
  |                             |                       |
```

TEXAS INSTRUMENTS
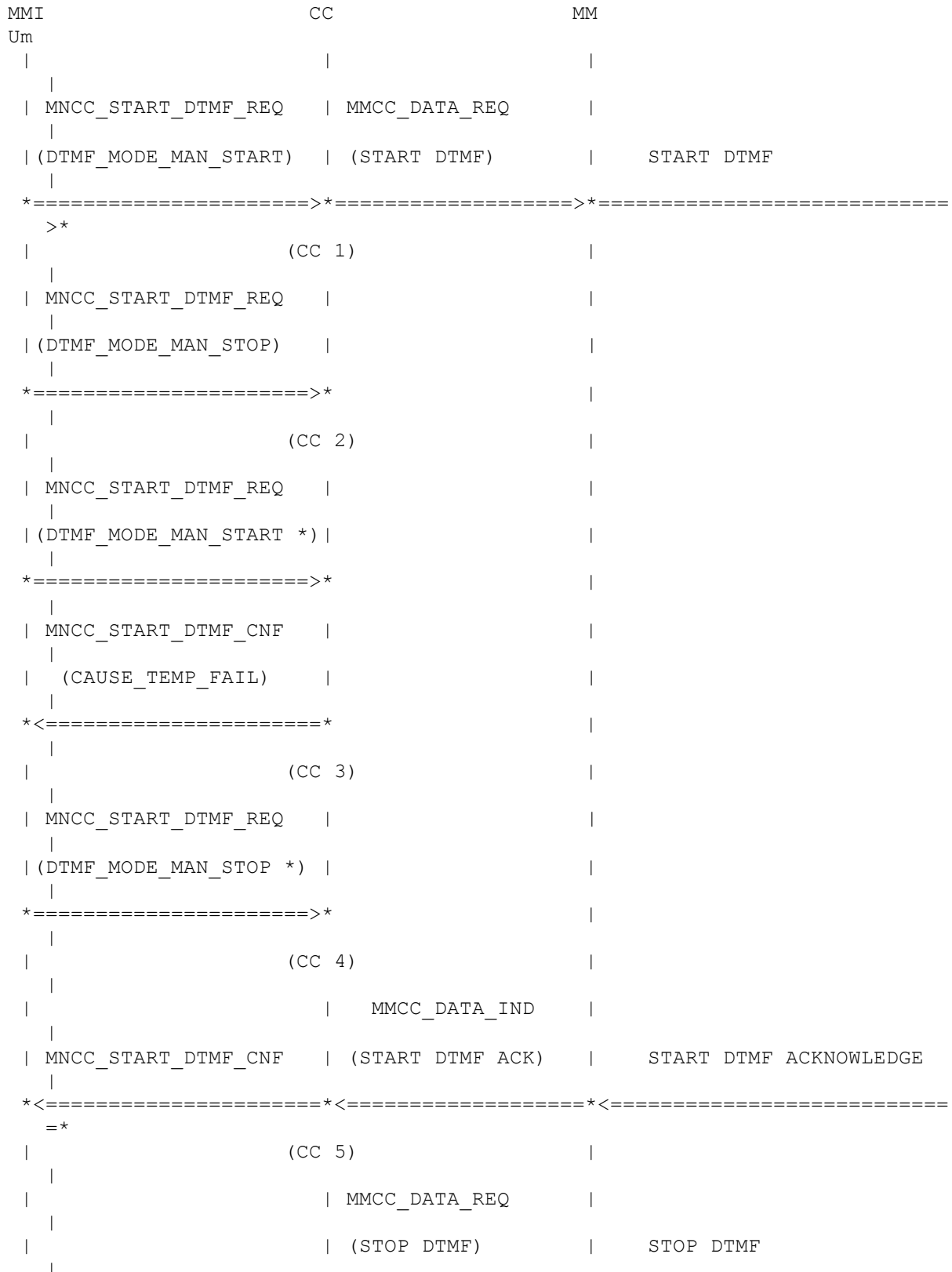
```
 |
   *===================>*===========================>*
 | MNCC_START_DTMF_REQ   |                           |
   |
 |(DTMF_MODE_MAN_START)  |                           |
   |
 *=====================>*                            |
   |
 | MNCC_START_DTMF_REQ   |                           |
   |
 |(DTMF_MODE_MAN_STOP)   |                           |
   |
 *=====================>*                            |
   |
 |                         (CC 6)                     |
   |
 |                       | MNCC_DATA_IND             |
   |
 |                       | (STOP ACK)        |     STOP DTMF ACKNOWLEDGE
   |
 |
   *<=================*<=========================*
 |                       | MMCC_DATA_REQ       |
   |
 |                       | (START DTMF)        |     START DTMF
   |
 |
   *==================>*===========================>*
 |                       | MMCC_DATA_IND       |
   |
 | MNCC_START_DTMF_CNF   | (START DTMF ACK)    |     START DTMF ACKNOWLEDGE
   |
 *<=================*<=================*<=========================
   =*
 |                       | MMCC_DATA_REQ       |
   |
 |                       | (STOP DTMF)         |     STOP DTMF
   |
 |
   *==================>*===========================>*
 |                       | MNCC_DATA_IND       |
   |
 |                       | (STOP ACK)          |     STOP DTMF ACKNOWLEDGE
   |
 |
   *<=================*<=========================*
 |                         (CC 7)                     |
   |
```

(CC 1)

DTMF is started by MNCC_START_DTMF_REQ with a tone as parameter. The buffer is empty, the DTMF state is DTMF_IDLE. The request can be immediately processed by CC.

(CC 2)

The stopping of the previous DTMF request is requested. The previous DTMF request is not yet acknowledged, so the stop request has to be stored until the START DTMF will be acknowledged by reception of START DTMF ACKNOWLEDGE.

(CC 3)

The MNCC_START_DTMF_REQ with a tone as parameter is dropped. There is one place in the DTMF buffer free, but it has to be ensured that the room for the respective stop mark in the buffer will be available, too, so the tone has to be dropped in

TEXAS INSTRUMENTS

manual mode if only one buffer place is free. The failure is indicated by MNCC_START_DTMF_CNF with cause CAUSE_TEMP_FAIL to the MMI.

(CC 4)

The stop mark for the tone will be disgarded later, no STOP DTMF will be sent for this. The respective tone has been lost in the last step.

(CC 5)

The START DTMF is acknowledged by the network by a START DTMF ACKNOWLEDGE. A stop mark has been stored in the buffer, so a STOP DTMF will be sent immediately to the network. All further stored stop marks are dropped until a tone is found in the buffer or the buffer becomes empty. This is to ensure that the state machine not becomes corrupted due to the loss of tones by buffer overflow.

(CC 6)

A tone and a stop are stored into the DTMF buffer. The DTMF state machine is not in the correct state to forward this now, it is still waiting for the STOP DTMF ACKNOWLEDGE by the network.

(CC 7)

After the STOP ACKNOWLEDGE has been received by the network, the stored tone and stop mark are sent to the network.

3.3.5 Call Reestablishment

```
MMI                         CC                      MM                        Um
 |                          |                       |                         |
 |                          |    MMCC ERROR IND      |                         |
 |                          *<===================*                            |
 |                          (CC 1)                  |                         |
 |                          |                       |                         |
a) Call Reestablishment is not allowed
 |                          |                       |                         |
 |    MNCC REJECT IND       |                       |                         |
 *<===================*                             |                         |
(MMI 1)                     |                       |                         |
 |                          |    MMCC RELEASE REQ    |                         |
 |                          *===================>*                            |
 |                          |                       (MM 1)                    |
 |                          |                       |                         |
b) Call Reestablishment is allowed
 |                          |                       |                         |
 |    MNCC SYNC IND         |                       |                         |
 *<===================*                             |                         |
(MMI 2)                     |                       |                         |
 |                          |MMCC REESTABLISH REQ|                            |
 |                          *===================>*                            |
 |                          |                       (MM 2)                    |
 |                          |                       |                         |
c) Call Reestablishment successful
 |                          |                       |                         |
 |                          |MMCC REESTABLISH CNF|                            |
 |                          *<===================*                            |
 |                          (CC 2)                  |                         |
 |    MNCC SYNC IND         |                       |                         |
 *<===================*                             |                         |
(MMI 3)                     |                       |                         |
 |                          |                       |                         |
d) Call Reestablishment is not successful
 |                          |                       |                         |
 |                          |    MMCC RELEASE IND    |                         |
 |                          *<===================*                            |
 |                          (CC 3)                  |                         |
 |    MNCC REJECT IND       |                       |                         |
 *<===================*                             |                         |
(MMI 4)                     |                       |                         |
 |                          |                       |                         |
```
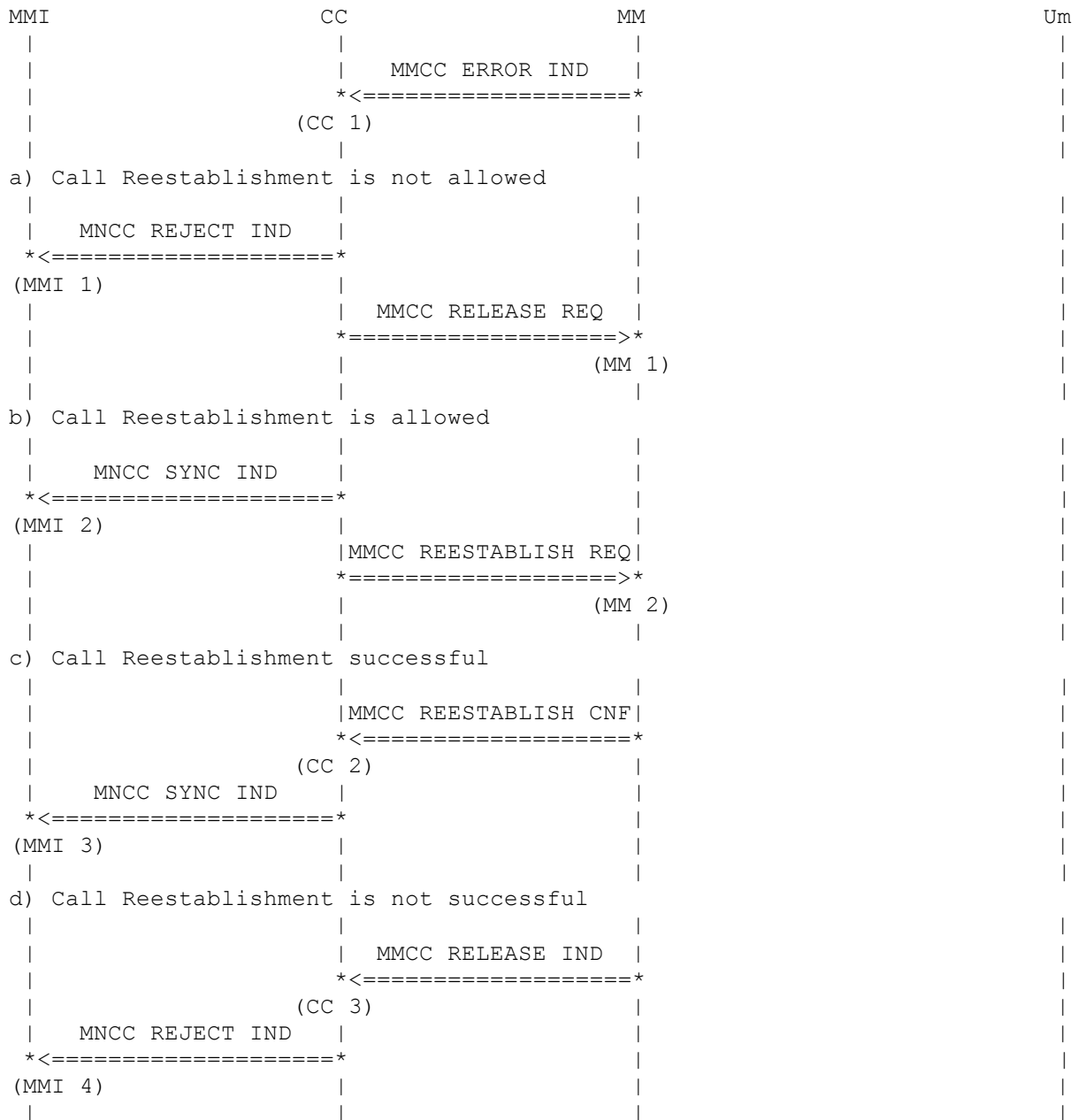
(CC 1)

During an existing MM connection, MM indicates that the connection is interrupted and CC may start a call reestablishment. Call reestablishment is meant to resume the MM connection. MM determines whether or not call reestablishment is supported by the cell.

(MMI 1)

Depending on whether or not call reestablishment is allowed in general, CC state CC decides to process call reestablishment. If MM indicates that no call reestablishment is allowed or CC is not in U10 ACTIVE or U25 MOBILE ORIGINATED MODIFY state, no call reestablishment is started. MMI is informed about the end of the call.

Texas Instruments

(MM 1)

The MM connection is released locally. CC enters U0 NULL state.

(MMI 2)

If call reestablishment is allowed in the cell and CC is in U10 ACTIVE or U26 MOBILE ORIGINATED MODIFY state, CC requests call reestablishment. MMI is informed about the call reestablishment procedure starting.

(MM 2)

CC requests call reestablishment by MM and enters U10.1 REESTABLISHMENT PENDING state.

(CC 2)

Call reestablishment was successfully processed. A new MM connection exists.

(MMI 3)

MMI is informed about the end of call reestablishment procedure. CC enters U10 ACTIVE state.

(CC 3)

If MM connection reestablishment fails, CC is informed by MM with the primitive MMCC RELEASE IND.

(MMI 4)

MMI is informed about the negative end of procedure. CC enters U0 NULL state.

Texas Instruments

3.3.6 Status

