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Multimedia Messaging Service

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EE 400

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First of all I would like to thanks Allah {God} for guiding me through my studies.
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MOHAMMAD MANSOUR

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INTRODUCTION

Multimedia Messaging Service (MMS) is the evolution of basic text messaging services into a wide range of multimedia content and services delivered to a mobile device. It involves new and existing technologies, promises innovative services and is supported by proven business models. It is quite different from traditional Internet services as its integration with billing systems allows for per message billing and premium content services, all delivered without the need for additional subscriptions.

With the improved capability of mobile devices, in terms of increased processing power and bandwidth, mobile operators are making the transition from supporting voice only communication to embracing data-driven applications (or data services). The most notable of these data services is the Short Message Service (SMS); during 2002 globally in excess of 24 billion messages were sent in one month.

Chapter one will present the history of cellular mobile radio and GSM, architecture of GSM and the stations of its network, and how does GSM work? Also the form of GSM and different areas that form a GSM network.

Chapter two will present the history of multimedia messaging service and the development of it. In addition, the differences between multimedia messaging services (MMS), short message service (SMS) and Enhanced Messaging Service (EMS).

Chapter three will present in detail Standardization of telecommunications technologies, the specification of WAP forum and that its components.

Chapter four will present the MMS architecture which comprises the software messaging application in the MMS phone and application that is required for the composition, sending and retrieval of multimedia messages.

1. ARCHITECTUTE OF GSM

1.1 Overview

During the early 1980s, analog cellular telephone systems were experiencing rapid growth in Europe, particularly in Scandinavia and the United Kingdom, but also in France and Germany. Each country developed its own system, which was incompatible with everyone else's in equipment and operation. This was an undesirable situation, because not only was the mobile equipment limited to operation within national boundaries, which in a unified Europe were increasingly unimportant, but there was a very limited market for each type of equipment, so economies of scale, and the subsequent savings, could not be realized [1].

In 1981 a joint Franco German study was initiated to develop a common approach, which, it was hoped, would become a standard for Europe. Soon after, in 1982 a proposal from Nordic Telecom and Netherlands PTT to the CEPT (Conference of European Post and Telecommunications) to develop a new digital cellular standard that would cope with the ever burgeoning demands on European mobile networks. Then a study group formed called the Group Special Mobile (GSM) to study and develop a pan-European public land mobile system. The proposed system had to meet certain criteria:

- Good subjective speech quality
- Low terminal and service cost
- Support for international roaming
- Ability to support handheld terminals
- Support for range of new services and facilities
- Spectral efficiency
- ISDN compatibility

In 1989, GSM responsibility was transferred to the European Telecommunication Standards Institute (ETSI), and phase I of the GSM specifications was published in 1990.

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Commercial service was started in mid-1991, and by 1993 there were 36 GSM networks in 22 countries. Although standardized in Europe, GSM is not only a European standard. Over 200 GSM networks (including DCS1800 and PCS1900) are operational in 110 countries around the world. In the beginning of 1994, there were 1.3 million subscribers worldwide, which had grown to more than 55 million by October 1997. With North America making a delayed entry into the GSM field with a derivative of GSM called PCS1900, GSM systems exist on every continent, and the acronym GSM now aptly stands for Global System for Mobile communications.

The developers of GSM chose an unproven (at the time) digital system, as opposed to the then-standard analog cellular systems like AMPS in the United States and TACS in the United Kingdom. They had faith that advancements in compression algorithms and digital signal processors would allow the fulfillment of the original criteria and the continual improvement of the system in terms of quality and cost. The over 8000 pages of GSM recommendations try to allow flexibility and competitive innovation among suppliers, but provide enough standardization to guarantee proper networking between the components of the system. This is done by providing functional and interface descriptions for each of the functional entities defined in the system.

The original French name was later changed to Global System for Mobile Communications, but the original GSM acronym stuck.

Global System for Mobile communications is a digital cellular communications system. It was developed in order to create a common European mobile telephone standard but it has been rapidly accepted worldwide. GSM was designed to be compatible with ISDN services.

The Global System for Mobile communications (GSM) is a digital cellular communications system initially developed in an European context which has rapidly gained acceptance and market share worldwide. It was designed to be compatible with

ISDN systems and the services provided by GSM are a subset of the standard ISDN services (speech is the most basic).

The functional architecture of a GSM system can be divided into the Mobile Station (MS), the Base Station (BS), and the Network Subsystem (NS). The MS is carried by the subscriber, the BS subsystem controls the radio link with the MS and the NS performs the switching of calls between the mobile and other fixed or mobile network users as well as mobility management. The MS and the BS subsystem communicate across the Um interface also known as radio link.

1.2 History of the Cellular Mobile Radio and GSM

The idea of cell-based mobile radio systems appeared at Bell Laboratories (in USA) in the early 1970s. However, mobile cellular systems were not introduced for commercial use until the 1980s. During the early 1980s, analog cellular telephone systems experienced a very rapid growth in Europe, particularly in Scandinavia and the United Kingdom. Today cellular systems still represent one of the fastest growing telecommunications systems, but in the beginnings of cellular systems, each country developed its own system, which was an undesirable situation for the following reasons:

- The equipment was limited to operate only within the boundaries of each country.
- The market for each mobile equipment was limited.

In order to overcome these problems, the Conference of European Posts and Telecommunications (CEPT) formed, in 1982, the Group Special Mobile (GSM) in order to develop a pan-European mobile cellular radio system (the GSM acronym became later the acronym for Global System for Mobile communications). The standardized system had to meet certain criteria:

- Spectrum efficiency
- International roaming
- Low mobile and base stations costs
- Good subjective voice quality
- Compatibility with other systems such as ISDN (Integrated Services Digital Network)
- Ability to support new services

In 1989 the responsibility for the GSM specifications passed from the CEPT to the European Telecommunications Standards Institute (ETSI). The aim of the GSM specifications is to describe the functionality and the interface for each component of the system, and to provide guidance on the design of the system. These specifications will then standardize the system in order to guarantee the proper networking between the different elements of the GSM system. In 1990, the phase I of the GSM specifications was published but the commercial use of GSM did not start until mid 1991.

The most important events in the development of the GSM system are presented in the table 1.1

Table 1.1 Events in the development of GSM

Year	Events
1982	CEPT establishes a GSM group in order to develop the standards for a pan-European cellular mobile system
1985	Adoption of a list of recommendations to be generated by the group
1986	Field tests were performed in order to test the different radio techniques proposed for the air interface
1987	TDMA is chosen as access method (in fact, it will be used with FDMA) Initial Memorandum of Understanding (MoU) signed by telecommunication operators

	(representing 12 countries)
1988	Validation of the GSM system
1989	The responsibility of the GSM specifications is passed to the ETSI
1990	Appearance of the phase 1 of the GSM specifications
1991	Commercial launch of the GSM service
1992	Enlargement of the countries that signed the GSM- MoU> Coverage of larger cities/airports
1993	Coverage of main roads GSM services start outside Europe
1995	Phase 2 of the GSM specifications Coverage of rural areas

From the evolution of GSM, it is clear that GSM is not anymore only a European standard. GSM networks are operational or planned in over 80 countries around the world. The rapid and increasing acceptance of the GSM system is illustrated with the following figures:

- 1.3 million GSM subscribers worldwide in the beginning of 1994.
- Over 5 million GSM subscribers worldwide in the beginning of 1995.
- Over 10 million GSM subscribers only in Europe by December 1995.

Since the appearance of GSM, other digital mobile systems have been developed. The table 2 charts the different mobile cellular systems developed since the commercial launch of cellular systems.

Table 1.2: Mobile cellular systems [2]

Year	Mobile Cellular System
1981	Nordic Mobile Telephony (NMT), 450>
1983	American Mobile Phone System (AMPS)
1985	Total Access Communication System (TACS) Radiocom 2000 C-Netz
1986	Nordic Mobile Telephony (NMT), 900>
1991	Global System for Mobile communications> North American Digital Cellular (NADC)
1992	Digital Cellular System (DCS) 1800
1994	Personal Digital Cellular (PDC) or Japanese Digital Cellular (JDC)
1995	Personal Communications Systems (PCS) 1900- Canada>
1996	PCS-United States of America>

1.3 Architecture of the GSM Network

The GSM network is composed of several functional entities, whose functions and interfaces are defined. The GSM network can be divided into four broad parts. The subscriber carries the Mobile Station; the Base Station Subsystem controls the radio link with the Mobile Station. The Network Subsystem, the main part of which is the Mobile services Switching Center, performs the switching of calls between the mobile and other fixed or mobile network users, as well as management of mobile services, such as authentication. With the Operations and Maintenance center, which oversees the proper operation and setup of the network. And the operational and support subsystem. The Mobile Station and the Base Station Subsystem communicate across the Um interface, also known as the air interface or radio link. The Base Station Subsystem communicates with the Mobile service Switching Center.

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GSM technical specifications define the different entities that form the GSM network by defining their functions and interface requirements.

The GSM network can be divided into four main parts:

- The Mobile Station (MS).
- The Base Station Subsystem (BSS).
- The Network and Switching Subsystem (NSS).
- The Operation and Support Subsystem (OSS).

The architecture of the GSM network is presented in figure 1.1.

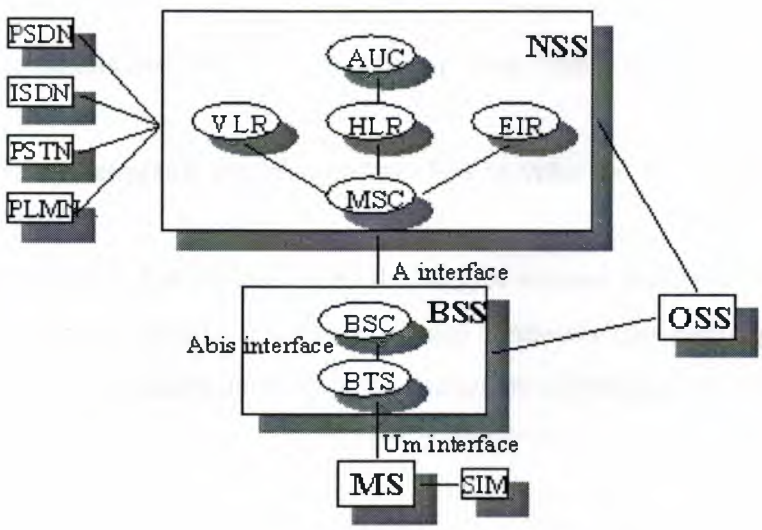

Figure 1.1 Architecture of the GSM network [2]

1.3.1 Mobile Station

The mobile station (MS) consists of the physical equipment, such as the radio transceiver, display and digital signal processors, and a smart card called the Subscriber Identity Module (SIM). The SIM provides personal mobility, so that the user can have access to all subscribed services irrespective of both the location of the terminal and the use of a specific terminal. By inserting the SIM card into another GSM cellular phone, the user is able to receive calls at that phone, make calls from that phone, or receive other subscribed services.

The International Mobile Equipment Identity (IMEI) uniquely identifies the mobile equipment. The SIM card contains the International Mobile Subscriber Identity (IMSI), identifying the subscriber, a secret key for authentication, and other user information. The IMEI and the IMSI are independent, thereby providing personal mobility. The SIM card may be protected against unauthorized use by a password or personal identity number.

- **The Terminal**

There are different types of terminals distinguished principally by their power and application:

1-The" fixed" terminals are the ones installed in cars. Their maximum allowed output power is 20 W.

2-The GSM portable terminals can also be installed in vehicles. Their maximum allowed output power is 8W.

3-The handheld terminals have experienced the biggest success thanks to their weight and volume, which are continuously decreasing. These terminals can emit up to 2 W. The evolution of technologies allows decreasing the maximum allowed power to 0.8 W.

- **The SIM**

The SIM is a smart card that identifies the terminal. By inserting the SIM card into the terminal, the user can have access to all the subscribed services. Without the SIM card, the terminal is not operational; a four-digit Personal Identification Number (PIN) protects The SIM card. In order to identify the subscriber to the system, the SIM card contains some parameters of the user such as its International Mobile Subscriber Identity (IMSI).

Another advantage of the SIM card is the mobility of the users. In fact, the only element that personalizes a terminal is the SIM card. Therefore, the user can have access to its subscribed services in any terminal using its SIM card.

1.3.2 The Base Station Subsystem

The Base Station Subsystem (BSS) is composed of two parts, the Base Transceiver Station (BTS) and the Base Station Controller (BSC). These communicate across the specified Abis interface, allowing (as in the rest of the system) operation between components made by different suppliers.

The BTS houses the radio transceivers that define a cell and handles the radio link protocols with the Mobile Station. In a large urban area, there will potentially be a large number of BTSs deployed. The requirements for a BTS are ruggedness, reliability, portability, and minimum cost. BTS is responsible for providing layers 1 and 2 of the radio interface, that is, an error-corrected data path. Each BTS has at least one of its radio channels assigned to carry control signals in addition to traffic.

