Virtualization with Automated Services Catalog for Providing Integrated Information Technology Infrastructure

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Abstract. This paper proposes a service catalog service integrated with virtualized systems aiming at the possibility of raising and automating the availability in an IT (Information Technology) infrastructure. This paper demonstrates that aligning the server virtualization concepts and infrastructure management tools is possible to have gains in time and costs when compared to systems without automated service catalog. The main results presented illustrates that the use of a virtualized environment, with a standard services catalog and specific tools for infrastructure management, provides a time saving, reducing the request interval to a new server from several days to a few hours.

1 Introduction

Organizations considered leaders in its industries are no longer purely focused on costs, but they have also become companies focused in value.The present panorama forces them to aspire, at the same time, in one hand for the gain of productivity and efficiency, and on the other hand, for an increase in the area of capacity of Information Technology (IT) in meeting the new demands of business strategy [1].

The agile, reliable and precise obtaining of technological resources might meet the demands of the two challenges proposed. It is evident that the servers infrastructure (hardware, software and IT services) used need to evolve in order to sustain the technological innovations by leveraging IT resources (for IT resources, it is considered the servers infrastructure, involving hardware and software).

It is taken into account the need of integration amongst the various concepts and technologies involved to support an IT service. For this paper, the definition of "IT service" used is presented by Galup *et al* [1], where it is related to one or more IT

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systems that enable a business process, taking into account that an IT system is a combination of hardware, software, facilities, processes and people. This article proposes the development of an automated catalog of services, integrating it with an infrastructure management tool and servers virtualization platforms.

The integration of servers virtualization tools with an infrastructure management tooland the services catalog aim at some objectives. First, standardizing the requests for new operational resources, such as servers, basic software and applications. Second, automating the availability of the requested resources as soon as they are approved. Third, reducing the time of availability of a new server, and at last, minimizing operational costs with specialized labor.

Currently, the time required to deliver an IT service depends directly on the stages of request, approval, acquisition, and installation of hardware/software exclusive to serve only one set of applications or systems.

Infrastructure management tools and an adequate control of the entire IT infrastructure can help reduce costs. Companies may losemoney without a services catalog, since its users do not know which IT services are supported by the IT department in terms of virtualization. Besides that, without a well-defined configuration management process, there is also an underutilization of IT resources.

Many companies utilize services from the IT area that cannot be interrupted. Thus, servers are required to remain connected full time and to be responsible for supporting a given service, for instance, a financial transaction server.

Therefore, in the same company there might have various computers with underutilized resources. An alternative solution to this problem is the use of virtualization [2] to group diverse services and other applications that need to be available in parallel.

With virtualization it is possible to consolidate and isolate different virtual machines, multiple operating systems (O.S.), thus uniting various logical servers on a single physical device [3], as illustrated in Figure 1.

The major contribution of this article isthe development of the System of Requests Registration of IT Infrastructure (SRRITI),which was created in order to integrate the concepts of three technologies: servers virtualization tools, infrastructure management tool and the services catalog. As an additional contribution, we can highlight the presentation of some results on simulation tests, proving the gains of this work.

In order to present the System of Requests Registration of IT Infrastructure (SRRITI), its contribution, its functionalities and concepts involved, this paper is organized as follows: in section II the concepts analyzed in the proposed work are presented. In section III the proposal of a service catalog for virtual servers is displayed and the environment is described. In section IV, the tests and results are introduced, and in section V the conclusions and future work are presented.

2 Bibliographic Review

Up to the present moment, proposals for servers virtualization [4], with an infrastructure management tool [5], and a services catalog [1], have been treated as independent concepts and do not serve the purpose of integration and cost reduction sought in this work.

According to [7] the major software is licensed for one single CPU, that is, the user has the right to use the software in one single system. When the discussion comes to large enterprise the situation is much worse because the need is to use software in more CPU at the same time but the demand for hardware varies.

When it is considered the time and cost of hardware and software, virtualization became an alternative for companies interested in providing system infrastructure without having to add more physical devices.

The System of Requests Registration of IT Infrastructure (SRRITI) proposes the integration between the previous concepts to serve its purposes.

A more detailed description of these concepts can be found in the following sections.

2.1 Virtual Machines

A virtual machine (VM) can be defined as an efficient and isolated duplicate of a real machine. In other words, it is an isolated copy of a physical system and this copy is fully protected.The term virtual machine has been described in the 1960s from one term of operating system, or a software abstraction that sees a physical system (real machine) [2].

The heart of the system, known as virtual machine monitor (VMM), runs directly on hardware. It implements the multiprogramming, thus providing not one, but multiple virtual machines to the next layer located above, as it is shown in Figure 1. Indeed, they are exact copies of the hardware [7].