```
MMI                       CC                      MM                        Um
 |                         |                       |                         |
 |                         |     MMCC DATA IND      |                         |
 |                         |       (STATUS)         |          STATUS         |
 |                        *<==================*<=========================*
 |                      (CC 1)                 |                         |
 |                         |                       |                         |
a) state is compatible, cause 95 to 100
 |                         |                       |                         |
 |  MNCC DISCONNECT IND    |                       |                         |
 *<====================*                       |                         |
(MMI 1)                    |                       |                         |
 |                         |     MMCC DATA REQ      |                         |
 |                         |      (DISCONNECT)      |        DISCONNECT        |
 |                        *==================>*=========================>*
 |                         |                   (MM 1)                     |
 |                         |                       |                         |
b) state is incompatible
 |                         |                       |                         |
 |   MNCC RELEASE IND      |                       |                         |
 *<====================*                       |                         |
(MMI 2)                    |                       |                         |
 |                         |     MMCC DATA REQ      |                         |
 |                         |  (RELEASE COPMPLETE)|      RELEASE COMPLETE     |
 |                        *==================>*=========================>*
 |                         |                   (MM 2)                     |
 |                         |    MMCC RELEASE REQ    |                         |
 |                        *==================>*                         |
 |                         |                   (MM 3)                     |
 |                         |                       |                         |
```

(CC 1)

CC receives a STATUS message from the network. The state included in the message is compatible with its own state and the cause included in the message is not equal to "#95 semantically incorrect message", "#96 invalid mandatory information", "#97 message type non-existent or not implemented", "#98 message type not compatible with protocol state", "#99 information element non-existent or not implemented", or "#100 conditional information element content". The message is then ignored.

(MMI 1)

If the state is compatible and the cause is one of the six above, the connection is released. MMI is informed. The cause is "normal clearing".

(MM 1)

CC sends a DISCONNECT message with the cause "normal clearing" to the network. Timer T305 is started and CC enters U11 DISCONNECT REQUEST state.

(MMI 2)

If the state in the STATUS message is incompatible, the connection is released. The cause is "message not compatible".

(MM 2)

CC sends a RELEASE COMPLETE message with the cause "message not compatible to the network".

(MM 3)

The MM connection is released locally.

3.3.7 Status Enquiry

```
MMI                     CC                      MM                          Um
 |                       |                       |                           |
 |                       |   MMCC DATA IND        |                           |
 |                       |  (STATUS ENQUIRY)      |       STATUS ENQUIRY      |
 |                      *<==================*<==========================*
 |                    (CC 1)                |                           |
 |                       |   MMCC DATA REQ        |                           |
 |                       |     (STATUS)      |          STATUS           |
 |                      *==================>*==========================>*
 |                       |              (MM 1)                           |
 |                       |                       |                           |
```

(CC 1)
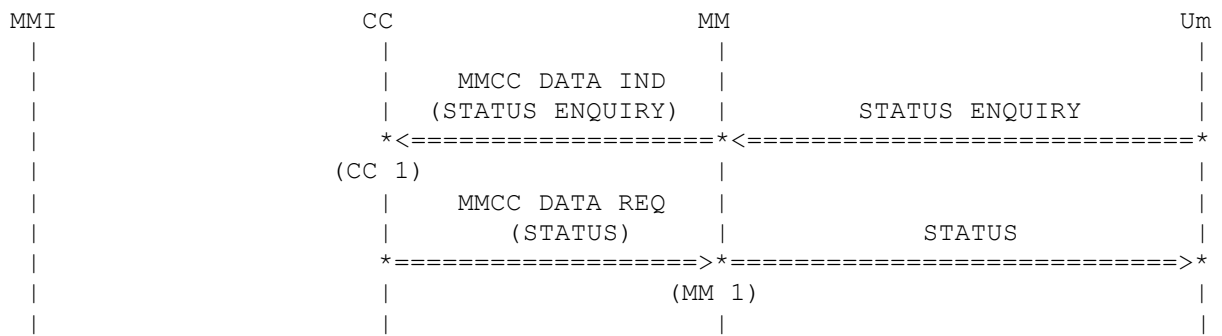
CC receives a STATUS ENQUIRY message. The network tests the current state of CC with this message.

(MM 1)

CC sends a STATUS message with the current CC state and the cause "#30 response to status enquiry". The procedure leads to no state transition.

The recommendations determine the possibility that a mobile station enquires as to the network CC status. This is not necessary and not implemented.

TEXAS INSTRUMENTS

3.3.8 Call Waiting

The supplementary service call waiting has no further requirements to the implementation. Call waiting for the mobile station is the handling of a parallel MM connection, each defined by its transaction identifier. Controlling which one is the active connection is carried out by MMI.

3.3.9 Hold

```
MMI                       CC                    MM                          Um
 |                        |                     |                           |
 |    MNCC HOLD REQ       |                     |                           |
 *=====================>* |                     |                           |
 |                       (CC 1)                 |                           |
 |                        |    MMCC DATA REQ    |                           |
 |                        |       (HOLD)        |          HOLD             |
 |                        *==================>*=============================>*
 |                        |                    (MM 1)                        |
 |                        |                     |                           |
a) Procedure successful
 |                        |                     |                           |
 |                        |    MMCC DATA IND    |                           |
 |                        |      (HOLD ACK)     |        HOLD ACK           |
 |                        *<=================*<============================*
 |                       (CC 2)               |                            |
 |    MNCC HOLD CNF       |                    |                            |
 *<===================*  |                     |                           |
(MMI 1)                  |                     |                           |
 |                        |                     |                           |
b) Procedure not successful
 |                        |                     |                           |
 |                        |    MMCC DATA IND    |                           |
 |                        |    (HOLD REJECT)    |      HOLD REJECT         |
 |                        *<=================*<============================*
 |                       (CC 3)               |                            |
 |    MNCC HOLD CNF       |                    |                            |
 *<===================*  |                     |                           |
(MMI 2)                  |                     |                           |
 |                        |                     |                           |
c) Notification to the other party
 |                        |                     |                           |
 |                        |    MMCC DATA IND    |                           |
 |                        |      (FACILITY)     |        FACILITY          |
 |                        *<=================*<============================*
 |                       (CC 3)               |                            |
 |   MNCC FACILITY IND    |                    |                            |
 *<===================*  |                     |                           |
(MMI 3)                  |                     |                           |
 |                        |                     |                           |
```
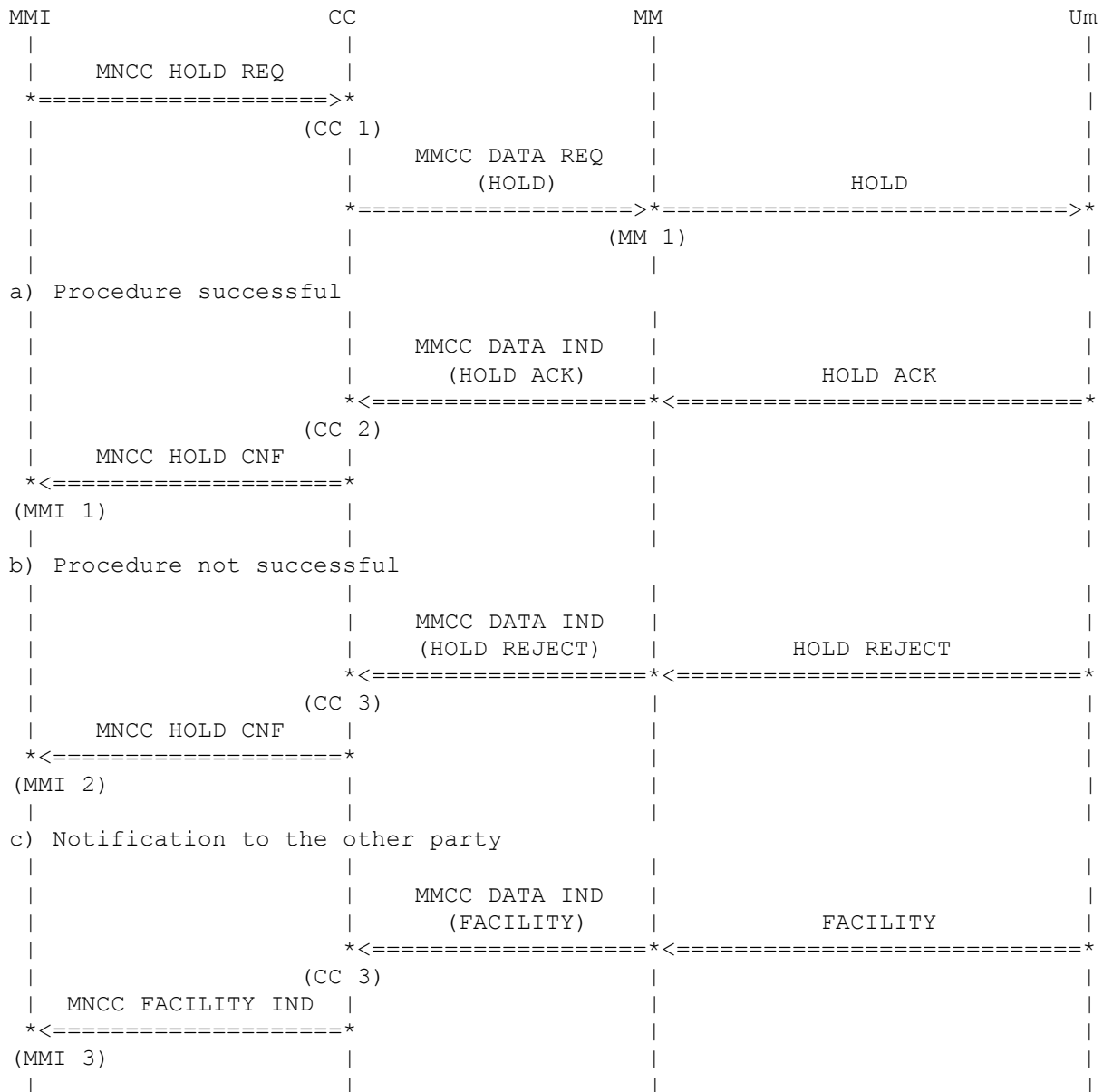
The hold procedure is carried out on an existing MM connection. It is used to forward an active connection into the help state call held. CC state is U10 ACTIVE. In this state, no speech connection exists between the users. The MM connection and the transaction identifier exist for later connection retrieval.

(CC 1)

The mobile station requests the hold procedure.

(MM 1)

CC sends the HOLD message to the network.

(CC 2)

The network responds with a HOLD ACK message. From the view of the network, the procedure has finished and the connection is held.

(MMI 1)

MMI is informed about the successful end of procedure. MMI interrupts speech connection and CC remarks that the connection is in call held state.

(CC 3)

The network HOLD REJECT message indicates the negative end of procedure. The cause informs about the rejection cause. Possible causes are "#29 facility rejected", "#50 requested facility not supported", and "#69 requested facility not implemented".

(MMI 2)

MMI is informed about the cause of rejection.

(CC 4)

The network sends a notification to the held user which indicates that the call is now held. Therefore, a FACILITY message is used with a notify SS element.

(MMI 3)

MMI is informed that the call is held.

3.3.10 Retrieve

