THE IMPACT OF SERVER VIRTUALIZATION ON ITIL PROCESSES

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Keywords: Virtualization, ITIL, IT service management, Cloud computing.

Abstract: Server virtualization influences all aspects of IT service management, and is a key enabling technology for cloud computing. In this paper we focus on the impact of server virtualization on service delivery and service support as described by ITIL. We identify advantages, disadvantages, and risks of server virtualization for capacity, management, availability, costs, and security of IT services, and relate these aspects to the ITIL processes. We validated our results using an empirical test within four different organizations. Our main conclusion is that server virtualization does not change the ITIL processes themselves, but it does change the way the processes are executed. Server virtualization is no silver bullet for solving problems in IT operations and management. If server virtualization has been properly introduced, it can offer faster and better execution of the ITIL processes. The impact is most significant on the Financial Management process, while also Service Level Management, Incident Management, Change Management, IT Service Continuity Management and Availability Management are affected considerably. The impact is less prominent for Application Management, Software Asset Management, Release Management, Configuration Management and Security Management.

1 INTRODUCTION

Organizations have considered server virtualization initially from a tactical viewpoint: an effective technology for consolidation, offering increased utilization levels, reduced server sprawl, and lower capital and energy expenses. Over time, server virtualization is being considered more from a strategic viewpoint: a catalyst for IT modernization that changes how IT is acquired, deployed, consumed, managed, and paid for.

Gartner states that server virtualization is the highest-impact issue changing IT infrastructure and operations through 2012 (Dawson & Bittman, 2008). Gartner also states that server virtualization offers a natural path to evolve from internal IT modernization towards cloud computing (Bittman, 2009). Server virtualization enables IT to become more service-based, allowing scalable and elastic delivery of resources at much greater speed, driving economies of scale with shared resources, and measuring and charging back based on dynamic usage. Hence, server virtualization makes an IT organization behave much more like an internal cloud-computing provider. This paves the way for outsourcing IT services to external cloud-computing providers. Once server virtualization has been introduced, organizations can more accurately compare internal IT services with external IT services, and they have gone through fundamental cultural, political and funding changes that will ease outsourcing to external cloud-computing providers.

Server virtualization has a clear impact on IT service management. ITIL (IT Infrastructure Library) is a set of best practices for IT service management (Rudd, 2004). Although the impact of server virtualization on ITIL is widely recognized, studies on their correlation are still missing. The research presented in this paper aims to fill this gap.

We first performed a literature study to identify advantages, disadvantages and risks of server virtualization, and the correlation between server virtualization and the ITIL processes. We next validated and extended these results in an empirical test by interviewing four organizations that practice both server virtualization and ITIL. The results of this research are reported in this paper.

This paper is organized as follows: Section 2 summarizes related work on server virtualization, ITIL, and their correlation. Section 3 lists the

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advantages, disadvantages and risks of server virtualization. In section 4 we correlate these aspects of server virtualization with the ITIL processes, and we report the results of an empirical test to validate this correlation. Section 5 discusses these results and section 6 concludes the paper.

2 RELATED WORK

ITIL is a set of best practices for IT service management, focusing on efficiency and cost effectiveness, and has become a de-facto standard (Brenner, 2006). ITIL v1 was introduced in 1980. ITIL v2 appeared in 2000, focusing on service support and service delivery. ITIL v3 appeared in 2007, arranging processes around the service lifecycle. Despite the appearance of ITIL v3, many organizations are still implementing ITIL v2 and consider this as sufficient or see only limited added value in ITIL v3 (Pollard & Cater-Steel, 2009). We therefore only consider ITIL v2 in this paper.

There is plenty of scientific literature on server virtualization and ITIL, however we discovered only few sources that discuss the correlation between them. Furthermore, none of these sources conducted a thorough scientific study on the correlation. Mandorla and Hallgårde (2006) state that almost all IT service management functions are impacted by the move to server virtualization. Baldwin, Shiu and Beres (2008) analyse the consequences of server virtualization on security and audit assurance, and discuss the impact on some of the ITIL management processes. Montero (2007) shows the impact of virtualization on ITIL processes, however without mentioning how these results were derived.

