GSM System Protocol Architecture

References:
Protocol architecture planes

Three Planes: User Plane (Speech, data)  
Control plane (Signaling for call setup etc.)  
Management Plane (management of network elements, like configuration, faults)

User Plane: Logical Channels at the Service Access Point (SAP) of layer 1 (Physical layer).

Left: Reference model for the GSM User-Network Interface (UNI) Um.  
User data across air interface using Traffic Channels, TCH.  
Protocols in signaling Plane needed e.g. for call set-up and network element management. The D channels (corresponding to ISDN D channels) in air IF are signaling channels.
GSM Network Architecture (protocols)
GSM Network Signaling Architecture as OSI Model
Protocol Architecture in User Plane

1. Connection between Reference points
2. Connections are constructed of connection elements
   - Radio Interface Connection Element
   - A Interface Connection Element
• The data link layer (layer 2) over the radio link is based on a modified LAPD (Link Access Protocol for the D channel) referred to as LAPDm (m like mobile).

• On the A-bis interface, the layer 2 protocol is based on the LAPD from ISDN.

• The Message Transfer Part (MTP) level 2 of the SS& protocol is used at the A interface.
User Data and Control at Air Interface

ISDN channels: $2 \times B + D = 2 \times 64 \text{ kb/s} + 16 \text{ kb/s} = 144 \text{ kb/s}$. D channel used for signaling and possibly some user data.

In GSM:
- Bm channel for traffic / user data
- Dm channel for signaling

As in ISDN the Dm channel in GSM can be used for user data if capacity is available.

GSM’s Short Message Service (SMS) uses this. Cases:
- No call, SDCCH channel
- During call, SACCH channel
## LAPD frame structure

<table>
<thead>
<tr>
<th>Octet</th>
<th>Description</th>
<th>Binary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Octet 1</td>
<td>Opening flag</td>
<td>0 1 1 1 1 1 1 0</td>
</tr>
<tr>
<td>Octet 2</td>
<td>Address octet 1</td>
<td></td>
</tr>
<tr>
<td>Octet 3</td>
<td>Address octet 2</td>
<td></td>
</tr>
<tr>
<td>Octet 4</td>
<td>Control octet 1</td>
<td></td>
</tr>
<tr>
<td>Octet 5</td>
<td>Control octet 2</td>
<td></td>
</tr>
<tr>
<td>Octet 6</td>
<td>Layer 3 information</td>
<td></td>
</tr>
<tr>
<td>Octet N-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Octet N-2</td>
<td>FCS octet 1</td>
<td></td>
</tr>
<tr>
<td>Octet N-1</td>
<td>FCS octet 2</td>
<td></td>
</tr>
<tr>
<td>Octet N</td>
<td></td>
<td>0 1 1 1 1 1 1 0</td>
</tr>
</tbody>
</table>

The structure of the control field depends on the frame type.

Layer 3 information is only presented in Layer in Layer 2 ‘information frame’.

Frame check sequence

Closing flag
Speech transmission in GSM

Overview of protocols for speech:

GSC = GSM Speech Codec
FEC = Forward error Correction
MPX = (Sub)Multiplexing – 3 x 13+3 kb/s inserted to 64 kb/s
TRAU = Transcoding unit: GSM Speech 13 kb/s coded to 64 kb/s ISDN speech
BTS architectures – with various positions of TRAU

BTS 1

BTS 2

BTS 3

BTS 4

BCF | TRX | TRX
---|---|---
Base Control Function | Transceiver | Transcoding and Rate Adaptation Unit

Inband remote control
GSM protocol architecture for speech – Air IF

Transcoding unit (TRAU) at BTS site

Logical flow of data
Protocol architecture for speech
Protocol architecture for transparent data

Provides transparent data transmission at 9.6 / 14.4 kb/s. Standard GSM error correction.
Protocol architecture for nontransparent data

- Provides non-transparent data transmission. Error correction based on checksum and Automatic Repeat Request (ARQ).
- Uses Radio Link Protocol (RLP). Fixed 240 bit frames, otherwise rather similar to HDLC link protocol. 24-bit Frame check sequence.
- Delay around 200 ms
# Frame structure for RLP protocol

The image shows a table and a diagram illustrating the frame structure for the RLP (RLP) protocol. The table and diagram are as follows:

<table>
<thead>
<tr>
<th>Bit number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control frame 1</td>
<td>C/R</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>P/F</td>
<td>M1</td>
<td>M2</td>
<td>M3</td>
<td>M4</td>
<td>M5</td>
<td>-</td>
</tr>
<tr>
<td>Control frame 2</td>
<td>C/R</td>
<td>S1</td>
<td>S2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>P/F</td>
<td>N(R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information frame</td>
<td>C/R</td>
<td>S1</td>
<td>S2</td>
<td>N(S)</td>
<td>P/F</td>
<td>N(R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Header**: 16 bit
- **User data**: 200 bit
- **Check sum FCS**: 24 bit

The table and diagram provide a detailed view of the bit structure and the placement of various fields within the RLP frame.
SIGNALING ARCHITECTURE
A – bis interface

- CM and MM messages are not interpreted by the BSC or the BTS. They are transferred over the A-bis interface as transparent messages and over the A interface using the Direct Transfer Application Part (DTAP).

- RR messages are mapped to the BSS Application Part (BSSAP) in the BSC. In the BTS, most of them are handled as transparent by the BTS (e.g. random access, start ciphering, paging).

- BTS Management (BTSM) is used to transfer all OAM related information to the BTS.
A interface

- The Message Transfer Part (MPT) and the SCCP (Signalling connection Control Point) are used to support the transfer of signalling messages between the MSC and the BSS.

- The SCCP part is used to provide a referencing mechanism to identify a particular transaction relating to, for instant, a particular call. The SCCP can also be used to enhance message routing, operation and maintenance information.
Signaling – Needed for call control

• Signaling is needed to setup and takedown of calls etc.
• The whole system is called Signaling System Number 7 (SS#7 or SS7) and it is used in Public telephone system and mobile telephone systems throughout the world. It enables calls throughout the world.
• Signaling system is separate system from speech
• Example of operations. Signaling in call set-up. Signaling is transferred as messages.

1. When you lift the receiver the light at the exchange starts to glow with a sound. An **Indication** that you need service.
2. The lady asks you whom you want to talk with and you tell the person’s name. An indication that service will be provided with a further request for address, which is provided.
3. She makes connection to your desired party and the phone starts ringing. **Connection of the speech path** and **alerting the called party**.
4. The called party answers, and is connected to you. **Answer and conversation**.
5. The lady at the exchange monitors your call during the conversation. **Supervision**.
6. When you hang up, a light glows to indicate this and she pulls out the plugs. **An indication of disconnection and clearing of the call**.
Message Transfer Part -MTP

• MTP is the infrastructure for transferring signaling messages between network elements
• The entire Signaling System number 7 (SS#7 or SST) is built on the foundation of MTP
  • Layer 1 – Physical layer, voltages etc.
  • Layer 2 – Datalink, error free transfer of signaling messages
  • Layer 3- Transfer of signaling messages **within one network** (only)
Telephone User Part (TUP) – call control

TUP is the entity that sends and receives messages used for actual call control.
In fixed network there are only these two parts. TUP can be replaced by National User Part (NUP), allowing some minor variations.
In ISDN more functionality -> ISDN User Part (ISUP)
Signaling Connection and Control Part - SCCP

Takes care of connections between networks allowing: virtual connection and connectionless signaling. This enables signaling between networks.

Summary:
MTP is Message Transfer Part, responsible for transferring messages between network elements within same network.
TUP is the user part for messages transferred by MTP. These messages deal with setting up supervising and clearing call connections. Two variations NUP (national) and ISUP (ISDN).
SCCP is the Signaling Connection and Control Part. Main function: virtual connection and connectionless signaling.
In GSM system more functionality is needed because of more functionally due to non-call related signaling (measurements, handover control etc.), user mobility and additional network elements. The additional protocol layers are:

1. **Base Station Subsystem Application Part (BSSAP)**
2. **Mobile Application Part (MAP)**
3. **Transaction Capabilities Application Part (TCAP)**

**BSSAP**: Used for signaling between MSC and BSC and MS. Since there is BSC between MSC and MS, there must be a virtual connection, thus SCCP is needed. Examples: Authentication, assigning new TMSI. BSSP need for signaling between MSC-BSC and MSC-MS.