```
MMI                      CC                      MM                              Um
 |                       |                       |                               |
 |  MNCC RETRIEVE REQ    |                       |                               |
 *=====================>*                        |                               |
 |                      (CC 1)                    |                               |
 |                       |  MMCC DATA REQ   |                               |
 |                       |    (RETRIEVE)    |              RETRIEVE          |
 |                       *=================>*=============================>*
 |                       |                      (MM 1)                        |
 |                       |                       |                               |
a) Procedure successful
 |                       |                       |                               |
 |                       |  MMCC DATA IND   |                               |
 |                       |  (RETRIEVE ACK)  |           RETRIEVE ACK         |
 |                       *<================*<============================*
 |                      (CC 2)                    |                               |
 | MNCC RETRIEVE CNF     |                       |                               |
 *<====================*                         |                               |
(MMI 1)                  |                       |                               |
 |                       |                       |                               |
b) Procedure not successful
 |                       |                       |                               |
 |                       |  MMCC DATA IND   |                               |
 |                       |  (RETRIEVE REJ)  |           RETRIEVE REJ         |
 |                       *<================*<============================*
 |                      (CC 3)                    |                               |
 | MNCC RETRIEVE CNF     |                       |                               |
 *<====================*                         |                               |
(MMI 2)                  |                       |                               |
 |                       |                       |                               |
c) Notification to the other party
 |                       |                       |                               |
 |                       |  MMCC DATA IND   |                               |
 |                       |    (FACILITY)    |              FACILITY          |
 |                       *<================*<============================*
 |                      (CC 3)                    |                               |
 | MNCC FACILITY IND     |                       |                               |
 *<====================*                         |                               |
(MMI 3)                  |                       |                               |
 |                       |                       |                               |
```

TEXAS
INSTRUMENTS

The retrieve procedure is carried out on an existing MM connection. It is used to forward a held connection to an active connection. The speech connection between the users is restored.

(CC 1)

The mobile station requests the retrieve procedure.

(MM 1)

CC sends the RETRIEVE message to the network.

(CC 2)

The network responds with a RETRIEVE ACK message. From the view of the network, the procedure has finished and the connection is retrieved to an active connection.

(MMI 1)

MMI is informed about the successful end of procedure. MMI enables speech connection and CC remarks that the connection is now active.

(CC 3)

The network RETREIVE REJ message indicates the negative end of procedure. The cause informs about the cause of rejection. A potential cause is "#30 no channel available".

(MMI 2)
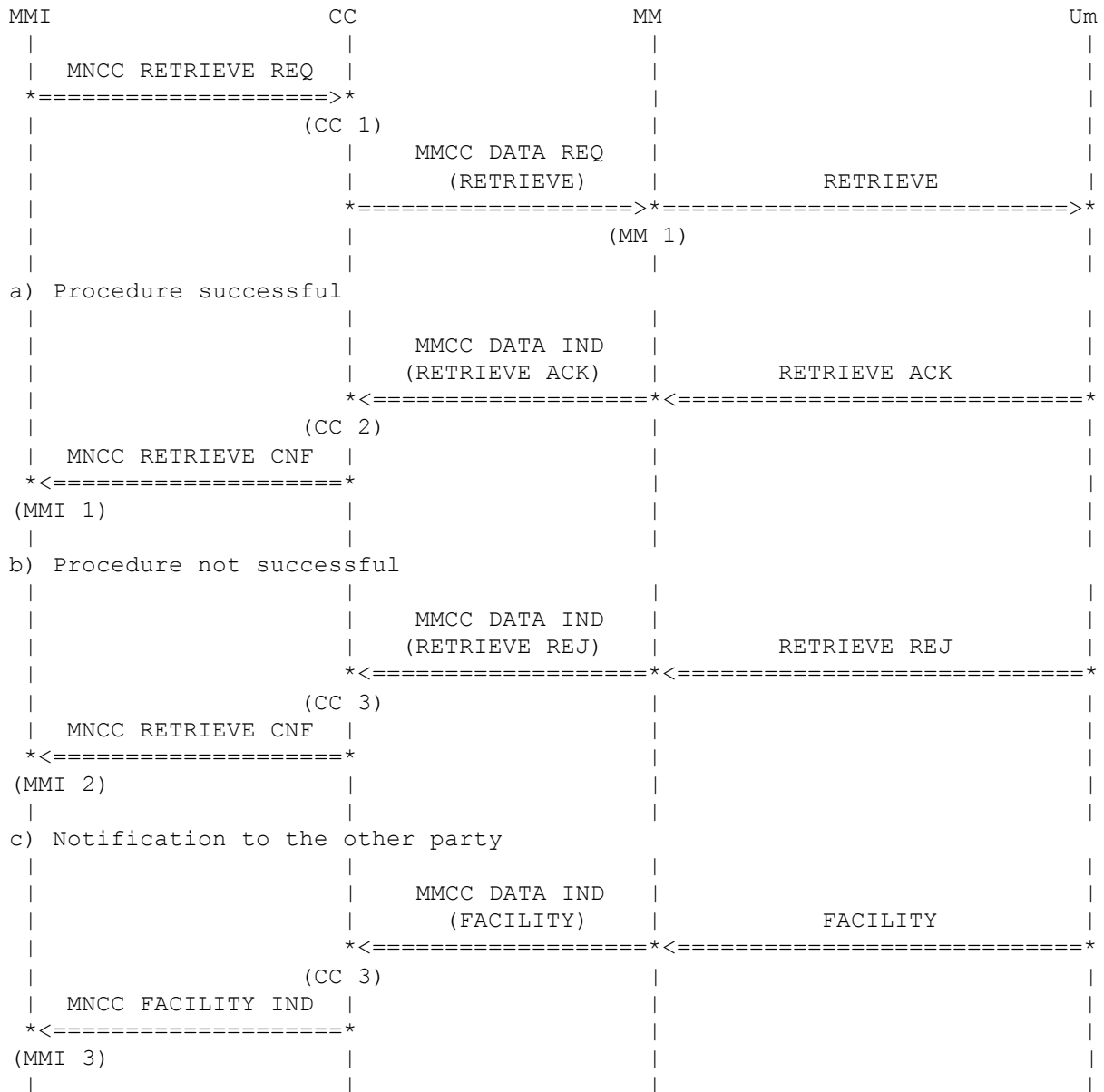
MMI is informed about the cause of rejection.

(CC 4)

The network sends a notification to the held user, which indicates that the call is now retrieved. Therefore, a FACILITY message is used with a notify SS element.

(MMI 3)

MMI is informed that the call is active again.

3.3.11 Mobile Originated In-Call Modification

```
MMI                         CC                      MM                              Um
 |                          |                       |                               |
 |    MNCC MODIFY REQ       |                       |                               |
 *====================>*                            |                               |
 |                         (CC 1)                   |                               |
 |                          |    MMCC DATA REQ      |                               |
 |                          |      (MODIFY)         |           MODIFY              |
 |                        *==================>*=============================>*
 |                          |                      (MM 1)                     |
 |                          |                       |                               |
a) Procedure successful
 |                          |                       |                               |
 |                          |    MMCC DATA IND      |                               |
 |                          |  (MODIFY COMPLETE)    |      MODIFY COMPLETE           |
 |                        *<==================*<=============================*
 |                         (CC 2)                   |                               |
 |    MNCC MODIFY CNF       |                       |                               |
 *<====================*                            |                               |
(MMI 1)                     |                       |                               |
 |                          |                       |                               |
b) Procedure not successful
 |                          |                       |                               |
 |                          |    MMCC DATA IND      |                               |
 |                          |   (MODIFY REJECT)     |      MODIFY REJECT             |
 |                        *<==================*<=============================*
 |                         (CC 3)                   |                               |
 |    MNCC MODIFY CNF       |                       |                               |
 *<====================*                            |                               |
(MMI 2)                     |                       |                               |
 |                          |                       |                               |
c) no answer by the network
 |                          |                       |                               |
 |                        *<time-out T323>          |                               |
 |                         (CC 4)                   |                               |
 |                          |    MMCC DATA REQ      |                               |
 |                          |    (DISCONNECT)       |         DISCONNECT             |
 |                        *==================>*=============================>*
 |                          |                      (MM 1)                     |
 |    MNCC MODIFY IND       |                       |                               |
 *<====================*                            |                               |
(MMI 3)                     |                       |                               |
 |                          |                       |                               |
```
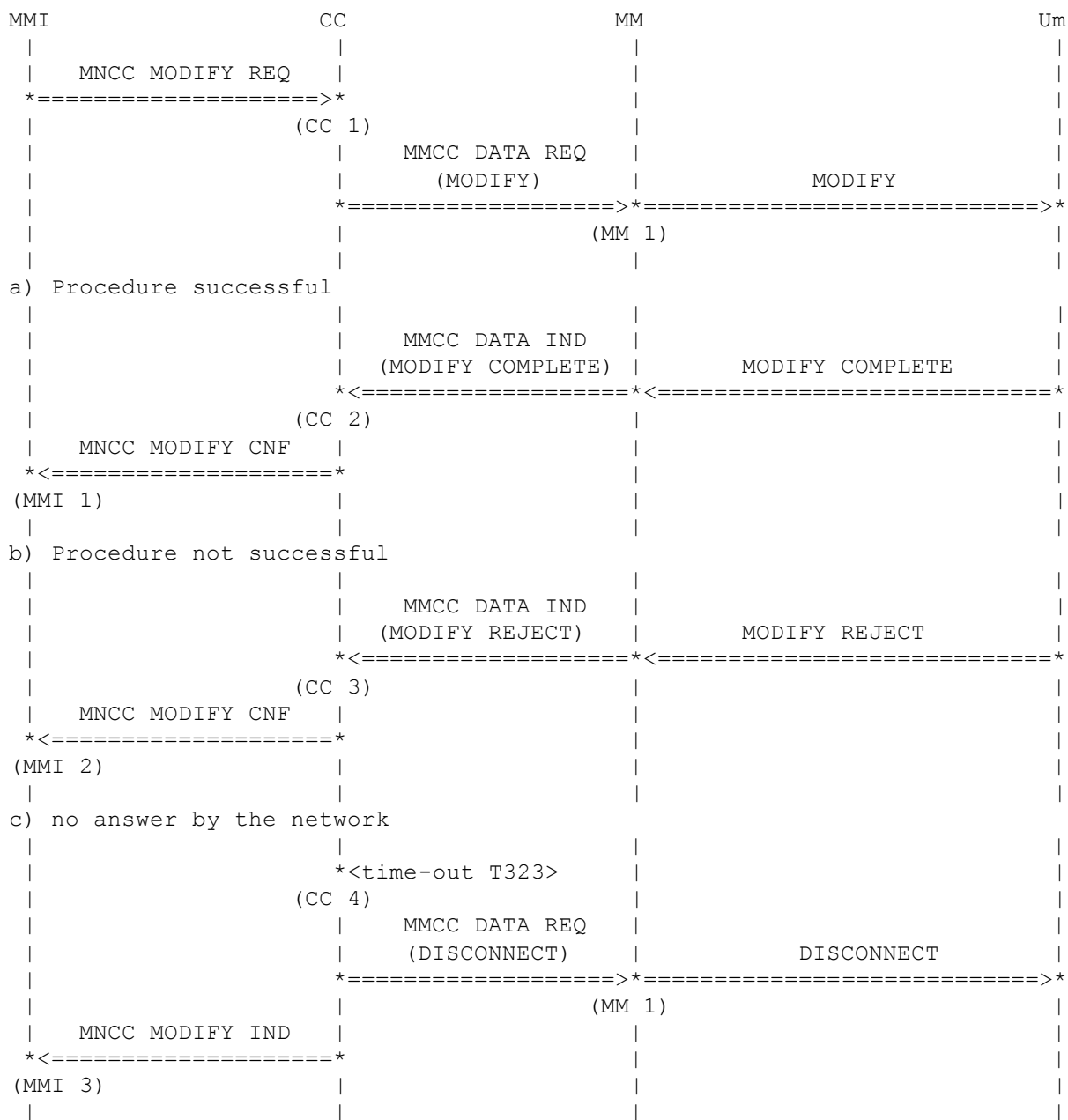
The in-call modification procedure is used to change the kind of service during an active connection. During call establishment phase, the possibilities of the calling and called party are negotiated. That means, that up to two bearer capabilities which describe two services that the user may carry out are exchanged with the SETUP message. Switching between these two services is the goal of the in-call modification procedure.

(CC 1)

MMI starts the mobile originated in-call modification. CC checks whether or not a hold, retrieve, or DTMF procedure is running. In this case, the request is stored until the end of these procedures.

(MM 1)

CC sends a MODIFY message to the network. The parameter information transfer capability (ITC) of the bearer capability is stored. Timer T323 is started to supervise the network response. CC enters U26 MOBILE ORIGINATED MODIFY state.

(CC 2)

If the network is able to change the service, it will change the channel mode. CC is informed with an MMCC SYNC IND primitive. The change procedure(channel assignment or channel mode modify procedure) is carried out in radio resource. The network sends a MODIFY COMPLETE message to the mobile station with the new ITC. CC checks whether or not the received is equal to the stored ITC. If they are equal, the message is ignored.

(MMI 1)

CC informs MMI about the successful change of service. Timer T323 is stopped and CC re-enters U10 ACTIVE state.

(CC 3)

If the network is not able to change the service, it sends a MODIFY REJECT message to the mobile station with the old ITC. The mobile station compares the received with the stored ITC. If both are not equal, the message is ignored.

(MMI 2)

MMI is informed about the failed in-call modification. Timer T323 is stopped and CC re-enters U10 ACTIVE state.

(CC 4)

If there is no response from the network, timer T323 times-out. The mobile station releases the call and sends a DISCONNECT message to the network.

(MMI 3)

MMI is informed about the release. Timer T305 is started and CC enters U11 DISCONNECT REQUEST state.

TEXAS INSTRUMENTS

3.3.12 Mobile Terminated In-Call Modification

