IMS Playground in Pan-European Network of Testbeds

Benefits and Challenges

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***Abstract*— The main idea for launching the FOKUS IMS Playground testbed in 2004 was to provide R&D for earlier IMS developments in order to validate existing and emerging IMS standards. The IMS Playground was extended appropriately to be used on top of new access networks as well as to provide new seamless multimedia applications. The FOKUS testbed originated from own developments as well as major industry players, and is being used by academic and industrial partners for prototyping new IMS related components, protocols, and applications. The next target is to integrate FOKUS testbed in a Pan-European Network of testbeds in order to reach a broader community with the benefits of such a testbeds federation. This paper describes the FOKUS experiences at running the IMS Playground, providing a look into administrative and technical issues that need consideration on integrating testbeds. This view can be applied to run any kind of testbed. The paper presents the descriptions of the issues from service/capabilities offer to test execution, as well as the intrinsic benefits and challenges.**

IP Multimedia Subsystem; IMS Playground; testbed; Pan-European Network of testbeds

I. INTRODUCTION

Today the telecommunication world is passing through the evolutionary phase i.e. the merger of the two of the most successful paradigms: the Internet and the cellular networks. In prospect of these global trends, the mobile communications world has defined within the evolution of cellular systems an All-IP Network vision which integrates cellular networks and the Internet. This is the IP Multimedia System (IMS) [1], namely overlay architecture for the provision of multimedia services, such as VoIP and videoconferencing on top of globally emerging 3G broadband packet networks. However, there are still many open issues within the IMS architecture and the 3GPP IMS standardisation is ongoing, particularly in the field of applying the IMS on top of different wireless networks (i.e. WLAN, WIMAX and DSL) and the IMS evolution towards an all-IP network.

In order to validate existing and emerging IMS standards and search for solutions for these and other issues, FOKUS developed an IMS core system for research and development purposes. This paper describes the FOKUS experiences at running this testbed and the challenges towards solutions in order to integrate this IMS testbed in a Pan-European network (Panlab) Framework.

Chapter II specifies the main IMS components and presents the Open IMS Playground testbed. Chapter III describes the FOKUS experiences in running the IMS Playground, from the offer to the test execution, addressing issues like resource description, costs calculation, operational issues and kinds of tests possible. Chapter IV addresses the benefits and challenges for integration, and finally, chapter V describes briefly the Panlab concept, which is investigating solutions to accomplish the European testbeds and laboratories integration.

II. IMS PLAYGROUND – TESTBED FOR IMS COMPONENTS AND APPLICATIONS

This chapter is structured as follows: first we describe the IMS main components, then what the IMS playground testbed is and what it, at a first glance, has to offer.

A. *IMS Components*

The IMS entities and key functionalities can be classified in six categories: session management and routing family (CSCFs), databases (HSS, SLF), interworking elements (BGCF, MGCF etc.), services (application server, MRCF, MRFP), support entities (THIG, SEG, PDF) and charging [2]. The Proxy Call Session Control Function (P-CSCF) is the first contact point within the IP Multimedia Core Network subsystem. it behaves like a proxy accepting requests and services them internally or forwards them. The Interrogating Call Session Control Function (I-CSCF) is the contact point within an operator's network for all connections destined to a subscriber of that network operator, or a roaming subscriber currently located within that network operator's service area. Its main functions are: Assigning an S-CSCF to a user performing SIP registration / Charging and resource utilization: generation of Charging Data Records (CDRs) / acting as a Topology Hiding Inter-working Gateway (THIG). The latest CSCF is the Serving Call Session Control Function (S-CSCF). It performs the session control services for the endpoint and maintains session state as needed by the network operator for support of the services. Within an operator's network, different S-CSCFs may have different functionality. Performed functions are: User Registration / Interaction with Services Platforms for the

support of Services. The Home Subscriber Server (HSS) is the master database of an IMS that stores IMS user profiles including individual filtering information, user status information and application server profiles. Application Servers (ASs) are the service relevant part in the IMS, and are responsible to host and execute services. The Media Resource Function (MRF) provides media stream processing resources for like media mixing, media announcements, media analysis and media transcoding as well as speech [2]. The triple of Border Gateway Control Function (BGCF), Media Gate Control Function (MGCF), and Media Gate (MG) perform the bearer interworking between RTP/IP and the bearers used in the legacy networks. Last, the IMS End User System (or User Equipment – UE) has to provide the necessary IMS protocol support, namely SIP, and the service related media codecs for the multimedia applications in addition to the basic connectivity support, e.g. GPRS, WLAN, etc for being capable to access IMS services.

