Fixed network Multimedia Messaging Services: Protocols and Gateway

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Abstract: The paper concerns the Multimedia Messaging Services in a context of Fixed-to-Mobile networks Convergence: problems and official standards are presented and analyzed, so to outline fixedline specific matters from network independent aspects. A practical solution has been designed to provide MMS over PSTN and ISDN fixed telephone networks, in order to get a great level of modularity and reliability. Several and detailed tests have been carried out to verify the complete compliance with F-MMS specifications provided by ETSI.

Key–Words: Fixed network Multimedia Messaging Service (F-MMS), Fixed-to-Mobile Convergence, SMS, ETSI.

1 Introduction

The Fixed to Mobile Convergence (FMC) has to be considered as one of the most interesting and important research engagement of the TLC players to implement the future telecommunication networks.

> "Next Generation Network is a packet-based network able to provide services including Telecommunication Services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It offers unrestricted access by users to different service providers. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users[1]."

FMC aims to provide a seamless integration between mobile and fixed telephone services, like messaging, one of the most successful applications, thanks to the simplest form, Short Message Service (SMS), and its evolution with multimedia capabilities: Multimedia Messaging Service (MMS). In fact, both SMS first, and MMS subsequently, have been initially introduced in the mobile network, and only later in the fixed line environment.

MMS implementations must comply with a complex set of standard rules concerning technical as well as functional aspects, coming mainly from three organizations. 3GPP (Third Generation Partnership Project) defined the basic requisites and general architectural structure of MMS, like codecs and protocols. OMA (Open Mobile Alliance) is a standardization forum with over two hundred companies engaged in the TLC field, whose mission is to produce interoperable service enablers working across countries, operators and mobile terminals. It is involved in maintaining MMS standards concerning the lower level protocols [5]. Finally, ETSI (European Telecommunications Standards Institute) has developed the technical aspects required to provide MMS service within the fixed network environment.

The paper deals with the design and implementation of an F-MMS gateway, i.e. a device capable to provide MMS service with the same functionalities as PLMN (Public Land Mobile Network) on both PSTN (Public Switched Telephone Network) as well ISDN (Integrated Services Digital Network) fixed telecommunication networks.

MMS is built upon a complex and flexible architecture,that encompasses a set of logical elements, each dedicated to specific application functions. This approach allowed to concentrate all aspects relating to underlying network technologies within a single communication interface. This is named MM1 and distinguishes communications between the key component in MMS environment, called MMSC (Multimedia Messaging Service Centre) and an MMS capable phone, called MMTE (Multimedia Messaging Terminal Equipment), in accordance with the ETSI terminology.

[1] http://www.itu.int/ITU-T/studygroups/com13/ngn2004/working_definition.html

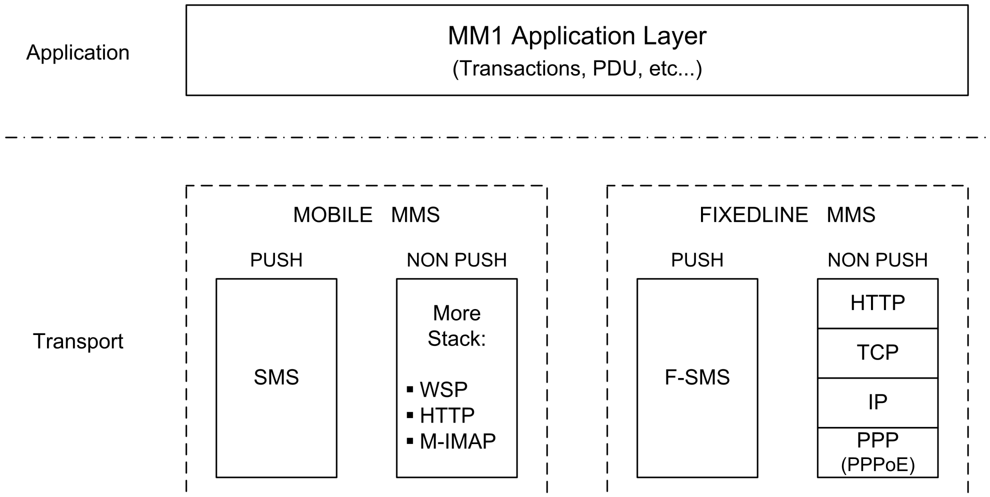

Figure 1: MM1 protocols stack.

