Server Virtualization for Energy Efficient Data Centers in Bosnia and Herzegovina

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Abstract - **This paper intends to raise awareness about possibilities of energy and cost savings in data centers. Situation in Bosnia and Herzegovina is analyzed through results of the survey from the IT area. There is a hypothetical estimation of cost saving of USD 500,000 for period of three years, for 500 servers in 60 local data centers. This should be good motivation for system administrators to consider server virtualization as a future strategy for data centers.**

Keywords - **data centers, server consolidation, virtualization, energy efficiency, cost savings**

I. INTRODUCTION

Global most important current issues are environment, electrical power, and natural resources. There is a question of IT influence on those problems and responsibility of IT society. It is not easy to identify local situation with global problems, but it is important to be aware about real influence on the environment around.

For electrical power issues there are two aspects of the problem. One is ecological, and the other is financial – care about cost savings. In this moment, Bosnia and Herzegovina focus is probably oriented to financial aspect.

Based on local survey results, this paper makes hypothetical estimation about significant data center cost savings that could be achieved using server virtualization.

A. Electrical power costs

Constant growth of electrical power prices is evident. In IT data centers a lots of costs for electrical power is dedicated to powering and cooling of the system [10]. Most of IT system administrators do not pay enough attention to those costs, because they are focus on obvious costs for hardware and software. Some of global big data centers are faced to a problem of system growth, because there cannot supply more power on location of particular data center [11]. In that case, electrical power issue is clearly visible, and care about power savings is a priority.

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B. Useful work of IT equipment

According to IBM results [6] most of the servers in data centers are underutilized, meaning that they use electrical power at the same way as they work with fully utilization. In a reality, their useful work is just about 20%, while being in so-called idle state is about 80%. It is obvious that working in useless state is just a waste.

Most popular mechanisms for getting better utilizations are consolidation and virtualization [9].

II. CONSOLIDATION

Consolidation is an idea for centralizing IT systems.

When it is about software solutions (e.g. ERP – Enterprise Resource Planning solutions), which could be based on couple of separated parts of the system for some functionality, consolidation means centralization of the solution, integration of data, redesign of business processes etc.

When it is about hardware, typical scenario is that there is a lot of separate servers with their backup policies, security policies etc. In that case, consolidation means centralization of those servers on just one bigger, more powerful and energy efficient server.

During implementation of some new IT services in the system, some data centers are faced to problems with available space, electrical power, and costs in general. Also, big and old data centers, which exist for over 10 years, have some limitations as an inheritance.

Very often practice for data centers is that every new IT service, e.g. some new software solution, causes purchase of new hardware, i.e. server [5]. That server is typically dedicated just for one work, and it is probably underutilized (for example, one server for a database, one server for e-mail system etc.). In that case, available and free resources cannot be used by other work, while servers consume electrical power the same way they do in ideal 100% utilization.

That trend is not good and some changes should be done as soon as possible.

III. VIRTUALIZATION

Virtualization idea is more important than a particular method of virtualization. There is couple of virtualization ways. Basic types of virtualization could be defined as software-based, hardware-based and combination of those two. Virtualization could be oriented on physical servers,

networking, storage, or software. Essence of a physical server virtualization is a creation of couple of virtual environments on one physical server, with a major goal of better server utilization but also lower costs for electrical power [4].

Servers that are underutilized consume same amount of electrical power for work and for cooling.

By server consolidation and virtualization, total number of physical servers is decreased, and total costs for electrical power are decreased also. But those costs saving are not the only reason for server consolidation and virtualization. Also, important reasons are better and easier system administration, system growth, security, backup policy etc.

A. Server virtualization

Server virtualization is a solution that provides multiple application workloads to be run on one server. Every workload has its own virtual environment, and its own set of available resources. That virtual environment is simulated in the way that looks like real independent server environment. Server resources are contributed to some workloads with a goal of optimized utilization of server capacities [1].

It is possible to define server virtualization as a technique of physical characteristics hiding. That is a method of organizing physical resources in logical way using virtualization of hardware.

For server virtualization, there are two basic roles on the server: host (operating system or virtual machine manager that hosts multiple operations systems), and guests (multiple guest operating systems that work on a top of host system) [11]. Every guest operating system has its own set of applications installed.

