Technical Criteria for Value-Added Services Creation, Execution and Deployment, on Next Generation Networks

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Abstract*—Create new services, in a faster way and at lower costs in order to attract new customers, keep existing ones and increase revenue, is the great target for telecom operators. This is possible with concepts like Next Generation Networks (NGNs), Service Delivery Platforms (SDPs) and Service Oriented Architecture (SOA), due to they enable the integration of the Telecommunications and Information Technologies (IT) domains. However, the telecom operators of non-developing countries have a limited knowledge about the technologies that adapt better to their needs, and how they can be used and integrated into their networks for Value-Added Services (VAS) provisioning. Therefore, a set of technical criteria that supports telecom operators in non-developing countries for VAS creation, execution and deployment, is proposed in this paper. In the same way, a general scheme for the establishment, description and definition of technical criteria is proposed under the context of NGN telecom operators with Softswitch in the control layer (without IP Multimedia Subsystem (IMS) control layer). Then, the Color/Caller Ring Back Tone (CRBT) as VAS, is developed for testing the general scheme and the technical requirements proposed. For this matter, Rhino Service Logic Execution Environment (SLEE) (Java Application Programming Interface (API) for Integrated Networks (JAIN) SLEE 1.1 specification compliance) was used. Furthermore, the results of CRBT integration into a real environment (NGN of EMCALI Colombian telecom operator) are presented. Finally, some conclusions are presented.

***Keywords*- JAIN; SDP; SLEE; NGN; Technical Criteria VAS.**

I. INTRODUCTION

Nowadays, telecom services providers understand their necessity to create new services in a faster way and at lower costs in order to attract new customers, as well as maintain the existing ones and increase revenue. New telecommunications services require more flexible systems with high levels of performance, large scalability and based on open standards [1]. The Next Generation Networks (NGNs) are the solution to almost all these challenges, defining a reference architecture that enables the development of new telecom services and integrates both legacy networks and Internet Protocol (IP) based ones. Today, many paradigms and technologies have emerged to develop and deploy this trend. This is the case of Service Delivery Platforms (SDPs), which was created with the idea of adapting the business model philosophy from the Information Technology context to the telecom domain.

Many research teams and communications companies look for those technologies that implement or adapt better to the SDP architecture, focusing on the solution for telecom service providers. However, a lot of telecom operators, mainly in the non-developing countries, have a lack of knowledge about how to integrate or exploit those emerging technologies for Value-Added Services (VAS) provisioning. Therefore, making technological changes is not simple and does not guarantee an optimal performance or good revenue to those telecom operators. Consequently, it is necessary to define technical criteria to be considered by telecom operators from non-developing countries in order to offer VAS on NGN. As a result this paper proposes: i) different technical criteria to be considered for VAS creation, execution and deployment on NGN with Softswitch in the control layer (non IP Multimedia Subsystem (IMS) in the control layer), and with SDP in the application layer. These criteria allow deciding the architecture and the required components to achieve a correct VAS provisioning. ii) A framework for organizing the technical criteria defined. For showing it, the reminder of this paper is organized as follows. Section 2 mentions the related work. Section 3 presents the technical criteria definition and the framework. Section 4 shows the implementation of the technical criteria under a study case. Finally, Section 5 presents the conclusions.

II. Related Work

In [2], a SDP is proposed in order to integrate both Telecommunication and (IT) industries. This SDP is focused on creation and execution control of IMS convergent services. However, for non-developing countries, where IMS has not been totally deployed, it is not possible to adapt those technical recommendations. This paper is only focused on technologies such as Parlay-X and on the Open Mobile Alliance (OMA), but Java Application Programming Interface (API) for Integrated Networks (JAIN) is not considered.

Tselikas et al. [3] presents an efficient performance comparison between several similar middleware systems based on open APIs and service protocols. The paper describes the implementation of telecom services supported by open interfaces and standard protocols exposing call control network functions. It analyzes a middleware implementation based on a subset of technologies, such as Open Service Architecture (OSA)/Parlay APIs, JAIN APIs and SIP, regarding call control functionality.