```
MMI                     CC                     MM                                    Um
 |                       |                      |                                     |
 |                       |    MMCC DATA IND      |                                     |
 |                       |      (MODIFY)         |              MODIFY                 |
 |                      *<==================*<===========================*
 |                    (CC 1)                 |                                     |
 |                       |                      |                                     |
a) Procedure successful
 |                       |                      |                                     |
 |    MNCC MODIFY IND     |                      |                                     |
 *<===================*                       |                                     |
(MMI 1)                  |                      |                                     |
 |                       |    MMCC DATA REQ      |                                     |
 |                       |  (MODIFY COMPLETE)    |         MODIFY COMPLETE             |
 |                      *==================>*===========================>*
 |                       |                  (MM 1)                             |
 |                       |                      |                                     |
b) Procedure not successful
 |                       |                      |                                     |
 |                       |    MMCC DATA REQ      |                                     |
 |                       |   (MODIFY REJECT)     |          MODIFY REJECT              |
 |                      *==================>*===========================>*
 |                       |                  (MM 2)                             |
 |                       |                      |                                     |
```

(CC 1)
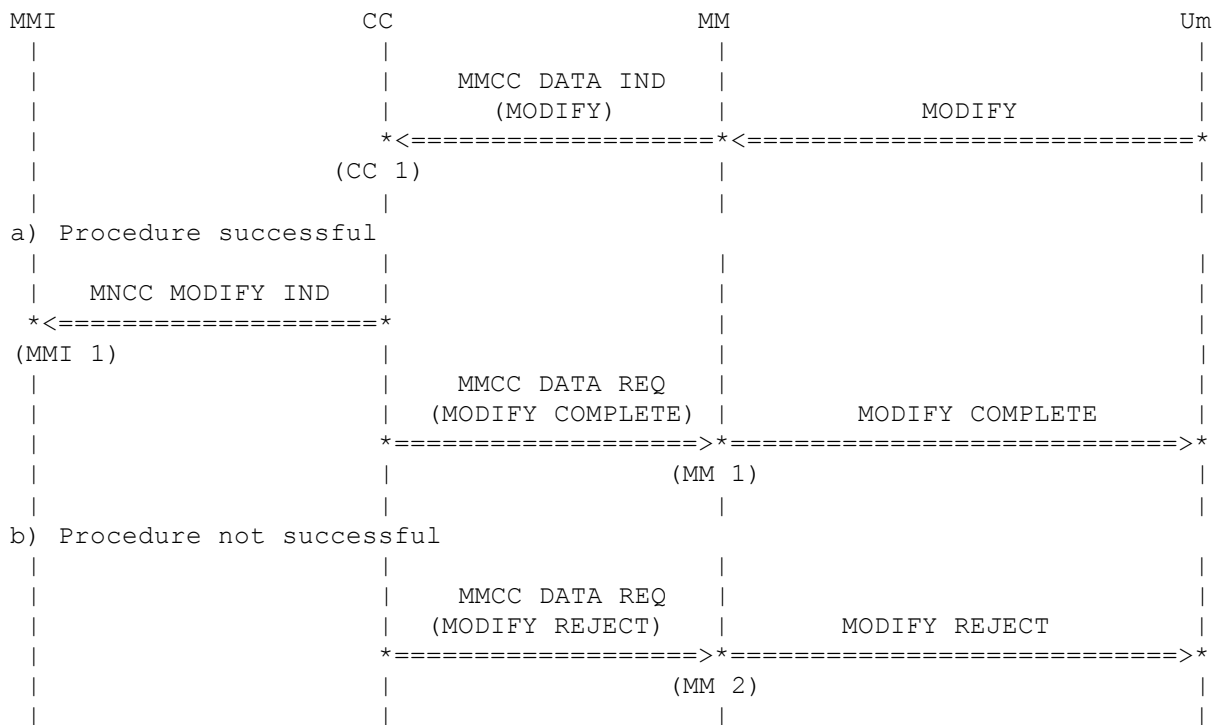
The network sends a MODIFY message to change the kind of service.

(MMI 1)

CC checks if the change of service is possible. If this check is positive, MMI is informed about the new service.

(MM 1)

CC sends a MODIFY COMPLETE message to the network.

(MM 2)

If the change is failed, CC sends a MODIFY REJECT message to the network.

TEXAS INSTRUMENTS

3.3.13 Mobile Originated Sending of User Data

```
MMI                       CC                    MM                             Um
 |                        |                     |                              |
 |     MNCC USER REQ      |                     |                              |
 *=====================>* |                     |                              |
 |                       (CC 1)                 |                              |
 |                        |    MMCC DATA REQ    |                              |
 |                        |     (USER USER)     |          USER USER           |
 |                        *=================>*===========================>*
 |                        |                   (MM 1)                          |
 |                        |                     |                              |
```
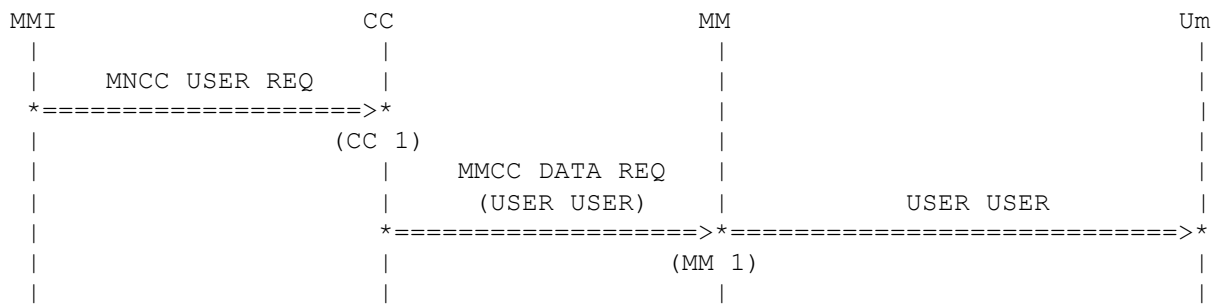
(CC 1)

MMI sends user to user data to CC.

(MM 1)

CC codes a USER USER message and sends it to the network.

3.3.14 Mobile Terminated Receiving of User Data

```
MMI                       CC                    MM                             Um
 |                        |                     |                              |
a) by USER USER message
 |                        |                     |                              |
 |                        |    MMCC DATA IND    |                              |
 |                        |     (USER USER)     |          USER USER           |
 |                        *<=================*<===========================*
 |                       (CC 1)                 |                              |
 |     MNCC USER IND      |                     |                              |
 *<=================*     |                     |                              |
(MMI 1)                   |                     |                              |
 |                        |                     |                              |
b) by another message
 |                        |                     |                              |
 |                        |    MMCC DATA IND    |                              |
 |                        |     (XX-message)    |          XX-message          |
 |                        *<=================*<===========================*
 |                       (CC 2)                 |                              |
 |     MNCC XX IND        |                     |                              |
 *<=================*     |                     |                              |
(MMI 2)                   |                     |                              |
 |     MNCC USER IND      |                     |                              |
 *<=================*     |                     |                              |
(MMI 3)                   |                     |                              |
 |                        |                     |                              |
```
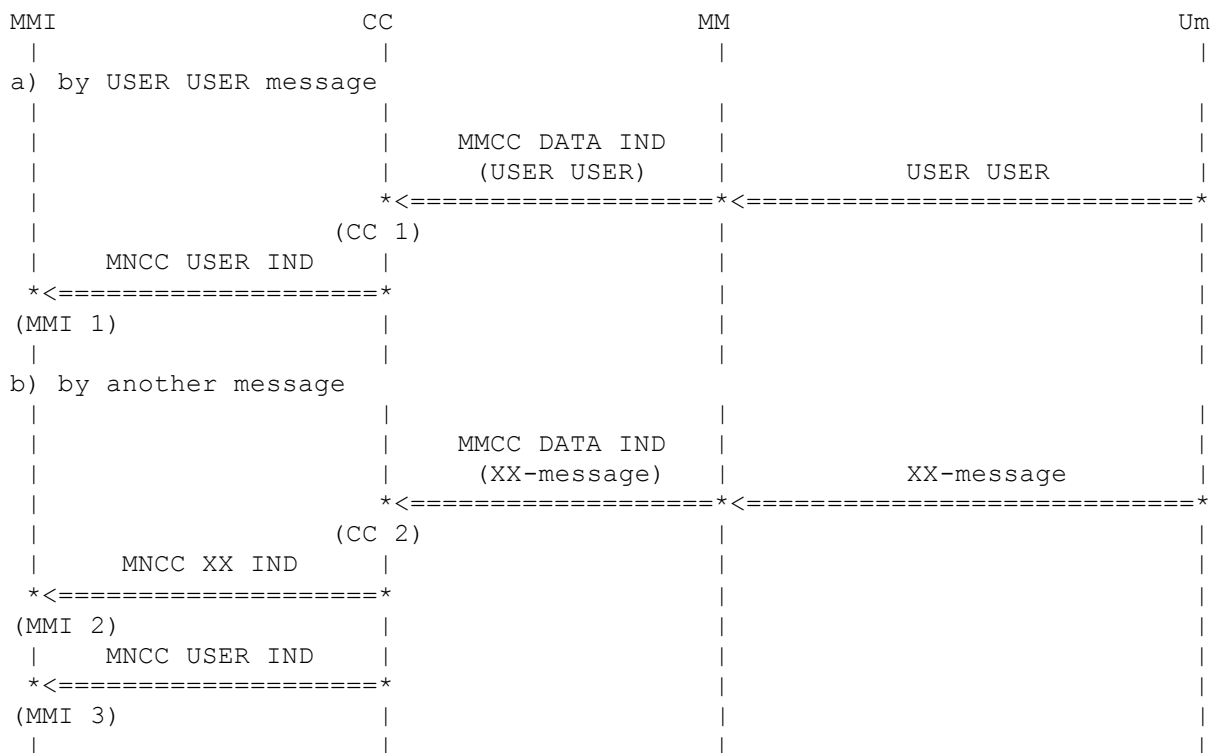
(CC 1)

CC receives user to user data from the network.

(MMI 1)

CC decodes the data from the USER_USER message and forwards the content to MMI.

(CC 2)

CC receives a messagewith user data from the network.

(MMI 2)

The normal processing for the message is carried out.

(MMI 3)

The user user information is send to the MMI. The context to the incoming message is a parameter of the primitive.

3.4 Call Release

3.4.1 Mobile Originated Call Release

```
MMI                        CC                 MM                           Um
 |                          |                  |                           |
 | MNCC DISCONNECT REQ |                       |                           |
 *====================>*                       |                           |
 |                        (CC 1)               |                           |
 |                          |   MMCC DATA REQ  |                           |
 |                          |   (DISCONNECT)   |        DISCONNECT         |
 |                          *=================>*==========================>*
 |                          |                (MM 1)                        |
 |                          |                  |                           |
a) normal case
 |                          |                  |                           |
 |                          |   MMCC DATA IND  |                           |
 |                          |    (RELEASE)     |         RELEASE           |
 |                          *<================*<==========================*
 |                        (CC 2)               |                           |
 |   MNCC RELEASE IND   |                       |                           |
 *<====================*                        |                           |
(MMI 1)                   |                      |                           |
 |                          |   MMCC DATA REQ  |                           |
 |                          | (RELEASE COMPLETE) |     RELEASE COMPLETE      |
 |                          *=================>*==========================>*
 |                          |                (MM 2)                        |
 |                          |  MMCC RELEASE REQ |                           |
 |                          *=================>*                           |
 |                          |                (MM 3)                        |
 |                          |                  |                           |
b) no response to DISCONNECT message
 |                          |                  |                           |
 |                          *<time-out T305>   |                           |
 |                        (CC 3)               |                           |
 |                          |   MMCC DATA REQ  |                           |
 |                          |    (RELEASE)     |         RELEASE           |
 |                          *=================>*==========================>*
 |                          |                (MM 4)                        |
 | MNCC DISCONNECT IND |                       |                           |
 *<====================*                        |                           |
(MMI 2)                   |                      |                           |
 |                          |   MMCC DATA IND  |                           |
 |                          | (RELEASE COMPLETE) |   RELEASE COMPLETE       |
 |                          *<================*<==========================*
 |                        (CC 4)               |                           |
 |   MNCC RELEASE CNF   |                       |                           |
 *<====================*                        |                           |
(MMI 3)                   |                      |                           |
 |                          |  MMCC RELEASE REQ |                           |
 |                          *=================>*                           |
 |                          |                (MM 5)                        |
 |                          |                  |                           |
```

Call release is determined by the sending of two messages. The DISCONNECT message is used to release the connection to the other party. The RELEASE message is used to release the connection to the network.

(CC 1)

The mobile station requests call release. All running call control timers are stopped.

(MM 1)

CC sends a DISCONNECT message to the network. Timer T305 is started and CC enters U11 DISCONNECT REQUEST state.

(CC 2)

The network answers with a RELEASE message. Timer T305 is stopped. MMI is informed about successful release.

(MM 2)

A RELEASE COMPLETE message is sent as confirmation to the network.

(MM 3)

The MM connection is released locally.

(CC 3)

If there is no response to the DISCONNECT message, timer T305 times-out.

(MM 4)

CC sends a RELEASE message to release the connection to the network.

(MMI 2)

MMI is informed that the connection to the other party is released.

(CC 4)

The network responds with a RELEASE COMPLETE message. The MM connection is released for the network. The possibility that no RELEASE COMPLETE message is sent by the network is described in the section "Mobile Terminated Call Release".

(MMI 3)

MMI is informed about the MM connection release.

(MM 5)

The MM connection is released locally.

3.4.2 Mobile Terminated Call Release