3 SERVER VIRTUALIZATION

We conducted a literature study to identify advantages, disadvantages and risks of server virtualization. Advantages have a positive impact on the IT organization. Disadvantages have a clear negative impact, while risks have a possible negative impact. We identified 34 aspects and grouped them into five categories: capacity, management, availability, costs and security (see table 1).

3.1 Capacity

Server virtualization offers better utilization of existing resources. Multiple virtual servers can be deployed on a single physical server (Daniels, 2009), and isolated environments for software testing, training and development activities can be created (Kamoun, 2009). However, the response time of mismanaged virtual machines can become unpredictable under heavy load (Computer Associates, 2008). Virtualization also introduces an additional layer of overhead that must be factored

Table 1: Server virtualization aspects from literature (**A**dvantage, **D**isadvantage, **R**isk).

Capacity	
better resource utilization	A
difficulty managing resources and peak loads	D
additional performance overhead	D

Management	
increased speed and flexibility of server deployment	A
faster deployment of environments for training, test and development	A
reduced complexity due to fewer physical servers	A
easier backup	A
central software update & patch management	A
larger consequences of human errors	R
unwanted vendor lock-in	D
immature management tools and incompatibilities	R
not all applications suitable for virtualization	D
no support software vendors on virtual environment	R
legacy application support	A
security concerns when keeping legacy applications	R
virtual machine sprawl	R

Availability	
higher availability levels without additional cost	A
faster recovery from crashes and disasters	A
reduced application conflicts due to isolation	A
hardware defects impacting large number of VMs	R
denial of service attack affecting all VMs on host	R

Costs	
reduced hardware purchases	A
increased costs for new, high-end hardware	D
reduced management costs	A
reduced energy and hosting costs	A
increased license costs	D
increased costs for personnel training and new hires	D

Security	
VMM as additional attack vector	R
increased security because of VM isolation	A
stealing sensitive information	R
breaching confidentiality or integrity of VM	R
difficult patch management suspended VMs	D
secure logging	A
rogue virtual appliances	R

into the total system load (Loveland et al., 2008).

3.2 Management

Server virtualization can significantly simplify the task of deploying servers. This often reduces the provisioning time for a new server from days to hours. Although tools for managing virtualized environments are important, they are still immature (Computer Associates, 2008; Dawson & Bittman, 2008). The number of physical servers is reduced, thereby reducing the complexity of server management. Since it is easy to deploy and run virtual machines, this may result in server sprawl (Pfister, 2008). Not all applications are suitable to be virtualized and certain software vendors will not support their product when virtualized (Tanaka, Tarui & Naono, 2009; Woltjes & Berg, 2008).

3.3 Availability

Virtualization offers faster disaster recovery (Montero, 2007). This allows decreased costs and higher availability levels (Loveland et al., 2008). However, failure of a physical host affects all virtual machines running on it (Pfister, 2008).

3.4 Costs

Server virtualization offers reduced costs for hardware, energy, hosting and management, while costs for licenses and training are increased.

3.5 Security

Virtualization is implemented by adding a privileged software layer, which introduces new vulnerabilities. Attacks against this layer may give access to multiple virtual machines (Ray & Schultz, 2009). On the other hand, attacks against a single virtual machine do not compromise other virtual machines due to their isolation (Menascé, 2005).

A virtual machine is a set of files, and hence can be easily copied, inspected or modified, breaching confidentiality and integrity (Cleeff, Pieters & Wierenga, 2009). Also patching suspended virtual machines introduces new challenges (Pfister, 2008).

4 EMPIRICAL RESULTS

Based on literature study, we created a correlation matrix containing aspects of server virtualization and ITIL processes. We validated the correlation matrix in an empirical test consisting of interviews. Figure 1 shows the conceptual research model.

