IST-Africa 2007 Conference Proceedings
Paul Cunningham and Miriam Cunningham (Eds)
IIMC International Information Management Corporation, 2007
ISBN: 1-905824-04-1

Open Source IP Multimedia Subsystem Core and Testbed Exploration Areas

Thomas MAGEDANZ[1], Fabricio GOUVEIA[1], and H. Anthony CHAN[2]
[1]*Fraunhofer FOKUS, Kaiserin-augusta-Allee 31, 10589 Berlin, Germany*
Tel: +49 30 3463 7200, Fax: +49 30 3463 8000
Emails: magedanz@fokus.fraunhofer.de; gouveia@fokus.fraunhofer.de
[2]*University of Cape Town, Rondebosch, 7700, South Africa, Email: h.a.chan@ieee.org*

Abstract: The Open IMS playground@FOKUS represents a pioneering NGN testbed, which currently will be interconnected with other remote NGN testbeds around the world, including those in Africa. This paper has as principal objectives, the provision of a brief overview about the IMS Technology, to describe the Open IMS Core and to describe the benefits that joint testbed cooperation and experiments can bring to the sub-Saharan Africa Countries. Such testbed interconnection enables the exchange of knowhow and the performance of international R&D activities with participation from local academic and industrial partners. Possible exploration areas that the IMS infrastructure can bring are also described.

Keywords: Africa, IP Multimedia Subsystem, Next Generation Network, Service Delivery Platform, Testbed.

1. Introduction

The availability of communication and information services through high-speed networks is important to every country. In the fiercely competing markets in advanced countries, there are needs to converge different network technologies, to efficiently and speedily deploy new services appealing to the customers, to reduce the costs of these services, and to future proof the investments of the service providers. In developing countries and in urban areas, there are often additional needs of empowering people with vast and fast development of communication and information services to enable the life activities and job functions that are essential for these countries to develop [1]. The network infrastructure also differs in many rural areas that cannot be reached with the same wireline network infrastructure used in the city and where wireless networks are used not only as the last minute access network but also to link many rural areas.

In today's trend of Next Generation Networks (NGNs), Internet is moving towards seamless service and content provision while networking technologies are hiding into the background. The NGNs are defining an Internet Protocol (IP) based framework, gluing together various access network technologies with an IP-based core network, and focusing on the standardization of a general service delivery platform (SDP) [2] which is able to control these networks. The IP Multimedia Subsystem (IMS) represents this SDP. It combines the classic telecoms world with the new Internet world and provides a uniform overlay service platform for multimedia information and communication services across different IP-based networks. IMS also paves the way for a more flexible service provision in an emerging open eco system, including virtual network operators and third party service providers. Therefore IMS is extending the plain Internet towards a telecom grade multimedia information and communication service platform.

Since the wired and wireless Internet is a globally available technology, NGN and IMS are also becoming a global issue and have reached international standardization within 3GPP, 3GPP2, ETSI, TISPAN, and ITU-T.

Besides enabling many new application developments, IMS itself also presents many issues for research. They include quality of service, security, charging or billing, cross-layer design, and possible extensions to IMS.

IMS uses standardized IP-based protocols and provides mechanisms to support quality of service (QoS), charging, and security (Section 2). The FOKUS IMS playground (Section 3) includes an open source IMS core. We are setting up such an IMS testbed to enable experiments and research collaboration (Section 4). The research areas with the testbed include the use of diverse networks, each possibly with a different charging model to serve different kinds of services and possibly using different languages and cultures (Section 5).

1.1 - Objectives of the Paper

This paper has as principal objective to describe the advantages of launching an Open IMS Testbed (open source license), in order to stimulate research and early developments also in developing countries. This is of interest of anyone developing services in the mobile telecommunications area, as well as for providing business opportunities at competitive prices. Other objectives include:

- The provision of a brief overview of the IMS Technology and Open IMS Toolkit;
- To point topics that need further studies in the IMS Domain;
- Describe which benefits joint Testbed cooperation and experiments can bring;
- And finally, pointing the possible exploration areas that the IMS infrastructure can bring to the sub-Saharan Africa Countries.