Femminella et al. [4] describes a Session Initiation Protocol (SIP) based call control service for Internet Telephony, designed for an IP-Public Switched Telephone Network (PSTN) converged scenario. The authors work with a service based on the Back-To-Back User Agent (B2BUA) architecture. The service is deployed into a Service Logic Execution Environment (SLEE) [5] based on Mobicents [6]; an open-source platform for telecom applications, which offers a JAIN SLEE specification implementation. In this case [4] doesn't address all the technical criteria to be considered in VAS development, and deployment.

In [7], the authors present a practical deployment of a contextual service offered by a convergent telecom operator, whose functionality is to provide intelligent context-based call routing and rerouting, orchestrated from the operator service layer. Nevertheless, [7] is based on IMS control layer capabilities to properly capture the user context in a ubiquitous coverage area, and it doesn't propose a schema for organizing the technical criteria for VAS creation.

III. Technical Criteria Framework

Figure 1 shows the general outline proposed structure for defining the technical criteria required for VAS provisioning.

A. VAS View

Telecom operators and third parties develop services defined in the VAS view. These new services should be defined for allowing market differentiation and the increasing of the operator revenues.

NGN Environment

NGN defines a reference architecture that enables the development of new telecom services and integrates both legacy networks and IP-based ones. Thus, it is necessary define clearly the NGN context to be used for VAS provisioning.

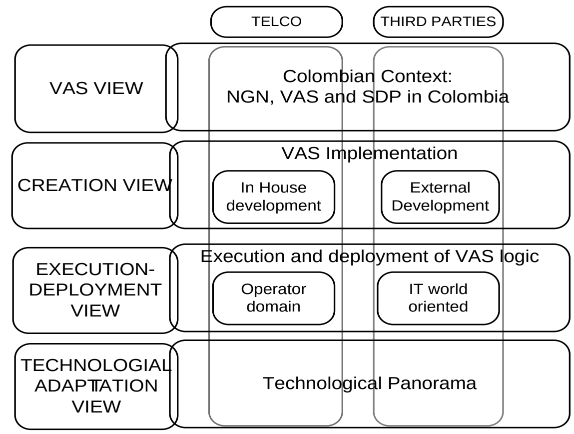

Figure 1. Framework for VAS creation, execution and deployment.

VAS Environment

There is not VAS standard definition. The VAS concept depends on the law regulations and the market context in each country. Therefore, it is extremely important to set a clear VAS definition and to establish a fully description. In order to do this, a functionality description based on states machines is recommended.

SDP Environment

It is vital for telecom operators to develop, deploy, implement, coordinate and manage new services, efficiently and effectively, generating higher incomes and maintaining low prices. These platforms enable telecom operators to have a complete environment for the creation, deployment, implementation, management and billing of a wide range of services and value-added content. Here, the main idea is to establish the environment(s) used for VAS provisioning, giving support to legacy infrastructure.

B. CreationView

In this case, the technical criteria are defined from two points of view: Third Parties and Telecom Operators.

Third Parties

Telecom operators need to increase the VAS portfolio. In order to do this, they must allow a safely interaction of third parties with their network infrastructure. Thus, in this case, open technologies, high level APIs network abstraction and solutions based on Web Services (WS), provides to IT developers, tools to develop more advanced services into telecom domain. Technologies such as OSA/Parlay [8], Parlay X [9] and Open network enablers API (OneAPI) [10], which is based on existing specifications, such as Parlay X, and has improved them to be far easier for Web developers to use, were designed with the intention of exposing network facilities to external domains through several protocols. In the other hand, Resources Adapters (RAs) from JAIN SLEE technology also enable network abstraction and third parties connection. Therefore, with these technologies a telecom operator is allowed to open its network in order to increase its services portfolio.

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Telco

It is important to know the technical criteria on the telecom operator side in order to find the most efficient way of creating and having a short time-to market.