```
MMI                     CC                      MM                              Um
 |                       |                       |                               |
 |                       |    MMCC DATA IND       |                               |
 |                       |     (DISCONNECT)       |          DISCONNECT           |
 |                       *<==================*<===========================*
 |                    (CC 1)                      |                               |
 |  MNCC DISCONNECT IND  |                       |                               |
 *<==================*                           |                               |
(MMI 1)                  |                       |                               |
 |                       |                       |                               |
a) normal case, no in-band tones
 |                       |                       |                               |
 |                       |    MMCC DATA REQ       |                               |
 |                       |      (RELEASE)         |           RELEASE             |
 |                       *==================>*===========================>*
 |                       |                    (MM 1)                              |
 |                       |    MMCC DATA IND       |                               |
 |                       | (RELEASE COMPLETE) |       RELEASE COMPLETE         |
 |                       *<==================*<===========================*
 |                    (CC 2)                      |                               |
 |   MNCC RELEASE CNF    |                       |                               |
 *<==================*                           |                               |
(MMI 2)                  |                       |                               |
 |                       |   MMCC RELEASE REQ     |                               |
 |                       *==================>*                               |
 |                       |                    (MM 2)                              |
 |                       |                       |                               |
b) normal case, in-band tones
 |                       |                       |                               |
 |   MNCC RELEASE REQ    |                       |                               |
 *==================>*                           |                               |
 |                    (CC 3)                      |                               |
 |                       |    MMCC DATA REQ       |                               |
 |                       |      (RELEASE)         |           RELEASE             |
 |                       *==================>*===========================>*
 |                       |                    (MM 3)                              |
 |                       |    MMCC DATA IND       |                               |
 |                       | (RELEASE COMPLETE) |       RELEASE COMPLETE         |
 |                       *<==================*<===========================*
 |                    (CC 4)                      |                               |
 |   MNCC RELEASE CNF    |                       |                               |
 *<==================*                           |                               |
(MMI 3)                  |                       |                               |
 |                       |   MMCC RELEASE REQ     |                               |
 |                       *==================>*                               |
 |                       |                    (MM 4)                              |
 |                       |                       |                               |
```

TEXAS INSTRUMENTS

```
MMI                    CC                    MM                    Um
 |                     |                     |                     |
c) no response to RELEASE message, first time-out
 |                     |                     |                     |
 |               *<time-out T308>     |                     |
 |               (CC 5)                     |                     |
 |                     |   MMCC DATA REQ     |                     |
 |                     |     (RELEASE)       |         RELEASE     |
 |               *==================>*============================>*
 |                     |                     (MM 5)                |
 |                     |                     |                     |
d) no response to RELEASE message, second time-out
 |                     |                     |                     |
 |               *<time-out T308>     |                     |
 |               (CC 6)                     |                     |
 |   MNCC RELEASE CNF  |                     |                     |
 *<===================*                     |                     |
(MMI 4)                |                     |                     |
 |                     |   MMCC RELEASE REQ  |                     |
 |               *===================>*                     |
 |                     |                     (MM 6)                |
 |                     |                     |                     |
```

(CC 1)

CC receives a DISCONNECT message from the other party. All running call control timers are stopped.

(MMI 1)

MMI is informed about disconnection.

(MM 1)

If no in-band tones are available, tones are generated locally in the mobile station. The release is processed immediately, although the mobile user has not hooked on. CC sends a RELEASE message to the network. Timer T308 is started to supervise the RELEASE COMPLETE message reception.

(CC 2)

The network confirms the release with a RELEASE COMPLETE message. CC stops timer T308.

(MMI 2)

MMI is informed about successful end of release procedure. CC enters U0 NULL state.

(MM 2)

The MM connection is released locally.

(CC 3)

If in-band tones are available, the network generates the tones and sends them via the speech channel to the mobile station. Release is processed after hook on of the mobile station.

(MM 3)

CC sends a RELEASE message to the network. Timer T308 is started to supervise RELEASE COMPLETE message reception.

(CC 4)

The network confirms the release with a RELEASE COMPLETE message. CC stops timer T308.

(MM 4)

The MM connection is released locally.

(CC 5)

The timer T308 times-out for the first time. There was no response by the network.

(MM 5)

CC re-sends a RELEASE message to the network. Timer T308 is started to supervise RELEASE COMPLETE message reception.

(CC 6)

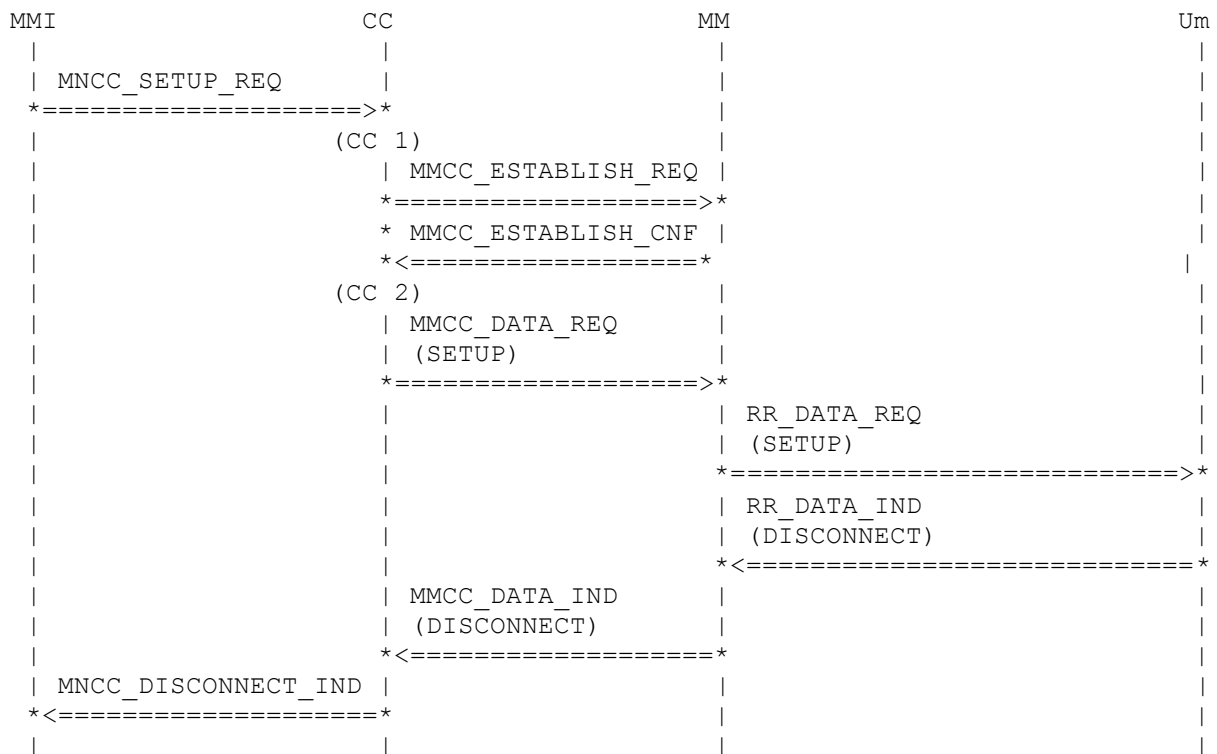The timer T308 times-out a second time. There was no response by the network.

(MMI 4)
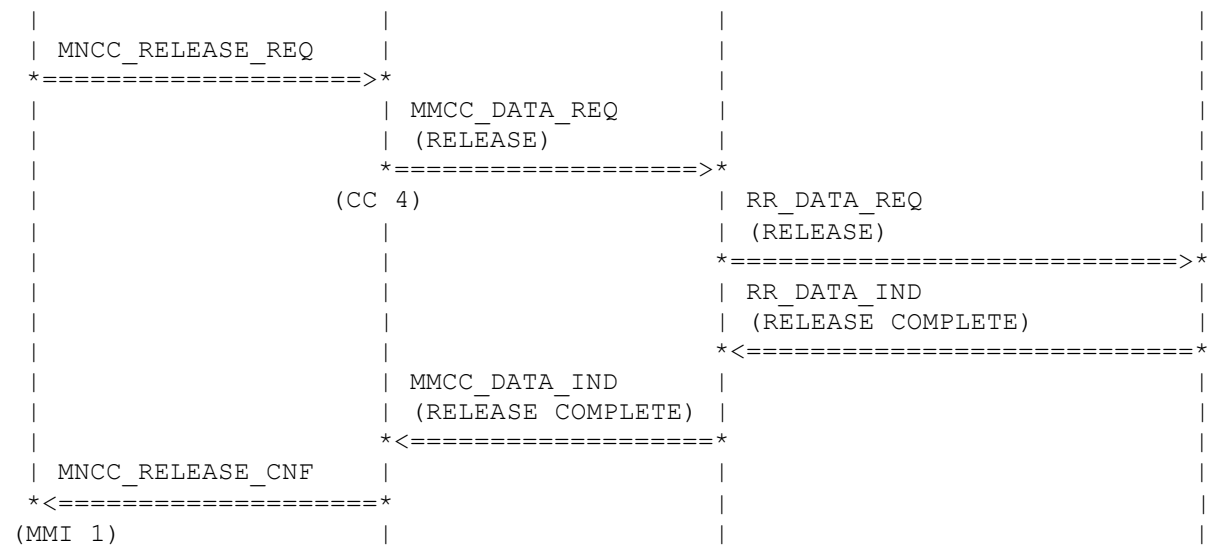
MMI is informed about the end of release phase.

(MM 6)

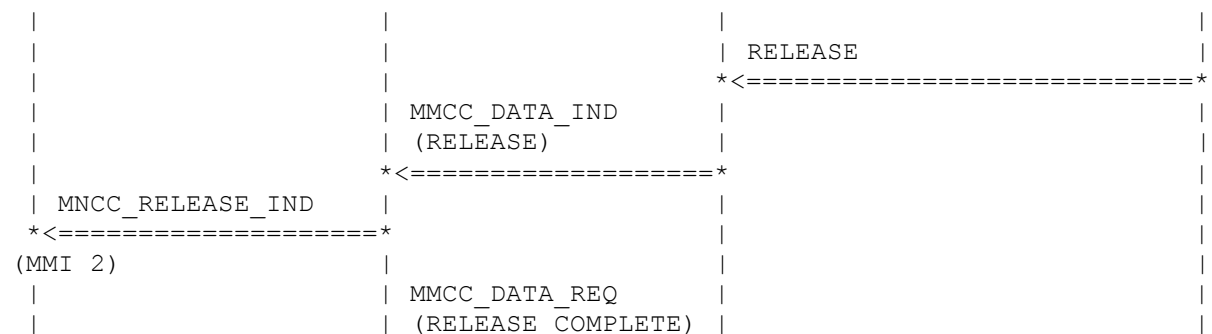The MM connection is released locally.

3.4.3 Mobile Terminated Call Release with CCBS offer

```
MMI                      CC                    MM                              Um
 |                        |                     |                               |
 | MNCC_SETUP_REQ         |                     |                               |
 *======================>*                      |                               |
 |                       (CC 1)                 |                               |
 |                        | MMCC_ESTABLISH_REQ  |                               |
 |                        *==================>*                                 |
 |                        * MMCC_ESTABLISH_CNF  |                               |
 |                        *<==================*                                 |
 |                       (CC 2)                 |                               |
 |                        | MMCC_DATA_REQ       |                               |
 |                        | (SETUP)             |                               |
 |                        *==================>*                                 |
 |                        |                     | RR_DATA_REQ                   |
 |                        |                     | (SETUP)                       |
 |                        |                     *==========================>*   |
 |                        |                     | RR_DATA_IND                   |
 |                        |                     | (DISCONNECT)                  |
 |                        |                     *<==========================*   |
 |                        | MMCC_DATA_IND       |                               |
 |                        | (DISCONNECT)        |                               |
 |                        *<==================*                                 |
 | MNCC_DISCONNECT_IND    |                     |                               |
 *<====================*                        |                               |
 |                        |                     |                               |
```

a) User decision: Invocation of CCBS/no invocation of CCBS

```
 |                        |                     |                               |
 | MNCC_RELEASE_REQ       |                     |                               |
 *====================>*                        |                               |
 |                        | MMCC_DATA_REQ       |                               |
 |                        | (RELEASE)           |                               |
 |                        *==================>*                                 |
 |                       (CC 4)                 | RR_DATA_REQ                   |
 |                        |                     | (RELEASE)                     |
 |                        |                     *==========================>*   |
 |                        |                     | RR_DATA_IND                   |
 |                        |                     | (RELEASE COMPLETE)            |
 |                        |                     *<==========================*   |
 |                        | MMCC_DATA_IND       |                               |
 |                        | (RELEASE COMPLETE)  |                               |
 |                        *<==================*                                 |
 | MNCC_RELEASE_CNF       |                     |                               |
 *<====================*                        |                               |
(MMI 1)                   |                     |                               |
```

b) No user decision in time, network timeout etc.
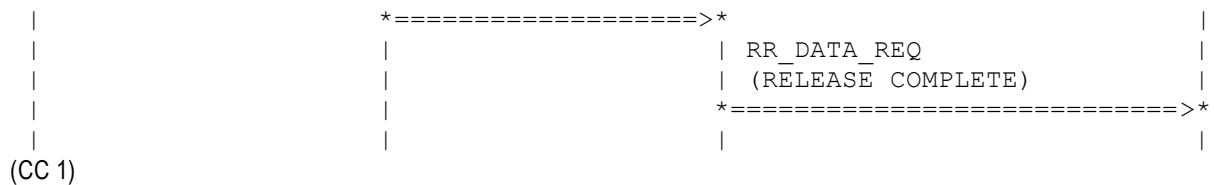
```
 |                        |                     |                               |
 |                        |                     | RELEASE                       |
 |                        |                     *<==========================*   |
 |                        | MMCC_DATA_IND       |                               |
 |                        | (RELEASE)           |                               |
 |                        *<==================*                                 |
 | MNCC_RELEASE_IND       |                     |                               |
 *<====================*                        |                               |
(MMI 2)                   |                     |                               |
 |                        | MMCC_DATA_REQ       |                               |
 |                        | (RELEASE COMPLETE)  |                               |
```

Texas Instruments