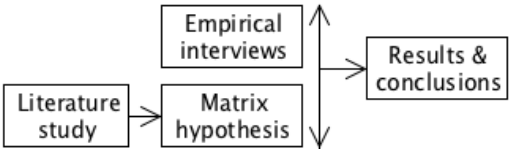

Figure 1: Conceptual research model.

4.1 Interviews

We interviewed IT managers at the following four Dutch organizations early July 2010:

- IT department of a university (300 virtual servers).
- Hosting service provider (500 virtual servers).
- IT organisation of government body on security and public order (2,300 virtual servers).
- Large IT consulting firm (8,000 virtual servers managed internally, thousands at customers).

Before the interviews, the interviewees received a short briefing on the scope of the research, definitions of ITIL and server virtualization, and a description of the 34 server virtualization aspects. This allowed the interviewees to prepare themselves for the interview and collect information if required. The interviews were semi-structured, based upon a questionnaire that was used in all interviews. The first questions ask for key figures of the organization (number of employees, sector and size of IT organization), how knowledge is acquired, which ITIL processes are present and which virtualization types are implemented. Next, the interviewees were asked to indicate for each aspect of server virtualization, whether it is applicable in their organization, how the ITIL processes are impacted, and whether recommendations can be given. Finally, the interviewees could identify additional aspects or recommendations. During the interview, the interviewees filled an empty correlation matrix. The interviews were recorded with permission.

4.2 Aspects of Server Virtualization

Table 2 shows the responses of the interviewees whether they consider each aspect of virtualization as not applicable, advantage, risk or disadvantage. Surprisingly, 11 of the 34 aspects are considered as not applicable by at least 3 interviewees. These aspects are mainly related to capacity, availability and security. While these aspects are being considered in literature as risks or disadvantages, the

interviewees indicate that they have been eliminated by fast improvements of virtualization tools.

Table 2: Server virtualization aspects from interviews (**N**ot applicable, **A**dvantage, **R**isk, **D**isadvantage).

Capacity	**N**	**A**	**R**	**D**
better resource utilization		4		
difficulty man. resources and peak loads	3		1	
additional performance overhead	3		1	
Management				
incr. speed and flex. of server deployment		4		
faster deployment of environments for training, test and development	1	3		
red. complexity by less physical servers	2	1	1	
easier backup	1	3		
central software update & patch manag.	2	2		
larger consequences of human errors	2		1	1
unwanted vendor lock-in	2		2	
immature manag. tools and incompat.	1		1	2
not all applications suitable for virt.	3			1
no support software vendors on virt. env.				4
legacy application support		4		
security concerns legacy applications	1		2	1
virtual machine sprawl	2		1	1
Availability				
higher av. levels without additional cost		4		
faster recovery from crashes and disasters		4		
reduced appl. conflicts due to isolation	1	3		
hardware defects impacting VMs	4			
DoS attack affecting all VMs on host	4			
Costs				
reduced hardware purchases	1	3		
increased costs for new hardware	3			1
reduced management costs		4		
reduced energy and hosting costs	1	3		
increased license costs	1	2		1
increas. costs for training and new hires		2		2
Security				
VMM as additional attack vector	2		2	
increas. security because of VM isolation	4			
stealing sensitive information	3		1	
breach. confidentiality or integrity of VM	3		1	
difficult patch manag. suspended VMs	2		2	
secure logging	4			
rogue virtual appliances	3		1	

Table 2 clearly indicates that the interviewees largely agree on whether aspects are advantages or disadvantages. They only deviate on the amount of risk that is still involved with certain aspects. For instance, one interviewee considers consequences of human errors as a clear disadvantage, while another interviewee considers this to be a risk. The interviewees disagree only on the costs for licensing and personnel. Although investments for training and education are generally considered as beneficial, the dangers are that budgets for doing so are insufficient and server virtualization is introduced by unqualified personnel. All interviewees consider licence costs for virtualization tools as a disadvantage. However, moving to server virtualization implies that an organization reconsiders many IT aspects, including software licenses. It may be concluded that some software is no longer required, or can be replaced by other software. Also, virtualization introduces new licence structures for operating systems and applications. The overall net result may be cost saving.