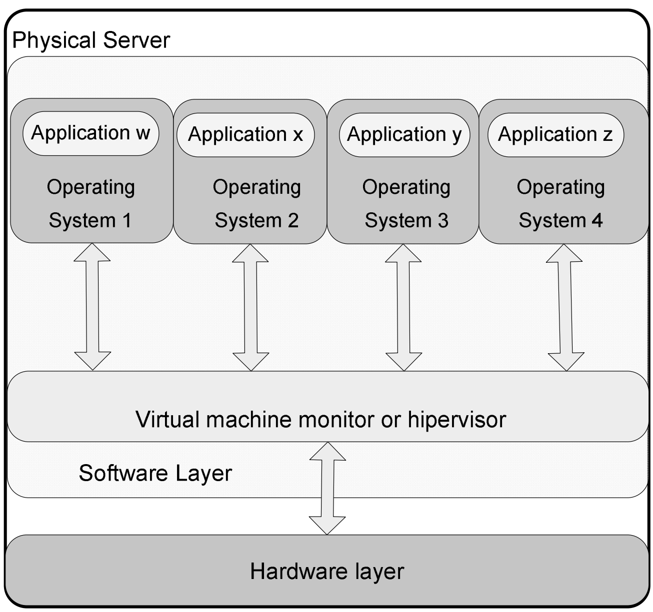

Fig. 1. A Physical Machine with 4 Virtual Machines

By running multiple instances of virtual machines on the same hardware, an efficient use of its processing power is also provided. In data centers, the reduction of physical machines means reduced costs for physical infrastructure such as space, power, cabling, cooling, support and maintenance of various systems [4].

There are four main architectures for virtualization in modern computing that allow the illusion of isolated systems: emulators, full virtualization, paravirtualization and virtualization in operating system level [8].

For this article, the full virtualization was chosen in virtue of the support for implementation given by nearly all virtualization software suppliers which were researched and cited.

2.2 Tools for Virtualization

Any person who currently uses a computer knows that there is something called operating system, which somehow controls the diverse devices composing it. The classical definition for operating system is a software layer inserted between the hardware and the applications that perform tasks for the users, and whose goal is to make the use of computers at the same time, more efficient and convenient [6].

There are commercial solutions, free software, integrated to operating systems, etc. It would be impossible and outside the scope of this article, to comment on all of them, therefore, we chose to present only the ones which are currently market leaders: VMware[9], Xen [8], QEMU[10] and Virtual Box[11]. Besides them, there is Microsoft's answer to the worldwide movement of virtualization [12].

2.3 Data Center Environment Management Tools

If a company wants to make the most of the process of computerization, organizational innovations are needed to sustain the technological innovations [13].

Tools that manage the virtualized environment (virtual machine motors), and also enable the management of the data center environment as a whole, are being developed. These machines can be either physical or virtual, amongst these initiatives, the ones researched were: Cobber[14], Puppet [15] and BladeLogic [5].

The tool BladeLogic was integrated into the service catalog developed in this work in order to enable the automation of availability tasks of a new server. This tool was chosen because of its differentiated amount of resources in relation to the other two competing tools surveyed.

2.4 Services Catalog

The IT services catalog is a menu offered by the information technology department to users of this corporation [16].

The catalog has all the services offered, software and corporate systems that can be installed and supported, avoiding users to request something that is not supported by the IT department.

With the increasing dependency of organizations in relation to Information Technology (IT), the importance of IT Service Management becomes larger every day. It is an excellent opportunity for IT to demonstrate its value and ability to leverage and bring innovation to business processes. But this is not a simple task.It demands clarity of focus and attention of the IT area [1].

2.5 Related Work

In [18] there is a discussion that agrees with the importance of a service catalog. When the infrastructure comes to a cloud environment it becomes important to formally represent knowledge in a services catalog. The focus is to enable automatic answering of user requests and sharing of building blocks across service offerings. In their work is proposed an ontology-driven methodology for formal modeling of the service offerings and associated processes.

[19] presents a model to support decision making for investments in IT services and affirms that it contributes to IT service portfolio management. Their work analyzes business impacts and investment options considering a Service Level Agreement (SLA) policy.

Discussion about the integration of multiple virtualized management tools for enterprise is discussed in [20]. It points that enterprise systems are in direction of the cloud and thus presents a strategy for accomplishing the migration process. It also considers the importance of integrated system management in user environment perspective.