```
 |                        *===================>*                                |
 |                        |                    | RR_DATA_REQ                    |
 |                        |                    | (RELEASE COMPLETE)             |
 |                        |                    *===========================>*   |
 |                        |                    |                            |    |
```

(CC 1)

MMI starts a mobile originated call. The kind of connection (basic or emergency call) and a few other parameters are stored by CC.

(CC 2)

MM signals to CC that the MM connection establishment was successfull.

(CC 3)

It is assumed that the DISCONNECT message indicates that the invocation of CCBS is possible here.

(CC 4)

In this situation, the invocation of CCBS is decided by the presence of an appropriate facility element and an SS-Version 3 indicator (this is required by GSM 04.93). If activation of CCBS is not wanted, the SS-Version indicator and the facility element are not present in the RELEASE message.

(MMI 1)

The invocation of CCBS may be acknowledged by a facility information element in the RELEASE COMPLETE message. The facility element. The facility element is delivered by the primitive MNCC_RELEASE_CNF.

(MMI 2)

If no user decision in time, a network timer expires and the call is cleared by the network. The MMI is informed about this. For CC, the call is cleared without further action by upper layers.

3.5 Error handling

The behaviour of CC with regard to erroneous messages is defined by GSM. It is possible to differentiate the following error types in their order of importance:

- Message too short

- Unknown or unforeseen transaction identifier

- Unknown or unforeseen message type

- Non-semantically correct mandatory information element errors

- Unknown or unforeseen IEs in the non-imperative message part

- Non-imperative message part errors

- Semantically incorrect contents

3.5.1 Message too Short

```
MMI                     CC                      MM                            Um
 |                      |                       |                             |
a) new transaction
 |                      |                       |                             |
 |                      |    MMCC DATA IND    |                             |
 |                      |      (MESSAGE)       |            MESSAGE           |
 |                      *<==================*<============================*
 |                    (CC 1)                   |                             |
 |                      |   MMCC RELEASE REQ   |                             |
 |                      *==================>*                             |
 |                      |                    (MM 1)                         |
 |                      |                       |                             |
a) existing transaction
 |                      |                       |                             |
 |                      |    MMCC DATA IND    |                             |
 |                      |      (MESSAGE)       |            MESSAGE           |
 |                      *<==================*<============================*
 |                    (CC 2)                   |                             |
 |                      |                       |                             |
```

(CC 1)
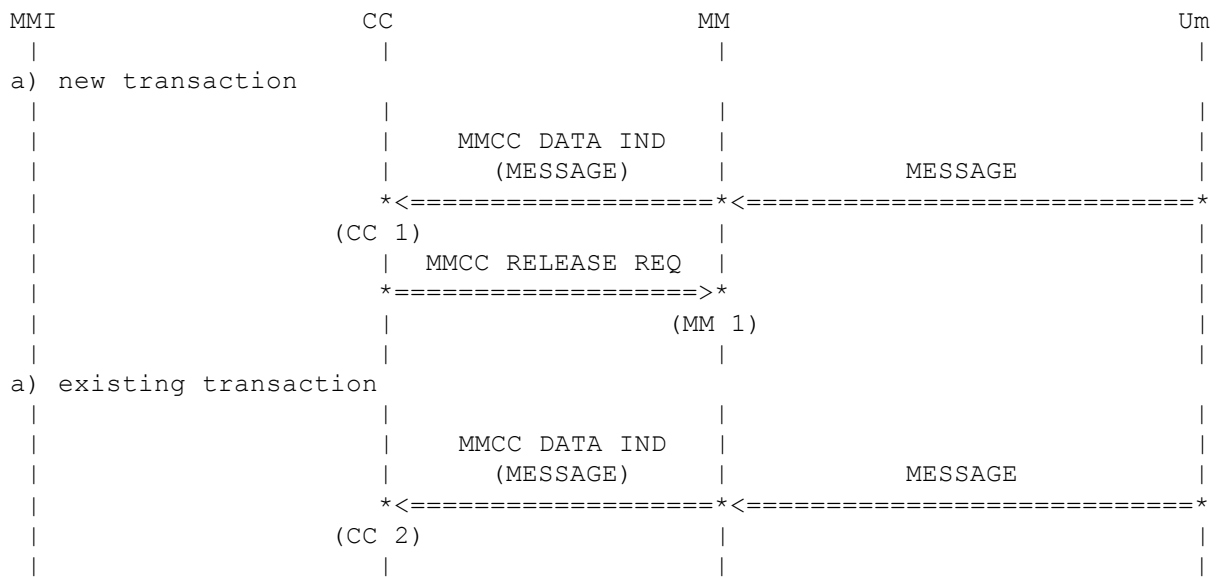
CC receives a message which consists of only the protocol discriminator and a new transaction identifier. The message is ignored.
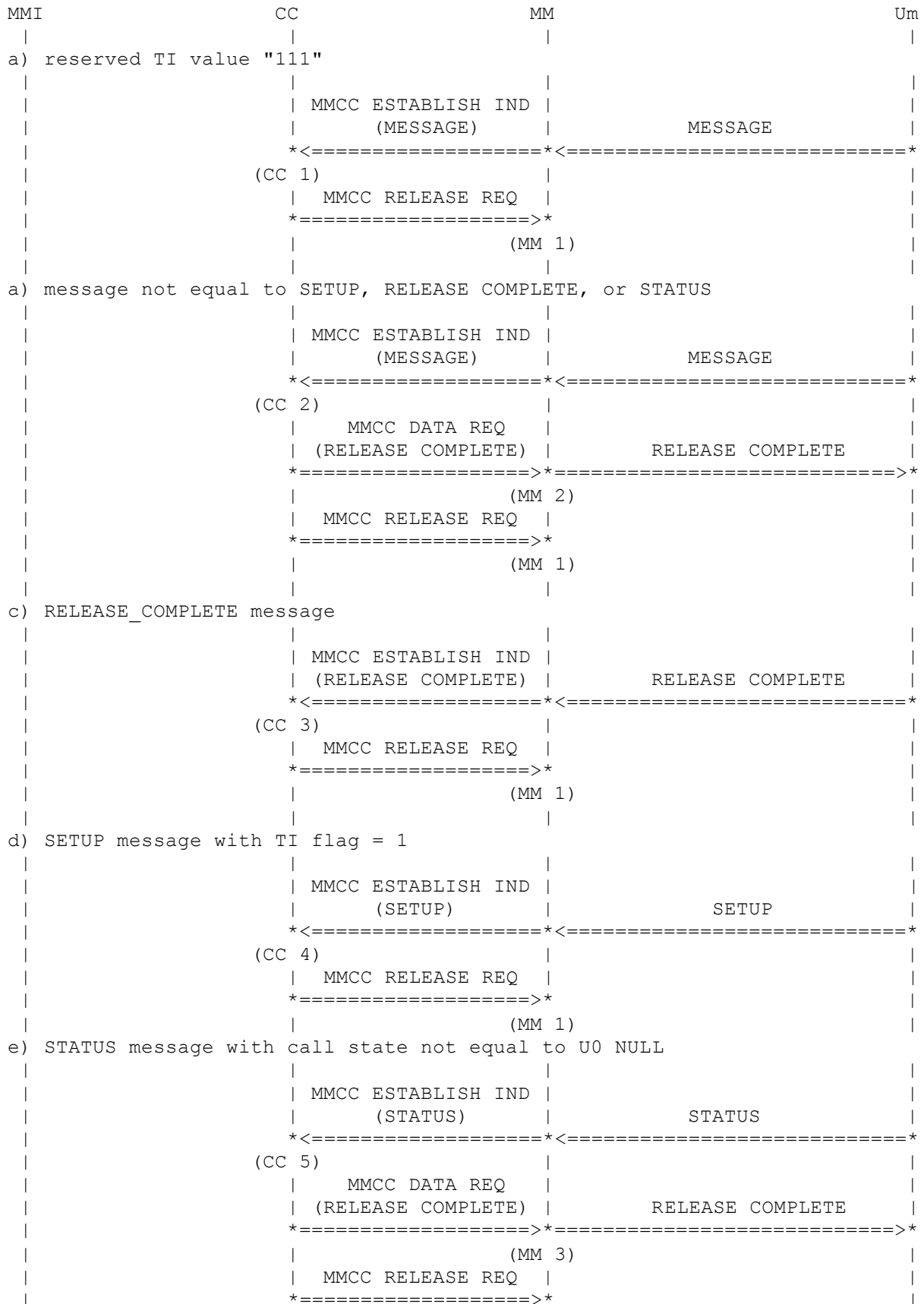
(MM 1)

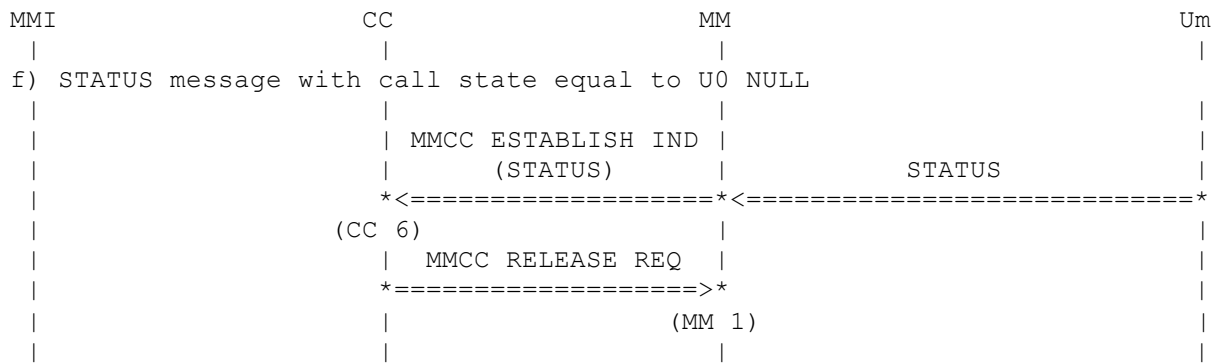The existing MM connection for this transaction identifier is released.

(CC 2)

CC receives a message which consists of only the protocol discriminator and an existing transaction identifier. The message is ignored.

TEXAS INSTRUMENTS

3.5.2 Unknown or unforeseen transaction identifier

```
MMI                     CC                      MM                              Um
 |                       |                       |                               |
a) reserved TI value "111"
 |                       |                       |                               |
 |                       | MMCC ESTABLISH IND |                                  |
 |                       |     (MESSAGE)      |           MESSAGE                |
 |                       *<==================*<===========================*
 |               (CC 1)   |                       |                               |
 |                       | MMCC RELEASE REQ   |                                  |
 |                       *==================>*                                   |
 |                       |                  (MM 1)                               |
 |                       |                       |                               |
a) message not equal to SETUP, RELEASE COMPLETE, or STATUS
 |                       |                       |                               |
 |                       | MMCC ESTABLISH IND |                                  |
 |                       |     (MESSAGE)      |           MESSAGE                |
 |                       *<==================*<===========================*
 |               (CC 2)   |                       |                               |
 |                       |   MMCC DATA REQ    |                                  |
 |                       | (RELEASE COMPLETE) |       RELEASE COMPLETE           |
 |                       *==================>*===========================>*
 |                       |                  (MM 2)                               |
 |                       | MMCC RELEASE REQ   |                                  |
 |                       *==================>*                                   |
 |                       |                  (MM 1)                               |
 |                       |                       |                               |
c) RELEASE_COMPLETE message
 |                       |                       |                               |
 |                       | MMCC ESTABLISH IND |                                  |
 |                       | (RELEASE COMPLETE) |       RELEASE COMPLETE           |
 |                       *<==================*<===========================*
 |               (CC 3)   |                       |                               |
 |                       | MMCC RELEASE REQ   |                                  |
 |                       *==================>*                                   |
 |                       |                  (MM 1)                               |
 |                       |                       |                               |
d) SETUP message with TI flag = 1
 |                       |                       |                               |
 |                       | MMCC ESTABLISH IND |                                  |
 |                       |      (SETUP)       |           SETUP                  |
 |                       *<==================*<===========================*
 |               (CC 4)   |                       |                               |
 |                       | MMCC RELEASE REQ   |                                  |
 |                       *==================>*                                   |
 |                       |                  (MM 1)                               |
e) STATUS message with call state not equal to U0 NULL
 |                       |                       |                               |
 |                       | MMCC ESTABLISH IND |                                  |
 |                       |      (STATUS)      |           STATUS                 |
 |                       *<==================*<===========================*
 |               (CC 5)   |                       |                               |
 |                       |   MMCC DATA REQ    |                                  |
 |                       | (RELEASE COMPLETE) |       RELEASE COMPLETE           |
 |                       *==================>*===========================>*
 |                       |                  (MM 3)                               |
 |                       | MMCC RELEASE REQ   |                                  |
 |                       *==================>*                                   |
```

```
|                         |                     (MM 1)                           |
|                         |                        |                             |
```