The BSC manages the radio resources for one or more BTSs. It is responsible for the management of the radio resource within a region. Its main functions are to allocate and control traffic channels, control frequency hopping, undertake handovers (except to cells outside its region) and provide radio performance measurements. Once the mobile has accessed, and synchronized with, a BTS the BSC will allocate it a dedicated bi-directional signaling channel and will set up a route to the Mobile services switching
Center (MSC). The BSC also translates the 13 KBPS voice channel used over the radio link to the standard 64 KBPS channel used by the Public Switched Telephone Network or ISDN.

BSS connects the Mobile Station and the NSS. It is in charge of the transmission and reception. The BSS can be divided into two parts:

1-The Base Transceiver Station (BTS) or Base Station.

2-The Base Station Controller (BSC).

- **The Base Transceiver Station**

The BTS corresponds to the transceivers and antennas used in each cell of the network. A BTS is usually placed in the center of a cell. Its transmitting power defines the size of a cell. Each BTS has between one and sixteen transceivers depending on the density of users in the cell.

- **The Base Station Controller**

The BSC controls a group of BTS and manages their radio resources. A BSC is principally in charge of handovers, frequency hopping, exchange functions and control of the radio frequency power levels of the BTSs.

1.3.3 The Network and Switching Subsystem

The central component of the Network Subsystem is the Mobile services Switching Center (MSC). It acts like a normal switching node of the PSTN or ISDN, and in addition provides all the functionality needed to handle a mobile subscriber, such as registration, authentication, location updating, handovers, and call routing to a roaming subscriber. These services are provided in conjunction with several functional entities, which together form the Network Subsystem. The MSC provides the connection to the public fixed network (PSTN or ISDN), and signaling between functional entities uses the ITUT Signaling System Number 7 (SS7), used in ISDN and widely used in current public networks.

The Home Location Register (HLR) and Visitor Location Register (VLR), together with the MSC, provide the call routing and (possibly international) roaming capabilities of GSM. The HLR contains all the administrative information of each subscriber registered in the corresponding GSM network, along with the current location of the mobile. It also contains a unique authentication key and associated challenge/response generators.

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The current location of the mobile is in the form of a Mobile Station Roaming Number (MSRN), which is a regular ISDN number used to route a call to the MSC where the mobile is currently located. There is logically one HLR per GSM network, although it may be implemented as a distributed database.

The VLR contains selected administrative information from the HLR, necessary for call control and provision of the subscribed services, for each mobile currently located in the geographical area controlled by the VLR. Although each functional entity can be implemented as an independent unit, most manufacturers of switching equipment implement one VLR together with one MSC, so that the geographical area controlled by the MSC corresponds to that controlled by the VLR, simplifying the signaling required.

Note that the MSC contains no information about particular mobile stations - this information is stored in the location registers, the other two registers are used for authentication and security purposes. The Equipment Identity Register (EIR) is a database that contains a list of all valid mobile equipment on the network

Mobile Equipment Identity (IMEI). An IMEI is marked as invalid if it has been reported stolen or is not type approved. The Authentication Canter is a protected database that stores a copy of the secret key stored in each subscriber's SIM card, which is used for authentication and ciphering of the radio channel.

The role is to manage the communications between the mobile users and other users, such as mobile users, ISDN users, fixed telephony users, etc. It also includes data bases needed in order to store information about the subscribers and to manage their mobility.
The different components of the NSS are described below.

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- **The Mobile services Switching Center (MSC)**

It is the central component of the NSS. The MSC performs the switching functions of the network. It also provides connection to other networks.

- **The Gateway Mobile services Switching Center (GMSC)**

A gateway is a node interconnecting two networks. The GMSC is the interface between the mobile cellular network and the PSTN. It is in charge of routing calls from the fixed network towards a GSM user. The GMSC is often implemented in the same machines as the MSC.

- **Home Location Register (HLR)**

The HLR is considered as a very important database that stores information of the subscribers belonging to the covering area of a MSC. It also stores the current location of these subscribers and the services to which they have access. The location of the subscriber corresponds to the SS7 address of the Visitor Location Register (VLR) associated to the terminal

- **Visitor Location Register (VLR)**

The VLR contains information from a subscriber's HLR necessary in order to provide the subscribed services to visiting users. When a subscriber enters the covering area of a new MSC, the VLR associated to this MSC will request information about the new subscriber to its corresponding HLR. The VLR will then have enough information in order to assure the subscribed services without needing to ask the HLR each time a communication is established.

The VLR is always implemented together with a MSC; so the area under control of the MSC is also the area under control of the VLR.

- **The Authentication Center (AuC)**

The AuC register is used for security purposes. It provides the parameters needed for authentication and encryption functions. These parameters help to verify the user's identity.

- **The Equipment Identity Register (EIR)**

The EIR is also used for security purposes. It is a register containing information about the mobile equipments. More particularly, it contains a list of all valid terminals. Its International Mobile Equipment Identity (IMEI) identifies a terminal. The EIR allows then to forbid calls from stolen or unauthorized terminals (e.g., a terminal which does not respect the specifications concerning the output RF power).

- **The GSM Interlocking Unit (GIWU)**

The GIWU corresponds to an interface to various networks for data communications. During these communications, the transmission of speech and data can be alternated.

1.3.4 The Operation and Support Subsystem (OSS)

The OSS is connected to the different components of the NSS and to the BSC, in order to control and monitor the GSM system. It is also in charge of controlling the traffic load of the BSS.

However, the increasing number of base stations, due to the development of cellular radio networks, has provoked that some of the maintenance tasks are transferred to the BTS. This transfer decreases considerably the costs of the maintenance of the system.

1.4 The Geographical Areas of The GSM Network

The figure 1.2 presents the different areas that form a GSM network.

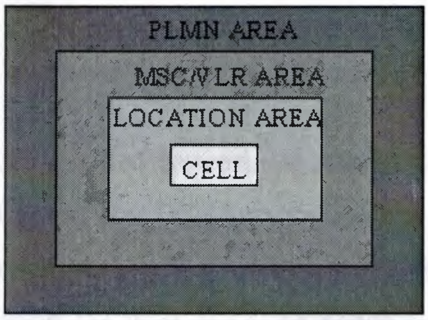

Figure 1.2 GSM network areas [3]

As it has already been explained a cell, identified by its Cell Global Identity number (CGI), corresponds to the radio coverage of a base transceiver station. A Location Area (LA), identified by its Location Area Identity (LAI) number, is a group of cells served by a single MSC/VLR. A group of location areas under the control of the same MSC/VLR defines the MSC/VLR area. A Public Land Mobile Network (PLMN) is the,
Area served by one network operator

1.5 The GSM Functions

In this paragraph, the description of the GSM network is focused on the different functions to fulfill by the network and not on its physical components. In GSM, five main functions can be defined:

- Transmission.
- Radio Resources management (RR).
- Mobility Management (MM).
- Communication Management (CM).
- Operation, Administration and Maintenance (OAM).

1.5.1 Transmission

The transmission function includes two sub-functions:

- The first one is related to the means needed for the transmission of user information.
- The second one is related to the means needed for the transmission of signaling information.

Not all the components of the GSM network are strongly related with the transmission functions. The MS, the BTS and the BSC, among others, are deeply concerned with transmission. But other components, such as the registers HLR, VLR or EIR, are only concerned with the transmission for their signaling needs with other components of the GSM network.

1.5.2 Radio Resources Management (RR)

The role of the RR function is to establish, maintain and release communication links between mobile stations and the MSC. The elements that are mainly concerned with the RR function are the mobile station and the base station. However, as the RR function is also in charge of maintaining a connection even if the user moves from one cell to another, the MSC, in charge of handovers, is also concerned with the RR functions.
The RR is also responsible for the management of the frequency spectrum and the reaction of the network to changing radio environment conditions. Some of the main RR procedures that assure its responsibilities are:

1- Channel assignment, change and release.

2- Handover.

3- Frequency hopping.

4- Power-level control.

5- Discontinuous transmission and reception.

6- Timing advance.

Handover, which represents one of the most important responsibilities of the RR, will Be described:

- **Handover:**

Movements can produce the need to change the channel or cell, especially when the quality of the communication is decreasing. This procedure of changing the resources is called handover. Four different types of handovers can be distinguished:

1- Handover of channels in the same cell.

2- Handover of cells controlled by the same BSC.

3- Handover of cells belonging to the same MSC but controlled by different BSCs.

4- Handover of cells controlled by different MSCs.

Handovers are mainly controlled by the MSC. However in order to avoid unnecessary signaling information, the first two types of handovers are managed by the concerned BSC (in this case, the MSC is only notified of the handover).

The mobile station is the active participant in this procedure. In order to perform the handover, the mobile station controls continuously its own signal strength and the signal strength of the neighboring cells. The base station gives the list of cells that must be monitored by the mobile station. The power measurements allow deciding which is the best cell in order to maintain the quality of the communication link. Two basic algorithms are used for the handover:

- The `minimum acceptable performance' algorithm. When the quality of the transmission decreases (i.e. the signal is deteriorated), the power level of the mobile is increased. This is done until the increase of the power level has no effect on the quality of the signal. When this happens, a handover is performed.
- The `power budget' algorithm. This algorithm performs a handover, instead of continuously increasing the power level, in order to obtain a good communication quality.

1.5.3 Mobility Management

The MM function is in charge of all the aspects related with the mobility of the user, specially the location management and the authentication and security.

- **Location Management**

When a mobile station is powered on, it performs a location update procedure by indicating its IMSI to the network. The first location update procedure is called the IMSI attach procedure.

The mobile station also performs location updating, in order to indicate its current location, when it moves to a new Location Area or a different PLMN. This location-updating message is sent to the new MSC/VLR, which gives the location information to the subscriber's HLR. If the mobile station is authorized in the new MSC/VLR, the subscriber's HLR cancels the registration of the mobile station with the old MSC/VLR.

A location updating is also performed periodically. If after the updating time period, the mobile station has not registered, it is then deregistered.
When a mobile station is powered off, it performs an IMSI detach procedure in order to tell the network that it is no longer connected.

- **Authentication And Security**

The authentication procedure involves the SIM card and the Authentication Center. A secret key, stored in the SIM card and the AuC, and a ciphering algorithm called A3 are used in order to verify the authenticity of the user. The mobile station and the AuC compute a SRES using the secret key, the algorithm A3 and a random number generated by the AuC. If the two computed SRES are the same, the subscriber is authenticated. The different services to which the subscriber has access are also checked.

Another security procedure is to check the equipment identity. If the IMEI number of the mobile is authorized in the EIR, the mobile station is allowed to connect the network.

In order to assure user confidentiality, the user is registered with a Temporary Mobile Subscriber Identity (TMSI) after its first location update procedure.

The SIM card and the Authentication Center are used for the authentication procedure involves the SIM card and the Authentication Center. A secret key, stored in the SIM card and the AuC, and a ciphering algorithm called A3 are used in order to verify the authenticity of the user. The mobile station and the AuC compute a SRES using the secret key, the algorithm A3 and a random number generated by the AuC. If the two computed SRES are the same, the subscriber is authenticated. The different services to which the subscriber has access are also checked.

Another security procedure is to check the equipment identity. If the IMEI number of the mobile is authorized in the EIR, the mobile station is allowed to connect the network, in order to assure user confidentiality, the user is registered with a Temporary Mobile Subscriber Identity (TMSI) after its first location update procedure.

1.5.4 Communication Management (CM)

The CM function is responsible for:

1 -Call control.

2 - Supplementary Services management.

3 -Short Message Services management.

- **Call Control (CC)**

The CC is responsible for call establishing, maintaining and releasing as well as for selecting the type of service. One of the most important functions of the CC is the call routing. In order to reach a mobile subscriber, a user dials the Mobile Subscriber ISDN (MSISDN) number, which includes:

1-A country code

2-A national destination code identifying the subscriber's operator

3-A code corresponding to the subscriber's HLR

The call is then passed to the GMSC (if the call is originated from a fixed network), which knows the HLR corresponding to a certain MISDN number. The GMSC asks the HLR for information helping to the call routing. The HLR requests this information from the subscriber's current VLR. This VLR allocates temporarily a Mobile Station Roaming Number (MSRN) for the call. The MSRN number is the information returned by the HLR to the GMSC. Thanks to the MSRN number, the call is routed to subscriber's current MSC/VLR. In the subscriber's current LA, the mobile is paged.

- **Supplementary Services Management**

The mobile station and the HLR are the only components of the GSM network involved with this function

- **Short Message Services management**

In order to support these services, a GSM network is in contact with a Short Message Service Center through the two following interfaces:

1 -The SMS-GMSC for Mobile Terminating Short Messages (SMS-MT/PP). It has the same role as the GMSC.