**MAP** is a GSM specific protocol, for non-call related applications between Network Elements. MAP signaling includes e.g. messaging between MSC and HLR.

**TCAP, Transaction Capabilities Application Part.** The MAP transactions need a sort of “secretary” for managing the transactions. This is the function of TCAP.
SS7 in GSM (2): MTP and BSSAP

• The MTP part provides a mechanism for providing the reliable transfer of signalling messages. A subset of MTP is used between the BSS and the MSC.

• The BSSAP provides the channel switching and aerial functions, it performs RR management, and the interworking functions between the data link protocols used on the radio and the BSS-MSC side for transporting signalling related messages.
## SS7 Protocols in GSM (3)

<table>
<thead>
<tr>
<th>Name</th>
<th>Protocol</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUP</td>
<td>Telephone User Part</td>
<td>User parts of MTP. They send, receive, analyse and act on the messages delivered by MTP. All of these are Call control messages that help in setting up, supervising and clearing a call.</td>
</tr>
<tr>
<td>NUP</td>
<td>National User Part</td>
<td></td>
</tr>
<tr>
<td>ISUP</td>
<td>ISDN User part</td>
<td></td>
</tr>
<tr>
<td>SCCP</td>
<td>Signalling Connection and Control Part</td>
<td>Protocol layer responsible for making virtual connections and making connectionless signalling across multiple signalling networks.</td>
</tr>
<tr>
<td>BSSAP</td>
<td>Base Station Subsystem Application Part</td>
<td>Protocol layer responsible for communicating GSM specific messages between MSC and BSC, and MSC and HLR.</td>
</tr>
<tr>
<td>MAP</td>
<td>Mobile Application Part</td>
<td>A GSM specific protocol for non-call-related applications between NSS elements.</td>
</tr>
<tr>
<td>TCAP</td>
<td>Transaction Capabilities Application Part</td>
<td>Protocol layer responsible for providing service to MAP by handling the MAP transaction messages between multiple elements.</td>
</tr>
</tbody>
</table>
SS7 layers in GSM system elements – overview
### Signaling functions in various GSM elements

<table>
<thead>
<tr>
<th></th>
<th>MTP</th>
<th>TUP/ISUP</th>
<th>SCCP</th>
<th>BSSAP</th>
<th>MAP</th>
<th>TCAP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MSC</strong></td>
<td>Transfer of SS7 messages between different network elements</td>
<td>Setting up, supervising and clearing call connections</td>
<td>Connection-less signalling and virtual connections</td>
<td>GSM signalling with BSC and MS</td>
<td>GSM Specific signalling with HLR and other MSC</td>
<td>Service Provider to MAP</td>
</tr>
<tr>
<td><strong>BSC</strong></td>
<td>Transfer of SS7 messages between different network elements</td>
<td>Unavailable</td>
<td>Virtual Connection between MSC and MS</td>
<td>GSM Signalling with MSC</td>
<td>Unavailable</td>
<td>Unavailable</td>
</tr>
<tr>
<td><strong>HLR</strong></td>
<td>Transfer of SS7 messages between different network elements</td>
<td>Unavailable</td>
<td>Connection-less signalling</td>
<td>Unavailable</td>
<td>GSM Specific signalling with MSCs and other HLRs</td>
<td>Service Provider to MAP</td>
</tr>
</tbody>
</table>
Protocol interfaces in Mobile Network

**Diagram:**

- **MSC**
  - MAP
  - TCAP
  - SCCP
  - ISUP

- **HLR/VLR**
  - MAP
  - TCAP
  - SCCP
  - SCCP

- **Interface E**
  - SCCP: Signaling Connection Control Part
  - TCAP: Transaction Capabilities Application Part

- **Interface B, C**
  - MTP
  - MAP
  - ISUP

- **Interface D, G**
  - MTP
  - Message Transfer Part
  - Mobile Application Part
  - ISDN User Part

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DM_7_GSM_Protocol_Architecture.ppt
International signaling relations via ISDN
Overview of signaling in GSM