When automation comes to the point of view regarding technology, [21] presents a large discussion of the subject. It presents reviews, benefits, domains and levels of application. One of the main contributions of the work presented is that automation inspires creative work and develops newer solutions. Than concludes the work with several emerging trends in collaborative control and automation, and risks to anticipate and eliminate situations where automation cannot be forget.

3 Proposal of the System of Requests Registration of IT Infrastructure

This section is divided in small parts to describe the main characteristics and functionalities of SRRITI.

3.1 System Persistent Layer

In order to collect users' information in a standardized way, the SRRITI was developed. The System provides its users with the hardware and software settings supported by the IT department. The whole system was developed using HTML and PHP pages and the support of a database as persistence layer.Table 1resumes the main tables and its characteristics.

Table 1. Resume of System Persistence Layer

NAME	DESCRIPTION
1.tb_usuarios	Storage system users' information such as profile and user identification.
2.tb_servidor_fisico	Table for the physical server pool that may support virtualized environment
3.tb_servidor_logico	Its main function is to standardize the names of the systems and main OS available for virtualization.
4.tb_requisicoes	Main system tableandstoresinformationaboutuser requests and status.
5.tb_hardware_processador	Stores information about physical infrastructure total number of available processors.
6.tb_hardware_capacidade_disco	Disk size related to physical available capacity.
7.tb_hardware_memoria	Memory size related to physical available capacity
8.tb_hardware_placa_rede	Stores the network interfaces speed to the virtualized hardware.
9.tb_software_sistema_operacional	This table stores the OS that has been previously prepared for installationusing a data center management tool.
10.tb_software_backup	Maintains the backup software that has been previously prepared to be installed for backing up a virtualized system.
11.tb_software_monitoracao	Maintains the monitoring software that has been previously prepared to be installed for the virtualized system.
12.tb_software_automacao	Stores the automation software for the selected virtualized system.
13.tb_software_servidor_http	This table stores software for HTTP servers that are available for installation in a virtualized environment.
14.tb_software_transferencia_arquivos	It maintains software for file transfer servers that are available for installation in a virtualized environment.
15.tb_software_banco_de_dados	Stores software for Database servers that are available for installation in a virtualized environment.

3.2 System Logics

The project was designed segmenting administration functions, registration of requests, and approval of registered requests. According to the user's credentials, he or she is redirected to the screen functionalities, in agreement with his/her previously registered profile.

Once the request is registered in the system, there must be an approval of the solicitation before it can be provided. The consultation to a request and its subsequent approval is accessed by users who have the approver profile or administrator.

At the moment of approval of a new server request, the files, which will interface with the virtualization tool in order to create the new server, are generated in disk. The files of interface with the infrastructure management tool are also created in order to install the operating system, and the previously registered applications. At this point it is chosen the physical machine where the virtual machine will be created. Figure 2 demonstrates the flow of a new request. Moreover, it is also possible to provision a physical machine without any virtualization feature within the developed system.

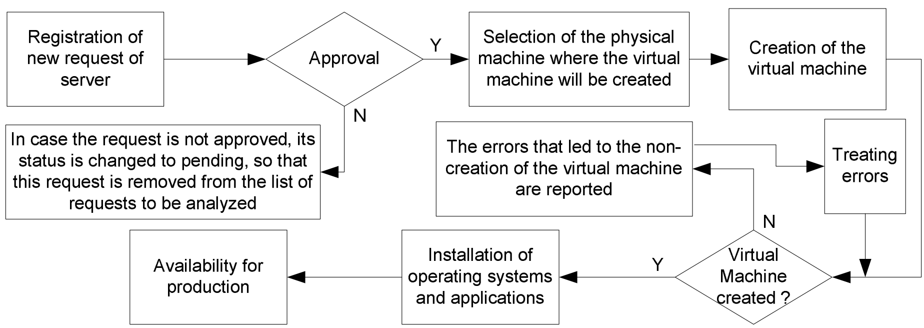

Fig. 2. Flowchart of a New Request

All the files created have the request number to which they are associated; therefore, it is possible to run more than one provisioning at the same time.

3.3 System Basic Caractheristics and Functions

SRRITI was developed using PHP with Apache HTTP Web Server and MySQL as database server. The system divides the user profile based in three main modules: 1) user requests, where users perform its system requests; 2) system approval, where system requests are approved following enterprise process policy by IT department; 3) the SRRITI administration, which is conducted by IT specialists in virtualization and system data center management.

The developed system has a lot of input screens where users can perform its actions based on its profile. As an example, Figure 3 shows one of the screens of SRRITI. There it is presented the registration of a new request from a server. On this screen, certain items are available: processor, disk capacity, memory size, speed of network card, operating system, monitoring software, backup software, automation software, software for transferring files and database software.