2 -The SMS-IWMSC for Mobile Originating Short Messages (SMS-MO/PP).

1.5.5 Operation, Administration and Maintenance (OAM)

The OAM function allows the operator to monitor and control the system as well as to modify the configuration of the elements of the system. Not only the OSS is part of the OAM, also the BSS and NSS participate in its functions as it is shown in the following examples:

1-The components of the BSS and NSS provide the operator with all the information it needs. This information is then passed to the OSS, which is in charge of analyzing it and control the network.

2-The self test tasks, usually incorporated in the components of the BSS and NSS, also contribute to the OAM functions.

3-The BSC, in charge of controlling several BTSs, is another example of an OAM function performed outside the OSS.

1.6 Summary

This chapter has presented History of the Cellular Mobile Radio and GSM , the GSM network is composed of several functional entities, the mobile station (MS) consists of the physical equipment, and the description of the GSM network is focused on the different functions to fulfill by the network ,

2. INTRODUCTION TO MULTIMEDIA MESSAGING SERVICE

2.1 Evolution of MMS

The Multimedia Messaging Service (MMS) can be seen as the 'best of the breed' of several messaging services such as the Short Message Service (SMS), the Enhanced Messaging Service (EMS) and the Internet mail. The first SMS short text message is believed to have been exchanged in 1992. Ten years later, MMS multimedia messages propagate over radio channels of major mobile networks. In between, EMS, designed as a rich media extension of SMS, attempted to penetrate the market but without great success. Since 2002, a first MMS wave has spread all over the world, with more than 100 operators adopting the service. The first MMS wave offers basic messaging features to mobile users and a second MMS wave is already appearing. This second wave builds up from basic messaging functions to offer more sophisticated features, from photo messaging to video messaging. In 2003, MMS is still in its infancy and still has to meet the expectations of the mass market.

From 2002, the first MMS wave has led to the roll-out of the service in many countries in Europe, Asia and North America. This first market opportunity for MMS relied mainly on the availability of color-screen phones with digital camera and the introduction of packet-based communications in mobile networks. This first wave of MMS allows mobile users to exchange multimedia messages with the Internet and mobile domains. Multimedia messages range from simple text messages to sophisticated messages comprising a slideshow composed of text, images and audio clips.

The roots of the Multimedia Messaging Service lie in the text-based Short Message Service and the Internet electronic mail. Indeed, features already supported by these services have not been forgotten in MMS. MMS supports the management of reports (delivery and read reports), message classes and priorities and group sending.

In addition, MMS differs from other messaging services with its multimedia capabilities, its support for email and phone number addressing modes, its efficient transport mechanism and flexible charging framework. From a marketing perspective, the first MMS wave is mainly regarded as the 'photo messaging' service for the mass market of mobile users. It is too early to speak about an overwhelming commercial success for the first MMS wave.

Operators have widely adopted the service but interoperability issues are still to be solved and penetration of MMS phones has to grow in order to allow a mass adoption of the service by mobile subscribers. As the first MMS wave was crossing the globe, open standards for MMS were evolving to enable future service evolutions and solving early interoperability issues. These evolutions represent the basis of the emerging second MMS wave, likely to start by the end of 2003. It will leverage the first MMS wave with the support of new features and new media formats. Certain MMS solutions already support the exchange of larger objects such as video clips. This will progressively lead to the transport and storage of larger messages. In the context of MMS, the concept of multimedia message box (MMBox) will ease the management of large messages by allowing the storage of multimedia messages in network-based user personal stores (e.g. message boxes, online photo albums, etc.).

The wide-scale deployment of these new features is still to be accomplished by mobile operators. The support of the second MMS wave faces interesting technical and marketing challenges.

In figure 2.1 it compares between the Short Messaging Service (SMS), Enhanced Messaging Service (EMS) and Multimedia Messaging Service (MMS)

SMS	EMS	MMS
• Plain text, black only	• Plain text, simple graphics and sound	• Text, colour, graphics, images, audio and video
• 160 characters max.	• Upper limit on message size	• 100–300K message size
• SS7/MAP in-brand signalling protocol	• SS7/MAP in-band signalling protocol	• Utilizes IP-based standards and Internet content standards
• Messages can be sent to mobile phone numbers	• Messages can be sent to mobile phone numbers	• Messages can be sent to mobile phone numbers and email addresses
• Supported by nearly all GSM phones in current use	• Low handset penetration	• Rapidly increasing handset penetration

Figure 2.1 SMS to MMS evolution

2.2 MMS Success Enablers

The commercial introduction of MMS started in March 2002. The future success of MMS is believed to rely on four main enablers:

- Availability and penetration of MMS phones: Mobile users require MMS-enabled phones for composing and sending multimedia messages. Availability of phones is less critical for message reception and viewing since, with message trans coding in the network side, users are often able to send messages to Internet users (via email) and to users of legacy handsets (non-MMS phones with support of SMS and/or WAP browser). However, a certain market penetration of MMS-enabled phones is required to enable significant revenues. The Global Mobile Suppliers Association1 believes that a penetration of at least

30% is necessary for MMS to succeed, and it expects this level of penetration to be reached by end of 2003. In 2002, MMS started with a very limited number of MMS phones. At the time of writing, more than 50 MMS phone models were available, and this figure is increasing at an impressive rate. MMS phones require the support of color-screens and are often shipped with a built-in digital camera. Obviously, these multimedia phones are relatively expensive to produce but mobile operators are ready to strongly subsidize the cost of producing phones in order to facilitate a rapid roll-out of the service. The mass production of MMS-enabled phones will lead to an economy of scale, and this will further increase the market penetration of these devices.

- Device interoperability and service inter working: The introduction of any new telecommunications service in a multi-vendor environment is always subject to equipment interoperability issues. Such an interoperability issue occurs, for instance, when two vendors of communicating devices interpret a standard differently. In the context of MMS, the number of standards and the number of vendors offering solutions are high; therefore the interoperability risk is proportionally high. Although the MMS standards have been designed with greatest care, too many options sometimes lead to the development of devices conforming to the standard, but which do not interoperate in an efficient manner. Initially, service inter working between MMS providers (typically mobile network operators) was seldom ensured. This made the exchange of multimedia messages among subscribers belonging to different MMS domains complicated. Lack of service inter working was mainly due to the non-existence of commercial agreements between MMS providers. These agreements are being negotiated now, and service interoperability barriers between MMS providers are being removed.

- Ease of use: Snapshot and send! The use of MMS should be as easy as this. No time for browsing through complex phone menu items. The use of MMS with the phone should be facilitated with dedicated buttons and simplified options, and message sending should be realized with a minimum of track point clicks. Besides the man-machine-interface issues, another cornerstone to achieve ease of use is the availability of pre-configuration methods for MMS settings. This encompasses the storage of default MMS settings during the device manufacturing process, the storage of settings in the SIM card or the provisioning of settings over the air (e.g. settings are sent dynamically from the network to the device).

- Added value for the end-user: The user should perceive significant added value using MMS compared to other messaging systems such as SMS or email. Added value of MMS includes its multimedia capabilities, an efficient message transport mechanism, the support of various addressing modes and management of reports (e.g. delivery and read reports). Added value is also provided by enabling mobile users to enjoy new types of information, entertainment and other services.

MMS is in its infancy. At present, much hype surrounds MMS, but it still has to prove that it can fulfill the four success enablers as described above. MMS has the key advantage of having full support from the major players of the mobile communications industry. Indeed, in a mobile phone market where the penetration rate is high, MMS is an opportunity for device manufacturers to replace the legacy voice centric phones by selling new sophisticated multimedia phones. Operators regard MMS as the revenue-generating service that is appropriately scaled for recent investments in terms of packet-based transport technologies (e.g. GPRS) leading to a smooth transition to the forthcoming roll-out of 3G networks. MMS bridges the once closed mobile communications world with the Internet domain, opening the door to the deployment of compelling services by innovative Value-Added Service (VAS) providers. Without any doubt, the entire industry has great expectations for the future of MMS. The future will tell if the actual hype will convert into commercial success.

2.3 Commercial Availability of MMS

Telenor from Norway was the first operator to launch MMS in Europe in March 2002. This initiative was followed by Vodafone D2 (April 2002), Westel Hungary (April 2002), Telecom Italia Mobile (May 2002), Orange UK (May 2002), Swisscom (June 2002), Orange France (August 2002), T-Mobile Germany/Austria (summer 2002), T-Mobile UK (June 2002), Vodafone UK (summer 2002), Telefonica Moviles Spain (September 2002) and others.

Outside Europe, China Hong Kong CSL launched MMS in March 2002 and was followed, shortly afterwards, by other local operators. In the United States, AT&T Wireless launched MMS in June 2002. In Singapore, SingTel Mobile launched MMS in September 2002 and China Beijing Mobile launched MMS in China in October 2002.In the first quarter of 2003, more than 100 operators around the world have announced the availability of their MMS services. The service is now available worldwide and MMS is gaining thousands of new users every day.

Figure 2.2 Sending an MMS using Vodafone Live

2.4 MMS Compared with Other Messaging Services

The first usage of the term 'MMS' dates back to 1998. At that time, operators and vendors were looking at opportunities to offer a messaging service for third-generation mobile systems. Considering the success of SMS, standardization work on MMS was rapidly kicked off. In this context, MMS can be considered as the 'best of the breed' of several existing messaging services. This section describes several messaging services that are close to MMS in terms of underlying concepts and offered features.

2.4.1 SMS and EMS

The roots of mobile messaging in Europe lie in the Short Message Service. In its initial form, SMS is a basic service for exchanging short text messages (with a maximum of 160 simple characters). The first text message is believed to have been transferred in 1992 over signaling channels of one of the major European GSM networks. Since this successful trial, SMS usage has been the subject of a tremendous growth reaching 1.5 billion SMS messages sent across the United Kingdom's four GSM networks in February 2003.

Despite its limitations, SMS is widely used today and accounts for a significant part of mobile operator revenues. In its most recent form, SMS allows short text messages to be concatenated to form larger messages, and several application-level extensions have been designed on top of SMS as a transport technology. Most notably, EMS is a standardized extension allowing SMS messages to incorporate rich media such as polyphonic melodies, simple black and white, color or grayscale images/animations and so on. Major phone manufacturers such as Alcatel, Motorola, Siemens and Sony-Ericsson have released EMS-enabled phones.

Another application-level extension of SMS is known as 'Picture Messaging' (part of Smart Messaging services). Picture messaging is a proprietary service developed by Nokia and available mainly on Nokia phones. Features offered by picture messaging are similar to the ones offered by EMS.Unfortunately; the two services have not been designed to interoperate.

SMS was originally developed as part of the GSM technical specifications from ETSI. SMS standardization work was later transferred to the Third Generation Partnership Project (3GPP).

2.4.2 Electronic Mail

One of the most common uses of the Internet is the electronic mail (email). First email systems were very basic and cumbersome but were quickly improved with the support of group sending, message attachments, automatic message forward and so on. Email has now become the universal messaging service for Internet users. In the past, email used to be limited to the exchange of plain text messages, sometimes with binary attachments. Now, the text part of email messages can be formatted with HTML, allowing more sophisticated message presentations (inline images, tables, formatted text, etc.).

An email user usually has an email service subscription with a service provider (Internet service provider or other). The email architecture is typically based on an interconnection of local email clients and email servers. The email client is used for the composition and sending of messages to the email server. It is also used for retrieving messages from the email server. The email server is responsible for storing messages in user mailboxes and is often interconnected with other email servers to allow the exchange of messages between distinct email systems.

The email client is typically in charge of retrieving messages from the email server without explicit notification of message availability from the email server. Retrieval of messages can be triggered explicitly by the email user, or the email client can automatically poll the email server for messages awaiting retrieval. This polling mechanism is not appropriate for mobile radio systems, which still have very limited network bandwidth compared to fixed networks. Furthermore, the size of email messages can reach several megabytes. Today, such large message sizes are still difficult to manage with mobile systems.

Several phone vendors have attempted to ship devices with embedded email clients but these attempts have not proved to be very successful. Email extensions have been developed to cope with the limitations of mobile systems.

2.4.3 J-phone's Sha-Mail and NTT Docomo's i-shot

In November 2000, J-Phone, the Japanese arm of Vodafone, launched a new messaging service known as 'Sha-mail' (literally stands for 'Picture mail' in Japanese).In October 2002, Vodafone reported that Japan's J-Phone had 7 million Sha-mail handsets operating on its network. Sha-mail is a messaging service for taking photos with a digital camera built into a mobile phone and sending them to another Sha-mail phone or to an Internet user (electronic mail message with picture as an attachment).