- Signalling is the transfer of information between subscriber interface points and the network and between different network elements to help establish a call.
- Signalling Information is interchanged as standard sets of messages which was developed and standardised in to the present SS7 system.
- GSM networks need non-call related signalling which is possible with SS7.
- The SS7 used in PSTN networks is not sufficient to fulfil the signalling requirements of GSM networks, thus new protocols specific to GSM were developed.
- MTP is the basis of SS7, and it is responsible for transferring of signalling messages form one element to another within the same signalling network.
- TUP/ISUP are the user parts of MTP which handle call control.
- SCCP is needed for virtual conniptions and connectionless signalling.
- BSSAP is used for signalling between MSC-BSC and MSC-MS.
- MAP is needed for signalling between MSC-HLR, MSC-VLR, HLR-VLR (and MSC-MSC in case of non-call related signalling).
Protocol architecture for Signaling

- **CM**: Connection Management
- **MM**: Mobility Management
- **RR**: Radio Resource Management
- **LAPDm**: Link Protocol (especially adapted for air interface Um)
- **BTSM**: Base Transceiver Station Management
- **BSSMAP**: Base Station System Management Application Part
- **DTAP**: Direct Transfer Application Part
- **SCCP**: Signaling Connection Control Part
- **TCAP**: Transaction Capabilities Application Part
- **MTP**: Message Transfer Part
- **MAP**: Mobile Application Part
- **UP**: User Part
Layer 3 Functions are divided into 3 categories:

1. **Radio Resource (RR) Management:**
   Function relating to the establishment of physical connections for the purpose of transmitting call-related signalling information.

2. **Mobility Management (MM):**
   Functions relating to location registration, paging, attachment/detachment, handover, dynamic channel allocation and management.

3. **Connection Management (CM):**
   Call control related functions, SMS and service handling functions.
Layer 3 Protocols at MS side

Main task of LAPDm is to transfer layer layer 3 protocols with special support for:

- Multiple entities in Layer 3 and Layer 2
- Signaling for broadcasting (BCCH)
- Signaling for paging (PCH)
- Signaling for channel assignment (AGCH)
- Signaling on dedicated channels (SDCCH)

RR = radio Resource Management
MM = Mobility management
CC = Call Control
Protocol architecture for SMS transfer
Signaling at Air Interface

Layer 1 service interfaces

**LAYER 1 SERVICES:**
- Layer 1 provides bit transport service to logical channels.
- Access Capabilities
- Error Detection
- Encryption

Physical layer connections. Logical channels defined.
Layer 1 services

MS Modes:
- Idle
- Dedicated
- NULL: Power off
- BCH: Synchronized with one BTS, ready for RACH
- Tuning DCH: Tries to synchronize with a channel

State diagram of MS physical layer

Layer 1 frame structure (SACCH block):
- Transport of signaling messages that occur as LAPDM frames at the Service Access Point (SAP).
- SACCH frame also carries power level etc.
Layer 2 signaling

L2 = Data link protocol for signaling channels at air interface. Similar to HDLC except fixed frame length.
Two modes:
Unacknowledged, no flow and error control
Acknowledged mode: Positive acknowledgement, Error correction based on ARQ.

Logical channels and modes for Layer 2 SAPIs

Specific SAPI values reserved for specific functions:
SAPI = 0 for signaling (CM, MM, RR)
SAPI = 3 for SMS
### LAPDm Frame Formats

#### LAPDm Frame Formats

**Typ A**

<table>
<thead>
<tr>
<th>Octet number</th>
<th>Bit number</th>
<th>Length Indicator</th>
<th>Control</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>N+1</td>
<td>n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>m+1</td>
<td>n+1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N201+m</td>
<td>k+1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Typ B**

<table>
<thead>
<tr>
<th>Octet number</th>
<th>Bit number</th>
<th>Length Indicator</th>
<th>Information</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>N201+m</td>
<td>k+1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Typ Bits**

- Fill Bits
- Information
- Length Indicator

**Usage**:

- SACCH, FACCH
- Abis, Bsis
- BCCH, PCH, AGCH
Radio Resource management

Procedures for Radio Resource Management (RR) are signaling and control procedures for air interface (Um): Assignment, allocation and administration of radio resources. Format of Um signaling message shown below. Message Type (MT), see next page.