Programmable APIs: define software components that abstract network protocols and allow the new applications development. The abstraction level can be classified like high, medium and low. For IT developers, it is recommendable use high level APIs. The other ones require a detailed knowledge about the mechanisms, the protocols and the infrastructure.

Scripting Language: scripting languages are appropriate technologies for faster application development due to the fact that they are used to connect existing components. They are lightweight and customizable interpreted languages based on eXtensible Markup Language (XML) representing the behavior of certain applications, making it possible to change at runtime. Therefore, the XML use may offer services customization and composition.

Service Creation Environment (SCE): a SCE should be based on open technologies and standards. A service usually developed by a SCE proprietary, it only runs in the SLEE of the same ownership, whereas a service created with a standard SCE can be implemented with few changes within any SLEE that supports the respective standard. For mentioned reason, here it is recommended to use standardized tools based on Java. Thus, it is possible to get better interoperability and costs decrease.

C. Execution and Deployment View

These technical criteria are developed from two points of view: third parties and telecom operators.

Third Parties

Integrating the IT world with NGN capabilities will enable to enrich the services offered to users and most important, it will enable third parties to develop new faster applications that impact the telecom services market. Hence, the idea is working with Java Enterprise Edition (JEE) [11] technology for third parties. This will make an easier and clearer communication possible between application providers and telecom operators, due to many telecommunication servers are based on Java SIP Servlets [1] or JAIN SLEE. Besides, a lot of services platforms based on Parlay X are also supported on Java.

Telecom Operator

It is extremely important that the operator has a service execution environment that optimizes the execution and deployment of convergent applications which are meeting the telecommunications requirements.

Performance: to achieve high performance, is desirable to use technologies to ensure high throughput and low latency. The architecture used here should meet these requirements. In this sense, JAIN SLEE is recommended. JAIN SLEE is a generic application environment designed specifically for supporting carrier-grade and event-driven requirements.

High Availability: in order to achieve high availability, the cluster server mechanisms are the most appropriate. These mechanisms increase the percentage of availability in critical environments such as telecom services. Although, the cluster configuration provides redundancy, it does not mean that high availability will be achieved. The reason for this affirmation is because of the fact that one node of the array can fail and the processed information will not be transmitted to the backup node automatically. Therefore, the memory synchronization process is also an important mechanism for high availability.

Reliability: an application server must include mechanisms to control bugs as well as robust processes that give the system the ability to bounce back and face different problems. In this case, the cluster active architecture is desirable.

Portable Service: in order to decrease the services development time is important to keep on the philosophy "written once, run anywhere" through technologies with high levels of interoperability between different Operating Systems (OSs), architectures and even other technologies, like the proposed by Java. This way, the selection of an execution environment based on JAIN SLEE standard, enables services to be developed and deployed with the least effort in any runtime environment compatible with the specification.

Event Driven Applications (EDA): to meet the requirements for telecom operators, the programmers need to develop applications over event-driven states and asynchronous platforms such as JAIN SLEE. Besides, the mechanisms of events distribution (service selection) enable a way to routing requests to the most appropriate functional blocks to process them.

D. Technological Adaption Criteria

The criteria in this view are focused on building a technology landscape that enables the operator to adopt and adapt any technologies into its network infrastructure in order to achieve convergence in any services that demand the NGN structures implementation.

Network abstraction layer

Here are considered all the technologies that enable the underlying network abstraction. This type of technologies exposes the capabilities that enable the smooth functioning of services, providing access to network resources. For example, into OSA/Parlay [8], JAIN, Parlay-X [9], OneAPI [10] and OMA [12], these capabilities are encapsulated in APIs which hide the network infrastructure complexity. Due to more abstraction high level, JAIN SLEE APIs are recommended. The JAIN SLEE RAs give a network high abstraction, as well as OneAPI, but this last one is focused on Web development, while the first one is oriented to telecom services. The Parlay APIs can be considered as medium level abstraction.