The main advantage of SRRITI is that in concentrates the user requests in one point of control and thus reduces de process complexity of requesting a new virtualized system.

It is important to consider that the automation of IT infrastructure is recommended for large enterprises with a heterogeneous and complex computing park. There are no well-known reports regarding the minimum number of servers or database, or even operating systems that suggest the minimum amount of the related items cited above should be automated.

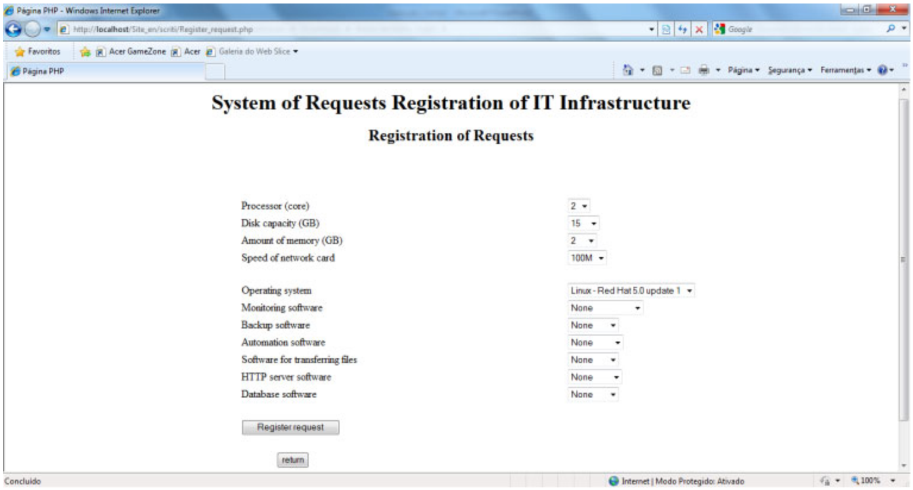

Fig. 3. Screen of Registration of Requests of the System SRRITI

3.4 System Main Outputs

Once the user completes a request for a virtualized service and has the IT department approval, SRRITIautomatically generates scripts to be directly executed in the data center management tool. SRRITIsystem files outputs are based in well-known standards as XML and BAT files, which are easily interpreted and may be imported and integrated in most systems and tools using common programing language. Figure 4 shows a XML output example.

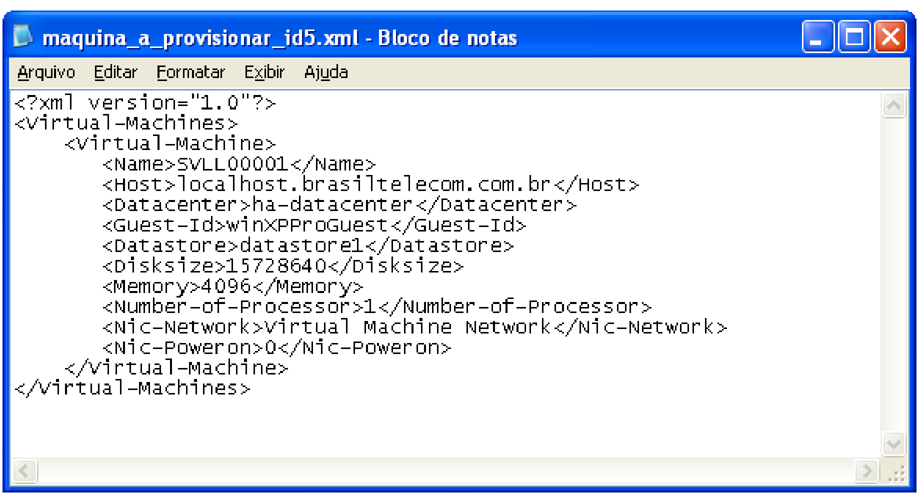

Fig. 4. XML Output of an User System Request

Also there are other XMLs inputs to the system, for instance, system name, system mac-address, system profile, system OS, etc. Each of them depends of the user request and availability of the IT infrastructure. Once the creation of a new virtualized environment is allowed by IT personal, SRRITI reads the XMLs files as data input than connects to the data center management tool and pass the new virtualized system parameters to be created. The whole process is automated using specific commands depending on the data center management tools. Figure 5 shows one type of command that can be executed.