2 *F*-MM1: Fixed network MM1 interface

A first step, it is necessary to analyze the basic functionalities of the MM1 interface, with respect to the fixed network telephone environment, named *F*-MM1 in the paper.

The communication between MMTE and MMSC can be split across just two logical protocol layers. The higher one defines the primitives that realize the basic MMS service, like message submission and retrieval. The underlying transport layer deals with the technical details depending on the particular telecommunication bearer. A first step, it is necessary to analyze the basic functionalities of the MM1 interface, with respect to the fixed network telephone environment, named *F*-MM1 in the paper. The communication between MMTE and MMSC can be split across just two logical protocol layers. The higher one defines the primitives that realize the basic MMS service, like message submission and retrieval. The underlying transport layer deals with the technical details depending on the particular telecommunication bearer.

As a result of this “information hiding”, only the transport layer part has to be changed when switching between different contexts, like mobile and fixed networks, while the application layer remains unchanged, as depicted in Fig. 1.

2.1 MM1 Application Layer

MMS is a store-and-forward service: Multimedia Messages (MM) are not sent directly between users, but rather via the MMSC, upon two separate steps, MM submission and MM reception. The latter requires two more steps: MM notification and MM retrieval.

The whole process involves two players: the MO (Message Originator) and at least one MR (Message Recipient). Likewise, we distinguish the service centres MMSC-O (MMSC Originator), that receives the message from MO, and MMSC-R (MMSC Recipient), forwarding the message to the final destination.

These operations are executed by means of transactions, i.e. the protocol primitives that exchange a service request and a corresponding service response, between two MMS entities. Each service request or response carries a Protocol Data Unit (PDU), that is composed of a set of mandatory, optional or conditional parameters. In the following section, submission, notification and retrieval mimics are explained, with remarks on the key parameters for each step.

2.1.1 Submission

Submission is the process by which a user can send a MM towards one or more recipients, either phone numbers or email addresses. It consists of a service request being sent from MMTE-O to MMSC-O, carrying MM content, i.e. multimedia objects, plus a protocol header that includes a transaction identifier. Then, MMSC-O sends back a service response matching that code, with the indication of acceptance or rejection of the MM. Upon successful receipt, it is up to MMS architecture to accomplish/complete message delivery: this means that MMTE-O could have to route MM toward a second MMSC-R, capable to reach recipient clients. The routing process is performed across MM4 interface.

2.1.2 Notification

MMS architecture includes an efficient message retrieval mechanism to face typical scarce radio resources problems of mobile networks. When a message is awaiting retrieval, it is stored temporarily in-