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Product support and maturity

The adoption of execution environments and tools for VAS creation should be based on standard specifications. For this reason, it is extremely important to choose a standard that clearly defines the technology path (versions of the specification), the backwards compatibility and the adaptability to future technologies.

Learning curve

If a parameter for the VAS deployment is the time spent in application development, then third parties (external services) and telecom operators (in-house services) should select a high-level API. Thus, the service creation time can be decreased. Likewise, to enrich the applications, the developers should select a high-capacity technology in order to enable the development of many applications supported by different protocols (e.g., JAIN SLEE).

Roadmap

Organizations such as European Telecommunications Standars Institute (ETSI), Parlay Group, 3GPPP and Telco companies, continually, through their working groups, study and analyze new requirements in order to further enhance the capabilities of technologies related to services provisioning. In fact, many companies have opted for existing architectures such as OSA/Parlay and JAIN SLEE. Therefore, it is important that the selected SDP for meeting telecom operator requirements also has a clear roadmap for supporting the new specifications [13]. In this sense, the support of previous specifications is essential, too.

Future permeability

The telecom operators must adopt new technologies with facility of growth [14].

Test environment

Years ago, the telecom operators of non-developing countries did not have test environments due to huge economical costs. However, technological advancement and the IT and Telco domains integration have enabled the test environment appearance. In a test environment, it is important to use simulation tools to emulate the SDP components and to test performance, traffic and latency, features, among others. In addition to performance testing, it is also possible to analyze the services behavior. Therefore, it is desirable to create a test environment for decreasing the development and deployment time.

SOA

Criteria such as the Services Buildings Blocks (SBBs), the reuse of components, the composition and the orchestration, enable a model inside the service layer, which streamlines and promotes the creation, implementation and deployment of new services [15]. These services must be defined so that they have loosely coupled and be interoperable. For achieving it, SOA is the most appropriated technology.

IV. STUDY CASE

This section will describe the way like the above criteria were applied. Promptly, in order to do it, the EMCALI study case is shown. EMCALI telecommunications is a fixed-line operator in Colombia, a non-developing country.

A. VAS View

NGN Environment

The study case was developed into the EMCALI NGN. It has two Softswitch in the control layer, and an application layer built on the Parlay X standard release three. Besides, this NGN has interoperability with PSTN, Global System for Mobile communications (GSM), TErrestrial Trunked RAdio (TETRA), among others. Due to market changes and challenges, EMCALI requires adapting new technologies that support new services for VAS provisioning, allowing positioning in the market and revenue increase.

VAS Environment

The adopted VAS concept is: "*Next Generation Services that integrate the world telecommunications and information, allowing an operator to develop and deploy a wide range of potential service according to some key futures and capabilities expected in the NGN"* [16]. The Color /Caller Ring Back Tone (CRBT) service was taken into account due to its high-host in mobile networks. The CRBT VAS allows the subscriber to replace the traditional Ring Back Tone (RBT), and even the busy-status and the not-available-status tones, by audio components that have been downloaded and defined by himself through a customized interface [17][18]. The CRBT operation process is as follows: when a call from a subscriber *A* is directed to subscriber *B* (service user), the caller (subscriber *A*) hears a sound fragment replacing the RBT. There are several audio files to configure the CRBT, such as song fragments, melodies, voice recordings, promotional messages, sound effects, among others.

SDP Environment

The EMCALI operator does not have an SDP. This makes its participation difficult on the VAS market. Thus, to meet this requirement, the OpenCloud Rhino SDP was used, which is compliant with JAIN SLEE, the open Java standard for telecommunications event-driven application servers.

Figure 2 shows the solution proposed in this work:

--JAIN SLEE server: contains the CRBT prototype service logic blocks, and the modules to adapt it to outside resources.

--Media server: exposes the module to play the audio file that replaces the call RBT. It communicates with the JAIN SLEE server through Media Gateway Control Protocol (MGCP) messages.

--Enterprise Information System (EIS): includes the module responsible for storing user information and the needed data for the CRBT prototype.