The interviewees also indicated two aspects of server virtualization that we had not encountered before. Server virtualization often implies the usage of SAN (Storage Area Network). Although maintenance of servers becomes easier with virtualization, the impact on the IT environment when doing maintenance on a SAN is very high. The preferred solution is to implement redundancy, which however comes at high costs. Another aspect is managing customer expectations. Thanks to server virtualization, new servers can be deployed quickly with high availability. This allows reconsidering SLAs, but the time available for updating, release planning, setting up security and solving incidents becomes more limited. The IT department should align strategies with the sales department in order to manage customer expectations.

Table 3 shows the correlation between the aspects of server virtualization and the ITIL processes, as indicated by the interviewees. The numbers in the cells of the matrix indicate the number of interviewees that identified an impact of a server virtualization aspect on an ITIL process. Table 3 clearly indicates that server virtualization aspects in the categories management and availability have most impact, while the aspects related to capacity, costs and security have less impact. The matrix also indicates that server virtualization has an impact on all ITIL processes, especially on the Financial Management process, while also Service Level Management, Incident Management, Change Management, IT Service Continuity Management and Availability Management are affected considerably. The following subsections discuss some key findings for these processes.

The empirical results indicate that server

Table 3: Correlation between aspects of server virtualization and ITIL processes (each matrix cell shows the number of interviewees that identified an impact of a server virtualization aspect on an ITIL process; totals are sums per row or column).

Category	Aspect	Configuration	Incident	Problem	Change	Release	Service Level	Financial	Capacity	Continuity	Availability	Application	Software Asset	Security	Total
	Total	**11**	**4**	**2**	**22**	**18**	**12**	**13**	**11**	**16**	**5**	**14**	**16**	**12**	**13**
Capacity	better resource utilization	1	-	-	2		2	2	4						
	difficulty managing resources and peak loads		1	1			1		1						4
	additional performance overhead							1	1						2
Management	increased speed and flexibility of server deployment	2	1	1	4		4	4	2	2	2				22
	faster deploy environm. for training, test and development		2	2	3	2	2	2	1	1	1	1		1	18
	reduced complexity due to fewer physical servers	1	2	2	2		1	1	1		1		1		12
	easier backup		2	2	1		2	1	1	3	1				13
	central software update & patch management	1	1	1	1	2	1	1				1	1	1	11
	larger consequences of human errors		2	1	2		2	1		2	2				12
	unwanted vendor lock-in		1	1	2		1	2		2	2				11
	immature management tools and incompatibilities	1	2	2	1	1	2	2	1	1	1		1	1	16
	not all applications suitable for virtualization		1	1	1					1	1				5
	no support software vendors on virtual environment		2	2	1		2	1		3	1	1	1		14
	legacy application support	1	1		1	1	4	3		1	3			1	16
	security concerns when keeping legacy applications	1	1				2	2		2	1			3	12
	virtual machine sprawl	3					1	2	3	1	1			2	13
Availability	higher availability levels without additional cost	1	1		1		4	4	1	3	4				19
	faster recovery from crashes and disasters		4	1	2		3	1		4	4				19
	reduced application conflicts due to isolation		3	3	2	2	2	1		2	2				17
	hardware defects impacting large number of VMs														0
	denial of service attack affecting all VMs on host														0
Costs	reduced hardware purchases	1	1	1	2			3	1						9
	increased costs for new, high-end hardware	1	1		1			1	1	1	1			1	8
	reduced management costs		3	2	3			3		1	1				13
	reduced energy and hosting costs							3							3
	increased license costs	1	1		1			4					2		9
	increased costs for personnel training and new hires							3			1			1	5
Security	VMM as additional attack vector		1				1	1		1				1	5
	increased security because of VM isolation														0
	stealing sensitive information													1	1
	breaching confidentiality or integrity of VM													1	1
	difficult patch management suspended VMs	1	1		2		1	1		1	1			2	10
	secure logging														0
	rogue virtual appliances		1	1					1	1	1		1	1	7
	Total	**16**	**36**	**24**	**35**	**8**	**38**	**50**	**19**	**33**	**32**	**3**	**7**	**17**	

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virtualization hardly influences Application Management, Software Asset Management and Release Management. Also the impact on Configuration Management and Security Management is limited. Most security concerns raised in literature, were deemed outdated by the interviewees and no security breaches due to virtualization have been reported yet. Configuration management requires a CMDB of the infrastructure, storing the mapping of virtual machines to physical resources and the location of suspended virtual machines. This is indicated in literature (Baldwin et al., 2008) and confirmed by the interviewees.

