Mobile Services (ST 2010)
Chapter 6: SMS, MMS & SAT

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6 SMS, MMS & SAT

6.1 Short Message Service
6.2 Multimedia Messaging Services
6.3 SIM Application Toolkit
6.1 Short Message Service

Introduction

Short Message Service (SMS)

- Wireless service that enables the transmission of alphanumeric messages between mobile devices as well as between mobile devices and external systems such as electronic mail, paging, and voice-mail systems.

- First short message is believed to have been sent in December 1992 from a Personal computer to a mobile phone on the Vodafone GSM network in the UK.

- Primary function of SMS initially was to notify mobile users of new voice-mail messages.

- It is now the preferred means of peer-to-peer communication and a source of important information and mobile entertainment.

### Table: SMS Traffic (In Billion)

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<thead>
<tr>
<th></th>
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<td>209.7</td>
<td>226.3</td>
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</tbody>
</table>

Source: Portio Research Ltd.
6.1 Short Message Service
Applications, Standards, Billing

SMS Applications & Services

- Information Alerts
  Travel updates, news alerts, stock alerts,...

- Customization Services
  Logos & screen savers, ringtones & music, ...

- Communities
  Personal chat, dating, private consulting ,...

- Entertainment
  Quiz & games, SMS voting, jokes & cartoons,...

- Mobile Marketing
  Direct marketing, special promotions, ...

- M-Commerce
  Bus tickets, tickets for movies, online purchases, pay-per-view web-content,...

SMS Standards

- SMSPP (SMS Point-to-Point)
  Sending and receiving of SMS messages to or from a mobile devices

- SMSCB (SMS Cell broadcast)
  Broadcast of SMS messages onto mobile phones according to pre-defined geographical area (cell)

Business Models

- Standard SMS
  Tariffs cover the cost of sending the SMS within the operator network of the sender and the interconnection fees on the other operator networks

- Premium SMS
  Content/service provider receives a proportion of the revenue paid by the user to the network operator
6.1 Short Message Service
SMS Network Architecture

- An active mobile handset is able to receive or submit a short message at any time, independent of whether a voice or data call is in progress
- GSM provides the basic capabilities to locate and to authenticate destination device
- SMS Center (SMSC): Store-and-forward principle
- External Short Messaging Entities (ESME) may be connected to the SMSC to push SMSs to a UE

- Temporary failures due to unavailable receiving stations are identified and the short message is stored in the SMSC until the destination device becomes available
- SMSCs of different operators are interconnected via Internet, X.25, Frame Relay, or SS7 in order to transmit messages across operator boundaries
6.1 Short Message Service
Mobile-Terminated Short Message

*) MSC retrieves subscriber information from the VLR. This operation may include the authentication procedure.
6.1 Short Message Service
Mobile-Originated Short Message

*) MSC interrogates the VLR to verify that the message transfer does not violate the supplementary services invoked or the restrictions imposed
6.1 Short Message Service
SMS Message Types

- **SMS_SUBMIT**
  Submits a message to the SMSC, generally for forward transmission to another mobile device.

- **SMS_SUBMIT_REPORT**
  Reports on the results of an SMS_SUBMIT.

- **SMS_DELIVER**
  Forwards a message from the SMSC to the mobile device.

- **SMS_DELIVER_REPORT**
  Reports on the success or failure of an SMS_DELIVER.

- **SMS_COMMAND**
  Used for transmitting instructions to the SMSC (independent of a particular SMS), e.g., for fine-tune control.

- **SMS_STATUS-REPORT**
  Reports on the results of an SMS_COMMAND.