2. IMS Technology and System Features

The IMS is an approach to provide overlay Service Delivery Platform (SDP) [2] architecture for IP networks, entirely build on Internet protocols defined by the Internet Engineering Task Force (IETF), which have been extended on request of 3GPP [3] to support telecommunications requirements, such as security, accountability, quality of service, etc.

In contrast to plain Internet services, the main value propositions of IMS are to provide better security and quality of service and to establish a flexible charging infrastructure combined with single sign on capabilities by the trusted network operators. In addition to these capabilities, which sometimes are considered with some skeptical eyes, the notion of so-called “combinational services” is probably describing best what the IMS can provide. Combinational services represent any combination of existing telecommunication services (e.g., voice calls, SMS, MMS, location, etc.) with Internet Protocol (IP) based services, such as email, instant messaging, push to talk, video conferencing, web browsing, shared web space, etc., which are typically combined with presence and group information. IMS is therefore considered to enhance classic Internet services with traditional telecommunications services and to add the above stated value added attributes. Hence the IMS provides an evolution path from the existing telecoms infrastructure towards an emerging IP-based Next Generation Network (NGN), which is in contrast to a disruptive NGN introduction strategy. The main IMS features (e.g. QoS support and charging), as well as IMS key protocols, are described in the next subsections.

2.1 - Quality of Service

The emerging NGN is expected to incorporate all the existing networks and provide the network users with all types of services. This convergent network will enable the users of one type of current networks to use the services of another type of networks. End-to-end QoS is provided through management of QoS in each network domain through a bearer service (BS) manager, which is a policy enforcement point (PEP) in the network

QoS may use service based local policy (SBLP) defined within each network domain Translation of QoS information across different domains and coordination of QoS management function among these different domains are needed to support end-to-end QoS. The QoS management functions involve signaling between application function (AF), which is the Proxy-CSCF in IMS, and policy decision function (PDF), which may be at the gateway of a network domain to manage the bearer service (Figure 1).

PDF enables coordination between events in the application layer and resource management in the IP layer. It is a logical policy decision element using IP mechanisms to implement SBLP in the IP layer.

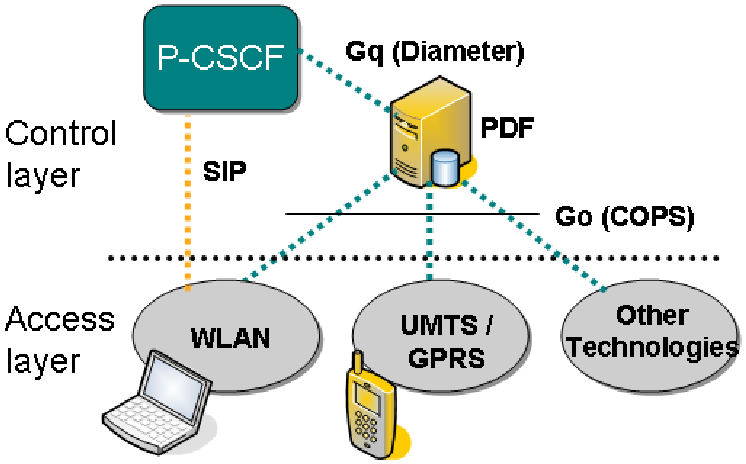

Figure 1. QoS Management Architecture

The policy based QoS architecture consists of policy decision point (PDP) as a server and policy enforcement points (PEPs) as clients, which exchange policy information with each other using common open policy service (COPS) protocol. It authorizes and controls the use of resources such as bandwidth and QoS classes for each bearer.

QoS is a research issue that needs further studies, since the interconnection of different domains through the Internet using different technologies, brings up many open issues. The work on these issues is ongoing within standardization bodies such as 3GPP and TISPAN.

2.2 - Charging

IMS provides a means for charging per media component (e.g. audio and video), as IMS sessions may include multiple media components (e.g., audio and video). This would allow a possibility to charge the called party, when a new media component is added in a session.