A service extension of Sha-mail, known as 'Movie Sha-mail', also allows recording and sending short video clips (up to 5 seconds). Sha-mail messages can be stored in Sha-mail digital albums stored in the network and managed remotely by the user via a Sha-mail phone. With Sha-mail, there is no application or monthly fee and customers are only billed for communication charges (based on volume of data).

NTT Docomo is well known for its successful i-mode services launched in February 1999 in Japan. In December 2002, NTT Docomo claimed that 36 million i-mode users have been provided access to the service. The denomination 'i-mode' refers not only to a technology for accessing the Internet from a mobile phone but also to the entire I-mode value chain including technologies, business model and marketing.

I-mode offers services such as browsing (access to Internet sites with i-mode-tailored contents), downloading (ring tones, Java applications, etc.) and messaging. I-mode messaging, also known as 'i-mail', is basically based on the Internet electronic mail technology, as described in the previous section.

The success of I-mode has spread to other countries outside Japan. Several operators have introduced I-mode in Europe (Eplus of Germany, KPN of Netherlands, BASE of Belgium and Bouygues Telecom of France) and Taiwan (KG Telecom). In response to the success of J-Phone's Sha-mail, NTT Docomo counter-attacked with the launch of a new i-mode messaging service known as 'i-shot'. With i-shot, users can take photos with an i-mode phone with a built-in camera. The photo is attached to an electronic mail message (JPEG file up to 30 kB) and sent to the i-shot server.

The i-shot server stores the photo and sends a URL referring to it as part of an email text message to the recipient(s). During this process, the i-mode server may modify the original photo according to the recipient's i-mode device capabilities. Upon reception of the message, the user reads the text message with the i-mode mail client and can directly launch the browser to fetch the photo identified by the URL.

The i-shot service is also open to the Internet. In this context, the message is directly transferred to the recipient Internet user as an email message with the photo as an attachment. A key advantage of i-shot is that i-shot messages can be fetched and viewed from any i-mode phone shipped with an i-mode browser. An i-shot phone is only required for originating an i-shot message. With i-shot, there is a monthly fee for accessing i-mode services, and customers pay for communication charges (based on volume of data).

J-phone's Sha-mail and NTT Docomo's i-shot are messaging services for second generation mobile systems targeted at the mass market of mobile customers. They are proprietary services relying on existing Internet-based protocols and controlled by operators (NTT Docomo, J-phone and other operator partners). At the time of writing, no third party was known to offer Sha-mail or i-shot services. Both services are open to the Internet.

The success of photo messaging services in Japan seems quite encouraging for the success of MMS in other parts of the world. However, Japan is a more data-driven market with shorter handset-replacement cycles, and, therefore, one cannot transfer the Japanese experience directly to other markets.

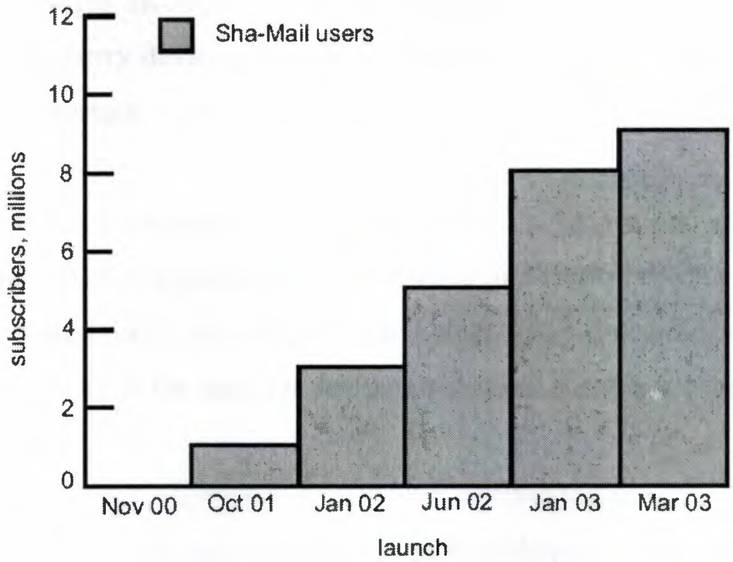

Figure 2.3 Sha-Mail Growths in Subscribers

2.4.4 RIM's Blackberry

In the context of mobile communications, it was shown earlier that Internet electronic mail solutions have proven to be very impractical to use without a minimum of adaptation to the constraints of mobile devices and networks. The major barriers to the success of these solutions are the 'pull' model for retrieving messages, which requires frequent accesses to the email server and the fact that server access protocols are not bandwidth efficient. In order to offer an Internet electronic mail service scaled to the requirements of mobile subscribers, the Canadian company Research in Motion (RIM) designed a set of extensions for the existing Internet email service. This extended service, offered to subscribers under the denomination 'Blackberry service', bypasses email inadequacies to the mobile domain by enabling

- A push model for message retrieval.
- Compression of messages.
- An encryption of messages.

Two main configurations are available for the Blackberry service. The first configuration limits the impact on existing email architectures by integrating a 'desktop' Blackberry application (the Blackberry desktop redirector) in the user's personal computer used for accessing email messages. When the user is on the move, the desktop application intercepts incoming messages, compresses them, encrypts them and pushes them to the Blackberry device via a mobile network. The other way round, the user can compose a new message with the Blackberry device.

The message is compressed and encrypted by the device and sent via the mobile network to the desktop application. The desktop application receives the message (by polling the email server), decompresses and decrypts it and sends it normally to the message recipients as if the message had been sent out directly by the user from his/her personal computer.

A more sophisticated configuration of the Blackberry service consists of installing an extension to the email server itself (the Blackberry enterprise server). In the second configuration, the user's personal computer does not have to be left running when the user is on the move. With this configuration, messaging functions performed by the desktop application in the first configuration are performed here by the server extension.

In addition, this configuration also allows the synchronization of calendaring and scheduling data between shared corporate databases and remote Blackberry devices.
The Blackberry service first started in North America and has now been deployed in other countries in Europe (e.g. United Kingdom and France). The service fulfils particularly well the needs of itinerant professional users, who avoid using laptop computers while on the move (because of long dial-up time for accessing email servers, etc.). Compared with the other messaging services described in this section, the Blackberry service targets professional users rather than the mass market of mobile users.

2.5 MMS Added Value and Success Factors

Why design a new messaging service in the form of MMS when there are so many existing services to choose from? In the late 1990s, SMS usage was booming and major mobile market players were looking for new service opportunities to exploit network resources for the coming years. It was understood that SMS was very limited and mobile messaging services had great margins for improvement. The Internet electronic mail available at this time was not optimized enough for low-bandwidth radio networks and input-limited mobile devices. Japanese photo messaging services were under development in a proprietary fashion and therefore could not meet the market demands in all parts of the world. What was then needed was a universal messaging service offering multimedia features to the mass market of mobile users.

MMS builds up from SMS, email and emerging Internet multimedia technologies. It differentiates itself from other messaging services on the following aspects:

- Multimedia capabilities: MMS integrates multimedia features, allowing message contents to be choreographed on the screen of the receiving device. MMS phones typically allow the composition of messages in the form of slideshow presentations composed of sounds, pictures, text and video clips.

- Electronic mail and phone number addressing modes: MMS supports several addressing models, including the Internet addressing mode (e.g. gwenael@ lebodic.net for an Internet user) and the phone number addressing mode (e.g. +33607080402 for a mobile user). Consequently, a message can be addressed to a recipient using an email address or a phone number.

- Efficient transport mechanisms: MMS relies on an efficient message retrieval mechanism.

When a message is awaiting retrieval, it is stored temporarily on the network side. The network provides a short notification to the recipient mobile device, indicating that a message awaits retrieval. The mobile device can then automatically fetch the message and notify the user of the reception of a new message. Alternatively, the mobile device can notify the user that a message is awaiting retrieval, and it becomes the user's responsibility to retrieve the message manually at his/her own convenience. Up to now, communications between the MMS phone and the network are performed with binary protocol data units instead of text-based transactions as commonly found over the Internet. This leads to a more optimal use of scarce radio resources.

Charging framework: Charging is of key importance for operators since it allows the generation of users' bills according to the billing model in place. MMS offers an extensive charging framework, which can feed any operator billing system.

The charging framework leaves freedom to operators for the development of billing models tailored to market specificities.

Future-proof open standards and worldwide acceptance: Last but not the least; MMS is the result of a collaborative work led by major market players from the mobile industry. MMS technical specifications are developed in open standardization forums with the continuous objective of designing a future-proof messaging service meeting the requirements of worldwide markets.

2.6 Usage Scenarios

Two types of usage scenarios are initially targeted for MMS: person-to-person messaging and content-to-person messaging. The person-to-person scenario is the prominent use case for the first wave MMS. The second wave MMS should see the emergence of new innovative content-to-person services.

2.6.1 Person-to-person Messaging

The use of the Multimedia Messaging Service in the person-to-person scenario is tightly associated with the availability of multimedia accessories such as a digital camera or a camcorder. These multimedia accessories may be built into the mobile handset as shown in Figure 2.4 or provided as external accessories that can be connected to the phone. They are used to capture still images and video clips to be inserted in multimedia messages. In this category, photo messaging refers to the typical scenario where the subscriber takes a snapshot of a scene while on the move and sends it as part of a multimedia message to one or more recipients.

The user usually has the possibility to send the message to one or more recipients belonging to the following groups:

• MMS users: Users who have an MMS phone and the corresponding service subscription.

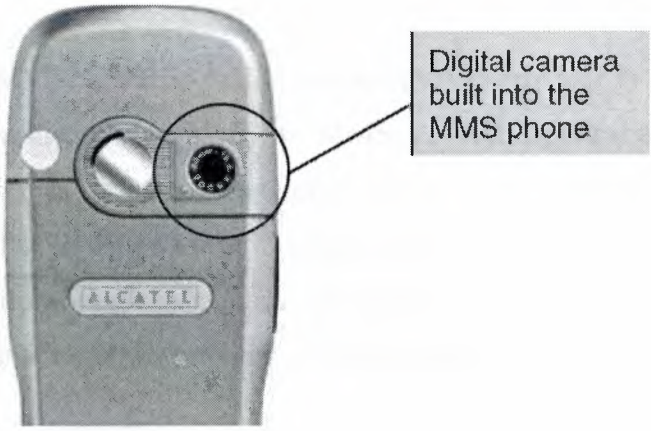

Figure 2.4 Built-In Cameras in MMS Phone

Users of legacy handsets: Users who have a legacy phone without support for MMS. For instance, if a user sends a multimedia message (via MMS) to a legacy user, the network can generate a short message and deliver it (via SMS) to the legacy user. The short message contains the address of an Internet page that can be viewed by the legacy user using any embedded WAP browser. Internet users: Internet users can receive multimedia messages originating from MMS users. Multimedia messages, as generated by MMS phones, are not 'yet' directly understandable by email clients such as Microsoft Outlook or Lotus Notes.

To cope with this issue, the multimedia message is transcoded in the MMS domain to a more suitable form understandable by email clients. Note that a transcoded multimedia message may not represent exactly the contents of the original multimedia message. The slideshow structure of multimedia messages is often lost in the transcoding operation. Owing to the low market penetration of MMS-enabled phones, the usage scenario where a mobile user sends a message to an Internet user is currently the most prominent one in the person-to-person domain. However, this is expected to change in the near future with the rising penetration of MMS-enabled phones.

2.6.2 Content-to-person Messaging

In the context of MMS, a Value-Added Service (VAS) provider is an organization that offers an added-value service based on MMS. A VAS application may provide weather notifications, news updates, entertainment services, location-based information and soon delivered to the phone as a multimedia message. For this purpose, the provider sets up a VAS application, which generates multimedia messages and sends them to one or multiple recipients via the MMS provider infrastructure.

In many cases, the user needs to subscribe first to the value-added service in order to receive corresponding messages. The service can be activated by sending a message to the VAS application.

Mass distribution of information can be achieved with a value-added service. In order to operate a value-added service, the VAS provider has to establish a service agreement with the MMS provider. In particular, such an agreement specifies how the revenue generated by the value-added service is shared between the MMS provider and the VAS provider. The content-to-person scenario is also referred to as the machine-to person scenario.

2.7 Further Applications

Recently, Kodak announced the availability of an online service allowing mobile users to upload, store, share and order prints of pictures using their MMS phones.
With this service, the mobile user takes a photo with the phone-embedded camera and stores it in an online personal photo album. Later, the user can access and retrieve the photo from the album, forwarding it again to other MMS phones, or order prints of the photo.

MMS can be considered as a building block enabling the development of other services. For instance, it can be envisaged to develop embedded monitoring applications that regularly take photos of critical sites and send messages with these photos to a remote monitoring centre. These applications typically address the requirements of niche markets.

2.8 Summary

This chapter has presented introduction to multimedia messaging service, and we have seen the different between the Multimedia Messaging Service (MMS), Short Message Service (SMS), and the Enhanced Messaging Service (EMS), usage of multimedia message service, and the further applications of the multimedia messaging service.