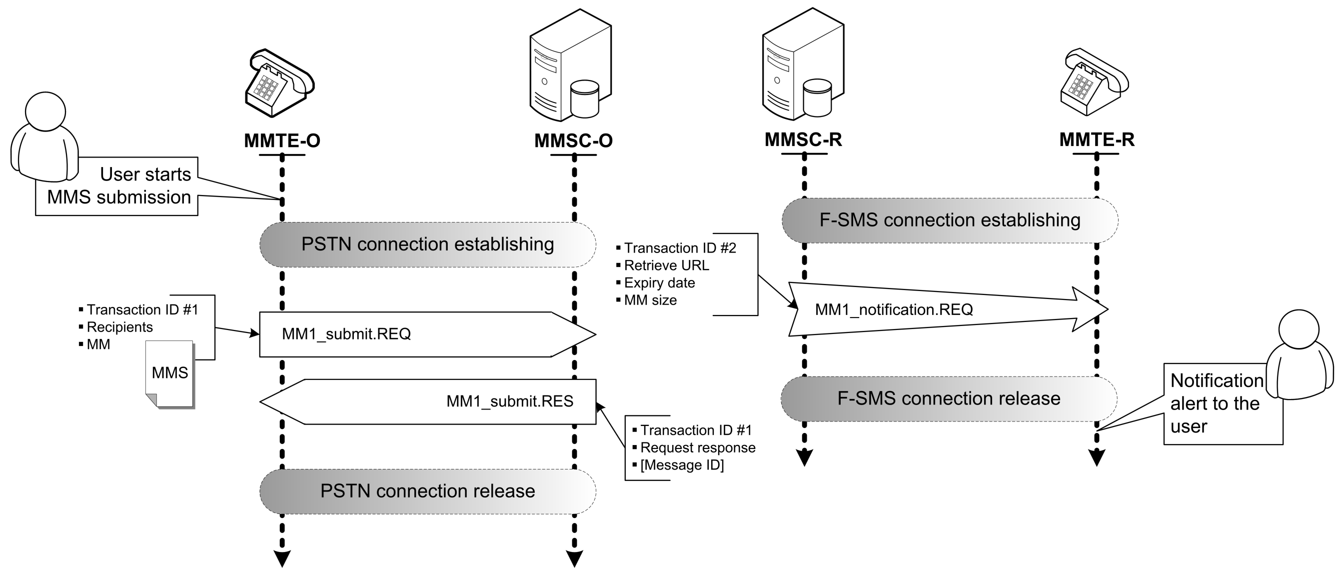

Figure 2: MM submission and notification transactions.

side MMSC-R. Then, just a short notification PDU is provided to MMTE-R, highlighting most relevant data, like originator, subject, size and a message identification for subsequent retrieval. By the way, recipient user can decide whether to retrieve message immediately, later or definitely discard message without having to retrieve it.

The notification message gets sent by MMSC-R to MMTE-R by means of a "push" mechanism, that does not require an active role by the recipient (Fig. 2).

2.1.3 Retrieval

This two-step retrieval mechanism achieves a second important feature: content adaptation. When requesting to retrieve a MM, the recipient device provides to MMSC-R a description of its technical capabilities, together with the message id, got by notification message (Fig. 3). Then, MMSC-R process the MM, removing or adjusting unsupported media contents, so that recipient device can display it correctly. This way, MMS service is granted to end users regardless of terminals heterogeneous capabilities, that are known to evolve very quickly.

2.1.4 Other functionalities / procedures

MMS offers a great variety of supplementary features like message forwarding, delivery and read-reply reports, anonymous messages, message priority, expiry date and so on. These are performed thanks to appropriate protocol transactions and PDUs defined on the Application Layer.

2.2 *F*-MM1 Transport Layer

Communication issues related with the type of telephone network used by MMS are faced and solved within the transport layer. The transactions defined by the application layer can be grouped into two sets, depending on which party begins a given procedure: push and non-push types. It will be shown that each of these is implemented using very different technologies.

2.2.1 Push transactions

When MMSC needs to send some kind of information to a MMTE, as in notification transaction, this is carried out by mean of a push mechanism, i.e. MMSC can send a PDU without waiting for an explicit request from the remote party.

MMS service relies on SMS as push technology and, more precisely, on a particular feature that allows to transport raw binary data within a SMS message (WAP Push). Likewise, F-MMS uses F-SMS, that is the ETSI standard that provides SMS service across a fixed network environment.

Both MM1 and *F*-MM1 interfaces define which information have to be exchanged during a push transaction, but it is up to SMS and F-SMS standards to define the actual transmission across the physical network. As a result, fixed and mobile telephone network differences are hidden by SMS and F-SMS implementations. By the way, those peculiarities can be managed by two specific transport layer gateways, that allow the MMSC to indifferently address both mobile and fixed network users.