B. Benefits of server virtualization

Benefits of server virtualization are [1], [7], [8]:
- business continuity and disaster recovery
- flexibility of a system
- server consolidation
- reduced downtime
- reduced administration costs
- better security system
- simpler education for new administration and maintenance staff
- reduced hardware and software costs
- reduced electrical power costs
- reduced bad influence on environment, better eco-image

Server virtualization software enables simple software migrations, including system backup and recovery that is very important for business continuity planning. It is possible to reduce downtime because virtual image can be migrated from one physical resource to another, during reparation of the first one. By server virtualization, it is possible to duplicate most important key servers, without duplicating physical servers.

C. Server virtualization considerations

Server virtualization considerations are [1]:
- security management
- checking of application compatibility with virtual environment (because some software vendors do not give full support for virtual systems)
- software licensing
- advanced system monitoring and management
- additional IT professional education
- management support needed, due to serious changes in the system

Server virtualization could be considered as an ideal solution for applications that had small or middle range server resources utilization. But, for high-performance and demanding applications, which need couple of servers in a cluster, server virtualization is not recommended.

D. Why server virtualization

Server virtualization is the most efficient method for electrical power saving in data centers [9]. Using server virtualization it is possible to accomplish 10-40% of electrical power saving, by consolidating physical servers and applications on smaller number of servers, in most cases blade servers. With that scenario, total costs for system cooling are also reduced.

IV. Bosnia and Herzegovina data centers survey

A. Survey idea

Information about big world-wide data centers is not relevant for IT area in Bosnia and Herzegovina. Since there are no official statistic data about situation in local data centers, on-line survey was the method to collect data for the analysis.

B. Survey realization

During 04.2009 and 05.2009 the survey was on-line, e-mail requests were sent, phone calls to the target companies/institutions were done, and answers were gotten.

Address list for the target companies/institutions were created based on Internet available data, mostly for telecoms, electrical utilities, posts, banks, leasing companies, insurance companies, big companies from private sector, universities, faculties etc. For some companies/institutions it was hard to find contact information, and e-mail requests for the survey might be sent to general e-mail address. For that reason, some of the requests probably did not get to the right key persons.

For easier answering and for the possibility of analysis, survey had 9 questions with predefined optional answers. At the end, as a last question, there was a form for personal contact data, function, and company/institution name. Survey answers without this last information, anonymous answers, were not treated as valid for survey results.

Survey requests were sent to about 100 addresses, and response rate were about 60%.

Professional positions of persons that answered the survey:
- directors of IT/ICT sectors/departments
- IT managers/administrators
- system/network/IS administrators
- IT consultants
- sector assistants

C. *Analysis of survey results*

Based on the answers on survey questions, results are:
- most of the companies/institutions in Bosnia and Herzegovina that answered the survey have just one data center
- just 3% have bigger (11 or more) number of data centers
- most of the companies/institutions in Bosnia and Herzegovina that answered the survey have small number (5 or less) of servers in their biggest data center
- just 6% have 51 or more servers in the biggest data center
- most of the companies/institutions in Bosnia and Herzegovina that answered the survey (more than 60%) do not track nor estimate electrical power costs for data center separately
- most of the companies/institutions in Bosnia and Herzegovina that answered the survey (more than 73%) do not include electrical power costs in their budget for IT
- about 47% of the companies/institutions in Bosnia and Herzegovina that answered the survey think that server utilization is not low
- but, about 32% are sure that server utilization in their data center is just 20% or less (as estimated by world IT professionals as a average for standard servers utilization)
- half of the companies/institutions in Bosnia and Herzegovina that answered the survey (i.e. about 52%) do not implement methods of server virtualization, and half do (i.e. about 46%)
- regarding level of server virtualization, almost 14% companies/institutions in Bosnia and Herzegovina that answered the survey have implemented server virtualization on all servers where applicable, but 46% answered that servers are not virtualized at all
- as basic reasons for already implemented or currently planned server virtualization in data centers most of the companies/institutions in Bosnia and Herzegovina that answered the surveys chose server consolidation and costs savings for hardware and/or software, and flexibility of the new system, simplifying system administration and system growth
- just small percentage (about 12%) chose cost saving for powering and cooling of the system as one of the basics reasons for server virtualization project
- regarding strategy for future growth and development of data centers, most of the companies/institutions in Bosnia and Herzegovina that answered the survey (i.e. 86%) say that their strategy includes server virtualization and cares about electrical power saving (for 49% it is completely included, and for 37% it is partially included)

V. ESTIMATION OF POSSIBLE SAVINGS

According to results of positive changes in data centers where server consolidation and virtualization is implemented, it is possible to have hypothetical estimation about cost saving in data centers in Bosnia and Herzegovina.