--Softswitch: contains the control and signaling units that handle the information flow of the EMCALI NGN. It communicates with the JAIN SLEE server through SIP messages.

--Transport network: refers to transport nodes that belong to the EMCALI NGN infrastructure.

-- The service logic CRBT prototype architecture is based on B2BUA because it offers the flexibility to handle all SIP call signaling between two users.

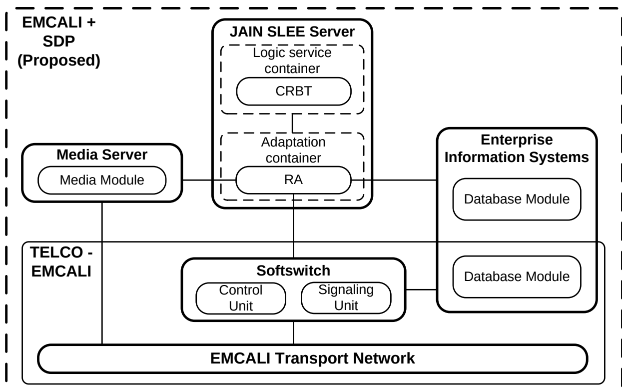

Figure 2: System solution modular architecture.

B. Creation View

The JAIN SLEE technology was selected because it allows abstraction at a high level, a not so steep learning curve for services creation and deployment. Besides, JAIN SLEE supports all SS7 protocols (including vendor variants) and all the IP/IMS protocols. As SCE, the Rhino Software Development Kit (SDK), by OpenCloud, and the Eclipse Integrated Development Environment (IDE) were used. Eclipse IDE easily integrated the libraries and plug-ins provided by OpenCloud to develop, deploy and test, the service. The SIP RA from OpenCloud (OCSIP RA) was used for binding the application layer and the control layer of the EMCALI NGN. Finally, the MGCP RA from Mobicents allowed the connection between the Rhino SLEE and the Mobicents Media Server (MMS).

C. Execution and Deployment View

Telco servers

It is extremely important to count with an execution environment geared exclusively for the telecom domain. As mention above, the JAIN SLEE technology is the most appropriate to meet the requirements of an operator like EMCALI. There are several JAIN SLEE implementations, such as Rhino SLEE [19], jNetX [20] and Mobicents JAIN SLEE [6]. In this case, Rhino SLEE by OpenCloud is highly recommended, because it is JAIN SLEE 1.1 specification fully compliant, it provides distinct licenses (open SDK, educational, commercial) and it supplies a complete set of RAs, tools, documentation and technical support.

Performance, high Availability and reliability

The technological developments made by OpenCloud, provide a robust environment to support large amounts of traffic, low latency, high availability, fault tolerance and overload. The active cluster architecture is widely used as a mechanism to resolve these high requirements.

Service Portability

The SBBs are the service basic elements that allow the development of reusable components with high performance operability [5]. The JAIN SLEE 1.1 specification defines a robust architecture that standardizes the RA, improving the interoperability and portability of its components.

EDA

Rhino SLEE is compliant with both versions 1.0 and 1.1 JAIN SLEE specification which are based on event-driven application model.

D. Technological Adaption Criteria

Rhino SLEE comprises a large number of RAs (SIP, Diameter, ISC, SOAP, SS7 family: INAP, CAP, MAP), allowing the development of applications that interact with all kind of network infrastructures.

Product support and maturity

JAIN SLEE is the only open standard for an application server designed to provide an execution environment for telecom services. Rhino SLEE, the selected JAIN SLEE implementation, is supported for a lot of companies such as Almira Labs, HP, Infocom, IBM, Motorola, Nokia Siemens, Sun (Oracle), among others.

Learning curve

This approach gathers the following three points: i) developer knowledge, where the selection of high-level APIs reduces the learning curve; ii) development and deploying time, which is decreased through high-level abstraction and service creation technology (e.g., EclipSLEE, OpenCloud JAIN SLEE plug-in); iii) high availability of tools.