```
MMI                            CC                       MM                         Um
 |                              |                        |                          |
f) STATUS message with call state equal to U0 NULL
 |                              |                        |                          |
 |                              | MMCC ESTABLISH IND |                              |
 |                              |      (STATUS)      |              STATUS          |
 |                              *<==================*<==========================*
 |                       (CC 6)                          |                          |
 |                              |  MMCC RELEASE REQ  |                              |
 |                              *==================>*                              |
 |                              |                        (MM 1)                    |
 |                              |                        |                          |
```

Messages with an unused transaction identifier are forwarded with the primitive MMCC ESTABLISH IND by MM.

(CC 1)

If the network uses the reserved transaction identifier value 111, CC ignores the message.

(MM 1)

The existing MM connection is released locally.

(CC 2)

CC receives a message not equal to SETUP, RELEASE COMPLETE, or STATUS.

(MM 2)

The first new transaction message has to be the SETUP message. CC releases the transaction with the RELEASE COMPLETE message. The cause is "#81 invalid transaction identifier".

(CC 3)

If CC receives a RELEASE COMPLETE message, it will be ignored.

(CC 4)

The network sets the transaction identifier flag for the SETUP message. This is a failure. It is not allowed for the transaction originator to set the flag. CC ignores the message.

(CC 5)

CC receives the STATUS message with a call state not equal to U0 NULL. This means that the network has a transaction for this transaction identifier but not for the mobile station.
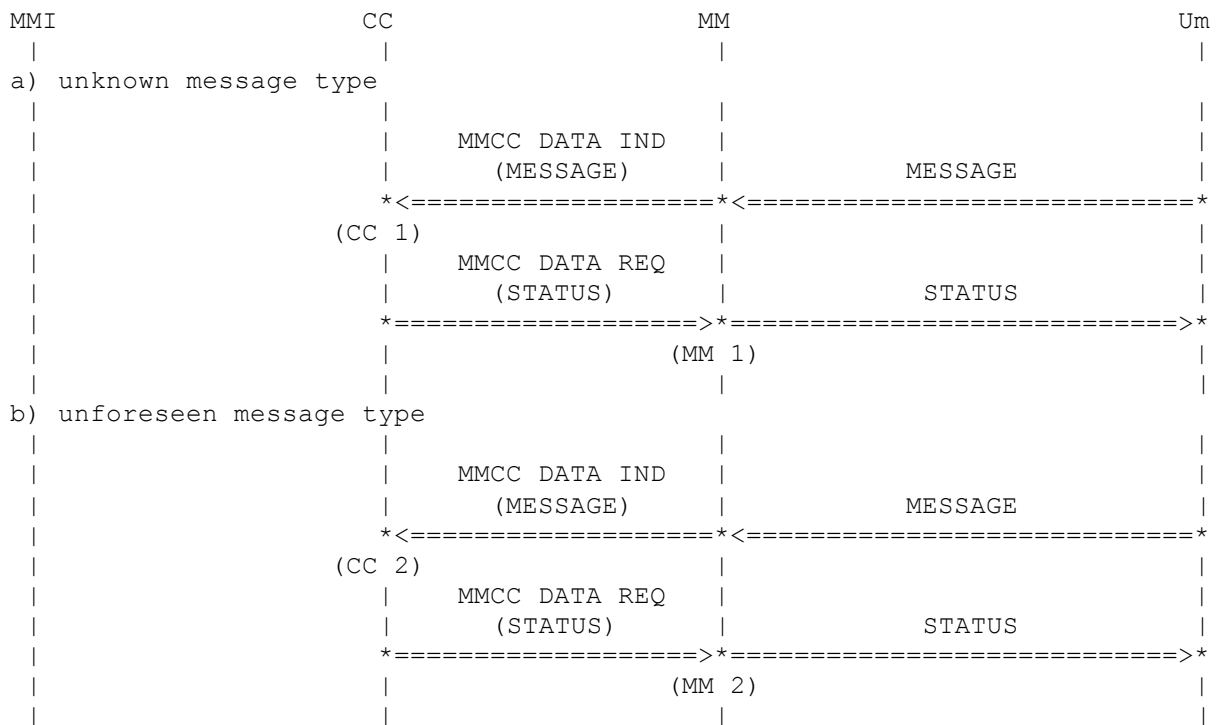
(MM 3)

CC releases the connection with a RELEASE COMPLETE message. The cause is" #101 message not compatible with call state".

(CC 6)

CC receives a STATUS message with a call state equal to U0 NULL. This means that network and mobile station are in U0 NULL state. The message is ignored.

3.5.3 Unknown or unforeseen message type

```
MMI                     CC                  MM                                Um
 |                       |                   |                                 |
a) unknown message type
 |                       |                   |                                 |
 |                       |   MMCC DATA IND    |                                 |
 |                       |    (MESSAGE)       |            MESSAGE              |
 |                      *<==================*<============================*
 |                      (CC 1)               |                                 |
 |                       |   MMCC DATA REQ    |                                 |
 |                       |    (STATUS)        |            STATUS               |
 |                      *==================>*============================>*
 |                       |                 (MM 1)                               |
 |                       |                   |                                 |
b) unforeseen message type
 |                       |                   |                                 |
 |                       |   MMCC DATA IND    |                                 |
 |                       |    (MESSAGE)       |            MESSAGE              |
 |                      *<==================*<============================*
 |                      (CC 2)               |                                 |
 |                       |   MMCC DATA REQ    |                                 |
 |                       |    (STATUS)        |            STATUS               |
 |                      *==================>*============================>*
 |                       |                 (MM 2)                               |
 |                       |                   |                                 |
```

(CC 1)

CC receives a message, which is not defined or implemented. The message is ignored.

(MM 1)

CC sends a STATUS message to the network. The cause is "#97 message type non-existent or not implemented".

(CC 2)

CC receives a message which is known and implemented by CC, but not in the current state. The message is ignored.

(MM 2)

CC sends a STATUS message to the network. The cause is "#98 message type not compatible with protocol state".

3.5.4 Non-semantically correct mandatory information element errors

A non-semantically correct mandatory information element error may occur if

- missing mandatory IE

An information element is missing in the mandatory part of the message.
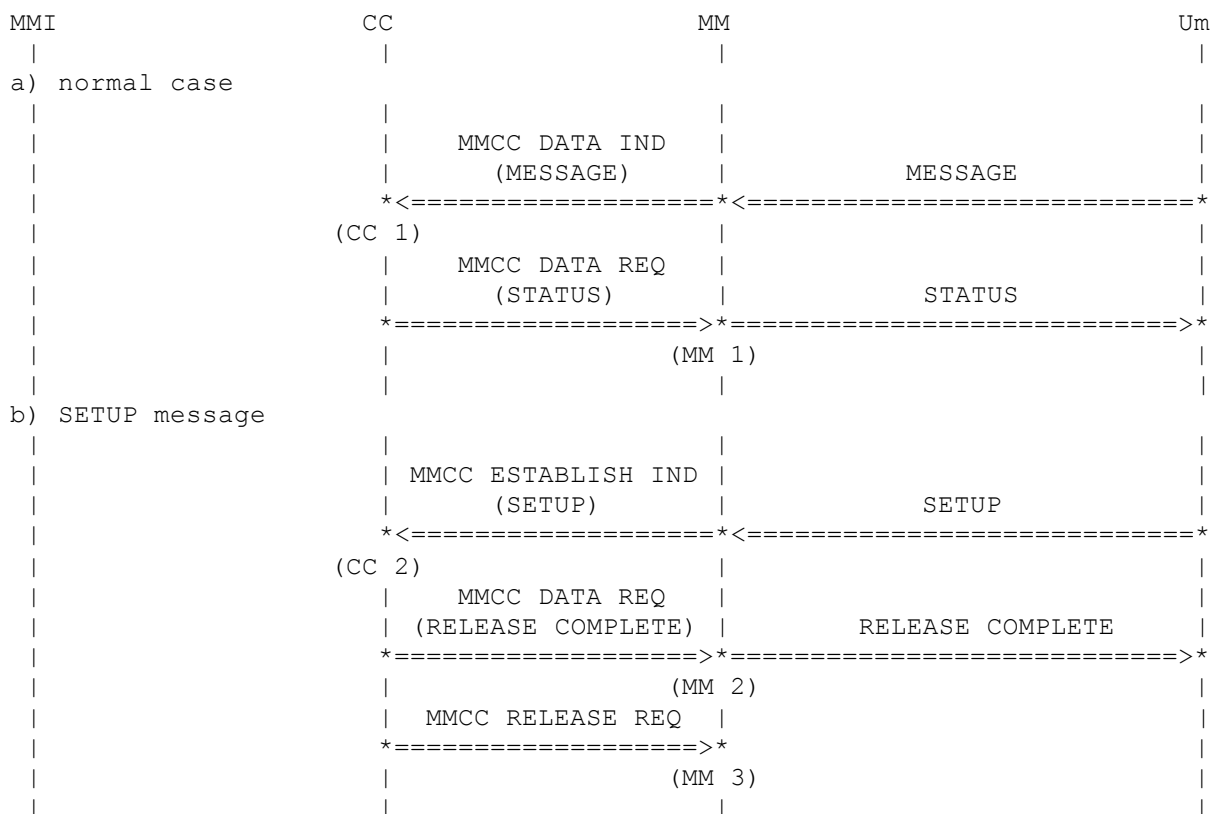
- Syntactically incorrect mandatory IE

Parameters of the information element are set to reserved values or the structure of the information element has failures.
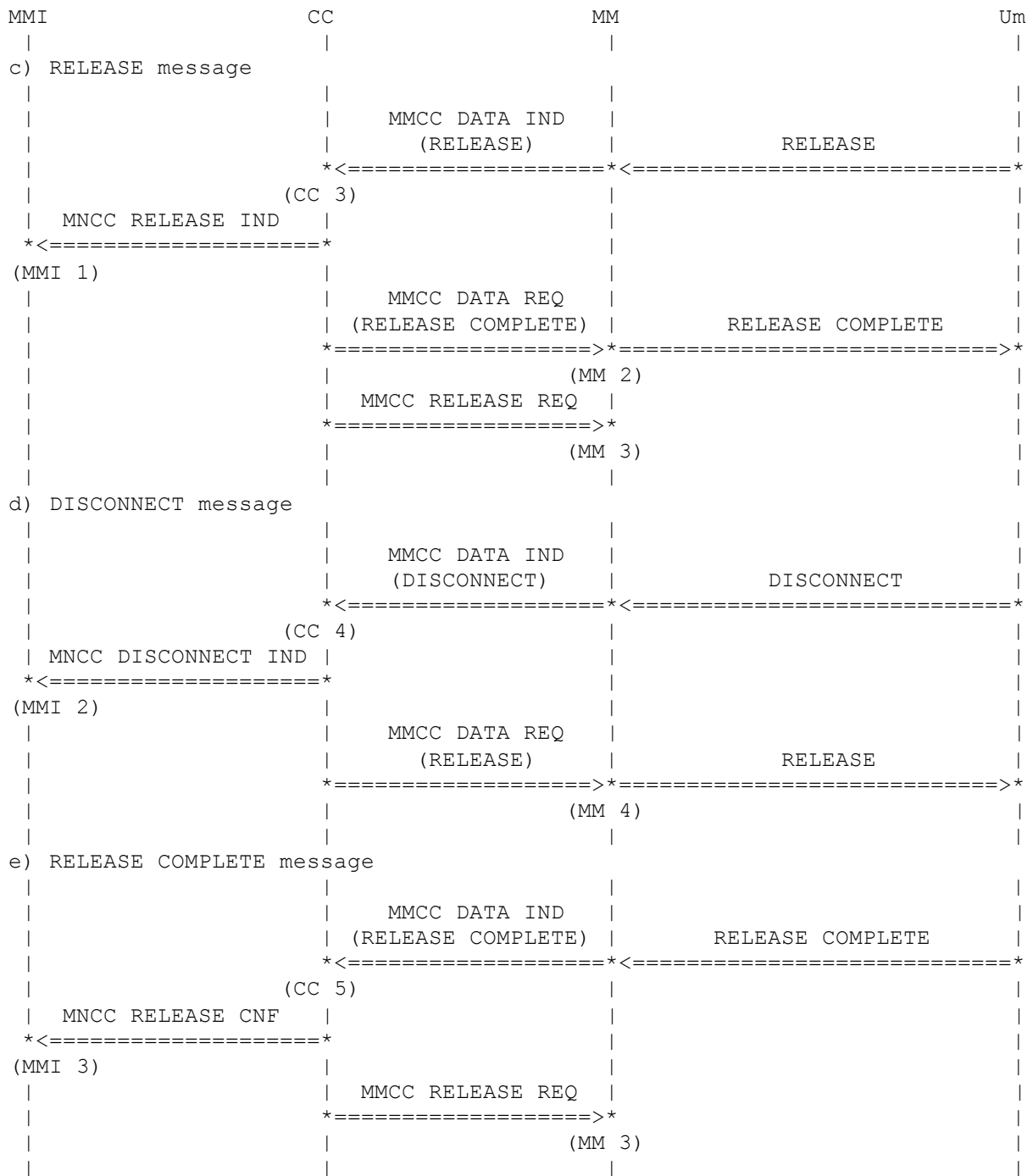
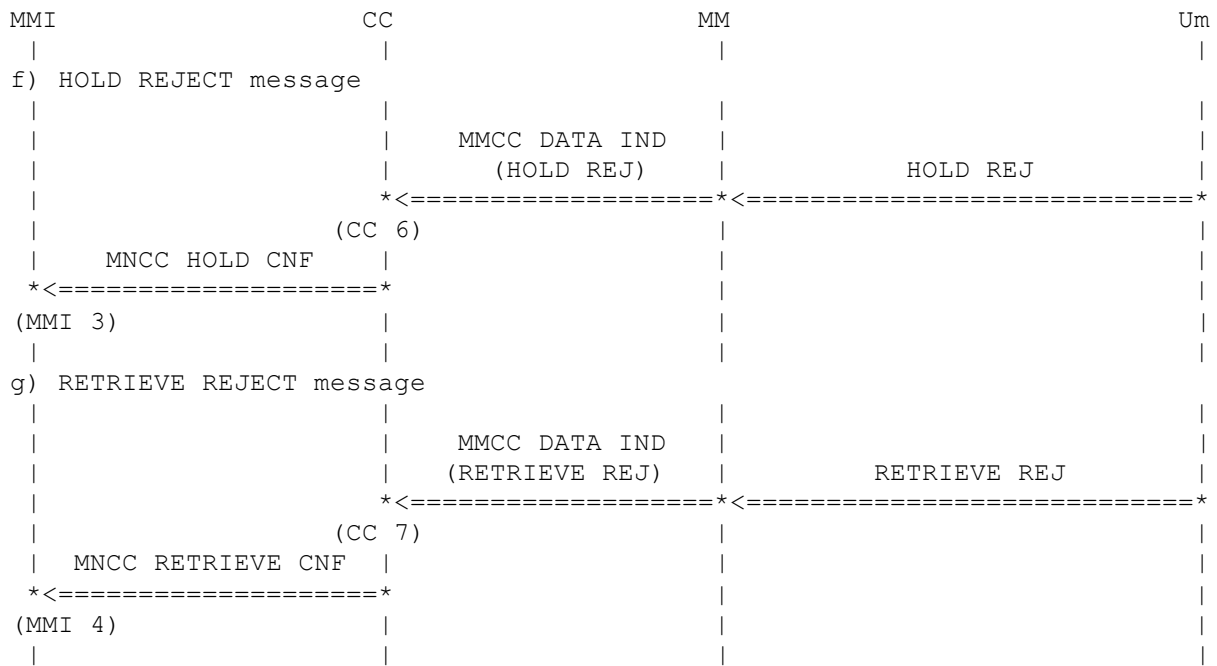- IE unknown in the message encoded as compression required

An unexpected optional information element is detected in the message. The upper nibble of the information element identifier is equal to zero, which is defined as "compression required". These information element identifiers are reserved for future extensions.

- Out of sequence IE encoded as compression required

The order of optional information elements is not as defined in the recommendation. The information element identifier is compression required.