B. IMS Playground

Based on the excellent know how in the different contributing domains of IMS, namely Internet and telecommunication protocols, information technologies, and service delivery platforms, FOKUS has decided – based on its mission to act as an independent technology advisor - to develop an IMS core system for research and development purposes and to establish around it an open IMS testbed – the Open IMS Playground. The FOKUS Open IMS Playground [3] components are displayed in Figure 1.

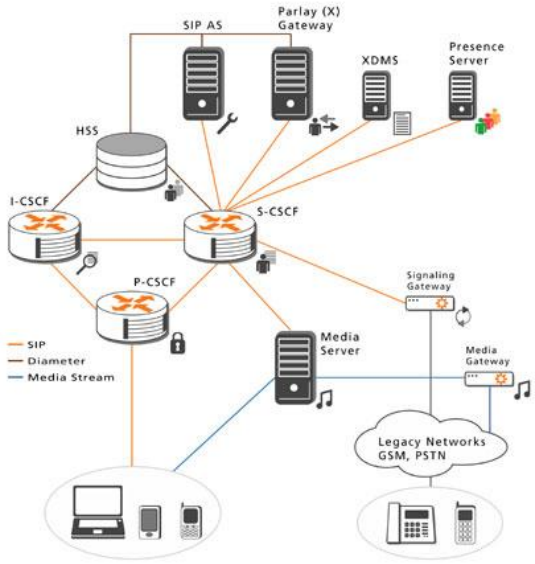

Figure 1. Open IMS Playground Components

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, to appropriately extend the IMS architecture and protocols to be used on top of new access networks, and to provide new seamless multimedia applications.

The IMS playground is used as the technology basis on the one hand for own 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. In addition, 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. Some research results from the testbed can be found in [7], [8], [9] and [10].

III. EXPERIENCE IN RUNNING THE IMS PLAYGROUND

In this chapter we describe our experiences at running an IMS testbed and the processes needed from offer to the test execution (as depicted in Figure 2).

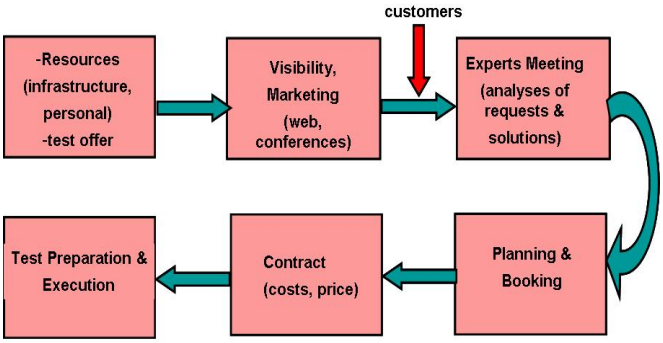

Figure 2. FOKUS Experience Steps from offer to Test Execution

The provision of the testbed starts with acquisition of the infrastructure and production of the inventory. The testbed has to be offered to the public. The IMS playground is described in the Internet [4], presented in many conferences and/or with direct contact with customers. The offering of the testbed is done by presenting its capabilities (e.g. available components, testing possibilities, etc.) to the potential customers. In the direct contact with customers, their requirements are discussed in order to find solutions for fulfilling them as well as their expectations. Here, the corresponding experts from FOKUS are brought together with them.

The FOKUS Open IMS Playground does not use any tool for scheduling at the moment. After understanding what needs to be done, the usage of the testbed needs to be planned. Here, the resources, the infrastructure as well as personal, has to be checked, whether they are available and when. At the moment we plan these resources in an ad-hoc manner. The replication of the testbed can be created, if needed (e.g. a customer wants to have a dedicated testbed with exclusive usage, which can be accomplished by replicating the main components of the testbed with specific requirements). After resource allocation, the resulting costs are calculated and consequently a contract can be defined.

Then we come to the execution of tests, which consists of three phases: the preparation of the testbed and the tests to be

executed, the main phase, which is the execution of the tests, and the last phase – analysis and evaluation of the tests and decomposition of the testbed, if required. The preparation phase includes not only the preparation of the infrastructure but also the preparation of the tests: e.g. definition of the test scenarios. During the execution of tests, two different staff personal are needed for the IMS playground provisioning, namely technical personal, which care about the infrastructure; and researcher/engineer, which have the understanding of the test scenarios and provide consulting.

The next sections describe in more detail what points are to be considered in order to run the IMS testbed.