The IMS architecture supports both online and offline charging capabilities. Online charging is a charging process in which the charging information can affect in real time the service rendered and therefore directly interacts with session/service control. In practice, an operator could check the user's account before allowing the user to engage a session and to stop a session when all credits are consumed. As an example, prepaid services are applications that need online charging capabilities. Offline charging is a charging process in which the charging information does not affect in real time the service rendered. This is the traditional model in which the charging information is collected over a particular period and, at the end of the period, the operator posts a bill to the customer.

2.3 - IMS Key Protocols

The IMS is based on Internet protocols defined by IETF, basically Session Initiation Protocol (SIP) is used for session control, the Diameter is for AAA and Real-time Transport Protocol (RTP) is for media transport.

SIP is an application layer protocol for the establishment, modification and termination of multimedia sessions between two or more participants [4], and these functions are implemented in the Call Session Control Functions (CSCFs) as SIP servers. It has support for registration and modification of multiple user location information, caller and callee authentication/call authorization, and privacy for call signaling and media streams and media path with ensured QoS.

The Diameter protocol is implemented in the HSS, CSCFs and various other IMS components in order to allow AAA functionality within the IMS. Diameter is based on the Remote Authentication Dial in User Service (RADIUS), which has previously been used to provide AAA services for dial-up and terminal server across environments.

The other protocol that is important for multimedia contents is RTP. It provides end-to-end delivery for real-time data. It also contains end-to-end delivery services like payload-type (codec) identification, sequence numbering, time stamping and delivering monitoring for real-time data.

3. FOKUS Open IMS Playground

FOKUS developed an IMS core system for research and development purposes and established an open IMS testbed around it – the Open IMS Playground. This comprehensive NGN testbed is the technological foundation for running national and international R&D projects with the academia and industry. The FOKUS Open IMS Playground [5] is a subset of this NGN testbed, with a specific focal point of activities, as displayed in figure 2.

The Open IMS playground is deployed as an open technology test field with the targets to prototype and validate existing and emerging NGN/IMS standard components originating from own developments and various partners/vendors and to appropriately extend the IMS architecture and protocols to be used on top of new access networks as well as to provide new seamless multimedia applications.

IMS playground is used as the technology basis on the one hand for industry projects serving national and international vendors and network operators and on the other hand for more mid-term academic R&D projects in the European IST context. The playground is also used by others, i.e., FOKUS is providing consultancy and support services around the IMS playground. Users of the “Open IMS playground” such as vendors are performing interoperability and benchmarking tests of their components. Developers are creating new IMS applications based on various playground-provided programming platforms such as IN/CAMEL, OSA/Parlay, JAIN, SIP Servlets, etc., to gain a proof of concept implementation for various fixed and mobile network operators. The different platform options, each with their strengths and weaknesses, can be selected and used according to the customers’ needs.