3. STANDARDIZATION OF MMS

3.1 Overview

Standardization of telecommunications technologies and associated service enablers is of key importance for the development of devices in a multi-vendor environment. In the context of Multimedia Messaging Services (MMS), standards allow mobile devices and network elements to interoperate in an efficient manner. Standardization of MMS does not mean designing from scratch all technologies required for enabling interoperable communications. Instead, standardization means identifying the most appropriate elements in the basket of existing technologies in order to allow a rapid roll-out of the service, creating new technologies only when no appropriate solution exists.

Compared with other mobile messaging services such as the Short Message Service (SMS) and the Enhanced Messaging Service (EMS), the standardization picture for MMS has become very complex. Several standardization organizations have collaborated in order to produce stable technical specifications for MMS in a timely manner.

Organizations that have been actively involved in the design of MMS standards are the Third Generation Partnership Project (3GPP) and the Wireless Application Protocol (WAP) Forum. Since 2002, the WAP Forum has merged with other bodies to form the Open Mobile Alliance (OMA). Consequently, MMS activities of the WAP Forum have now been transferred to OMA. Most MMS standards produced by these organizations partially rely on existing technologies developed by bodies such as World Wide Web Consortium (W3C) and Internet Engineering Task Force (IETF).

For any engineer involved in designing solutions based on MMS standards, it becomes essential to acquire a basic understanding on how standardization bodies proceed to produce standards. Most importantly, engineers need to identify dependencies linking MMS standards among themselves and understand how standards get created, reach a mature stage and evolve over time. For this purpose, this chapter introduces the working procedures of organizations outlined below and provides an insight of their organizational structure in terms of working groups. Rules for numbering/referencing MMS standards are explained and illustrated with examples.

Regional standardization bodies from Europe, North America, Korea, Japan and China. The prime objective of 3GPP is to develop UMTS technical specifications. It is also responsible for maintaining existing GSM specifications and developing further GSM extensions (e.g. GPRS). This encompasses the development of widely accepted technologies and service capabilities. 3GPP is strongly involved in the development of MMS standards (general service requirements, architecture, formats and codec's and several low-level technical realizations).

• Third Generation Partnership Project 2 (3GPP2): 3GPP2 is another standardization partnership project established out of the International Telecommunication Union's (ITU) International Mobile Telecommunications "IMT-2000" initiative.
The role of 3GPP2 is to produce specifications for industrial players from North American and Asian markets with focus on next-generation CDMA networks. In the scope of this project, 3GPP2 looks at refining requirements for MMS and designing alternative realizations of interfaces defined in 3GPP and OMA standards.

• WAP Forum: The Wireless Application Protocol (WAP) Forum was a joint project for the definition of WAP technical specifications. This encompassed the definition of a framework for the development of applications to be executed in various wireless platforms. The WAP Forum produced the initial MMS standards for the support of MMS in the WAP environment.

• Internet Engineering Task Force (IETF): IETF is a large community of academic and industrial contributors that defines the protocols in use on the Internet.

• World Wide Web Consortium (W3C): W3C is a standardization body that concentrates on the development of protocols and formats to be used in the World Wide Web. Well-known formats and protocols published by W3C are the Hypertext Transfer Protocol (HTTP) and the extensible Modeling Language (XML).

• Open Mobile Alliance (OMA): OMA is a standardization forum established in June 2002. Activities of several existing standardization bodies including the ones of the WAP Forum (MMS and others) have been transferred to OMA. OMA is therefore actively involved in maintaining MMS standards designed by the WAP Forum and producing new standards for next generations of MMS devices.

3.2 MMS Standards

MMS is a sophisticated multimedia messaging service and has required a tremendous standardization workload. Several standardization bodies have therefore collaborated in order to produce the technical specifications to allow the introduction of MMS capable devices on the market at the most appropriate time. In this configuration, 3GPP has taken the lead in identifying the high-level service requirements, designing the MMS architecture, producing several low-level technical realizations and identifying appropriate codec's/formats and streaming protocols. On the other hand, the WAP Forum took the responsibility of defining the low-level technical realizations of the interface bridging the MMS phone and the network in the WAP environment. Additionally, a group of telecommunications vendors, known as the MMS-IOP group, also produced specifications (the MMS conformance document) to guarantee the interoperability between first MMS devices. In 2002, MMS activities of the WAP Forum and the MMS-IOP group were merged into OMA to allow a more efficient standardization development process for MMS. Of course, 3GPP and the WAP Forum/OMA did not produce all MMS specifications from scratch and did manage to build up. MMS standards on the basis of existing proven standards such as the ones produced by W3C and IETF, developing new technologies only when not available elsewhere.

Regarding this collaborative work, the standardization picture for MMS is becoming more and more complex as the MMS standards evolve. It becomes difficult for developers of applications to understand the dependencies linking MMS standards produced by different organizations and to value the level of maturity of available standards.

3.3 Third Generation Partnership Project

The European Telecommunications Standard Institute (ETSI) and the Conference Europeans des Posts et Telecommunications (CEPT) have carried out work on the GSM standards during a period of almost 18 years. Within the scope of the ETSI standardization organization, the work was carried out by the Special Mobile Group (SMG) technical committee. In 2000, the committee agreed to transfer the responsibility the development and maintenance of the GSM standards to the Third Generation Partnership Project. 3GPP was set up in 1998 by five standard development organizations (including ETSI) with the objective of collaborating on the development of interoperable mobile systems (a sixth organization joined the partnership later).The six organizations represent telecommunications companies from five different parts of the world:

- European Telecommunications Standards Institute (ETSI) for Europe.
- Committee T1 for the United States.
- Association of Radio Industries and Businesses (ARIB) for Japan.
- Telecommunications Technology Committee (TTC) for Japan.
- Telecommunications Technology Association (TTA) for Korea.
- China Wireless Telecommunication Standard (CWTS) for China.

Each individual member of one of the six partners can contribute to the development of 3GPP specifications. In order to define timely services and technologies, individual members are helped by several market representative partners. At the time of writing this book, 3GPP market representatives were the UMTS Forum,1 the Global mobile Suppliers Association (GSA),2 the GSM Association (GSMA),3 the IPv6 Forum,4 the 3G.IP focus group5 and the 3G Americas.6 The responsibility of these market representative partners consists of identifying requirements for 3G services. In this process, the six partner organizations take the role of publishers of 3GPP specifications. It has to be noted that large parts of the 3GPP work, such as SMS and MMS are also applicable to 2G and 2.5G systems.

3.3.1 3GPP Structure

The 3GPP standardization process strictly defines how partners should coordinate the standardization work and how individual members should participate in the development of specifications. There is a clear separation between the coordination work of 3GPP partners and the development of specifications by individual members. This separation enables a very efficient and robust standardization process. In order to achieve it, the 3GPP structure is split into the Project Coordination Group (PCG) and five Technical Specifications Groups (TSGs). The PCG is responsible for managing and supervising the overall work carried out within the scope of 3GPP, whereas TSGs create and maintain 3GPP specifications. PCG and TSGs endeavor to reach consensus on all issues. However, decisions in PCG and TSGs can be made by vote if consensus cannot be reached. In each TSG, several working groups (WGs) create and manage specifications for a set of related technical topics (for instance CN WG5

deals with the set of technical topics related to the Open Service Architecture). If the set of technical topics is too broad, then a WG may be further split into Sub Working Groups (SWGs). This is the case for T WG2 (or also T2 for short), which deals with mobile terminal services and capabilities. T2 is split into three SWGs:

- T2 SWG1 deals with the Mobile Execution Environment (MExE).
- T2 SWG2 deals with user equipment capabilities and interfaces.
- T2 SWG3 deals with messaging aspects. Activities of sub-working group T2 SWG3 encompass the development of messaging services and technologies including SMS, EMS, Cell Broadcast Service and MMS. Figure 3.1 shows the list of 3GPP TSGs and corresponding WGs. Note that all TSGs are responsible for their own work items and specifications. However, TSG SA, being responsible for the overall architecture and service capabilities, has an additional responsibility for cross TSG coordination.

3.3.2 3GPP Specifications: Release, Phase and Stage

Documents produced by the 3GPP are known as specifications. Specifications are either Technical Specifications (TS) or Technical Reports (TR). Technical specifications define a GSM/UMTS standard and are published independently by the six

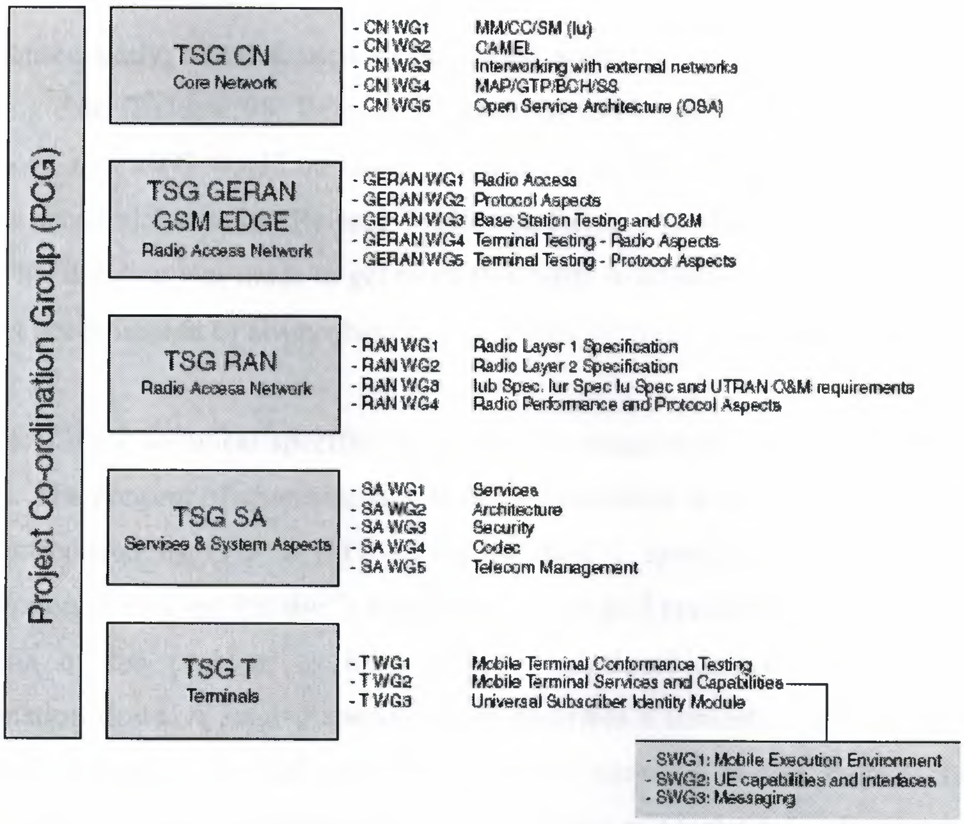

Figure 3.1 3GPP Structure

Partners (ETSI, Committee T1, ARIB, TTC, TTA and CWTS). Technical reports are, for example, feasibility studies for new features/services and they sometimes become technical specifications later. In order to fulfill ever-changing market requirements, 3GPP specifications are regularly extended with new features. To ensure that market players have access to a stable platform for implementation and, meanwhile, to allow the addition of new features, the development of 3GPP specifications is based on a concept of parallel releases.

In this process, specifications are regularly frozen. Only essential corrections are permitted for a frozen specification. New work can still be carried out but will be incorporated in the next release of the same specification. An engineer implementing a commercial solution based on one or more 3GPP standards should, as much as possible, base the work on frozen specifications. An unfrozen specification is subject to change and should never be considered as a stable platform on which to build a commercial solution. In 3GPP, technical specifications are typically frozen in intervals of one to one-and-a-half year.

Consequently, releases used to be named according to the expected specification freezing date (Release 98, Release 99, etc.). In 1999, the 3GPP decided that releases produced after 1999 would no longer be named according to the year but according to a unique sequential number (Release 5 followed Release 4, which itself followed Release 99). This decision was made to get more flexibility in adjusting the timing of releases to market needs instead of always having one release per year.

Each 3GPP technical specification is usually categorized into one of three possible stages. The concept of characterizing telecommunication services into three stages was first introduced by ITU in [ITU-I.130]. A stage 1 specification provides a service description from a service-user's perspective. A stage 2 specification describes a logical analysis of the problem to be solved, a functional architecture and associated information flows. A stage 3 specifications describes a concrete implementation of the protocols between physical elements onto the elements of the stage 2 functional architecture. A stage 3 implementation is also known as a technical realization.