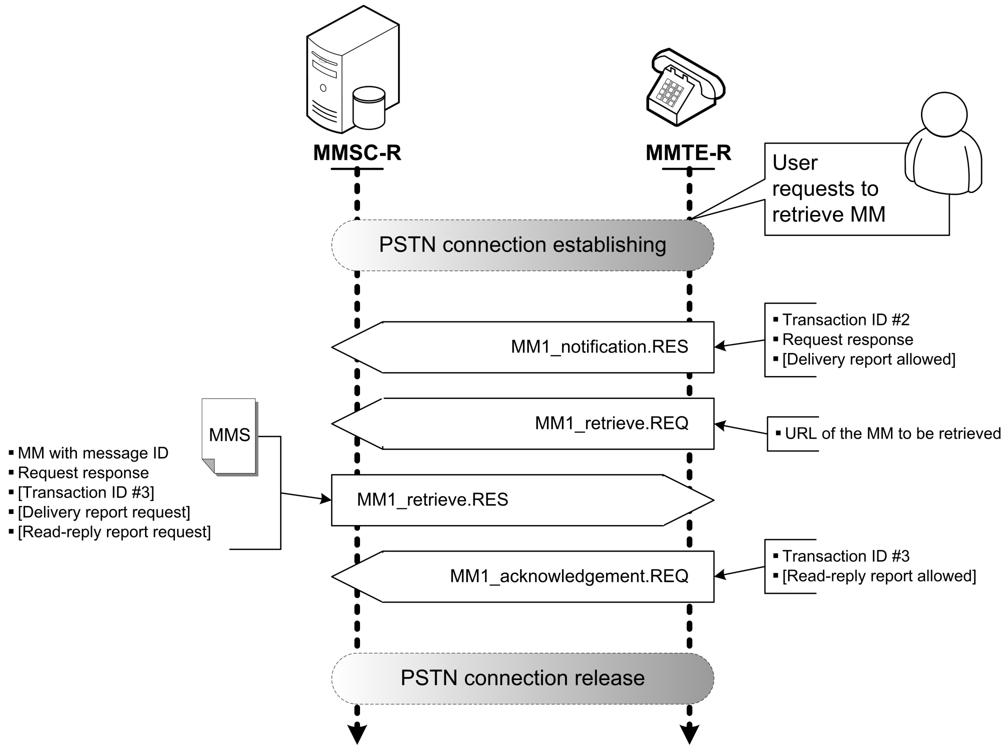

Figure 3: MM complete retrieval transaction.

2.2.2 Non-push transactions

Within "non push" are grouped all the transactions started by MMTE toward MMSC. It is very interesting the strong convergence between the transport layer implementation of non push transactions defined by F-MMS standard and Internet.

As a matter of fact, a standard TCP/IP stack has been adopted, and *F*-MM1 application primitives have been mapped upon standard HTTP methods like POST and GET. At the physical layer, a communication path needs to be established between MMTE and MMSC on the fixed telephone network using either a standard dial-up analogue access (PSTN) or a digital one (ISDN). At the data-link layer, a PPP link allows to run the TCP/IP stack over the physical connection (Fig. 4).

3 *F*-MM1 Gateway

MMS architecture is built around the key role played by MMSC, that is responsible for organizing the interaction between all the parties involved. It has been shown that a MMSC for mobile service is substantially equivalent to a fixed network one: they have to manage the same high level application logic, while using different lower layer protocols to communicate with client terminals.

The benefits that come from the split-up of these two matters can be easily understood, i.e. the MMSC can focus only on higher level logic, leaving lower layer implementation to network-specific components. These are gateways capable of hiding all telephone network related details: from an ISO/OSI like perspective, they realize a service to the MMSC user, that can indifferently communicate with a mobile phone or a fixed line device.

This paper suggests a design and implementation of FMM1 gateway, that is a gateway capable of handling all protocols specified by MM1 interface over fixed PSTN/ISDN telephone network, in compliance with ETSI standards. Among the functionalities that a *F*-MM1 gateway should provide, maybe the most relevant are the management of both "push" and "non push" transactions and terminal authentication based on Calling Line Identity (CLI).

3.1 Structure

The structure of the *F*-MM1 gateway designed here reflects the essential vertical partition that distinguishes the transport layer of *F*-MM1 interface, depending upon the type of transaction being considered. The system is in turn made up by two separate components with distinct roles and implemented with different technologies (Fig. 5).