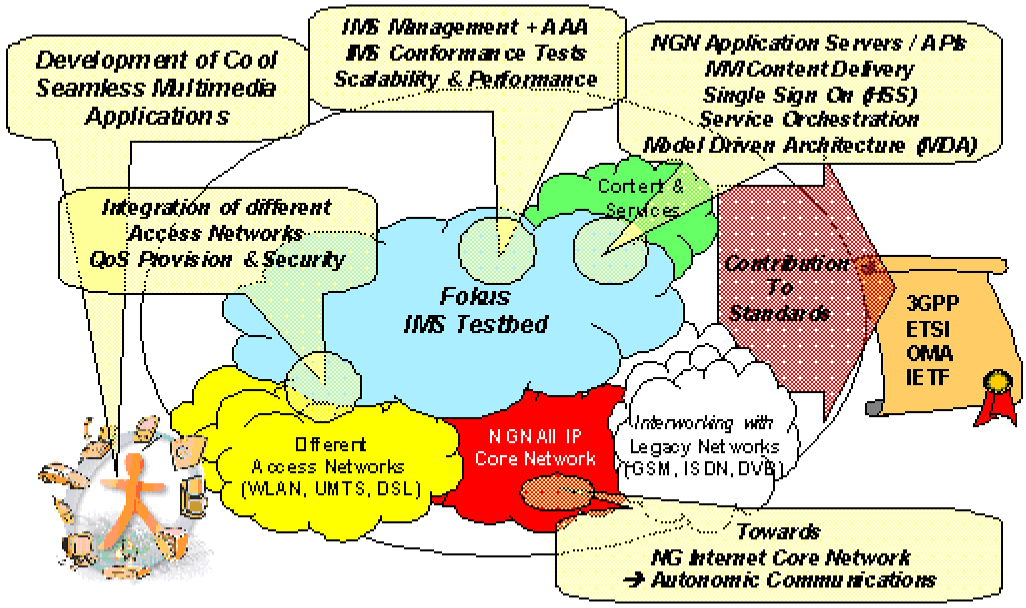

Figure 2. The FOKUS NGN Testbed Research Activities.

IMS playground is used as the technology basis on the one hand for industry projects serving national and international vendors and network operators and on the other hand for more mid-term academic R&D projects in the European IST context. FOKUS is providing consultancy and support services around the IMS playground, where its users (such as vendors) are performing interoperability and benchmarking tests of their components. Figure 3 displays the Open IMS playground partner components (note that not all partners are listed, and not all own components are reflected here).

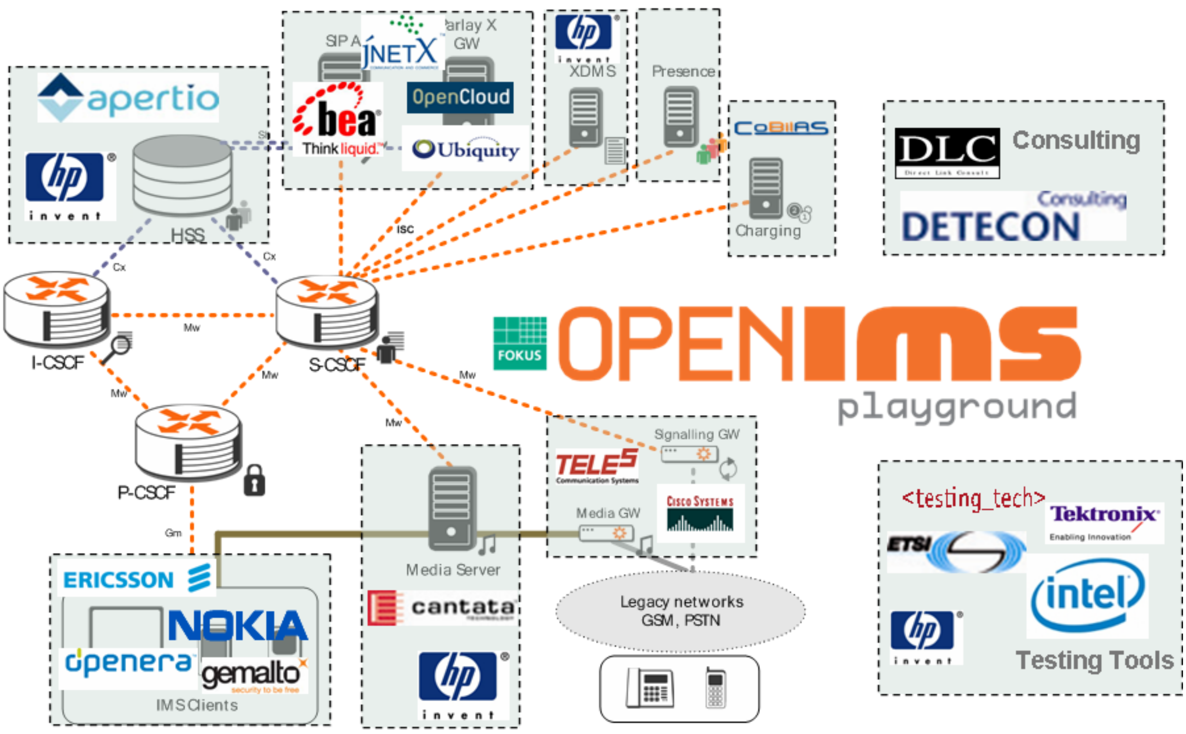

Figure 3. The IMS Playground as Integration Point for Partners.