A. *IMS Playground resource description*

Describing the available resources in the testbed should be as complete as possible, without having irrelevant or excess information. We have all major IMS core components, i.e., P-CSCF, S-CSCF, I-CSCF, HSS, MG, MRF, IMS end user system, etc. plus infrastructure available like the access technologies (e.g. WLAN, GPRS, UMTS) and other kind of resources (e.g. Application Server Simulators, service creation toolkits, and demo applications). The description of these features should be available for customers in a way that they can have an overview of what is possible to test/develop with the available testbed resources.

For a detailed example, Table 1 presents the feature list of our end user system (called Open IMS Client). It presents the features in each of the supported platforms and comments on the stability and details on Codecs (Compressor-Decompressor) available.

TABLE I. FEATURE LIST FOR THE OPEN IMS CLIENT

Features	.NET	Java
Network registration with AKA, MD5	Yes (stable)	Yes (stable)
Reg. Event Support	Yes (stable)	Yes (stable)
Presence Management (PUBLISH, SUBSCRIBE, NOTIFY)	Yes (stable)	Yes (stable)
Instant Message	Page Mode (stable) Session Mode (beta)	Page Mode (stable) Session Mode (alpha)
File Transfer	Yes (alpha)	Yes (alpha)
Audio Session	Codec – PCMA, PCMU, GSM 6.10 (stable) AMR (alpha)	Codec – PCMA, PCMU, GSM 6.10 (stable)
Address book	Yes (stable)	Yes (stable)
XCAP Integration	Yes (stable)	Yes (stable)
Call History Management	Not yet supported	Not yet supported (alpha)
Video Session	Not yet supported	Not yet supported
Audio Conference	Yes (stable)	Yes (stable)

In addition to the feature list, the Open IMS Client supports the following protocols in conformance with their respective standards:

- SDP - Session Description Protocol (RFC 2327)
- SIP - Session Initiation Protocol (RFC 3261) and extensions
- MSRP - Message Session Relay Protocol (draft-ietf-simple-message-sessions-16)
- XCAP – XML (Extensible Markup Language) Configuration Access Protocol via HTTP (OMA specification)

This kind of information is generated for each testbed component.

B. *IMS Playground cost calculation*

With the provisioning of the IMS Playground there are a wide range of different costs associated. The three main categories are personal costs, equipment costs and communication costs. The duration of the offered services is also directly associated with the resulting costs. In the following the main categories will be introduced and the covered costs will be briefly explained.

1) *Personnel Costs*

Highly trained personnel tends be a limited resource, which is why the costs will be higher for an exclusive dedication of testbed engineers to one project. If a testbed engineer is supervising different projects at the same time, the resulting costs for one involved contractor will be lower. The contractor can choose in most cases which type of staff dedication is desired based on the requirements of the project.

The costs will also vary depending on the knowledge of the supervisor. Different costs will be associated with the dedication of junior or senior researchers, PhDs, etc. Contractors can choose from a portfolio of different staff types in order to best meet the project's requirements. This requires some categorization of staff such as maintenance staff, supervision staff, etc. Contractors would benefit from a unified classification system regarding testbed staff across all interconnected testbeds in larger contexts such as a Pan-European Laboratory.

2) *Equipment Costs*

Testbeds can vary in size and the number of available system components. Costs will be higher the more components are involved for a specific project. We generally have to distinguish between two different types of testbeds: real life environments and software-based simulation testbeds. The first type of testbed tries to copy a realistic setup of the system under test by providing all necessary components in terms of hardware and software on dedicated system components. The second type of testbed simply simulates the real life environment with a special software that has been designed to run different sorts of tests for this software-based testbed simulation. This might even be done on a single machine with sufficient processing power. In the following, the term testbed shall always refer to the first type of testbed that is a real life testbed environment.

The provisioning of the testbed includes application set up and configuration. This generates costs depending of the complexity of the task in question. Monitoring and measurement tools, if needed, can transparently and optionally be included in the testing or even be of central relevance for the entire testing process. This creates extra costs. Such tools can be software tools or hardware components that are integrated into the testbed environment.

As stated above, the costs depend on the system components involved. Additionally, extra costs are associated with the usage of software interfaces. As interfaces must be interoperable and standard conformant, an ongoing development and maintenance process is needed from the testbed perspective to guarantee conformance. This leads to higher costs for the contractor the more interface are provided and used during the test runs. Also maintenance and support is subject to charging depending on duration and comprehensiveness.

3) Communication Costs

The communication costs are divided into two main factors. The used bandwidth, as well as call volume. As the testbed provider might be charged itself for provided bandwidth or call volume by its provider/operator (Internet, 2G/3G networks, etc.), these costs represents direct costs which are directly passed on to the contractor.