The first building block is dedicated to manage "push" transactions: it provides a reliable F-SMS communication path toward MMS phones for MMSC. On the other side, a second component has been arranged to receive messages, that are carried out by means of HTTP transactions over a PPP link estab-

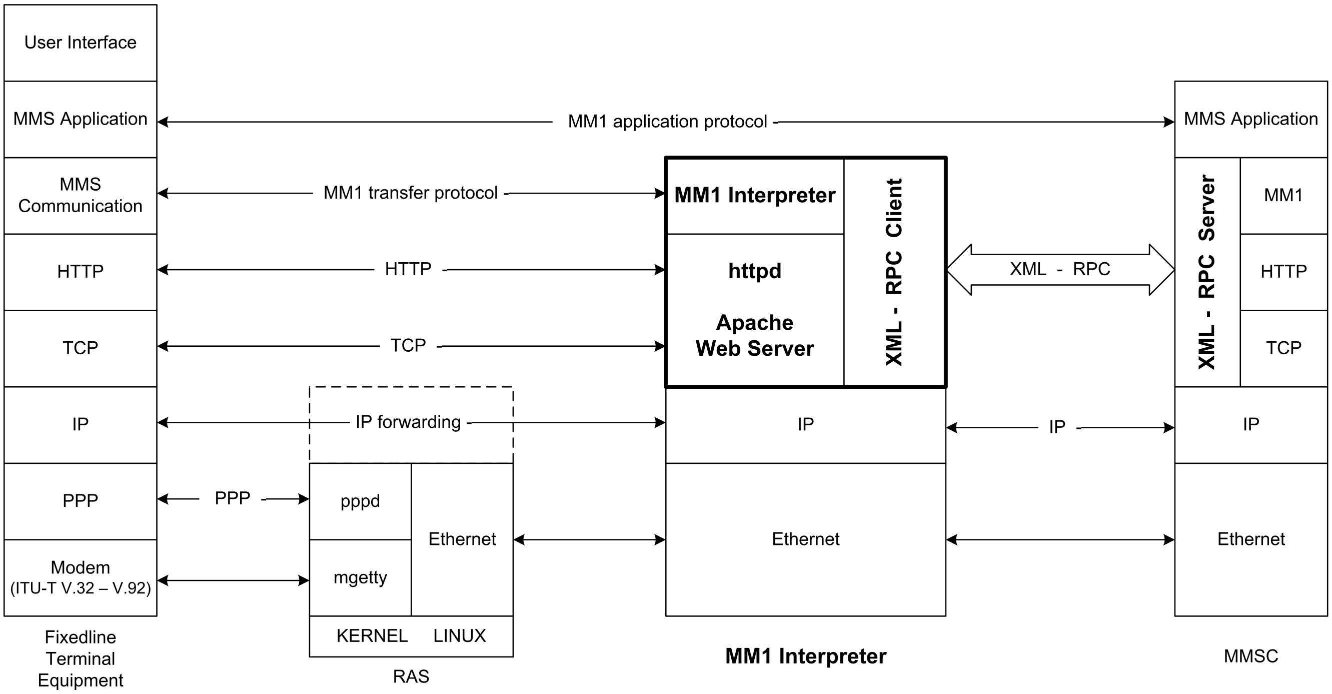

Figure 4: *F*-MM1 gateway protocols stack for "non push" transactions.

lished by a standard dialup connection.

As a result of a global integration, the two components together actually manage all fixed telephone network specific details and provide to MMSC a set of primitives independent of the underlying technologies. The *F*-MM1 gateway uses two types of hardware interfaces - one suitable to communicate with phones and one with MMSC and acts as a translator in the middle.

3.2 Implementation

From an external point of view, the *F*-MM1 gateway is a device connected directly to the PSTN/ISDN fixed telephone network and communicates with the MMSC by means of commands and events, that get sent to MMSC whenever a suitable activity is detected on the network side.

The global interface exposed by the *F*-MM1 gateway has been implemented by an open protocol such as XMLRPC, that provides high reliability, performance and platform-independent third-party integration.

A common feature that has been taken into particular consideration is the implementation of the algorithms to encode and decode MM1 PDUs, that have been designed in compliance with the Wireless Session Protocol (WSP) specifications as stated by official MMS standards.

As said before, the implementation of the two blocks of the *F*-MM1 gateway has been carried out relying on very different technologies, so they will be described separately.

3.2.1 Push transactions implementation

The management of "push" transactions has been implemented relying on the implementation of the F-SMS stack, available from a commercial product, MIDAGateway[2], as depicted in upper area of Fig. 5.

This is a complex gateway suitable for network services, that is capable of managing various types of protocols, including F-SMS. It can be interfaced directly with a PSTN/ISDN fixed telephone network thanks to dedicated hardware resources, via E1 trunk running various types of signalling protocols, like SS7 and DSS1 (EuroISDN).