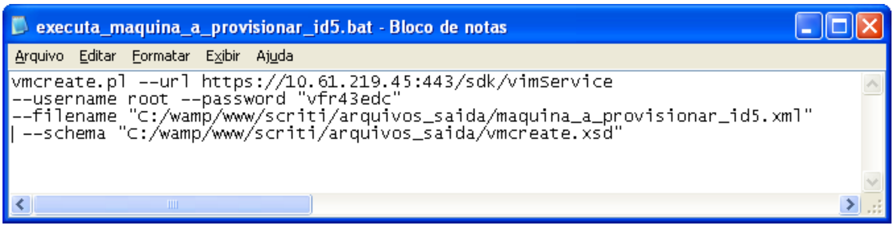

Fig. 5. System Command for Creating a Virtualized System

4 Tests and Results

The testing environment was built seeking to clarify the following questions:

a) Is it viable to automate the availability of a new server from a service request?

b) Is it possible to develop and integrate a services catalog with hypervisors and IT infrastructure management tools, enabling a reduction in the time availability of a new server and also reducing the operating system installation time?

c) How much can the operating cost be reduced by using the integration of concepts and tools presented?

SRRITI was tested as a response to the questions presented.

4.1 Testing Environment

For this article the VMware ESX Server 4, which is the base software for creating virtual data center, was used. The ESX server is a virtual machine monitor that virtualizes hardware resources like processor, memory, storage and networking. Thus, the ESX Server allows a physical server to be partitioned into several isolated and secure virtual machines and, each one is seen as a physical machine in a conventional network infrastructure.

Tests for the creation of virtual machines were performed. Following this, the installation of the operating systems RedHat Enterprise Linux 5.0 update 1 and Windows Server 2003, with various configurations of central processing unit (CPU) and variation of Random Access Memory (RAM), took place.

All the tests were performed by booting only a VM at a time in order to avoid any kind of interference in the tests due to the amount of memory allocated in some other virtual machine.

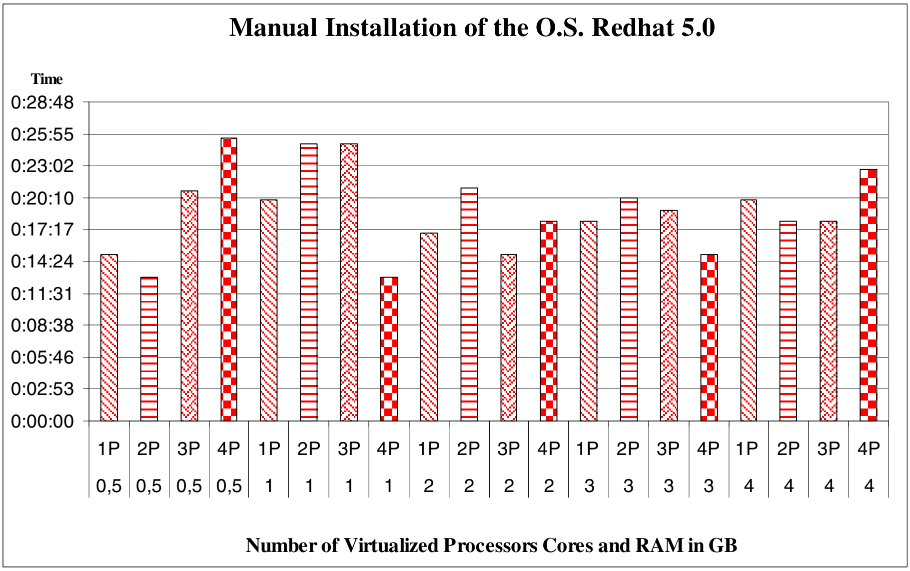

Fig. 6. Manual Installation of RedHat Enterprise Linux 5.0 update 1

The graphs of this paper are organized as follows: on the left side, it is shown the time spent for installation in the format hours: minutes: seconds (h:m:s). At the bottom of each graph, the number of processors (cores: from 1P to 4P) of the virtual machine created, and the amount of RAM in GB (from 0,5 to 4) allocated to each machine, respectively, are presented.