3.4 WAP Forum Specifications

Prior to its integration in OMA, the WAP Forum concentrated on the definition of a generic platform for the development of applications for various wireless technologies. The WAP Forum was organized into functional areas as shown in Figure 3.2 the WAP Forum used to manage four types of technical documents:

• Specification: A specification contains technical or procedural information. At any given time, a specification is associated with a stage such as proposal, draft and so on. This stage indicates the level of maturity of the specification content.
• Change Request (CR): An unofficial proposal to change a specification. A change request is proposed by one or more individuals for discussion between WAP Forum members.
• Specification Change Document (SCD): An SCD is the draft of a proposed modification of a specification. An SCD can only be produced by the specification

working group responsible for the corresponding specification. An SCD applies to a specific version of a specification.

• Specification Implementation Note (SIN): An SIN is an approved modification of a previously published specification. SINs are used to fix bugs or to revise an existing approved specification. A SIN applies to a specific version of a specification.

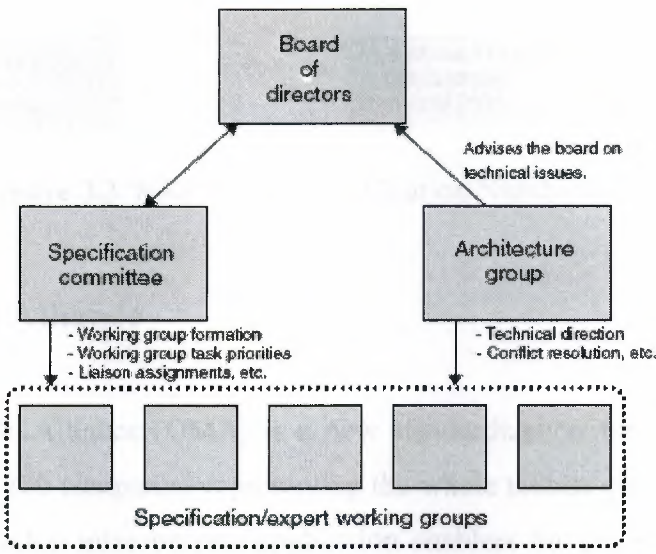

Figure 3.2 WAP forum Organizations

A WAP Forum document is identified by a Document Identifier (DID). A specification keeps its associated DID for its entire lifespan (all revisions of the specification and the approved specification).

WAP Forum specifications are named according to the convention outlined in Figure 3.3 Only approved specifications should be considered as a basis for the development of WAP-based solutions.

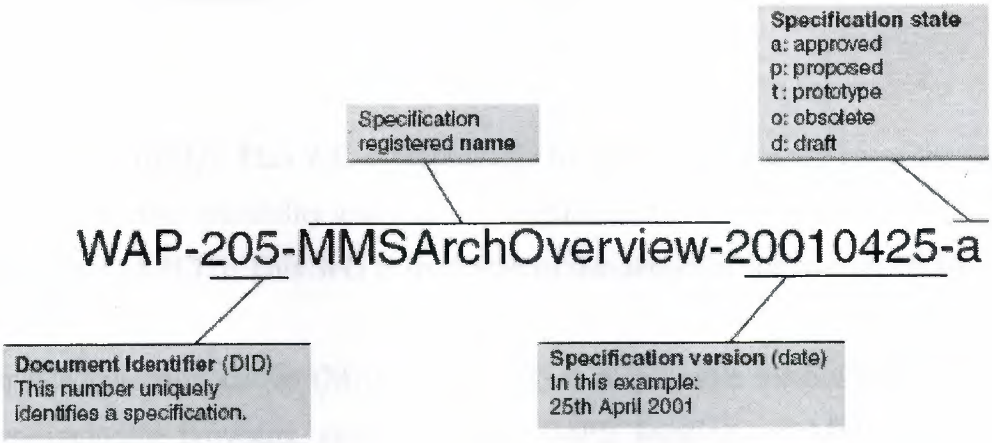

Figure 3.3 WAP Forum Specification Numbering

3.5 Open Mobile Alliance

The Open Mobile Alliance (OMA) is a new standardization forum established in June 2002 by nearly 200 companies representing the whole mobile services value chain. It is chartered to develop interoperable application enablers for the mobile industry. It designs specifications for applications enablers, which are bearer-agnostic and independent from any operating system. OMA was not created from scratch but was rather organized as a merge of several existing standardization forums. These forums, with sometimes overlapping activities, included the WAP Forum, the Wireless Village (WV), the MMS Interoperability Group (MMS-IOP), the Sync ML Initiative, the Location Interoperability Forum (LIF), the Mobile Wireless Internet Forum (MWIF) and the Mobile Games Interoperability Forum (MGIF).

3.5.1 OMA Organization

In the OMA organization, the technical plenary is a chartered standing committee of the board of directors. The technical plenary is responsible for technical specification drafting activities, approval and maintenance of technical specifications and resolution of technical issues. The organization of OMA is depicted in Figure 3.4. The task of OMA working groups (WG) is to accomplish the technical work as defined by the technical plenary. On the other hand, committees are responsible for establishing rules for OMA operations and processes and for controlling the release of OMA specifications. Responsibilities of OMA working groups and committee are described below:

• Requirements (REQ): This WG is responsible for identifying the use cases for services and identifying interoperability and usability requirements.
• Architecture (ARCH): This WG is in charge of the design of the overall OMA system architecture.
• Mobile Application Group (MAG): This WG is responsible for building application enablers including browsing, synchronization, IMPS, location and MMS. Activities of this WG are delegated to sub-working groups. The MMS Sub-working Group (MMSG) is responsible for the design of OMA MMS standards.
• Mobile Web Services (MWS): This WG is responsible for defining application enablers for web services in OMA.

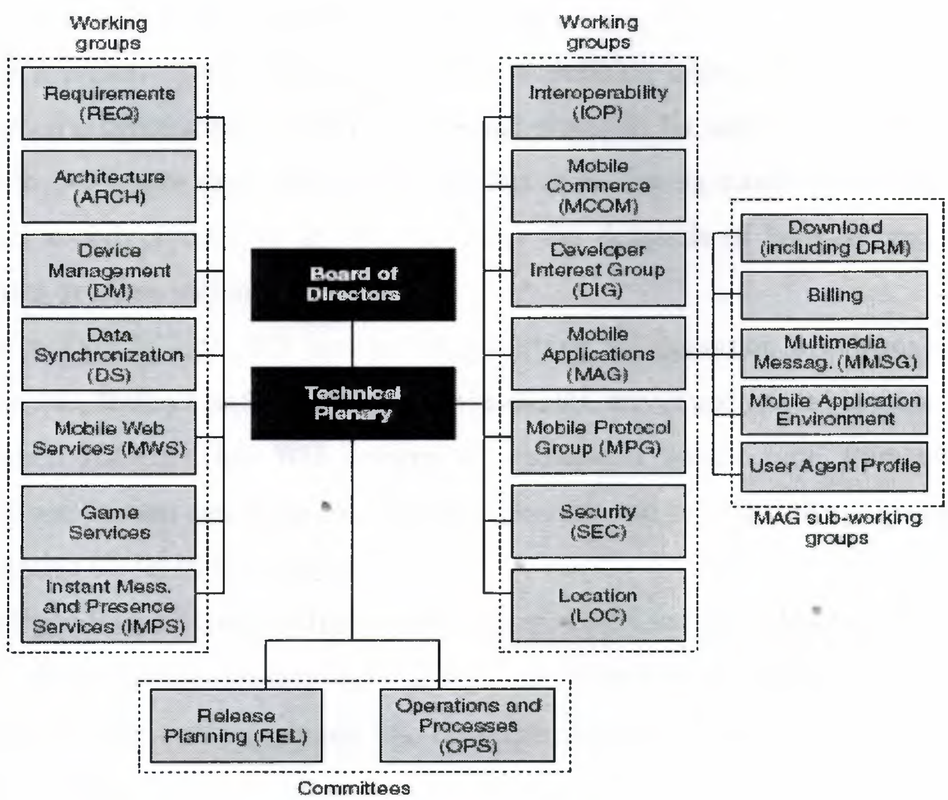

Figure 3.4 OMA Organization

Instant Messaging and Presence Services (IMPS): The IMPS WG's objectives are to identify, specify and maintain the requirements, architecture, and technical protocol/format/interface and interoperability specifications for mobile instant messaging and presence services.

• Interoperability (IOP): This WG focuses on testing interoperability and solving identified issues. Activities of this WG are delegated to sub-working groups (browsing, synchronization, IMPS, location, MMS, etc.).

• Mobile Protocols Group (MPG): This WG is responsible for providing a consolidated and consistent approach within OMA towards the use of generic bearers and protocols (including WSP, WTP and DNS).

Device Management (DM): This WG is in charge of specifying protocols and mechanisms that achieve management of devices (e.g. configuration settings, operating parameters, software installation and parameters, application settings, user preferences).

• Data Synchronization (DS): This WG designs specifications for data synchronization (including but not limited to the Sync technology).

• Game services: This WG is responsible for defining interoperability specifications, application programming interfaces (APIs) and protocols for network-enabled gaming.

• Mobile Commerce (MCOM): This WG aims at producing standards for technologies enabling mobile commerce in order to meet the demands of banking and financial industries, retailers and mobile users.

• Security (SEC): This WG focuses on specifying the operation of adequate security mechanisms, features and services by mobile clients, server and related entities.

• Location (LOC): This WG designs an end-to-end architectural framework with relevant application and contents interfaces, privacy and security, charging and billing, and roaming for location-based services.

• Developer Interest Group (DIG): In this group, OMA software developers are able to express their requirements into OMA as input for other working groups.

In addition to the working groups, two committees are part of the OMA organization as described below:

• Operations and Processes (OPS): This committee provides support for OMA operation and process activities. This includes the support for liaising with other forums, the assessment for IT requirements and staffing needs and so on.

• Release Planning (REL): This committee is responsible for planning and managing OMA releases according to OMA specifications and interoperability testing (IOT) programmers.

3.5.2 OMA Specifications

The OMA process for publishing public technical specifications is based on the delivery of enabler releases and interoperability releases. An enabler release is a set of specifications required for enabling the realization of a service such as MMS, browsing, digital rights management and so on. OMA technical specifications in a draft stage are only made available to OMA members and should not be considered as mature inputs for the design of commercial solutions.

When a set of technical specifications has gained enough maturity to be considered for the development of commercial solutions, then OMA publicly releases the set of specifications in the form of an enabler release. Enabler releases evolve over a scale of two maturity phases as shown below:

• Candidate enabler release (phase 1): A candidate enabler release is an approved set of OMA specifications forming the basis of product implementations, which can be tested for interoperability.

• Approved enabler release (phase 2): An approved enabler release has passed phase 1 (candidate release), and associated interoperability test cases have been designed by OMA

Additionally, multiple approved enabler releases (phase 2) can be grouped into a single interoperability release (phase 3). For this purpose, a set of devices conforming to the approved enabler releases are required to pass end-to-end interoperability tests.

An OMA specification is uniquely identified as shown in Figure 3.5

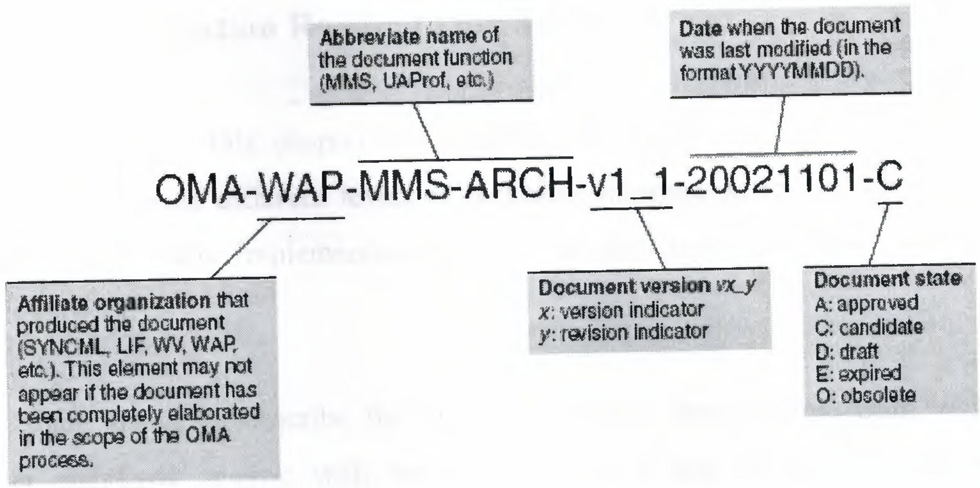

Figure 3.5 OMA Specification Numbering

3.5.3 Available Documents

At the time of writing, several sets of OMA specifications had been made publicly available. This includes the following candidate enabler releases (phase 1) – August 2003 status:

- OMA Billing Framework v1.1 (2 documents)
- OMA Browsing v2.1 (18 documents)
- OMA Client Provisioning v1.1 (6 documents)
- OMA DNS v1.0 (2 documents)
- OMA Digital Rights Management v1.0 (4 documents)
- OMA Download v1.0 (2 documents)
- OMA Email Notification v1.0 (2 documents)
- OMA IMPS v1.2 (17 documents)
- OMA Multimedia Messaging Service v1.1 (5 documents)
- OMA User Agent Profile v1.1 (3 documents)
- OMA User Agent Profile v2.0 (2 documents).