We designed and implemented directly inside MIDAGateway, the procedures for handling "push" primitives. These have been designed as application commands that MMSC can send to the *F*-MM1 gateway, that will execute them in an asynchronous fashion, so as to increase global performance.

3.2.2 Non-push transactions implementation

Non-push transactions require to handle a whole stack of protocols starting from the physical layer up to an application layer based on the HTTP protocol.

We decided to split up into two sub-systems the component responsible to manage non push transactions, as depicted in lower area of Fig. 5. More precisely, lower layers, both physical and data-link, are

[2]MIDAGateway is a product by Mida Solutions s.r.l.

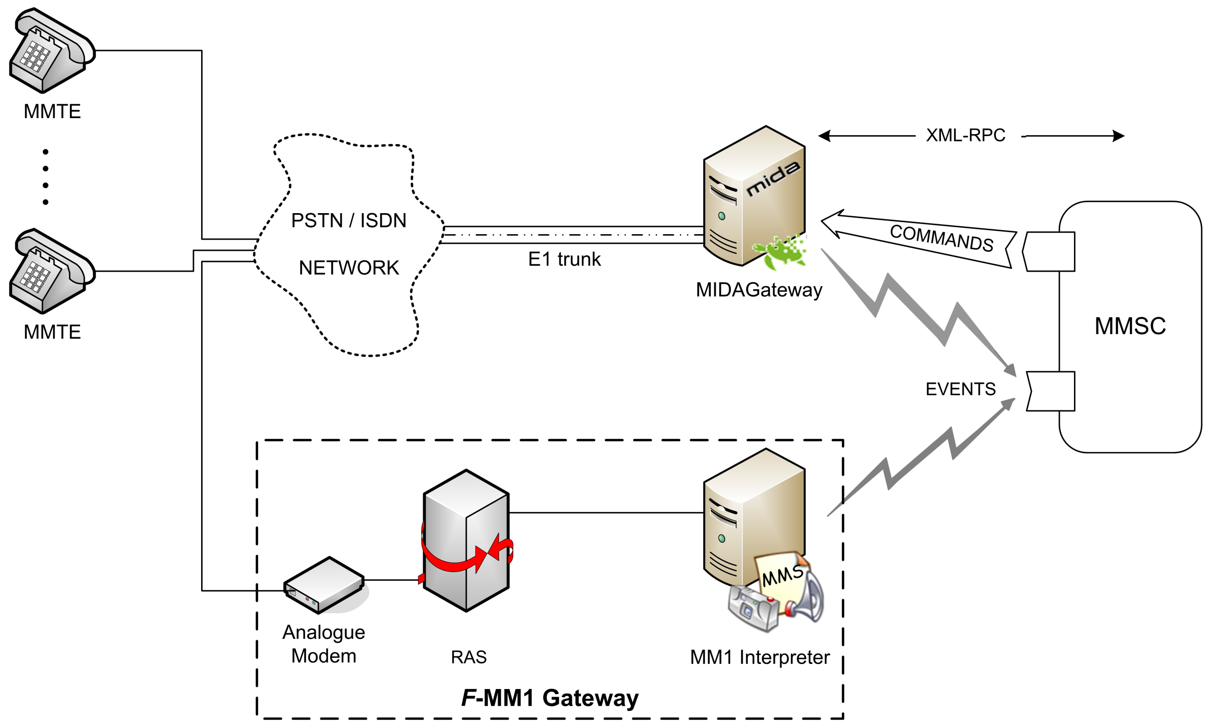

Figure 5: *F*-MM1 gateway structure.

implemented by a block, that acts as a Remote Access Server (RAS), while a softwareonly solution, called MM1 Interpreter in this paper, serves the remaining upper layers.

RAS provides linkage between the fixed telephone PSTN network and a standard IP-based computer network. To allow the MMS phone to dial-in a number and establish a PPP connection over the fixed telephone network, RAS operates on three different layers: physical, data-link and network.