Focus in this chapter: SMS_SUBMIT, SMS_DELIVER.
6.1 Short Message Services

TPDUs* of SMS_SUBMIT and SMS_DELIVER

<table>
<thead>
<tr>
<th>SMS_SUBMIT Field</th>
<th>SMS_DELIVER Field</th>
<th>Bytes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Destination Address</td>
<td>Originating Address</td>
<td>8</td>
<td>Telephone number of source/destination</td>
</tr>
<tr>
<td>SMS Flag</td>
<td>SMS Flag</td>
<td>1</td>
<td>General information about the message</td>
</tr>
<tr>
<td>Message Reference</td>
<td>Protocol Identifier</td>
<td>1</td>
<td>Number ID of the message; set by the device</td>
</tr>
<tr>
<td>Protocol Identifier</td>
<td>Data Coding Scheme</td>
<td>1</td>
<td>How the message is going to be used</td>
</tr>
<tr>
<td>Data Coding Scheme</td>
<td>SMSC Time Stamp</td>
<td>7</td>
<td>Time that the SMSC received the message</td>
</tr>
<tr>
<td>User Data Length</td>
<td>User Data Length</td>
<td>1</td>
<td>Length of the following user data field</td>
</tr>
</tbody>
</table>

*) TPDU Transfer Protocol Data Unit
6.1 Short Message Services
Description of SMS Flags

<table>
<thead>
<tr>
<th>Subfield name</th>
<th>Bits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Message Type Indicator</td>
<td>2</td>
<td>0x01 for SMS_SUBMIT</td>
</tr>
<tr>
<td>Reject Duplicates</td>
<td>1</td>
<td>If set to 1, the SMSC should reject this message, if it is currently holding an exact copy of it</td>
</tr>
<tr>
<td>Validity Period Format</td>
<td>2</td>
<td>Tells how long to try to keep delivering this message</td>
</tr>
<tr>
<td>Reply Path</td>
<td>1</td>
<td>If set to 1, receiving mobile should allow easy selection of sending phone number to return a message or to initiate a voice-call</td>
</tr>
<tr>
<td>User Data Header Indicator</td>
<td>1</td>
<td>If set to 1, there are optional User data header fields between the mandatory header and the user data itself</td>
</tr>
<tr>
<td>Status Report Request</td>
<td>1</td>
<td>If set to 1, a delivery report should be returned</td>
</tr>
</tbody>
</table>

Example:
User data Header Indicator

- **User Data Header Indicator=0**
  - **SMS_SUBMIT**
    - Mandatory Header Fields
    - User Data
    - Size of user data

- **User Data Header Indicator=1**
  - **SMS_SUBMIT**
    - Mandatory Header Fields
    - User Data Header Fields
    - User Data
    - Size of User Data Header and User Data
    - Total size of User Data Header and User Data
6.1 Short Message Services

Typical Protocol Identifiers

- The Protocol Identifier byte tells the mobile receiving the message what to do with it

Value 0x40
- Causes an immediate transmission of a return message from the mobile phone back to the sender but doesn’t log in the message as a received message
- If the initial sender receives this return message, it has determined that the phone is on without bothering the user

Values 0x41 to 0x47
- Replaces any message with the same Protocol Identifier and the same originating address with this message
- **Example**: Stock tracking service, where the user could always read the latest value when accessing the message

Values 0x7D and 0x7E
- Pass the entire message to the device’s operating system
- User data header fields then instructs the operating system how to handle the message
- Used for communicating with applications on the handset
- **Example**: Pass an SMS to the WAP browser in order to trigger WAP-Push services

Value 0x7F
- Forward of a message to the SIM application toolkit
- **Example**: Passing operator-specific location-based accounting information to the user (O2: homezone)
- **Remark**: quite different from simply storing the SMS message on the SIM for later viewing
6.1 Short Message Services
Example (I)

Example

- Transmitting a message with the content “Hello, world” via a serial port connection to a mobile device
- Information is hex-encoded as ASCII characters
- Note: transmission of ASCII characters as bytes would waste a bit for every character (because ASCII uses only 7 bits)
- Packing: concatenate 7 bits of all characters and code the resulting bit-string byte-wise