As a result of the global recognition of the Open IMS playground, various international vendors and operators from all over the world, including also most South African operators and system integrators, have already made use of FOKUS professional services. In addition, FOKUS staff, known as independent technology experts, has already performed various NGN courses at South African universities to spark academic cooperation. Naturally, a stronger linkage of the FOKUS NGN testbed and particularly the open IMS playground with South African universities, such as UCT and TUKS as local proxies to the South African industry is currently under way. Such a testbed linkage and the resulting cooperation in the academic and industry will provide benefits to both sides.

3.1 - Open Source IMS Core

The idea for developing an Open Source IMS (OSIMS) [6] Core System has been sparked by the experiences FOKUS has encountered with the development of the SIP Express Router (SER). SER was developed many years ago in the early years of VoIP as an open source SIP server based on GPL (GNU Public License) to enable the fast prototyping of VoIP for R&D purposes and thus to stimulate the adoption of VoIP technologies and related vendor products in the real world.

In face of setting up the Open Source IMS Core System for implementing IMS testbeds, the SER has been extended over time by FOKUS to cope with the extended version of SIP for IMS and to act as an IMS CSCF. Additionally a minimum HSS has been developed based on a MySQL and the JavaDiameterPeer stack to interact for IMS service provisioning via Diameter with the CSCFs.

The main proposal of the Open Source IMS Core is to provide early adoption of IMS technology and stimulate the international take up of IMS, for the research and development of end user driven IMS multimedia services for a converging world.

4. Joint Testbed Cooperation, Experiments, and Benefits

In Africa, Testbeds with the Open Source IMS Toolkit are being set up at the University of Cape Town (UCT) and other locations. The testbeds may also serve as local proxies to other regional universities and industry to enable collaborative research using the testbed.

At UCT the planned experiments with IMS may include investigating the QoS, mobility, security, layer interactions with IMS, and cross layer design. IMS will need to be tested under the different charging models as well as with different services needed in developing countries. Applications will also be built on the application servers for the services relevant to the developing countries.

A design to enable human intelligence in the network is given in [7], and this design may be realized within the IP multimedia subsystem testbed. Investigation may therefore be conducted using IMS to bring in an intelligence mechanism between the end user and the service layer to make the future network more friendly and helpful to the end user. Three options to implement intelligence are considered: (1) An intelligence functional entity may be supplementary to the existing testbed entities; (2) The entity may work together with an IMS testbed entity to behave as one extended function entity; (3) The entity may also be implemented as a characteristic of the existing IMS functional entity.

Experiences with the FOKUS IMS testbed bringing together different players in the emerging NGN / IMS space, including particular small and medium sized enterprises will play an important role in the future eco system. Importing the testbed idea to South Africa at UCT and TUKS and linking up with the FOKUS testbed provides unique opportunities. Such a local testbed could act as a catalyst for business opportunities in the African market. IMS is of interest to many operators throughout the world, including those in the sub-Saharan Africa. Whereas the advanced countries need to cope with the business in the existing infrastructure, the developing countries that lack existing infrastructure have the advantage to leap forward to the new technologies without legacy to hinder them. For example, countries in South Africa are now starting with the latest UMTS products at competitive prices. In addition, while migrating from IPv4 to IPv6 is extremely difficult, deploying IPv6 network is faster for countries without substantial IPv4 network.

Benefits related to economical research point of view are due to the possibility to help many research projects and industry initiatives to make planning for testing and validation of prototypes and research results more easily. The interconnection of testbeds enables the integration in large scale, offering the possibility of low cost market-oriented developments.

The relentlessly competing markets of communication network in the advanced countries challenges the operators to come up with financially viable solutions in the face of the flat rates. Sub-Saharan African countries also have the need to provide more people with access to communication network. The need for fixed-mobile convergence (FMC) poses additional challenges. IMS does provide the hope and is a global challenge because its many promises have to be validated in the near future. International R&D efforts in IMS are needed and are especially desired from the academia and SMEs.