Roadmap

The roadmap of JAIN SLEE technology and building services in Java is certainly promising. This community has highly distributed structured mechanisms and participation agreements for defining new recommendations.

Future Permeability

As well as JAIN SLEE achieves satisfactory scalability levels, technologies based on Java allow the constant binding and interoperability with emerging technologies to contribute to the new services enrichment [13].

E. Tests and results analysis

Signaling test

To proof that the CRBT service has been successfully integrated into the EMCALI NGN infrastructure, it has been registered the distinct messages of the different protocols present between the several equipments involved in a phone call from a PSTN conventional phone to an IP domain Softphone, which has subscribed the CRBT service. Both user terminal devices are configured with numbers that are registered into the EMCALI Softswitch that has been configured to operate with the Rhino SLEE (see Figure 3).

Data recording was made using:

-- ZXNM01 ZTE Equipment Management System, which includes a signaling tool that logs the traffic sent and received by the Softswitch.

--Wireshark, a protocol analyzer that logs all the traffic that passes through the network which is connected to the computer where it has been installed.

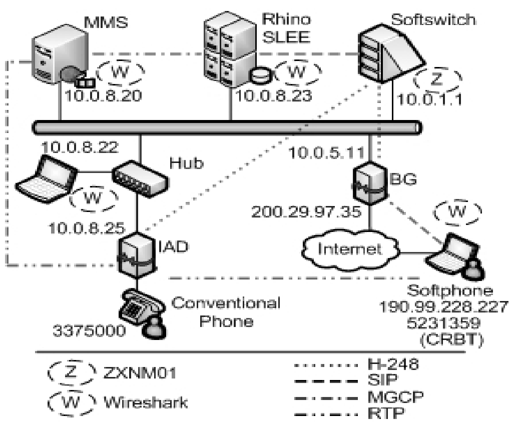

Figure 3: Network topology and test-design tools

F. Performance Test Description

The reference scenario used for the performance test was entirely independent from the EMCALI NGN. The Rhino SLEE Server 2.1 was deployed on a HP desktop PC with Intel Core 2 Duo E8300 @ 2.83 GHz; 2 GB RAM; OS Debian 5.0.4; Java Virtual Machine (JVM) 1.6.0_18 64 bit. The MMS 2.0.0.CR1 was deployed on a Gateway laptop PC with AMD Turion X2 TL-60 @ 2.0 GHz; 4 GB RAM; OS Debian 5.0.4; JVM 1.6.0_18 64 bit. The SIPp traffic generator was deployed on a HP laptop PC with Intel Core 2 Duo T9400 @ 2.53 GHz; 4 GB RAM; OS Linux Ubuntu 9.10. All computers were connected using a dedicated switch ZTE ZXR10 2826S Local Area Network, Ethernet 100 Based-TX.

Taking into account the MMS hardware features, it was configured to support 500 simultaneously multimedia sessions. Furthermore, the MMS source code was modified to solve an implementation failure. Moreover, the open files limit on OS Linux was incremented to 65535 due to the number of simultaneous calls to test.

Two different services were tested: the Traditional Call Service (TCS) and the CRBT service. Both services were configured in a SIPp scenario with 10 seconds call answer time and 3.5 minutes call duration. In the TCS, the MMS component doesn't operate.

The SIPp UAC and UAS were used to generate SIP traffic with an average rate equal to λ ranging: i) for TCS, from 10 to 110 calls per second (cps) in 10 cps steps; ii) for CRBT, from 10 to 50 cps in 10 cps steps. This last one has a smaller range due to MMS capacity limitations.

Each test was done with a constant λ value for 30 minutes. Before starting to collect statistics, a warm-up session of 15 minutes was performed to allow the Java Garbage Collector to be executed at least once and avoid JVM and JAIN SLEE transient effects [4].

G. Performance Test Metrics and Results

Throughput, obtained as the percentage of successful calls, and Session Request Delay (SRD) are used as performance metrics. SRD [21] is measured on the caller side and it is defined as the time interval from the initial INVITE to the first non-100 provisional response. It is used to measure the latency experienced by the caller when initiating the call session. Also, the CPU utilization was measured, which is extremely important to define hardware requirements.