- Communication with the mobile device via AT commands
- Examples of standard AT commands:
  - ATD Dial command
  - ATH Hang up call
  - ATA Answer call
- Examples of GSM-specific AT commands
  - AT+CPBF Find phone book entries
  - AT+CPBR Read phone book entries
  - AT+CMGL List messages
  - AT+CMGR Read messages
  - AT+CMGS Send messages

**Hello, world**

| Unpacked: | 48 65 6C 6C 6F 2C 20 77 6F 72 64 |
| Packed:  | C8 32 9B FD 66 81 EE 6F 39 9B 0C |
6.1 Short Message Services

Example (II)

AT+CMGS=24
07 91 9171095710F0 01 00 OB 91 6171321043F6 00 00 0C C8329BFD6681EE6F399B0C^Z

1. Length of the SMSC telephone number (7 octets)
2. Format of the SMSC number 0x91 (international format)
3. Telephone number of SMSC (Voice Stream)
4. Transfer protocol parameter=0x01 (SMS_SUBMIT)
5. Message reference number=0x00 (assigned by the handset)
6. Length of destination number in digits=0x0B (11 digits)
7. Type of destination number=0x91 (int. format)
8. Destination telephone number=6171321043F6
9. Protocol identifier=0x00 (implicit)
10. Data coding scheme=0x00 (GSM default alphabet)
11. Message length=0x0C (there are 12 characters in “Hello, world”)
12. Message=0xC8329BFD6681EE6F399B0C
6.2 Multimedia Messaging Service
Motivation

Multimedia Messaging Services (MMS)

- Standard way to send and receive messages that may include a variety of media types
- Extends the core SMS capability which only allows to exchange text messages up to 160 characters
- Non-real time delivery of messages
- Store-and-forward approach (like SMS and Email)
- Message exchange follows the WAP approach where the MMS Center acts as on origin server (pull operation) or as a push initiator
- Introduced in 2002, and showed serious technical problems in the beginning
- Meanwhile a commercial success, especially in the Asian-Pacific region
- Standardized by OMA and 3GPP

<table>
<thead>
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<td>Latin America</td>
<td>1.6</td>
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</tr>
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<td>Africa and Middle East</td>
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<td>1.4</td>
<td>1.9</td>
<td>2.7</td>
<td>3.4</td>
<td>4.4</td>
<td>4.9</td>
<td>5.4</td>
</tr>
</tbody>
</table>

Source: Portio Research Ltd.
6.2 Multimedia Messaging Service

Introduction

MMS Client
- System element that interacts with the user
- Usually implemented as an application on his device

MMS Proxy Relay
- Component the client interacts with
- Provides access to MMS
- Responsible for accepting and delivering messages

MMS Server
- Provides intermediate storage if target is not available

Email server
- Provides traditional Internet email services
- Supports SMTP protocol to send messages as well as POP/IMAP to receive messages
6.2 Multimedia Messaging Service

Basic Sequence for Sending and Receiving an MMS

1. Message originator addresses it to the receiver
   - Terminal contains information about MMSC, initiates a HTTP connection (GPRS; UMTS PS) and sends the message as WSP/HTTP POST
   - MMSC accepts message, and responds to the originator "message sent"

2. MMSC forwards message to the recipient's network

3. Foreign MMSC uses Push Proxy to send indication message to the recipient

4. Recipient's terminal initiates a WAP/HTTP connection and uses WSP/HTTP GET to retrieve the MMS message from the MMSC
   - MMS message is sent to recipient as content of WSP/HTTP GET RESPONSE
   - Recipient's terminal acknowledges receipt with WSP/HTTP POST message

5. Delivery is confirmed to the originator, using a Push Proxy (not shown on the slide)
6.2 Multimedia Messaging Service

Multipart Messages (I)

- MMS PDU consists of an MMS header and body
- MMS PDUs are passed in the content section of HTTP messages
- Multipart message: an MMS that carries different files, separated by a boundary (like an email may contain different attachments)

Multipart-related

- Apart from the content files, MMS contains also a special presentation part at the beginning of the message
- Presentation part refers to other content files and determines how they are presented to the user
- Markup languages used for presentation: Synchronized Multimedia Integration Language (SMIL) or XHTML