Format of Layer 3 signaling message at air interface (Um)
## RR messages, channels and MT codes

<table>
<thead>
<tr>
<th>Category</th>
<th>Message</th>
<th>Logical channel</th>
<th>Direction</th>
<th>MT-code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel establishment</td>
<td>Additional assignment</td>
<td>DCCH</td>
<td>N → MS</td>
<td>00111011</td>
</tr>
<tr>
<td></td>
<td>Immediate assignment</td>
<td>CCCH</td>
<td>N → MS</td>
<td>00111111</td>
</tr>
<tr>
<td></td>
<td>Immediate assignment extended</td>
<td>CCCH</td>
<td>N → MS</td>
<td>00111001</td>
</tr>
<tr>
<td></td>
<td>Immediate assignment rejected</td>
<td>CCCH</td>
<td>N → MS</td>
<td>00111010</td>
</tr>
<tr>
<td>Ciphering</td>
<td>Ciphering mode command</td>
<td>DCCH</td>
<td>N → MS</td>
<td>00110101</td>
</tr>
<tr>
<td></td>
<td>Ciphering mode complete</td>
<td>DCCH</td>
<td>MS → N</td>
<td>00110010</td>
</tr>
<tr>
<td>Handover</td>
<td>Assignment command</td>
<td>DCCH</td>
<td>N → MS</td>
<td>00101110</td>
</tr>
<tr>
<td></td>
<td>Assignment complete</td>
<td>DCCH</td>
<td>MS → N</td>
<td>00101001</td>
</tr>
<tr>
<td></td>
<td>Assignment failure</td>
<td>DCCH</td>
<td>MS → N</td>
<td>00101111</td>
</tr>
<tr>
<td></td>
<td>Handover access</td>
<td>DCCH</td>
<td>MS → N</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Handover command</td>
<td>DCCH</td>
<td>N → MS</td>
<td>00101011</td>
</tr>
<tr>
<td></td>
<td>Handover complete</td>
<td>DCCH</td>
<td>MS → N</td>
<td>00101000</td>
</tr>
<tr>
<td></td>
<td>Handover failure</td>
<td>DCCH</td>
<td>MS → N</td>
<td>00101000</td>
</tr>
<tr>
<td></td>
<td>Physical information</td>
<td>DCCH</td>
<td>N → MS</td>
<td>00101101</td>
</tr>
<tr>
<td>Channel release</td>
<td>Channel release</td>
<td>DCCH</td>
<td>N → MS</td>
<td>00001101</td>
</tr>
<tr>
<td></td>
<td>Partial release</td>
<td>DCCH</td>
<td>N → MS</td>
<td>00001010</td>
</tr>
<tr>
<td></td>
<td>Partial release complete</td>
<td>DCCH</td>
<td>MS → N</td>
<td>00001111</td>
</tr>
<tr>
<td>Paging</td>
<td>Paging request, Type 1/2/3</td>
<td>PCH</td>
<td>N → MS</td>
<td>00100kxxx</td>
</tr>
<tr>
<td></td>
<td>Paging response</td>
<td>DCCH</td>
<td>MS → N</td>
<td>00100111</td>
</tr>
<tr>
<td>System information</td>
<td>System information Type 1/2/3/4</td>
<td>BCCCH</td>
<td>N → MS</td>
<td>00011kxxx</td>
</tr>
<tr>
<td></td>
<td>System information Type 5/6</td>
<td>SACCH</td>
<td>N → MS</td>
<td>00011kxxx</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Channel mode modify</td>
<td>DCCH</td>
<td>N → MS</td>
<td>00100000</td>
</tr>
<tr>
<td></td>
<td>Channel mode modify acknowledge</td>
<td>UU/L1H</td>
<td>MS → N</td>
<td>00101111</td>
</tr>
<tr>
<td></td>
<td>Channel request</td>
<td>RAOH</td>
<td>MS → N</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Classmark change</td>
<td>DCCH</td>
<td>MS → N</td>
<td>00010110</td>
</tr>
<tr>
<td></td>
<td>Frequency redefinition</td>
<td>DCCH</td>
<td>N → MS</td>
<td>00010100</td>
</tr>
<tr>
<td></td>
<td>Measurement report</td>
<td>SACCH</td>
<td>MS → N</td>
<td>00010101</td>
</tr>
<tr>
<td></td>
<td>Synchronization channel</td>
<td>SCH</td>
<td>N → MS</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>status</td>
<td>DCCH</td>
<td>MS → N</td>
<td>00010010</td>
</tr>
</tbody>
</table>
RR connection set-up and take-down