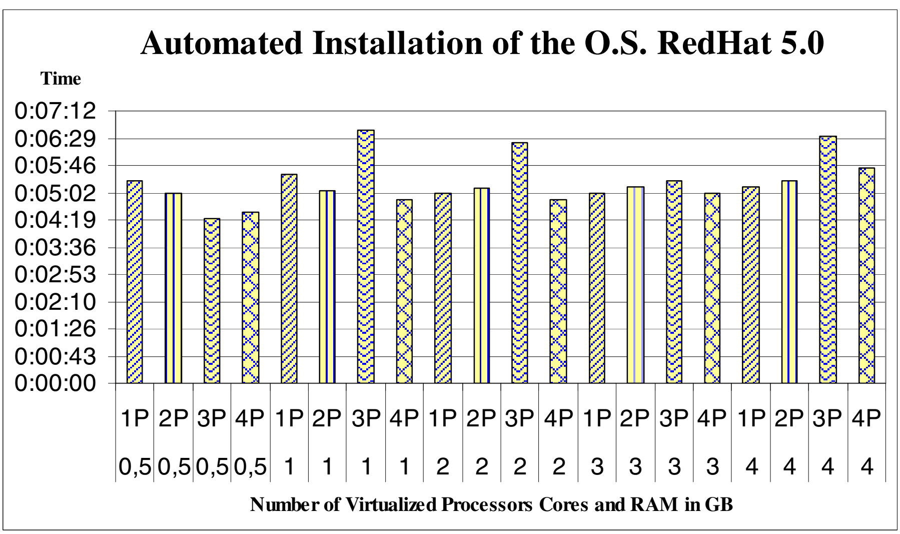

Fig. 7. Automated Installation of RedHat Enterprise Linux 5.0 update 1

Figure 6 illustrates the results obtained in the tests of the manual installation of the operating system, RedHat Enterprise Linux 5.0 update 1. Figure 7 presents the results obtained in the automated installation tests of the operating system RedHat Enterprise Linux 5.0 update 1 utilizing SRRITI.

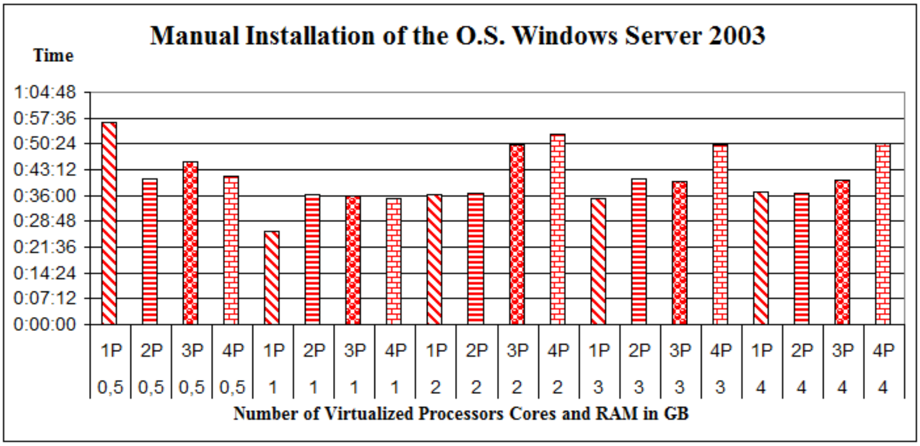

Fig. 8. Manual Installation of the O.S. Windows Server 2003

Figure 8 shows the results obtained in the manual testing of installation of Windows Server 2003 operating system. Figure 9 illustrates the results obtained in the automated test of installation of Windows Server 2003 operating system.

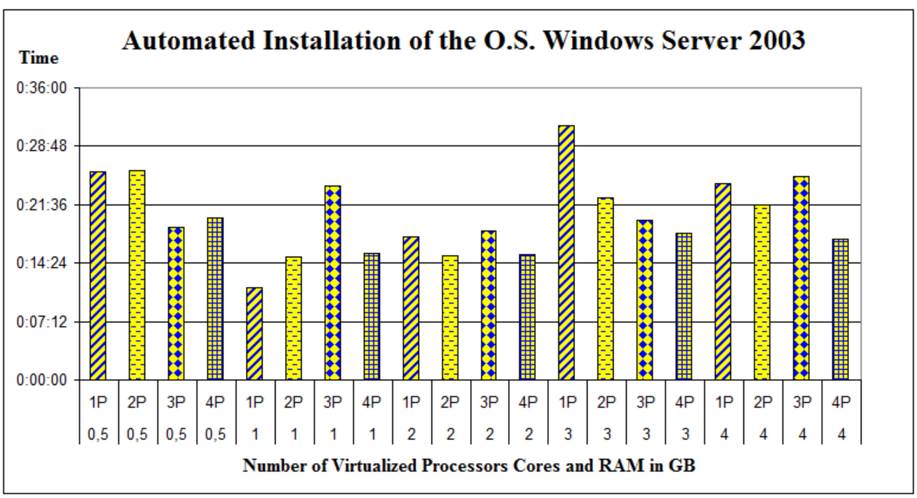

Fig. 9. Automated Installation of the O.S. Windows Server 2003

As shown in Figures 6 through 9 the numbers of processors are not changed because the objective of these tests was to compare the time that the same machine with the same characteristics would take to perform the process of installation of the virtualized environment in a manual fashion compared to an automated fashion provided by SRRITI.