Multipart-alternative

- Some devices do not support all presentation formats and content types
- Multipart-alternative allows to define alternative files that are presented if the primary format is not supported

Multipart-mixed

- Just treat files as email attachments, no mode of presentation
### 6.2 Multimedia Messaging Service

#### Multipart Messages (II)

<table>
<thead>
<tr>
<th><strong>Multipart-related</strong></th>
<th><strong>Multipart-alternative</strong></th>
<th><strong>Multipart-mixed</strong></th>
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<td><strong>MMS PDU</strong></td>
<td><strong>MMS PDU</strong></td>
<td><strong>MMS PDU</strong></td>
</tr>
<tr>
<td>MMS Header</td>
<td>MMS Header</td>
<td>MMS Header</td>
</tr>
<tr>
<td>X-Mms-Message-Type: m-send-req</td>
<td>To: +123456/TYP=PLMN</td>
<td>X-Mms-Message-Type: m-send-req</td>
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<td>Content-type:</td>
<td>Content-type:</td>
<td>Content-type:</td>
</tr>
<tr>
<td>application/vnd.wap.multipart.related;</td>
<td>application/vnd.wap.multipart.related;</td>
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</tr>
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<td>text/plain</td>
<td>vCard</td>
</tr>
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<td>Content-ID:&lt;HelloWorld.txt&gt;</td>
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<td>...txt...</td>
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<td>...video...</td>
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6.2 Multimedia Messaging Service
SMIL (I)

Synchronized Multimedia Integration Language (SMIL)

- XML-based HTML-like markup language
- Used for creating slide-like presentations with text, images, streaming audio/video, and other media types
- Defines markups for timing, layout, animations, visual transitions, and media embedding
- 3rd Generation Partnership Project: SMIL profile for MMS
- W3C: SMIL Mobile Profile (compatible with 3GPP), Basic Profile, Extended Mobile Profile

Module and Elements of SMIL 2.1 Mobile Profile

<table>
<thead>
<tr>
<th>Module</th>
<th>Elements included</th>
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<td>ContentControl</td>
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<td>Layout</td>
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<td>Transition</td>
<td>&lt;transition&gt;</td>
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</tbody>
</table>
6.2 Multimedia Messaging Service

SMIL (II)

XML document type and the SMIL namespace – very similar to XHTML

Defines the layout of the presentation

Here: two regions, one for the image, another for the text

ID attribute is used for placing content elements in that region

Definition of transitions to be used with content elements

Defines a slide that is shown for 3 seconds

Elements within <par> are shown in parallel

Defines the source of content

Applies transition defined in the header

```xml
<xml version="1.0"?>
<!DOCTYPE smil PUBLIC "-//W3C//DTD SMIL 2.0//EN" http://www.w3.org/2001/SMIL20/SMIL20.dtd>
<smil xmlns="http://www.w3.org/2001/SMIL20/Language">
  <head>
    <layout>
      <root-layout width="120" height="140" />
      <region id="Image" width="120" height="80" left="0" top="0" />
      <region id="Text" width="120" height="60" left="0" top="80" />
    </layout>
    <transition id="wipeScreen" type="clockWipe" subtype="clockwipeTwelve" dur="1s" scope="screen" />
  </head>
  <body>
    <par dur="3s">
      <img src="logo.jpg" region="Image" />
      <text src="intro.txt" region="Text" transOut="wipeScreen" />
    </par>
    <par dur="5s">
      <img src="pizza-pepperoni-120.jpg" region="Image" />
      <text src="cid:special-offer.txt" region="Text" />
    </par>
    <par dur="3s">
      <img src="pizza-pepperoni-120.jpg" region="Image" />
      <text src="discount.txt" region="Text" transIn="wipeScreen" />
    </par>
    <par dur="2s">
      <img src="logo.jpg" region="Image" />
      <text src="thank-you.txt" region="Text" />
    </par>
  </body>
</smil>
```
6.2 Multimedia Messaging Service
What the Reasons for the Success of SMS?