Developing countries are a huge market to be explored. The IMS concept provides a feasible solution to their needs but further research is needed. While the tests needed with the IMS testbed for the developing countries are different, it is expected that their results will also shed light on the ongoing global research efforts of IMS. Economy of scale is then further achieved when both the developed countries and the developing countries may collaborate to develop and to standardize IMS. Related work in joint testbed research can be found in [13], [14] and [15].

5. Exploration Areas with IMS Testbed

Decoupling of the service layer from the underlying transport is convenient. The IMS is an overlay on top of the networks and does not depend on the specific underlying network technology. Yet the decoupling is perfect only when there are no limitations of resources in the underlying transport mechanism.

Consider QoS. While the IMS may determine whether the needed resources are indeed available and may be utilized for a request, it is the underlying network that has to provide the bearer with such QoS.

Consider also the mobility functions. For intra-network movements, the mobility functions such as Hierarchical Mobile IP (HMIP) is conducted in the link layer, whereas for inter-network movements, the mobility functions as is in Mobile IPv6 are is in the network layer. Yet there are performance limitations in these schemes. Cross-layer mobility functions are needed to improve the performance [8]. In order to enable cross-layer mobility functions, the underlying network will need to exchange messages with the service and control/signaling IMS platform.

Research with different technologies will need to be conducted with the IMS testbed on top of different networks.

In addition, the needed services, usage model, and networks in the sub-Saharan Africa countries are different. Further areas to explore with the IMS testbed include the following:

5.1 - Diverse Networks

Most parts of advanced countries are reached by optical core network augmented only in the last mile with different access technologies. In many cases, the bandwidth in the Dense Wavelength Division Multiplexing (DWDM) optical core can be far exceeding the traffic needs so that the access networks and the edge networks may be the only major bottlenecks of the traffic.

Yet most areas in the sub-Saharan Africa are remote from the international optical core networks. Wireless technologies have become the faster and less expensive solution. In addition, wireless not only is used in the last mile access but may even be the long links among numerous remote urban areas. In principle, these wireless links may still be considered architecturally as the edge networks to the optical network. The differences here are that these edge networks can be really far from the optical core, so that as far as the traffic within and among these rural areas are concerned, these wireless links are their internal core network.

5.2 - Different Charging Models

The model in sub-Saharan Africa is different from that in other countries. The dominant ones are pre-paid. The charges are more often based on the amount of data usage rather than in terms of a flat fee. In addition, options to base on the cost and the traffic conditions are being looked at. The effects and the requirements on the performance of the network with different charging models with different services need to be thoroughly tested.

5.3 - Different Kinds of Services

There are many rural areas and disadvantaged areas. High-speed communication is needed as an investment to enable people to perform essential life functions, job functions, and business functions. Investments in the development of such functions will enhance the work outputs, enable people to make more contributions to the society, and create more job and business opportunities.

As the economy and life style of the people are enhanced, people will find other use of high-speed communication. The initial investments will see a much higher return in future.

5.4 - Diverse Languages and Cultures

There are many different African languages. At least 10 of them are needed to serve the needs of most people. Efficient and low-cost solutions for the applications are needed to cater for the different African languages.

Consider for example a cluster of rural areas that are far from the optical core network but may be linked through WiMAX wireless links or satellite links with each other and to the global Internet. The majority of people in many areas speak local languages.

Currently, most web pages throughout the world are not in African languages and are also lacking the specific information needed for the specific applications mentioned above. A model may be regional servers with proxy within each regional network. These proxy servers will store the more often needed webpage information from other parts of the world, and will perform language translation.

Getting early access to the newest technologies enables South Africa to develop more rapid solutions which not only address the local needs but also can be exported to other countries due to the standards compliance. This will help to reduce the digital divide. On the other hand, the cooperating countries and FOKUS will benefit from specific skills and experiences in building solutions for multi language countries and for people with limitations in writing and reading. These skills and experiences are also needed in other parts of the world. For example, emerging pan-European services provided by international players need to support multiple local languages, rather than just to provide English solutions as common denominator.