4.2 Comparison of Results

Technology can be used for automating operations. The objective is to replace the effort and provide the human qualification via technologies that allow the same processes to be executed at a lower cost, under control and continuity.

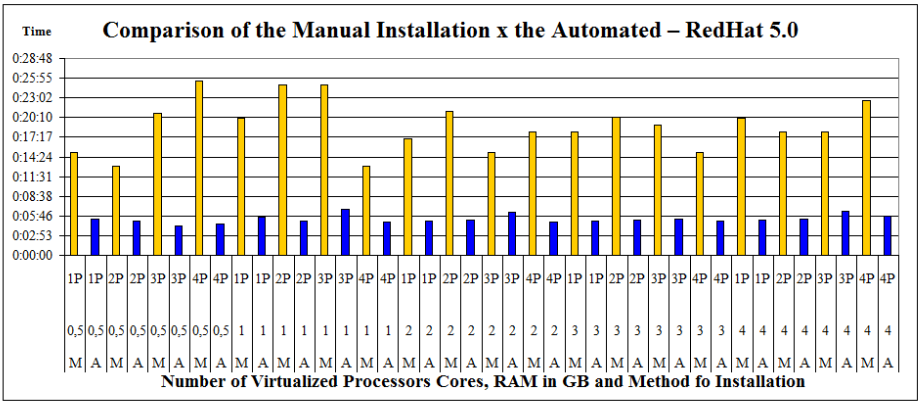

Fig. 10. Comparison of the Manual Installation x the Automated - O.S. Redhat Enterprise Linux 5.0 update 1

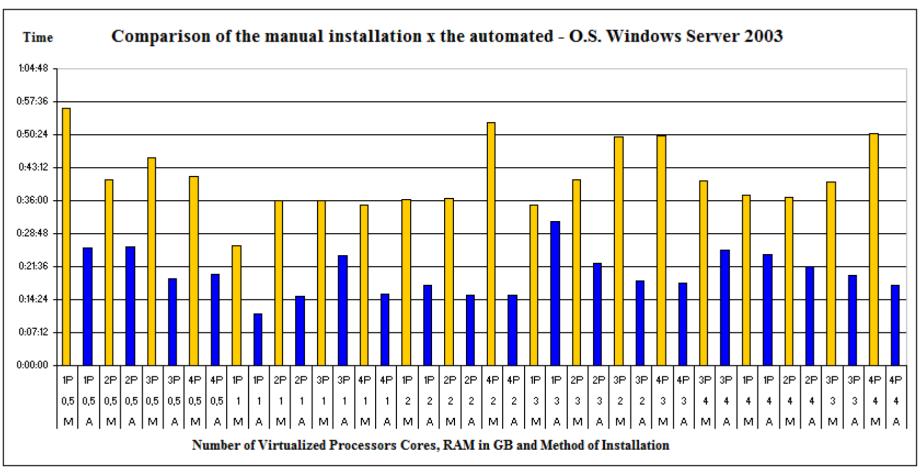

Fig. 11. Comparison of the Manual Installation x the Automated - O.S. Windows Server 2003

Automating a process, which is executed manually, initially, aims at reducing the possibility of human error and, in the background, increasing the productivity by making available a good or service. This can be verified comparing graphs of results in Figures 10 and 11. They show that an automated process has better time results that a manual installation process.

In addition, information concerning time spent with installation; number of processors (cores) of the virtual machine created; amount of RAM in GB; and the method used for installation manual (M) versus automated (A) are also described.

The system SRRITI proposed in this paper, confirms these concepts.The productivity gain ranged from 57.56% for the scenario of two processors and 2 GB of RAM in the worst case, to 82.30% for the installation of the operating system RedHat Enterprise Linux, including three processors and 0.5 GB RAM, as it is presented in Figure 10.

In relation to the operating system Windows Server 2003, the productivity gain ranged from 10.38% for the scenario of one processor and 3 GB RAM, representing the worst case, to 70.91% in a scenario of four processors and 2 GB RAM, which was the best case as illustrated in Figure 11.

4.3 Comparative Analysis of Costs Estimate

In the case of a large telecommunications enterprise studied in this paper, after analyzing the whole process that is used to make an virtualized system available (Figure 12), it was observed that the process takes 46 days from the user request up to the deploy of the user request. Considering an 8-hour workday, it is possible to conclude that from the request to its proper availability, 368 working hours are required in order to provide a new server. These are reference values, which were obtained through the analysis of the studied process which are also listed in Table 2.