Comparison of the four mobile messaging services on four parameters

- Total cost of use: How expensive is it to use the service (includes costs charged by operators as well as the cost of the handset required to support the service)?
- Usability: How easy is it to navigate through and use the service?
- Utility: What purpose does the service fulfill and how critical is it?
- Awareness: How well aware are users about the service?
6.3 SIM Application Toolkit

Motivation

Requirements on service platforms

- Competition among operators through new sophisticated and tailored services
  - Today: competition through tariffs
- Rapid service creation and deployment
  - New services must be rapidly and easily created without long-lasting coordinations between operators, manufacturers, and standardization bodies
  - New services must be easily integrable into the operator’s existing network infrastructure, i.e., with no or only minor modifications
- Simple man-to-machine interface due to reduced interaction capabilities of mobile devices
  - SMS is too awkward and cumbersome to serve as underlying service platform for new services

The SIM Application Toolkit is a set of commands which defines how the card should interact with the outside world and extends the communication protocol between the card and the handset.

- The card has a proactive role in the handset (this means that the SIM initiates commands independently of the mobile device and the network)
- Operator specific applications can run on the SIM card (like security algorithms A3 and A8) and can thereby control clearly defined, selected functions of the terminal
6.3 SIM Application Toolkit

Introduction

SIM Functions
- Authentication and key generation (A3 & A8)
- Basic telephone services (SMS storage, phone book service, ...)
- SIM Application Toolkit (SAT)

SAT functions
- SIM data download
- Display of text
- Transmission of SMS messages
- Connection setup (speech and data) triggered by the SIM card
- Playing of sounds in the mobile equipment
- Read out of local information from the equipment into the terminal

Technical parameters
- 8-bit microcontroller, e.g., Intel 8051, Motorola 6805
- 32-64 KBytes RAM/EEPROM
- 32-64 KBytes ROM
- Programming languages: JavaCard, C, Visual Basic, ...
6.3 SIM Application Toolkit

OTA – Over-the-Air

- Code on the SIM is probably only part of a distributed application that might work with codes on the handset, network servers, and certainly Internet services.
- OTA (Over-the-Air) is a technology used to communicate with, download applications to, and manage a SIM card without being connected physically to the card.

In order to implement OTA technology, the following components are needed:

- A back end system to send requests
- An OTA Gateway to process the requests in an understandable format to the SIM card
- An SMSC to send requests through the wireless network
- A bearer to transport the request: today it is the SMS bearer...
- Mobile equipment to receive the request and transmit it to the SIM card
- A SIM card to receive and execute the request
### 6.3 SIM Application Toolkit

#### SAT APIs

**Inward-looking APIs**
- Provides standard operating system services to the application such as file reading and writing, and computational functions such as cryptographic calculations

**Outward-looking APIs**
- Connects the SIM applications to the human interface capabilities of the handset and to the network

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**Proactive Commands**

```
"Please do this"

TERMINAL_RESPONSE
```

**Event Downloads**

```
Event
```
6.3 SIM Application Toolkit
Proactive Commands

- SIM initiates communication with mobile device
- SAT application is asking the handset to do something

Examples

- SETUP MENU
  - Allows to add an operator-specific menu item to the device’s setup menu, e.g., to launch or configure SAT applications

- PROVIDE LOCATION INFORMATION
  - Instructs the mobile device to deliver the current network ID, signal strength, cell identifiers of serving and neighboring base stations, ...