```
MMI                    CC                    MM                        Um
 |                      |                     |                         |
a) normal case
 |                      |                     |                         |
 |                      |   MMCC DATA IND     |                         |
 |                      |     (MESSAGE)       |         MESSAGE         |
 |                      *<==================*<============================*
 |                    (CC 1)                  |                         |
 |                      |   MMCC DATA REQ     |                         |
 |                      |     (STATUS)        |         STATUS          |
 |                      *==================>*============================>*
 |                      |                   (MM 1)                       |
 |                      |                     |                         |
b) SETUP message
 |                      |                     |                         |
 |                      | MMCC ESTABLISH IND  |                         |
 |                      |     (SETUP)         |          SETUP          |
 |                      *<==================*<============================*
 |                    (CC 2)                  |                         |
 |                      |   MMCC DATA REQ     |                         |
 |                      | (RELEASE COMPLETE)  |     RELEASE COMPLETE     |
 |                      *==================>*============================>*
 |                      |                   (MM 2)                       |
 |                      |  MMCC RELEASE REQ   |                         |
 |                      *==================>*                           |
 |                      |                   (MM 3)                       |
 |                      |                     |                         |
```

```
MMI                      CC                      MM                              Um
 |                       |                       |                               |
c) RELEASE message
 |                       |                       |                               |
 |                       |    MMCC DATA IND      |                               |
 |                       |      (RELEASE)        |           RELEASE             |
 |                       *<==================*<===========================*
 |                     (CC 3)                    |                               |
 |   MNCC RELEASE IND    |                       |                               |
 *<====================*                        |                               |
(MMI 1)                  |                       |                               |
 |                       |    MMCC DATA REQ      |                               |
 |                       | (RELEASE COMPLETE)    |     RELEASE COMPLETE          |
 |                       *==================>*===========================>*
 |                       |                     (MM 2)                             |
 |                       |   MMCC RELEASE REQ    |                               |
 |                       *==================>*                                   |
 |                       |                     (MM 3)                             |
 |                       |                       |                               |
d) DISCONNECT message
 |                       |                       |                               |
 |                       |    MMCC DATA IND      |                               |
 |                       |    (DISCONNECT)       |          DISCONNECT           |
 |                       *<==================*<===========================*
 |                     (CC 4)                    |                               |
 | MNCC DISCONNECT IND   |                       |                               |
 *<====================*                        |                               |
(MMI 2)                  |                       |                               |
 |                       |    MMCC DATA REQ      |                               |
 |                       |      (RELEASE)        |           RELEASE             |
 |                       *==================>*===========================>*
 |                       |                     (MM 4)                             |
 |                       |                       |                               |
e) RELEASE COMPLETE message
 |                       |                       |                               |
 |                       |    MMCC DATA IND      |                               |
 |                       | (RELEASE COMPLETE)    |     RELEASE COMPLETE          |
 |                       *<==================*<===========================*
 |                     (CC 5)                    |                               |
 |   MNCC RELEASE CNF    |                       |                               |
 *<====================*                        |                               |
(MMI 3)                  |                       |                               |
 |                       |   MMCC RELEASE REQ    |                               |
 |                       *==================>*                                   |
 |                       |                     (MM 3)                             |
 |                       |                       |                               |
```

TEXAS INSTRUMENTS

```
MMI                       CC                    MM                           Um
 |                         |                     |                            |
f) HOLD REJECT message
 |                         |                     |                            |
 |                         |       MMCC DATA IND  |                            |
 |                         |        (HOLD REJ)    |          HOLD REJ          |
 |                        *<===================*<===========================*
 |                       (CC 6)                 |                            |
 |     MNCC HOLD CNF       |                     |                            |
 *<===================*                         |                            |
(MMI 3)                    |                     |                            |
 |                         |                     |                            |
g) RETRIEVE REJECT message
 |                         |                     |                            |
 |                         |       MMCC DATA IND  |                            |
 |                         |      (RETRIEVE REJ)  |        RETRIEVE REJ        |
 |                        *<===================*<===========================*
 |                       (CC 7)                 |                            |
 |   MNCC RETRIEVE CNF     |                     |                            |
 *<===================*                         |                            |
(MMI 4)                    |                     |                            |
 |                         |                     |                            |
```

(CC 1)

CC receives a message with a non-semantically correct mandatory information element error. The message is ignored.

(MM 1)

The network is informed with a STATUS message. The cause is "#96 invalid mandatory information".

(CC 2)

CC receives a SETUP message with a non-semantically correct mandatory information element error. This will happen only in U0 NULL state. In all other states, the error unforeseen message type which has a higher priority will be detected.

(MM 2)

CC sends a RELEASE COMPLETE message to the network. It contains the cause "#96 invalid mandatory information".

(MM 3)

The MM connection is released locally.

(CC 3)

The network releases the connection with a RELEASE message. Although the error is detected, the message will be processed.

(MMI 1)

MMI is informed about the end of connection.

(CC 4)

The network sends a DISCONNECT message to the mobile station. Although the error is detected, the message will be processed.

(MMI 2)

MMI is informed about the end of connection.

(CC 5)

The receiving of a RELEASE COMPLETE message with an error is handled like a RELEASE COMPLETE message without an error.

(CC 6)

CC receives a HOLD REJECT message which has errors. The error is ignored and CC uses the message like a normal HOLD REJECT message.

(MMI 3)

MMI is informed about the failed hold procedure.

(CC 7)

CC receives a RETRIEVE REJECT message, which has errors. The error is ignored and CC uses the message like a normal RETRIEVE REJECT message.

(MMI 3)

MMI is informed about the failed retrieve procedure.

3.5.5 Unknown or unforeseen IEs in the non-imperative message part

An unknown or unforeseen IEs in the non imperative message part error may occur if:

- IEIs unknown in the message

The message contains optional information elements, which are not compression required. They are ignored by CC.

- Out of sequence IEIs

CC ignores all information elements which are not compression required and occur in the wrong order.

- Repeated IEs

If more information elements occur than expected, they will be ignored.

3.5.6 Non-imperative message part errors

A non-imperative message part error may occur if

- Syntactically incorrect optional IEs

The message contains optional information elements, which are not compression required. They are ignored by CC.
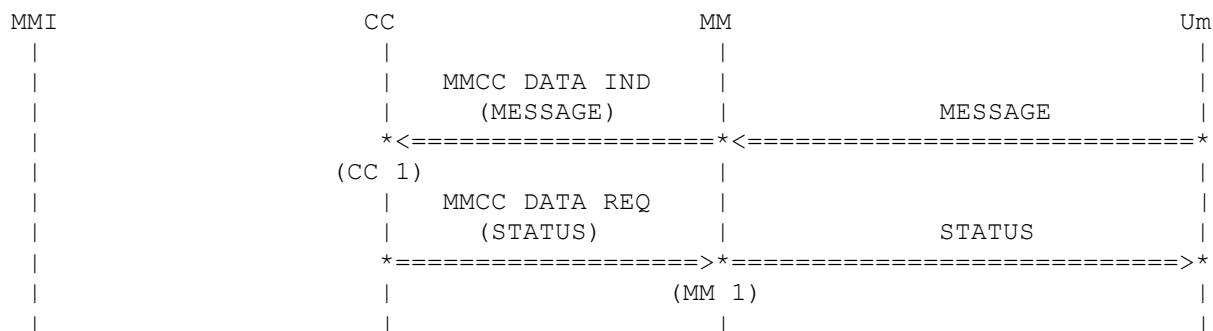
- Conditional IE errors

```
MMI                     CC                    MM                              Um
 |                       |                     |                               |
 |                       |   MMCC DATA IND      |                               |
 |                       |     (MESSAGE)        |             MESSAGE           |
 |                      *<====================*<===========================*
 |                     (CC 1)                  |                               |
 |                       |   MMCC DATA REQ      |                               |
 |                       |     (STATUS)         |             STATUS            |
 |                      *====================>*===========================>*
 |                       |                   (MM 1)                             |
 |                       |                     |                               |
```
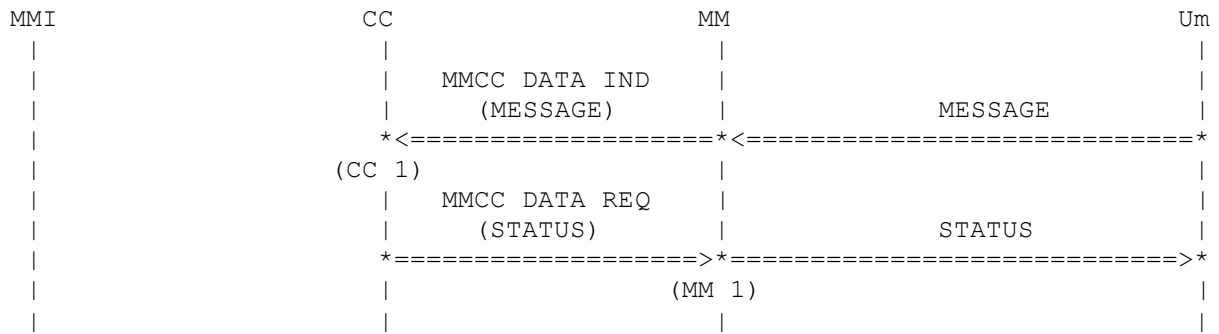
(CC 1)

CC detects that a conditional information element is missing, not expected, or syntactically incorrect. The message is ignored.

(MM 1)

The network is informed by a STATUS message with the cause "#100 conditional IE error".

TEXAS INSTRUMENTS

3.5.7 Semantically incorrect contents

A message has a semantically incorrect content if it contains information which is opposite to the state of the mobile station or the available resources.

```
MMI                     CC                  MM                              Um
 |                       |                   |                               |
 |                       |    MMCC DATA IND   |                               |
 |                       |     (MESSAGE)      |              MESSAGE          |
 |                      *<==================*<============================*
 |                   (CC 1)                  |                               |
 |                       |    MMCC DATA REQ   |                               |
 |                       |     (STATUS)       |              STATUS           |
 |                      *==================>*============================>*
 |                       |                (MM 1)                            |
 |                       |                   |                               |
```

(CC 1)

CC detects semantically incorrect contents. The message is ignored.

(MM 1)

The network is informed by a STATUS message with the cause "#95 semantically incorrect message".

TEXAS INSTRUMENTS

Appendices

A.   Acronyms

DS-WCDMA   Direct Sequence/Spread Wideband Code Division Multiple Access

B.   Glossary

International Mobile Tel-ecommunication 2000 (IMT-2000/ITU-2000)

Formerly referred to as FPLMTS (Future Public Land-Mobile Telephone System), this is the ITU's specification/family of standards for 3G. This initiative provides a global infrastructure through both satellite and terrestrial systems, for fixed and mobile phone users. The family of standards is a framework comprising a mix/blend of systems providing global roaming. <URL: http://www.imt-2000.org/>