6. Conclusions

Open testbeds will expose NGN enabling technology to encourage research collaboration between academia and industry [9, 10]. Individual parts of the testbed, i.e., specific wireless end systems and access networks, as well as different service platforms (e.g. Web and Streaming servers, the Parlay or servlet API) on top of multiple networks can be used as needed on demand. The FOKUS IMS Open Playground is providing the platform for such research [11, 12]. The Open Source IMS Core System enables setting up of IMS testbeds for IMS technology testing and IMS application prototyping for research purposes.

Academia and industry, i.e. universities as well as operators, integrators and vendors are already benefiting from the availability of the IMS Open Source Core System. The substitution of OSIMS components by carrier grade IMS products can happen smoothly, which enables early adoption of IMS technology and stimulates the international take up of IMS technology and the development of end user driven IMS multimedia services for a converging world.

These benefits brings up ideas on exploration areas with the IMS testbed, which are described in this paper: the use of different networks for rural areas, different charging models, creation of different kinds of services, and low-cost solutions for the applications with different African languages and cultures.

References

[1] Y. Li, H. A. Chan, and J. I. Agbinya, "Networking in Rural Environments: Benefits, Feasibilities, and Requirements," African Journal of Information and Communication Technology (AJICT), vol. 2, no. 2, June 2006, ISSN: 1449-2679, pp. 50-55.

[2] Magedanz, T., & Sher, M. (2005), Chapman & Hall/CRC Press, IT-based Open Service Delivery Platforms for Mobile Networks -From CAMEL to the IP Multimedia System, book chapter "Mobile Middleware".

[3] 3GPP, Third Generation Partnership Project (3GPP). www.3gpp.org.

[4] 3GPP TS 24.228, "Signaling flows for the IP multimedia call control based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP)," Stage 3

[5] http://www.fokus.fraunhofer.de/ims

[6] http://www.openimscore.org

[7] Yang Li and H. Anthony Chan, "Design of Network Intelligence for Future Generation Network on an IP Multimedia Subsystem Testbed," Information Society Technologies in Africa (IST-Africa), Pretoria, South Africa, 3-5 May 2006.

[8] J. McNair, T. Tugcu, W. Wang, and J. Xie, "A survey of cross-layer performance enhancements for Mobile IP networks," Computer Networks, Elsevier, 2005, vol. 49, pp. 119-146.

[9] T. Magedanz, "On the role of national 3Gb Test beds and their interconnection for setting up a European Open 3Gb R&D environment," invited keynote speech at Interconnecting Heterogeneous Wireless Networks Workshop, European Commission, Brussels, Belgium, March 26, 2003, www.cordis.lu/ist/rn/wireless-testbed-ws.htm .

[10] T. Magedanz, "The FOKUS 3G Beyond Test and Development Center - An Open Technology Play Ground for 3Gb M-Commerce Applications," Mobile Europe, Bremen, Germany, July 3, 2003, www.mobile-europe.org .

[11] K. Knüttel, T. Magedanz, and D. Witszek, "The IMS PLAYGROUND @ FOKUS – An Open Testbed for Next Generation Network Multimedia Services," 1st Int. IFIP Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities (Tridentcom), Trento, Italy, February 23 - 25, 2005.

[12] T. Magedanz, D. Witaszek, and K. Knuettel, "Service Delivery Platform Options for Next Generation Networks within the National German 3G Beyond Testbed," South African Telecommunication Networks Architectures Conference (SATNAC), Stellenbosch, South Africa, September 6-8, 2004, ISBN 0-620-32632-8, www.satnac.org.za

[13] Gavras, A.; Bruggemann, H.; Witaszek, D., "Pan European Laboratory for next generation networks and services", IEEE Tridentcom 2006, 6 pp., March 2006.

[14] Zaheen A. Sherwani, "Research, Design and Implementation of a Joint ACREO-TSLab GMPLS Enabled Metropolitan Area Testbed in the Stockholm Region", Master of Science Thesis in Telecommunication Systems, Stockholm, April 2005.

[15] D. Vingarzan, P. Weik, T. Magedanz: "Development of an Open Source IMS Core for emerging IMS Testbeds for Academia and Beyond", Special Issue on IMS, Journal on Mobile Multimedia (JMM), Vol.3 No.2, Rinton Press, Princeton, USA, 2007.