The RAS has been realized connecting a PC to an analogue modem, with the help of standard programs available on a Linux OS. In practice, physical layer is managed by the modem controlled by an appropriate program like `mgetty`, that is in charge of setting up the device and instruct it to accept and answer incoming calls. Moreover, when a call is answered, `mgetty` launches `pppd`, that takes care to initialize a PPP connection with the remote party, to realize an affordable communication link. A final feature, IP forwarding, has to be implemented by RAS, so that the remote device can reach any other host on the hosting network. This can be carried out directly by the Linux kernel.

MM1 Interpreter can be considered as the core component of *F*-MM1 gateway, since it is responsible to receive any *F*-MM1 PDUs sent by MMTE, decode them and provide suitable high-level notifications to MMSC, as well as the capability to send responses back to the clients.

Since upper layer protocols used by a non-push transaction are HTTP and TCP, we decided to realize the MM1 Interpreter relying on well-known web technology like web server and server-side scripting. As a result, the whole system has gained a lot in terms of reliability, because protocol layers are managed indirectly, thanks to scalable, safe and widely used programs like Apache web server.

This allowed us to focus our attention on the implementation of the decoding and encoding of *F*-MM1 PDUs, as well as the development of a reliable and efficient XML-RPC interface being exposed toward MMSC.

A positive aspect of the design that can be noted here is its global modularity. Having separated RAS functionalities from higher-level ones establish to build large and scalable systems for thousands of end users, by just providing more and more RAS devices. Moreover, the MM1 Interpreter turns out to be independent from the underlying telephone network, as well as the application layer defined on the MM1 interface which is the same as the one on *F*-MM1.

So, the gateway presented here can be adopted also for mobile environments, just using a component that, like RAS, can provide linkage between the mobile telephone network and a computer IP-based network.

3.2.3 Authentication

A final few words have to be spent about the authentication mechanisms provided by the *F*-MM1 gateway, designed in compliance with the official ETSI standard.

The first one relies on the basic Calling Line Identity (CLI) of the F-MMS phone that sends or receives a message. As this feature concerns the physical layer, it is a matter of the RAS device and its capabilities to detect information supplied by the fixed telephone network.

The second one affects data-link layer and is based on the authentication provided by PPP protocol by means of PAP or CHAP mechanisms and, again, is pertinence of the RAS.

The last mechanism has been implemented into the MM1 Interpreter, because it works during HTTP transactions, thanks to HTTP built-in features like *basic* and *digest* authentication.

4 Test-bed results

The software implemented following the design has been subject to several tests to verify both the gateway capabilities to supply F-MMS service and compliance with ETSI specifications.

Tests have been carried out within an environment close to a real one, thanks to a hardware simulation of a fixedline network and with the support of a commercial F-MMS capable terminal.

The main aim is to confirm the agreement between the behaviour described in the official specifications and the one observed for each involved player. Moreover, the operational correctness of the designed system mimics and of all the technical issues implemented to ensure global reliability has also been verified.

Particular attention has been paid to the XML-RPC interface towards MMSC. Correctness of encoding and decoding WSP algorithms has also been carefully checked.

4.1 Test conditions

It has been identified a lot of case studies of particular concern for system observation. We have recorded both systems and phones activity in each case that has been executed.

Very often, a given test has been reproduced many times, just changing one parameters at a time. This approach allows to stress and figure out most interesting facts in a differential fashion. So, the main matter is focused on guide lines used to define the case study: we have considered various instances, from the ones closer to typical service usage, to the most unique ones. It is possible to organize them according to the logical layer of the OSI stack interested by each test session (Fig. 6).

- Transport Layer: this is the *F*-MM1 gateways own working logical layer. The capability to face communication exceptions, both with the F-MMS phone and with MMSC, has been examined. Moreover, the XMLRPC interface has been stressed: various internal errors have been simulated to verify the triggering of timeout policies.
- WSP encoding sub-layer: this is one of the most important aspects, since it gets involved in each system transaction. We examined the content of each PDU transmitted from and to the F-MMS device to verify the agreement with the data encoded and decoded by the *F*-MM1 gateway and the ones sent to MMSC via XMLRPC.
- Application Layer: the correctness of the *F*-MM1 gateway behavior from the user perspective, i.e. MMSC and F-MMS device, has been verified. We paid particular attention to exception handling and application errors management.