4.3 Financial Management

Financial Management is impacted mostly by server virtualization aspects in the categories management and costs. The traditional cost models in IT organizations are no longer applicable, because deploying a new virtual server does not necessarily imply purchasing and charging new hardware. In order to prevent an explosion in demand of virtual servers, activity-based costing should be introduced, which means that usage of services and servers are billed based on actual resource consumption.

Management tools for automatic resource reporting have not yet matured, so activity-based costing must still be done manually for now. Server virtualization also offers higher availability levels, which provides the opportunity for improved SLAs. It is inconclusive if virtualization decreases or increases the total costs.

4.4 Service Level Management

Service levels are much easier to meet when using virtualization. This is due to an overall increase in flexibility, and a reduction in downtime and costs.

4.5 Incident Management

The consensus in literature is that Incident Management becomes more difficult, due to the added complexity of virtualization which makes incident solving and root cause analysis more difficult. The interviewees however clearly indicate that the advantages of virtualization dominate: the amount of incidents as well as the time required to solve them, decreases.

4.6 Change Management

Some authors state in literature that changes are easier to execute but harder to keep track of (Cleeff et al., 2009). In practice, certain changes can be easier because there is no need to acquire new hardware. Since the risks involved are lower, changes can be executed more often during daytime.

4.7 IT Service Continuity Management

Virtualization allows much faster recovery from a crash or disaster, against low costs. There are however risks involved with virtualization, that might threaten continuity. Human errors can have larger consequences in a virtual environment. Also, some software vendors may not give support if their products are run in a virtualized environment. Calamity plans need to be reevaluated for additional factors that have been introduced by virtualization.

4.8 Availability Management

Virtualization enables high-availability solutions against very low costs. The number and duration of downtime incidents will decrease and hardware failures can be managed better.

5 DISCUSSION

Our research resulted in a comprehensive overview of ITIL and virtualization implementation aspects that can for instance be used as a checklist for organizations that are incorporating ITIL and server virtualization.

Our results however do not generally apply to all organizations. We interviewed only a small number of organizations in a small number of sectors. We also did not use specific selection criteria for the interviewed organizations. Therefore, the validity of our results is limited, and the results of semi-structured interviews are difficult to reproduce. Despite these restraints, the interview results contain little contradictions.

We observed that only 68% of the server virtualization aspects identified in literature could be confirmed in our empirical test. It becomes apparent that server virtualization is rapidly evolving, which quickly outdates literature. Furthermore, literature on the correlation between virtualization and ITIL is largely missing.

Our research could be extended by using a larger population and applying a quantitative measurable research method. Future research is also recommended on security and capacity aspects, and on measuring costs related to virtualization.

6 CONCLUSIONS

We showed that server virtualization influences all ITIL processes for IT service support and IT service delivery. We identified advantages, disadvantages and risks of server virtualization for capacity, management, availability, costs and security. Especially aspects related to management and availability have a large impact on the ITIL processes. Our empirical results indicate that some aspects related to capacity, availability and security, which are being considered in literature as risks or disadvantages, have been eliminated by fast improvements of virtualization tools.

Our main conclusion is that server virtualization does not change the ITIL processes themselves, but it does change the way the processes are executed. The impact is most significant on Financial Management. Also Service Level Management, Incident Management, Change Management, IT Service Continuity Management and Availability Management are affected considerably.

Server virtualization is no silver bullet for solving problems in IT service management. If

server virtualization has been properly introduced, it can offer faster and better execution of the ITIL processes, and paves the way to cloud computing.

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