Real costs savings could be achieved by investing in new and more energy efficient hardware (like blade servers) and software environment (like server virtualization, using for example VMware products, Microsoft Hyper-V, or others) [3], [11].

According to results published by Microsoft [2], power savings and estimation of cost savings for standalone 10 IIS physical servers, comparing to 10 guest virtual IIS servers on just one physical server could be around USD 3,500 per year.

TABLE 1: MICROSOFT PHYSICAL/VIRTUAL SERVERS COMPARISON AND SAVINGS

Server Setup	Average Watts	kWh / Year	Cost / Year
Standalone IIS x 10	5,001.00	43,839.00	USD 4,007.00
One Hyper-V server with 10 IIS virtual machines	512.00	4,490.00	USD 410.00
Savings	**4,489.00**	**39,349.00**	**USD 3,597.00**

Using this Microsoft results [2] and data from previous presented survey, estimation for biggest local data centers could be based on:
- total number of 1,000 servers in 60 different biggest data centers in Bosnia and Herzegovina (based on survey answers on questions 1. and 2.)
- possibility to presume that 50% servers (i.e. 500 servers) could be good candidates for server virtualization, due to low utilization (based on survey answers on question 5., 6. and 7.)
- usage of published Microsoft Physical/Virtual Servers Comparison [2]

It is possible to make hypothetical estimation about three-year savings on electrical power costs. Using presented Microsoft results for example of 10 physical servers comparing to 10 virtual servers on 1 physical machine, it is possible to use factor 50 to make estimation

for data centers in Bosnia and Herzegovina (500 physical servers as 50 x 10 physical servers; 500 virtual servers, as 50 x 1 physical server with 10 virtual machines/servers).

TABLE 2: PHYSICAL/VIRTUAL SERVERS SAVINGS ESTIMATION FOR 500 SERVERS IN DATA CENTERS IN BOSNIA AND HERZEGOVINA

Server Setup	Average Watts	kWh / Year	Cost / Year
Physical 500 servers (as 50 x 10 servers)	250,050.00	2,191,950.00	USD 200,350.00
Servers with 500 virtual machines (as 50 physical servers with 10 virtual servers per physical server)	25,600.00	224,500.00	USD 20,500.00
Savings	**224,450.00**	**1,967,450.00**	**USD 179,850.00**

TABLE 3: THREE-YEAR PHYSICAL/VIRTUAL SERVERS SAVINGS ESTIMATION FOR 500 SERVERS IN DATA CENTERS IN BOSNIA AND HERZEGOVINA

Server Setup	Cost / Year	No. of Years	Total Costs
Physical 500 servers (as 50 x 10 servers)	USD 200,350.00	3	USD 601,050.00
Servers with 500 virtual machines (as 50 physical servers with 10 virtual servers per physical server)	USD 20,500.00	3	USD 61,500.00
Savings	**USD 179,850.00**	**3**	**USD 539,550.00**

When considering possible savings for specific data center, lots of costs could be shown as investments, but another savings that is not visible at first sight should be emphasized, because every watt saved for server powering also includes saving another watt for cooling, server virtualization and consolidation includes better data center management and administration, better control of costs, better security system etc.

VI. CONCLUSION

Comparing world recommendations for data centers and IT area in Bosnia and Herzegovina, conclusion could be that local IT market does not have enough maturity of information technology. But, some of serious companies/institutions, which have large number of servers and do implement or plan to implement server virtualization, show right IT strategies.

Based on the survey, it is obvious that data centers in Bosnia and Herzegovina do not pay enough attention to electrical power savings. It gives the opportunity to make estimations and financial calculation about possible savings of electrical power.

Data centers in Bosnia and Herzegovina could achieve better energy efficiency and real cost savings using server consolidation and virtualization. Some of the local companies/institutions have already done projects of server virtualization for data center improvements, some of them currently work on strategies and future plans, but some of them should now recognize possibilities and benefits of server virtualization. Possible three-year savings of USD 500,000 is hypothetical estimation based on published Microsoft savings results and answers on presented survey results. Is it realistic or not, it is a matter of detailed analysis of specific data centers in Bosnia and Herzegovina. But it is still a good motivation to consider server virtualization as a right direction for future data center development.

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