LAPDm held back until complete

BTS sends RR message:
Physical information, TA

Measurement result
Channel change encryption and handover

Diagram:

- **MS** to **BSS**
  - Assignment Command
  - Assignment Complete
  - Dedicated Channel Assignment

- **MS** to **BSS**
  - Cipher Mode Command
  - Cipher Mode Complete
  - Ciphering Activation

- **MS** to **BSS**
  - Handover Command
  - Handover Access
  - Handover Access
  - Handover Access
  - Handover Access
  - Handover Complete
  - Handover (synchronous)

- **BSS** to **MS**
  - Handover Command
  - Handover Access
  - Physical Information
  - Handover Complete
  - Handover (nonsynchronous)
# Mobility Management (MM)

MM messages

<table>
<thead>
<tr>
<th>Category</th>
<th>Message</th>
<th>Direction</th>
<th>MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>IMSI detach indication</td>
<td>MS → N</td>
<td>0x000001</td>
</tr>
<tr>
<td></td>
<td>Location updating accept</td>
<td>N → MS</td>
<td>0x000010</td>
</tr>
<tr>
<td></td>
<td>Location updating reject</td>
<td>N → MS</td>
<td>0x000100</td>
</tr>
<tr>
<td>Security</td>
<td>Authentication reject</td>
<td>N → MS</td>
<td>0x010001</td>
</tr>
<tr>
<td></td>
<td>Authentication request</td>
<td>N → MS</td>
<td>0x010010</td>
</tr>
<tr>
<td></td>
<td>Authentication response</td>
<td>MS → N</td>
<td>0x010100</td>
</tr>
<tr>
<td></td>
<td>Identity request</td>
<td>N → MS</td>
<td>0x001000</td>
</tr>
<tr>
<td></td>
<td>Identity response</td>
<td>MS → N</td>
<td>0x001001</td>
</tr>
<tr>
<td></td>
<td>TMSI reallocation command</td>
<td>N → MS</td>
<td>0x001010</td>
</tr>
<tr>
<td></td>
<td>TMSI reallocation complete</td>
<td>MS → N</td>
<td>0x001011</td>
</tr>
<tr>
<td>Connection</td>
<td>CM service accept</td>
<td>MS → N</td>
<td>0x100001</td>
</tr>
<tr>
<td>management</td>
<td>CM service reject</td>
<td>N → MS</td>
<td>0x100010</td>
</tr>
<tr>
<td></td>
<td>CM service request</td>
<td>MS → N</td>
<td>0x100100</td>
</tr>
<tr>
<td></td>
<td>CM reestablishment request</td>
<td>MS → N</td>
<td>0x101000</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>MM-status</td>
<td>MS → N</td>
<td>0x110001</td>
</tr>
</tbody>
</table>
MM messages – category common

Specific: e.g Location Update, see Eberspächer
Call Set-Up

Mobile originating and Mobile terminating
Mobile initiated call setup using late assignment (OACSU = Off Air Call Set-Up)

Radio resource reserved only in last minute when call is fully routed
Realization of Short Message Services (SMS)
EXTRA
• **MSISDN** is the ‘directory number’ used to call GSM subscribers.

• **IMSI** is the main subscriber number used internally within GSM.

• **MSRN** is the routing number used on the second leg of an incoming call between GMSC and serving MSC. It is not known to GSM users.

• Both **MSISDN** and **IMSI** contain a country identity and a network identity within the country.

• **MSRN** can be contained in the HLR record if the serving MSC/VLR has provided it when updating the location information.
An example of a call routing (to route an incoming call towards serving MSC)

- **MSISDN**: Mobile Station ISDN Number
- **IMSI**: International Mobile Subscriber Identity
- **MSRN**: Mobile Station Roaming Number
Protocols in the call control producers

- RIL3-CC: Radio Interface Layer 3 - Call Control
- MAP: Mobile Application Part

Diagram:
- MS (Mobile Station) connected to MSC/VLR (Mobile Switching Center/Visitor Location Register)
- MSC/VLR connects to GMSC (Gateway Mobile Switching Center)
- GMSC connects to HLR (Home Location Register)
- MAP/C and MAP/D protocols are indicated between the nodes.
Format of BTSM-RSL protocol messages

Layer 3 between BSC and BTS