OMA IMPS v1.1 (17 documents) is also publicly available as an approved enabler release (phase 2).

3.6 Standardization Roadmap for MMS

As shown in this chapter, the roadmap of MMS standards is rather complex. Standards provide different levels of technical information to allow MMS experts to build interoperable implementations, while always improving the existing enabling technologies.

Some standards describe the high-level service requirements from which derive other standards dealing with service architecture and interactions between MMS devices. Other standards identify formats and codec's used in the context of MMS, whereas some others concentrate on billing and charging aspects. 3GPP and OMA have designed major MMS standards required for designing MMS solutions. These standards rely on existing generic standards developed by W3C and IETF. Table 3.1 presents a general organization of 3GPP and OMA MMS standards around the four following specification sets:

• MMS requirement specifications, service aspects and technical realizations.
• MMS codec's and support of streaming.
• MMS charging aspects.
• MMS-related files in the SIM/USIM.

Table 3.1 MMS Standard Sets

3GPP standards	WAP forum OMA standards	Features
MMS Release 99	MMS 1.0	Basic features: • Message notification • Message sending/retrieval • Delivery and read reports • Address hiding • Definition of the MM1 interface • WAP configuration: WSP and HTTP.
MMS Release 4	MMS 1.1	Additional features: • Reply charging • Forward from notification • Enhanced read report management • Message sending/retrieval over secure connections • Support of MMS settings and notifications in (U)SIM • Definition of the MM4 interface/Updates of MM1 interface • WAP stack configurations: WSP and HTTP.
MMS Release 5	MMS 1.2	Additional features: • Persistent network-based storage of message (MMBox). • Detailed message notification • Message distribution indicator • Definition of the MM7 interface/Updates of MM1 and MM4 interfaces • WAP stack configurations: WSP and HTTP.

3.7 Summary

This chapter has presented multimedia messaging service standards, third generation partnership project and the structure of it, WAP forum specifications, open mobile alliance (OMA), the (OMA) process for publishing public technical specifications is based on the delivery of enabler releases and interoperability releases, the roadmap of MMS standards is rather complex. Standards provide different levels of technical information to allow MMS experts to build interoperable implementations.

4. SERVICE ARCHITECTURE

4.1 Overview

Before going deeper into the description of features offered by the Multimedia Messaging Service (MMS), it is important to understand the role of each element composing the MMS architecture. This architecture encompasses network elements required for managing MMS devices and routing multimedia messages according to user or service provider instructions in a multi-vendor environment. Network elements communicate over a set of eight identified interfaces. Interaction protocols for several of them have been standardized to ensure maximum interoperability while others are unfortunately still the subject of proprietary implementations.

One of the key interfaces in the MMS architecture enables communications between the MMS phone and the network element in charge of handling all message transactions.
Available realizations of this interface are based on the Wireless Application Protocol (WAP) framework for optimal transfer of messages over bandwidth-limited radio links. This chapter presents the MMS architecture and the role of its components. In addition, an overview of the WAP framework is provided and possible realizations of the WAP-based interfaces are explained.

4.2 MMS Architecture

The MMS architecture comprises the software messaging application in the MMS phone. This application is required for the composition, sending and retrieval of multimedia messages. In addition, other elements in the network infrastructure are required to route messages, to adapt the content of messages to the capabilities of receiving devices, and so on. Figure 3.1 shows the general architecture of elements required for the realization of the MMS service.

The MMS client (also known as MMS user agent in the 3GPP terminology) is the software application shipped with the mobile handset, which allows the composition, viewing, sending, retrieval of multimedia messages and the management of reports. For the exchange of a multimedia message, the MMS client that generates and sends the multimedia message is known as the originator MMS client, whereas the MMS

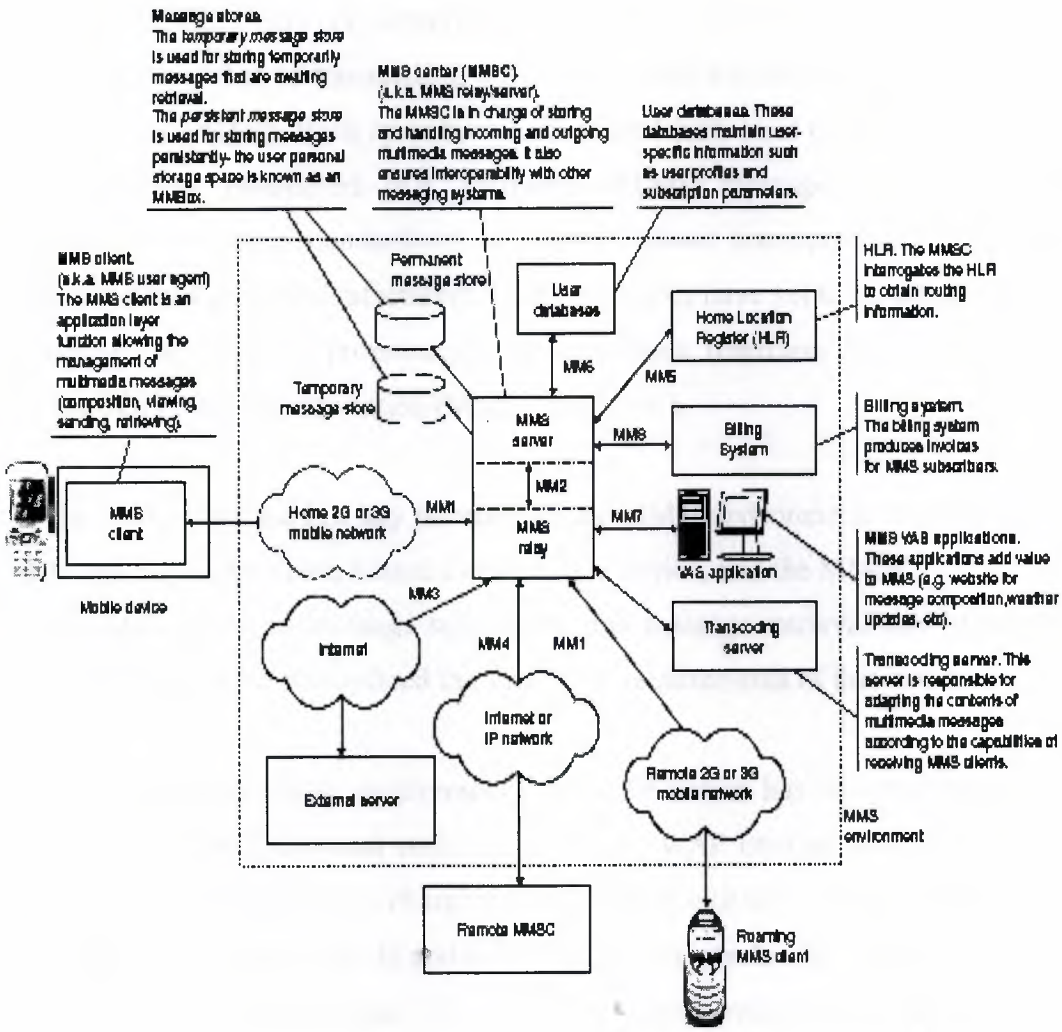

Figure 4.1 MMS Architecture

Client that receives the multimedia message is known as the recipient MMS client. The MMS Environment (MMSE) refers to the set of MMS elements, under the control of a single administration (MMS provider), in charge of providing the service to MMS subscribers. Recipient and originator MMS clients are attached respectively to the recipient and originator MMSEs. A key element in the MMS architecture is the MMS

Centre (MMSC). The MMSC is composed of an MMS relay and an MMS server. The relay is responsible for routing messages not only within the MMSE but also outside the MMSE, whereas the server is in charge of storing messages.

4.3 MMS Interfaces

In an MMSE, network elements communicate via a set of interfaces. Each interface supports a number of transactions such as message submission, message retrieval and message forwarding. Each operation is associated with a set of protocol data units with corresponding parameters (e.g. recipient address, message priority, etc.). Several interfaces have been standardized in order to ensure interoperability between devices produced by various manufacturers. Other interfaces have yet to be standardized and are therefore the subject of proprietary implementations. interfaces are referred to according to the 3GPP naming convention (MM1, MM2, etc.).

• The MM1 interface is a key interface in the MMS environment. It allows interactions between the MMS client, hosted in the mobile device, and the MMSC.
Transactions such as message submission and message retrieval can be invoked over this interface. 3GPP has defined the functional requirements of this interface.

On the basis of these requirements, the WAP Forum has designed associated initial WAP-based MM1 technical realizations for the WAP environment. The Open Mobile Alliance (OMA) is now in charge of maintaining existing technical specifications for existing MM1 realizations. In addition, OMA is responsible for the development of new MM1 technical realizations for the WAP environment according to high-level requirements defined by 3GPP. This interface is also known as the MMSM interface in the WAP/OMA standards.

• The MM2 interface is the interface between the two internal elements composing the MMSC: the MMS server and the MMS relay. Most commercial solutions offer a combined relay and server in the form of an MMSC. Consequently, the interface between the two components is developed in a proprietary fashion. At the time of writing, no technical realization of this interface had been standardized, and it is unlikely that one would ever be standardized. This interface is also known as the MMSS interface in the WAP/OMA standards.

• The MM3 interface is the interface between an MMSC and external servers. Transactions invoked over this interface allow the exchange of messages between MMSCs and external servers such as email servers and SMS Centers (SMSCs).

This interface is typically based on existing IP protocols. MMS standards do not specify exactly how systems should be interconnected, and it is therefore common to adapt this interface to the way the external messaging system already communicates (e.g. Simple Mail Transfer Protocol for email). This interface is also known as the E or L interface1 in the WAP/OMA standards.

• The MM4 interface is the interface between two MMSCs. This interface is necessary for exchanging multimedia messages between distinct MMS environments (e.g. between two distinct mobile networks). 3GPP has standardized this interface in the Release 4 timeframe. Transactions invoked over this interface are carried out over the Simple Mail Transfer Protocol (SMTP). This interface is also known as the MMSR interface in the WAP/OMA standards.

• The MM5 interface enables interactions between the MMSC and other network elements. For instance, an MMSC can request routing information from the Home Location Register (HLR) or from a Domain Name Server (DNS).

• The MM6 interface allows interactions between the MMSC and user databases (e.g. presence server). Unfortunately, the MM6 interface is yet to be standardized.

• The MM7 interface fits between the MMSC and external Value Added Service (VAS) applications. This interface allows a VAS application to request services from the MMSC (message submission, etc.) and to obtain messages from remote MMS clients. Prior to 2003, implementations of this interface were all proprietary. 3GPP completed the work on the MM7 interface in the Release 5 timeframe, and commercial implementations of the standardized interface are about to appear on the market.

• The MM8 interface enables interactions between the MMSC and a billing system. 3GPP has standardized Charging Data Records (CDR) that are generated by the MMSC on the occurrence of certain events (e.g. message submission, message retrieval, etc.). Unfortunately, the interface used for the transfer of CDRs from the MMSC to the billing system has not been standardized yet.

4.4 MMS Client

The MMS client is the software application that resides in MMS-enabled mobile devices and which offers the following features:

• Management of message, notification and reports: Devices are commonly shipped with a unified message box for the management of MMS elements (messages, notifications and reports) and other elements such as SMS/EMS messages, WAP push messages, and so on.

• Message composition: The message composer is used for creating new multimedia messages.

• Message viewing: The message viewer is used to render received messages or to preview newly created messages before sending.

• Configuration of MMS preferences and connectivity parameters.

• Handling of a remote message box stored in the user personal network-based storage space. Such storage space is known as a Multimedia Message Box (MMBox). The support of an MMBox is optional.

4.5 MMS Centre

The MMS Centre (MMSC)2 is a key element in the MMS architecture. The MMSC is responsible for handling transactions from MMS phones and transactions from other messaging systems (e.g. other MMS systems, email systems, etc.). The server is also in charge of temporarily storing messages that are awaiting retrieval from recipient MMS clients. Optionally, the server may also support a persistent message store where users can store messages persistently in their MMBoxes. This feature is particularly useful when devices have limited storage capabilities.

2 The MMSC is also known as the MMS Proxy/Relay (WAP/OMA standards) or the MMS Relay/ The MMSC may rely on the WAP content negotiation mechanism to adapt multimedia messages to the capabilities of receiving devices. For this purpose, the MMSC has built-in trans coding capabilities or is connected to an external trans coding server as shown in Figure 4.1. The transport protocol for the interface connecting the MMSC and an external Trans coding server has not yet been standardized. However, OMA is carrying some work on the definition of such an interface.