- SET UP EVENT LIST
  - Tells the device what events the SIM would like to be informed about
  - Interface between Proactive Commands and Event Downloads

Proactive Commands

- DISPLAY TEXT
- GET INKEY
- GET INPUT
- MORE TIME
- PLAY TONE
- POLL INTERVAL
- REFRESH
- SET UP MENU
- SELECT ITEM
- SEND SHORT MESSAGE
- SEND SS
- SEND USSD
- SET UP CALL
- POLLING OFF
- PROVIDE LOCATION INFORMATION
- SET UP EVENT LIST
- PERFORM CARD APDU
- POWER OFF CARD
- POWER ON READER
- GET READER STATUS
- TIME MANAGEMENT
- SET UP IDLE MODE TEXT
- RUN AT COMMAND
- SEND DTMF
- LANGUAGE
- NOTIFICATION
- LAUNCH BROWSER
- OPEN CHANNEL
- CLOSE CHANNEL
- RECEIVE DATA
- SEND DATA
- GET CHANNEL STATUS
6.3 SIM Application Toolkit
Event Downloads

- SIM can register for events that it wants to be told about
- If a pre-defined event occurs, handset initiates communication with the SIM to inform about the occurrence of an event
- Registration for events is done via the proactive command SET UP EVENT LIST

Examples
- **SMS PP**: A point-to-point SMS message has arrived
- **CELL BROADCAST**: A cell-broadcast SMS message has arrived
- **MT CALL**: A voice call is coming in
- **ACCESS TECHNOLOGY CHANGE**: The user has roamed into a new kind of access network (e.g., GERAN→UTRAN)

### Events
- SMS-PP
- CELL BROADCAST
- MENU SELECTION
- CALL CONTROL
- SMS CONTROL
- TIMER EXPIRATION
- MT CALL
- CALL CONNECTED
- CALL DISCONNECTED
- LOCATION STATUS
- USER ACTIVITY
- IDLE SCREEN AVAILABLE
- CARD READER STATUS
- LANGUAGE SELECTION
- BROWSER TERMINATION
- DATA AVAILABLE
- CHANNEL STATUS
- ACCESS TECHNOLOGY CHANGE
- DISPLAY PARAMETERS CHANGE
### 6.3 SIM Application Toolkit

**Example: Indication of Tariff Information (I)**

#### Scenario

- Indication of location-dependent tariff information to the user
- Operators want to subdivide their coverage areas into different tariff zones on an individual user basis
- Corresponding accounting mechanism can easily be realized, because zone is known as soon as the user establishes a connection
- However, the user wants to know the valid tariff before establishing a connection (i.e., he wants to know in advance whether or not he currently stays in a zone with a special relief):
  - Standard GSM does not provide any signaling mechanisms to do so

#### Solution

- Operator distributes SIM cards containing an application for zone checks
- Cell ID or coordinates of base stations are permanently broadcasted on a signaling channel
- Application in the SAT makes the terminal permanently listen to this signaling channel
- Each time the terminal changes the BS (in idle mode), broadcast message is forwarded to the SAT, which then performs the zone check
### 6.3 SIM Application Toolkit

**Example: Indication of Tariff Information (II)**

- Each O2 base station broadcasts coordinates on channel 221
- SAT can manage several zones (e.g., home, city, office, family,...)
- Changes of zones can be sent to the SAT via SMS (transparent to the user)

- Reasons for using Gauss-Krueger coordinates instead of Cell-ID:
  - Radio network is permanently expanded with new BSs and Cell-IDs might change
  - List of Cell-IDs belonging to a certain zone may exceed the storage capacity of the SAT (especially in the cases of large zones)

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**Check whether or not user is in his home zone**

**If so, indicate home zone on the display**

Cell broadcast on channel 221:
369240533828

BTS

Interkom home

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1. Cell broadcast on channel 221: 369240533828
2. Check whether or not user is in his home zone
3. If so, indicate home zone on the display
6.3 SIM Application Toolkit
Example: Indication of Tariff Information (III)

Gauss-Krueger coordinates:
369240 533828

- Antennas covering the home zone
- Antennas outside the home zone
- Antennas with no assignment
- Center of the home zone
- Applied position of the home zone (subscriber residence)

- distance with an accuracy of 10m to the equator
- distance with an accuracy of 10m to the reference longitude

Gauss-Krueger coordinates:
35490005806000