4) Additional Costs

As the duration of personnel dedication, the duration of the testbed usage in terms of equipment usage represents a cost factor. In addition it is highly relevant for the associated costs, if the testbed usage is of exclusive or shared manner. As while the testbed is exclusively used by one contractor, the operator is not able to contract other interested parties (this also requires a far more precise planning of the testbed usage and usage duration from the testbed operator side), the cost will be notably higher than for a shared access. This might be different for tests running on software based replications of the testbed.

An additional cost to be considered is when the testbed includes partner components. While parts of the testbed equipment (in terms of testing hard- and software) may have been developed by the testbed operator, partner components might be involved where own developments are too cost intensive or a partner component has already reached a market leading position. In those cases, tests will be run making use of the partner components where appropriate. Depending on the contracts with their partners, testbed operators need to be aware of the costs and the legal consequences resulting from partner component usage.

C. Kinds of tests

In general there are two kinds of testing we are offering in the FOKUS IMS playground: experiments and the systematic tests. The experiment testing is the kind of testing where the testbed is used as a real world like environment.

1) Experiments

a) Functionality tests:

Here the functionality of some IMS components or IMS related components can be tested.

We can test the IMS core components, other IMS components, like application servers, media servers etc., the IMS services which can be executed on our infrastructure, IMS test tools, which run IMS test suites in order to check that they don't have errors. For example a vendor application server can be interconnected with FOKUS infrastructure. First we have to check if the connection if working. Second we have to determine which functionality we need to check and in which way it can be achieved: we need to define a scenario, how to trigger the execution of the scenario and what to expect as a results.

b) Interoperability tests:

The IMS playground can participate in interoperability tests and test events. In this tests the testbed are connected and some scenarios crossing the border of the testbeds are executed. There are some initiatives in this area, like OMS PPT interoperability tests or IMS tests organized by ETSI.

2) Systematic tests

Before you release your hardware/software you need to test your product in real world like environment and by running of systematic step-by-step tests. The IMS Playground constitutes such an environment, where various experiments can be run.

FOKUS is developing systematic tests to test performance, functionality, interoperability and conformance of IMS components, including definition of test purposes, choice of the method, test case specification, execution of tests and evaluation of results. Some of the test suites together with tool set to execute the tests are part of the IMS playground and can be offered to customers.

a) Performance

Another group of test comprises performance tests and benchmarking. Different kinds of tests are possible: load/stress – how systems perform under load; capacity testing – max load the system can handle before failing; scalability testing – to plan capacity improvements; benchmarking – for comparison.

Performance benchmarking allows the comparison of performance of different implementations. It is a qualitative and quantitative evaluation of a system under realistic conditions to identify problems for scalability or usability aspects under heavy load and to collect measurements as success/fail rate, response times or round-trip delay.

FOKUS is participating in the Definition at ETSI of the IMS Benchmark Specification and the IMS Playground provides a tool set to execute the specification and evaluate the results. The performance tests can be executed by using a TTCN-3 toolkit or IMS SIP specific tools.

b) Development of conformance/Interoperability test suites

IMS Playground provides also a service to define and develop a conformance/interoperability test suite for the whole IMS system or particular components. The goal is to continuous increase the offer of the tools supporting this kind of testing. The testbed can also be used to test the new developed test tools to check their conformity to the standards and lack of errors.

IV. BENEFITS AND CHALLENGES

With the official release of the Open Source IMS Core during the 2nd FOKUS IMS Workshop held in November 2006 in Berlin, Fraunhofer FOKUS is facing challenging times. The IMS Core source code is ready for download since the 16th of November 2006 under a GNU General Public License (GPL) as on the FOKUS BerliOS platform. This means that the system can be freely complimented or extended with own developments.

We currently observe the setup of several IMS testbeds based on the Open Source IMS Core around the globe. These IMS testbed environments can be seen as small-scale replication instances of our Open IMS Playground. Putting our experience at the disposition of other national and international testbeds enables further conclusions on portability and robustness of the core software. We also hope to profit from the experience and knowledge of our partners and gain insights to the validation of the IMS core in many different test environments and setups. We have realized that in the end it will be the variety of different applications that will measure the overall success of the IP Multimedia Subsystem as an all-pervasive service platform.

It is planned to connect the FOKUS IMS Playground to many IMS nodes that are currently growing thanks to the Open Source IMS Core release. This kind of interconnection or network of testbeds would bring several benefits.