4.6 Wireless Application Protocol

With available MMS implementations, all MMS devices communicate with the network over the Wireless Application Protocol. WAP is the result of a collaborative work between many wireless industry players, carried out in the scope of the WAP Forum.

The forum, launched in 1997 by Nokia, Phone.Com (now Openwave), Motorola and Ericsson, produced technical specifications enabling the support of applications over various wireless platforms (GSM, GPRS, UMTS, etc.). For this purpose, the WAP Forum identified and defined a set of protocols and content formats according to the standardization process presented in Chapter 2. In 2002, activities of the WAP Forum were transferred to another standardization organization: the Open Mobile Alliance.

4.6.1 Introduction to WAP

The WAP technology is an enabler for building applications that run seamlessly over various wireless platforms. The objective of the WAP Forum is to provide a framework for the development of applications with a focus on the following aspects:

• Interoperability: Applications developed by various parties and hosted on devices, produced by different manufacturers, interoperate in a satisfactory manner.

• Scalability: Mobile network operators are able to scale services to subscribers needs.

• Efficiency: The framework offers a quality of service suited to the capabilities of underlying wireless networks.

• Reliability: The framework represents a stable platform for deploying services.

• Security: The framework ensures that user data can be safely transmitted over a serving mobile network, which may not always be the home network. This includes the protection of services and devices and the confidentiality of subscriber data.

In line with these considerations, the WAP technology provides an application model close to the World Wide Web model (also known as the web model). In the web model, content is represented using standard description formats. Additionally, applications known as web browsers retrieve the available content using standard transport protocols. The web model includes the following key elements:

• Standard naming model: Objects available over the web are uniquely identified by Uniform Resource Identifiers (URI).
• Content type: Objects available on the web are typed. Consequently, web browsers can correctly identify the type to which a specific content belongs.
• Standard content format: Web browsers support a number of standard content formats such as the Hyper Text Markup Language (HTML).
• Standard protocols: Web browsers also support a number of standard protocols for accessing content on the web. This includes the widely used Hyper Text Transfer Protocol (HTTP).

The WAP model borrows a lot from the successful web model. However, the web model, as it is, does not efficiently cope with constraints of today's mobile networks and devices. To cope with these constraints, the WAP model leverages the web model by adding the following improvements:

• The push technology allows content to be pushed directly from the server to the mobile device without any prior explicit request from the user.
• The adaptation of content to the capabilities of WAP devices relies on a mechanism known as the User Agent Profile (UAProf).
• The support of advanced telephony features by applications, such as the handling of calls (establishment and release of calls, placing a call on hold or redirecting the call to another user, etc.).

• The External Functionality Interface (EFI) allows 'plug-in' modules to be added to browsers and applications hosted in WAP devices in order to increase their overall capabilities.

• The persistent storage allows users to organize access, store and retrieve content from/to remote locations.

• The Multimedia Messaging Service (MMS) is a significant added value of the WAP model over the web model. It relies on generic WAP mechanisms such as the push technology and the (UAProf) to offer a sophisticated multimedia messaging service to mobile users. The WAP model uses the standard naming model and content types defined in the web model. In addition, the WAP model includes the following:

• Standard content formats: Browsers in the WAP environment, known as micro browsers, support a number of standard content formats/languages including the Wireless Markup Language (WML) and the Extensible HTML (XHTML). WML and XHTML are both applications of the Extensible Markup Language (XML).

• Standard protocols: Micro browsers communicate according to protocols that have been optimized for mobile networks, including the Wireless Session Protocol (WSP) and HTTP from the web model.

The first WAP technical specifications were made public in 1998 and have since evolved to allow the development of more advanced services. The major milestones for WAP technology were reflected in the availability of what the WAP Forum called 'specifications suites'. Each specification suite contains a set of WAP technical specifications providing a specific level of features as shown in Table 4.1.

With WAP specification suites 1.x, the WAP device communicates with a web server via a WAP gateway. Communications between the WAP device and the WAP gateway is performed over WSP. In addition, WAP specification suite 2.x allows a better convergence of wireless and Internet technologies by promoting the use of standard protocols from the web model.

4.6.2 WAP Architecture

Figure 4.2 shows the components of a generic WAP architecture. The WAP device can communicate with remote servers directly or via a number of intermediary proxies. These proxies may belong to the mobile network operator or alternatively to service providers. The primary function of proxies is to optimize the transport of content from servers to WAP devices.

Supporting servers, as defined by the WAP Forum, include Public Key Infrastructure (PKI) portals, content adaptation servers and provisioning servers.

4.6.3 Push Technology

In a typical client/server model, a client retrieves the selected information from a server by explicitly requesting the download of information from the server. This retrieval method is also known as the pull technology since the client pulls some data from a server. Internet browsing is an example of models based on pull technology.

Table 4.1 WAP Forum Specification Suites

WAP Forum specification suite	Delivery date	Description
WAP 1.0	April 1998	Basic WAP framework Almost no available commercial solutions since the published standards did not allow the design of interoperable solutions.
WAP 1.1	June 1999	First commercial solutions supporting: • Wireless Application Environment (WAE) • Wireless Session Protocol (WSP) • Wireless Transaction Protocol (WTP) • Wireless Markup Language (WML) • WML script
WAP 1.2	Nov. 1999	Additional features: • Push • User Agent Profile (UAProf) • Wireless Telephony Application (WTA) • Wireless Identity Module (WIM) • Public Key Infrastructure (PKI)
WAP 1.2.1	June 2000	Minor corrections
WAP 2.0	July 2001	Convergence with Internet technologies. Additional features: • Support of MMS 1.0 (3GPP Release 99) • HTTP, TCP, persistent storage • XHTML, SyncML, client provisioning, etc.

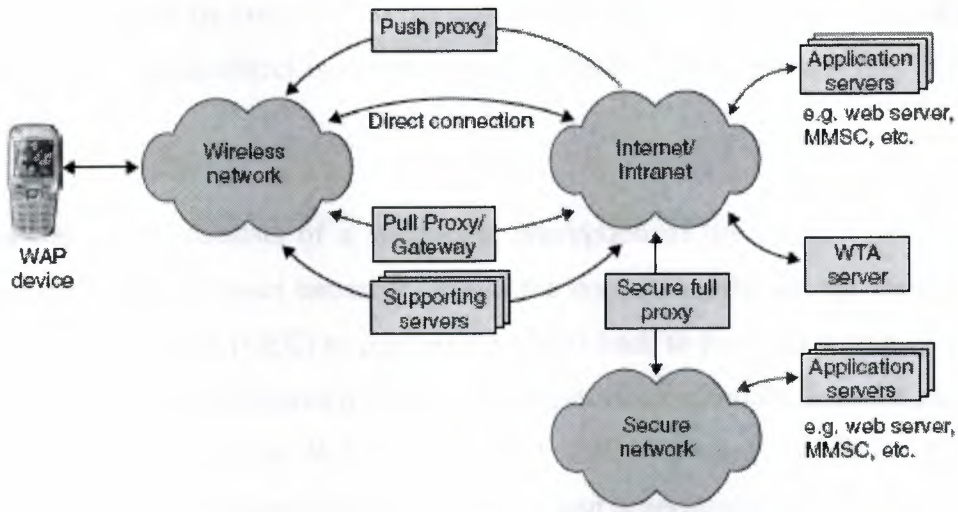

Figure 4.2 Generic WAP Architecture

4.7 OMA Digital Rights Management

At the end of 2002, OMA published technical specifications [OMA-DRM] for mechanisms representing the basis for the management of digital rights associated with media objects downloaded via WAP download or MMS. Digital Rights Management (DRM) provides a means, for operators and providers, to control the usage of media objects once they have been downloaded to a mobile device (also known as a 'consuming device' in the DRM context).

DRM enables content providers to define usage rules specifying the user's rights regarding the usage of the corresponding media object. For instance, a content provider can grant a user the rights to preview for free and charge for more sophisticated usages. Three main mechanisms are defined in OMA-DRM as shown in Figure 4.3. They differ in the way rights are communicated to the consuming device:

• Forward lock is the simplest of the OMA-DRM mechanisms. This is a special case of the combined delivery mechanism in which the DRM message contains only the media object, without the associated rights. For forward lock, the following set of rights applies: the user is not allowed to forward or modify the media object.

• Combined delivery consists of delivering the media object along with the associated rights in a single DRM message with separate delivery, the media object and corresponding rights are conveyed to the consuming device over separate transports. In this context, the media object is converted into a DRM Content Format (DCF) [OMA-DRM-CF].

This conversion consists of a symmetric encryption of the original media object, making the converted object unusable, unless the consuming device has the necessary Content Encryption Key (CEK) to convert the object back to its original form. The CEK along with the rights is delivered to the consuming device separately from the associated media object, typically over WAP push. OMA DRM forward lock is of particular interest to the content-to-person scenario of MMS and is applicable from MMS 1.2.

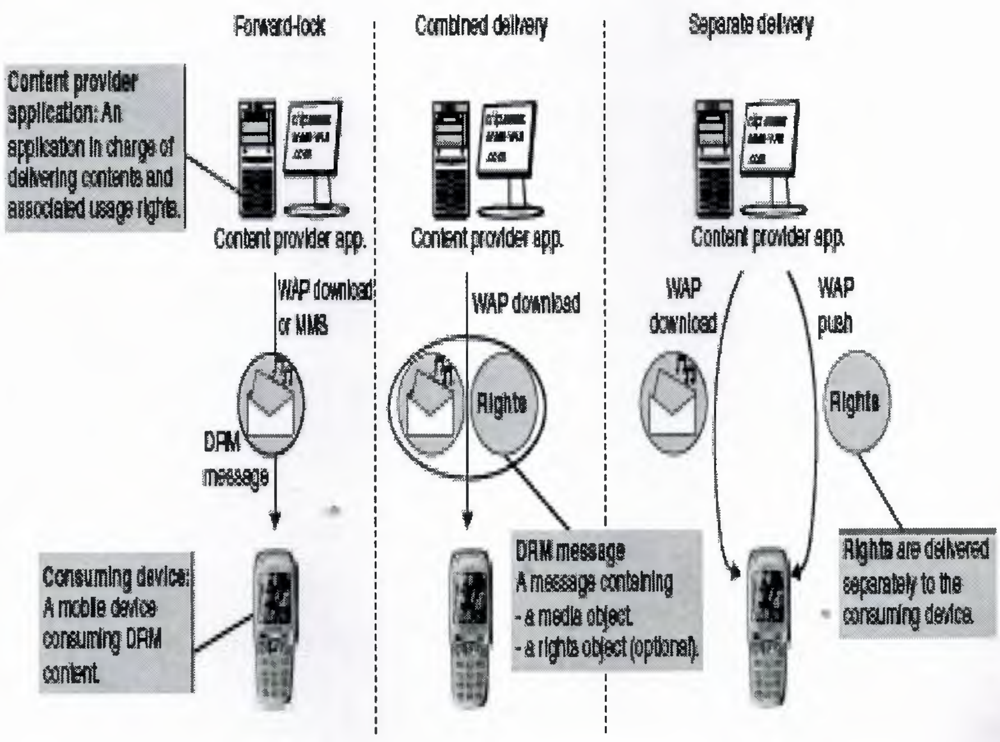

Figure 4.3 OMA Digital Rights Management

4.8 Summary

This chapter has presented the MMS architecture comprises the software messaging application in the MMS phone, the MMS client is the software application that resides in MMS-enabled mobile devices, WAP is the result of a collaborative work between many wireless industry players, carried out in the scope of the WAP Forum.

CONCLUSION

The main elements of the GSM architecture [3GPP-23.002]. The GSM network is composed of three subsystems: the Base Station Subsystem (BSS), the Network Subsystem (NSS), and the Operation Subsystem (OSS). The realization of SMS implies the inclusion of several additional elements in the network architecture (GSM, GPRS, or UMTS).

Each end-to-end feature offered by the Multimedia Messaging Service (MMS) relies on a series of consecutive transactions occurring over one or more of the 11 identified MMS interfaces. These transactions allow the transfer of messages and associated reports between MMS communicating entities including network servers and mobile devices.

MMS entities (MMS clients or MMS centers) communicate by invoking transactions over a set of 11 interfaces. A transaction is typically composed of a service request and a corresponding service response/confirmation containing the transaction results (e.g., message sending request and message sending confirmation). However, several transactions are limited to a service request only and are also known as indications. A Protocol Data Unit (PDU) is associated with each service request, response or indication that can occur over one of the MMS interfaces. A PDU is composed of a set of mandatory, optional, or conditional parameters.

The simplest transaction flow for a message exchange is the one that involves two MMS clients attached to the same MMS Environment (MMSE). In this context, the message exchange usually involves one MMSC only.

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