Figure 4 shows that for up to 50 cps almost all call attempts were successful. Besides, taking into account that the operator handles 45 cps so during peak hours, this indicates that the development of CRBT using the technical criteria is appropriate.

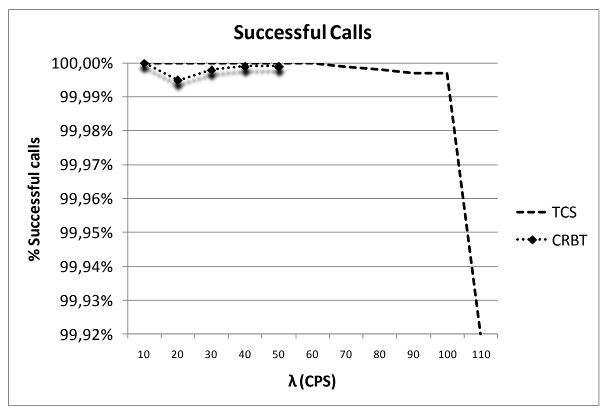

Figure 4: Throughput vs. cps

Figure 5 shows less than 100 ms between 0 and 50 cps, presenting a great performance and low latency in the response message.

The Creation View criteria were evaluated through two service implementation development time cases: while in this project the CRBT prototype service was built in four months, other project developers created a similar one in eight months [22], demonstrating the reduced development time with the JAIN SLEE use. Besides, after documentation, the components service (SBBs) building started soon and they were developed faster each time, exposing a slow learning curve of this technology. These SBBs were successfully deployed and tested in another JAIN SLEE implementation (Mobicents JAIN SLEE), evaluating the service portability capacity provided by the standard release 1.1. On the other hand, high availability and reliability criteria were reached through the Rhino SLEE technological tool, due to its exclusive cluster architecture design.

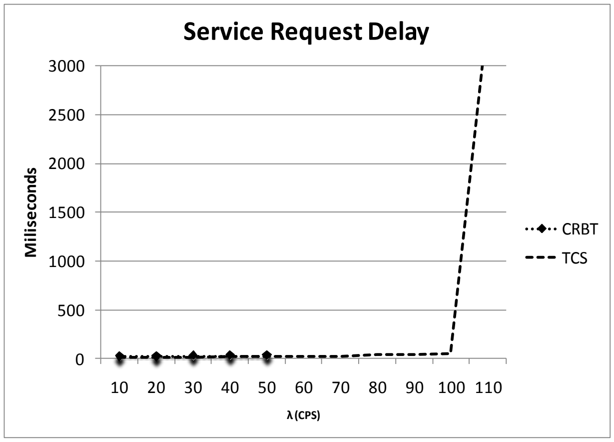

Figure 5: Average setup delay vs. cps

V. CONCLUSION

This paper presents technical criteria necessary for the creation, execution and development of VAS in NGN with Softswitch in the control layer. It also shows the technologies and tools for the creation, execution and development of VAS.

Within the development, implementation and deployment of VAS, the service execution environment is the key element in a NGSDP. This component must meet the high requirements in the Telco domain.

JAIN SLEE is the only open standard agreement for a telecom application server designed for high performance event-driven applications with reuse of components and high levels of growth.

The JAIN SLEE technology enables to make through its RA architecture, an abstraction of the transport layer of the NGN architecture, achieving rapid development and deployment of new applications and services.

The development of NGN applications is similar in many aspects to developing applications on the Internet, mostly because the main skills required for application development in this context are based on the use of Java and XML technologies. This makes creating applications more accessible to a broad community of developers, as it is easier, more productive and more creative.

The technical criteria defined allowed to decrease the development time, an outstanding achievement in the market context.

The technical criteria defined above, allowed meet the requirements for VAS provisioning on non-developing countries. This was demonstrated in the EMCALI operator study case.

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