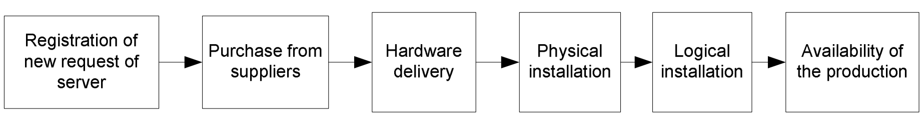

Fig. 12. The Process of a Large Telecommunications Company in Order to Make a Server Available

Based on a salary survey [17], in Table 2, the average salary of a support analyst is presented (expressed in Brazilian currency, reals). The final amount was divided by the total working days within a month, and then this value was divided by the total of working hours. These calculations are needed to reach the analyst's value of one hour of work.

Table 2. Amount of Time Demanded for the Availability of a New Server without Virtualization

Reference Value	Description
46	Workdays in order to make a new server available
8	Daily work hours
368	Total of hours needed for creating a new server

In Table 3 the value of an analyst's hour of work is presented. This value is multiplied by the total of hours needed for creating a new server. The final amount represents how much it costs for a company to create a new server using only specialized labor.

Table 3. Cost of one Hour of Work of a Support Analyst

Reference Value	**Description**
R$4616,48 22	Average salary of a senior Linux support analyst. Total of workdays in a commercial month.
R$209,84	Valueof a workday.
R$ 26,23	Value of one hour of work of a Linux support analyst.

Table 4 presents a financial analysis utilizing non-automated virtualization infrastructure.

Table 4. Cost for a Company with Specialized Labor to Create a New Server without Virtualization

Reference Value	**Description**
368 R$26,23	Total of hours needed to make a new server available Value of a support analyst's hour of work
RS 9.652,64	Total cost of an analyst working for 46 days

In Table 5 a financial analysis using virtualization and the automated process integrated with the services catalog are shown, also the amount of time needed in order to make a new server available through the system SRRITI, which was developed and presented in this paper.

Table 5. Financial Analysis of the Cost utilizing Virtualization

Reference Value	**Description**
48 RS 26,23	Total of hours needed in order to make a new server available with virtualization Value of a support analyst's hour of work
RS 1259,04	Total cost in order to make a new server available

The approval of request may be responsible for the time increase in making a new server available, and for this reason, it was considered the worst case: two workdays or 16 hours were necessary for the new server to become available. This analysis is resumed in Table 6.

In order to solve this matter, a set of physical servers with available resources to enable the creation of virtual machines is demanded.

Table 6. Financial Analysis of the Cost of the Automated Process Integrated with the Services Catalog

Reference value	Description
16	Total of hours needed to make a new server available
RS 26,23	Value of a support analyst's hour of work
RS 419,68	Total cost in order to make a new server available

5 Conclusions

Automating a process for a few executions can be more financially costly and onerous in amount of time than executing the proceeding manually. However, after a defined number of repetitions in each specific environment, the time invested, and, consequently, the capital allocated, are to compensate the time spent on automating the task.

The automated process reduced the amount of time demanded for the availability of a new server in virtue of the standardization of requests. With the standardization of the requests, it was possible to automate the delivery of required resources as soon as they were approved. This fact reduced the costs with specialized labor.

Table 7 presents data on the reduction of time and operating costs achieved through the utilization of the System of Requests Registration of IT Infrastructure (SRRITI). Comparing the time to deliver a new server with virtualization to SRRITI, there was a time reduction of 66.67% with the use of the system SRRITI.

Table 7. Comparative analysis of time and cost

Scenario	Time (in work hours)	Cost (in Reais R$)	Percentagegain (*)
WithoutVirtualization	368	9,652.64	--
WithVirtualization	48	1,259.04	66.67
Via the system SRRITI	16	419.68	95.65

(*) The percentage gain considers the time column in relation to the system SRRITI.

With the integration of concepts presented in this paper (virtualization, infrastructure management and services catalog), and through SRRITI it was possible to observe the gains offered and their true contribution to the standardization and automation of IT services. The reduction of time and costs also adds essential value to the System of Requests Registration of IT Infrastructure.

5.1 Future Work

As future work, new studies regarding trust, virtualization, cloud and service catalog may be necessary in order to provide more availability do users in mixed environments.

Trust and security [22], [23] [24] have become crucial to guarantee the healthy development of cloud platforms. Most studies tries to provide solutions for concerns such as the lack of privacy and protection. These characteristics are important to guarantee security and author rights.

When trust comes to discussion, it is also important to consider that there is no common trust and reputation consensus in distributed environment, for example, to guarantee that a pool of servers are trustworthy in the same service catalog. That makes trust and reputation analysis fully dependent of specific variables and the definitions of the environment that it is attached to.

In the cloud the situation gets more complicated because it is necessary to employ trusts model in cloud environments to guarantee users security and privacy.

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