One of the benefits is to enlarge the number of customers/users. The information about testing facilities will be easier to access, more public, so many of the potential customers can decide to use the testbed. For the users it can be easier to find a corresponding testbed. Several customers will need to test scenarios when more than one testbed is needed, e.g. roaming scenarios, scenarios with international testbeds, etc. So the possibility to cooperate with other testbed enlarges the number of possible tests. The cooperation with other testbeds allows for better resource utilization and resource sharing. It is not always needed to provide all the resources in a local testbed. The resources can be partly used from other testbeds. This can reduce cost of the testbed and make the offer for the customer more attractive.

However, running a network of testbeds notably increases the management costs and operational issues. The operational procedures needed for interconnecting different testbeds in order to successfully perform testing and validation must be identified and defined properly. These procedures should be standardized and enforced by all the participants for implementing consolidated solutions. Although technology is critical for improving consolidated solutions, other elements, like rights and responsibilities, hierarchy among players, testing procedures and methods, play a vital role. These and other operational guidelines are briefly explained below.

1) Rights and responsibilities of the different players involved

The rights and obligations of the customers should be clarified, agreed and enforced. When using an infrastructure, a user should be provided with a list of allowed/forbidden rules. The users should be monitored during the Testbed use to ensure that their responsibilities are being met. This case is of importance when considering the cases of remote management of resources and remote access to the testbed. The users and the connection should be monitored during the entire infrastructure use (from the start up to the end of the testing session).

2) Testing Procedures, methods

For the definition of the testing procedures, it is needed to identify what are the resources that should be available for the specific tests (e.g. components, personal), which standards should be considered (Standardization body, release, etc.), which procedures to follow in case of a fault in the connection during use of a testbed, as well as the provision of support during the contracted time of use.

3) Schedule

This is a very important operational issue, because of avoiding troubles with time conflicts. Time zone differences should be considered and managed for ensuring correct scheduling. There should be a unified schedule (for resources management). All scheduling should be well stored and managed for the smooth execution of the programmed tasks without conflicts.

4) Security

As the testbed is being used by third parties, security becomes a very important issue. Both in the case of local or remote accesses, all connections should be based on a secure link (e.g. Virtual Private Network (VPN) accounts, IPSec, TLS, etc.). User accounts should be created and managed by administrators in each testbed, which will also associate each user with a respective profile. This profile contains the access rights permitted. Additional measures will depend of the institution policies, but as an example, internal networks could be separate from testbed networks for protection against unauthorized access. System administrators are needed (For controlling operational procedures in the machines e.g. install / uninstall of programs, created accounts, etc.)

5) Equipment from partners used in the Testbed

The IMS testbed has many components from partners, which are used in specific project/developments. The use rights of these components (e.g. should FOKUS pay for using partner equipment, should FOKUS state clearly that it has these equipment from different partners, can FOKUS offer these components to third parties, etc.) should be appropriately agreed.

Also the legal aspects become more challenging. Using partner components might draw limitations on interconnected test. It needs to be ensured that partners can protect their commercial interest and that interconnection does not lead to the disclosure of sensitive information. Generally, security is one of the main problems related to interconnection. Interconnected testbed operators need to be aware of the implications resulting from testbed interconnection. Other challenges to be overcome are the definition of mechanisms for operation of the testbeds, definition of the steps in the process from offer to test execution, definition of the consortium and the rules in order to know how to participate, ensuring transparent classification of the testbeds, definition of the infrastructures and standardization of the information and the definition of the roadmap to create the network. These points have been recognized, which is why the Panlab project has been launched. Panlab is supported by the European Commission as a Specific Support Action (SSA) under EU

Framework Programme 6. The following chapter describes the Panlab project in more detail.

V. PANLAB PROJECT

The Pan-European Laboratory (Panlab) is an IST Project that is going towards the concept of federation of distributed laboratories and testbeds that will be interconnected to provide access to different platforms, networks and services for broad interoperability testing. The Panlab concept is enabling the trial and evaluation of service concepts, technologies, system solutions and business models to the point where the risks associated with launching of these as commercial products will be minimized. The Panlab project is a Specific Support Action which enables and facilitates the vision for a Pan-European laboratory. The envisaged framework includes general legal and operational mechanisms (e.g. different Customer-Provider relationship) as well as the approach for the technical infrastructure (e.g. databanks, search engines). Panlab investigates several issues from logistics, qualified personal, remote access and management to economic, legal and operational terms. The results will enable the implementation of a physical infrastructure, aiming at establishing integration, testing, validation/verification and possibly certification services for specific technologies and services with global solution prototypes developed by European collaborative projects. More about Panlab can be found in [5] and [6]. FOKUS is participating from the Panlab initiative together with other partners and will contribute with its expertise in order to find necessary solutions for the challenges highlighted in this paper.

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