4.2 Test tools

To execute test procedures, various software tools have been used to capture and analyze the behaviours of the involved blocks:

- `pppd` program running within the RAS component of *F*-MM1 gateway. It allows to trace the data flowing from RAS to a terminal device, i.e. a telephone, through PPP link. The tool `pppdump` allows to analyze these data off-line to study data-link activities.
- a network traffic analyzer, helping us to study the performance of transmissions from terminal to gateway *F*-MM1 and then to MMSC.
- the log files generated by the *F*-MM1 gateway have been very useful to diagnose the internal evolution of the system.

5 Conclusions

The paper describes an efficient and reliable solution for Fixed-to-Mobile Convergence in the context of advanced Unified Messaging for telephone services.

The invariant aspects of the problem were outlined and set against network-dependent details. This approach leads us to design and realize a suitable system that takes advantage of a great level of modularity and flexibility. As a result, the solution is already intended for integration into future scenarios of completely IP-based services of the Next Generation Network as the IP Multimedia Subsystem (IMS).

Thanks to the adoption of open standards such as XMLRPC and well-known and several widely used software, the gateway is also ready for third-party integration. It allows to quickly develop platform-independent solutions to provide MMS service over PSTN and ISDN fixed telephone network.

Relying upon the test sessions outcome, the compliance with official F-MMS specifications by ETSI has been proved as well as the general reliability.

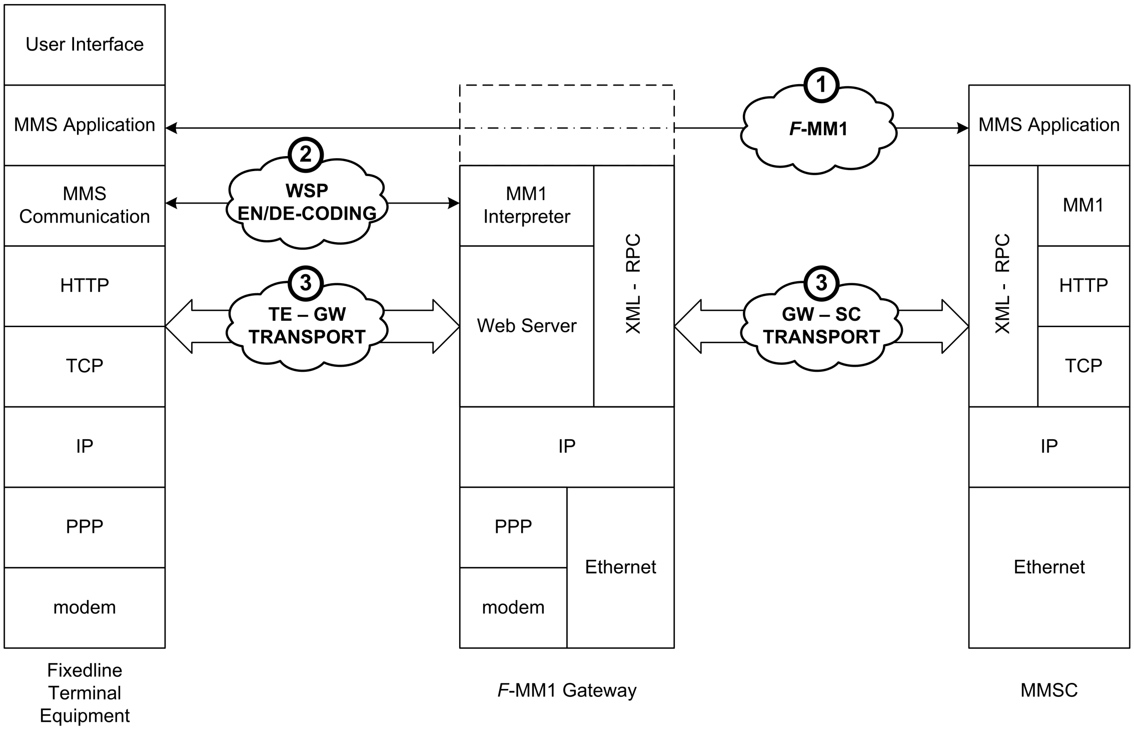

Figure 6: Tests organization.

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