Server Virtualization and Government Organizations

Jenny Woolley

Sandra Williams

Ryan Boulais

June 2010 SCEA Conference

Scitor Corporation

Table of Contents

- **Purpose of Research**
- **Past Research**
- **Industry Examples**
- **Unique Government Characteristics**
- **Impacts of Virtualization**
    - Security
    - Time Savings
    - Hardware Procurement
    - Application Development
    - Power, Space, and Cooling
    - Systems Administrators
    - Other Virtualization Concerns
- **Conclusions**
- **Summary of Findings**
- **Future Research**
- **References**

Purpose of Research

Scitor Corporation

- **Purpose**
  - To understand the "realistic" cost impacts and savings of virtualization from available data in the Intelligence Community (IC) and Department of Defense (DoD)
  - Use the data available to develop a suite of Cost Factors to assess a program's potential future savings due to virtualization

- **Background**
  - Virtualization is the ability of one computer or server to do the job of multiple computers or servers
  - Server virtualization allows for the configuration of servers with sufficient processing capacity and network interfaces to function as multiple virtual servers on a single hardware platform
    - Through the use of commercial software packages, a "virtual machine" (VM) can be created to run its own operating system and applications similar to a physical computer or server
    - Gartner predicts that virtualization will be the most important trend for servers through 2010

Past Research
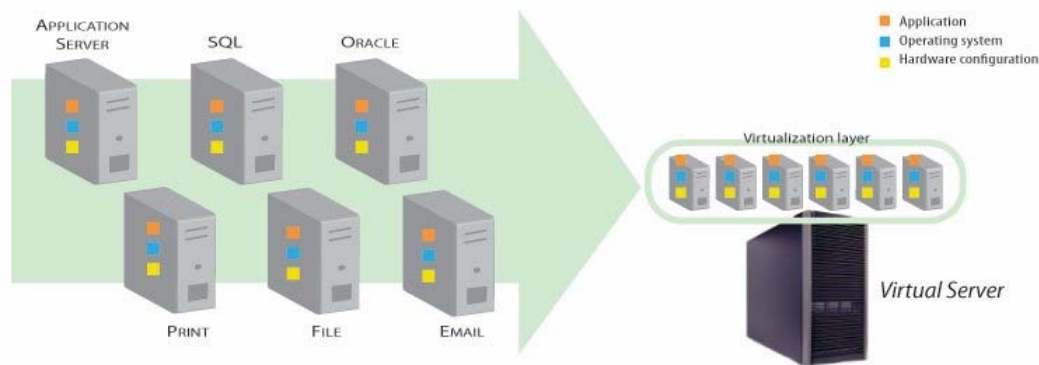
- **This research is a continuation of the 2009 SCEA paper entitled "Cost Impacts of Server Virtualization"**
  - The 2009 research investigated the virtualization experiences of the commercial sector
    - Understand the benefits and limitations of server virtualization
  - One IT government program was also considered as an example of virtualization
    - The program was a new development effort
  - Research conclusions:
    - Server virtualization is beneficial and will most likely lead to overall cost savings
    - Differences in program attributes between commercial and government programs may limit virtualization savings
- **In 2009, many government programs were only just beginning to embrace virtualization**
  - Limited data availability because the trend was so new
  - More data is now available as virtualized systems have matured and more programs have transitioned to virtualization over the past year
    - These virtualization efforts provide new data from multiple agencies that offers insight into the benefits of virtualization in the IC and DoD

4

Industry Examples

Scitor Corporation

- **The table below displays benefits due to server virtualization as advertized by various leaders in the virtualization industry**

Company	Physical Servers	Power	Space	Cooling	Provisioning Time	Server Utilization
vmware	Reduction of 10:1 or better	70%-80% reduction		80+% reduction	Accelerate by 50%-70%	Increase from 5%-15% to 80%
hp	Reduction of 13:1	95% reduction			6 months down to a day or a week	Increase from 5%-10% to 60%-70%
Sun microsystems	Reduction of 50%	60%-80% reduction	Reduction of up to 80%			Increase from 5%-15% to 80%
IBM		Decrease of up to 91%	Need 1/7 the rack space		From days to minutes	Increase from 5%-15% to over 70%
CITRIX	Reduction of 10:1	Decrease of around 65%		Heat dissipation decrease by 66%		

- **These projections may not be indicative of what government agencies can expect to see**
  - Every company/agency/program is different
  - Specific characteristics of government programs may limit gains due to virtualization

Unique Characteristics

Scitor Corporation

- **Requirements for some government programs can limit virtualization efforts**
  - This is not a bad thing, just a byproduct of the type of work done by government programs
  - Attributes that can restrict virtualization gains include
    - Program size
    - Program/application age
    - COTS software products
    - Security concerns
    - Unique/developed hardware
    - Mission criticality
- **The following slides consider how these characteristics can impact specific cost aspects of virtualization efforts, including**
  - Security
  - Disaster Recovery
  - Hardware Procurement
  - Application Development
  - Power, Space, and Cooling
  - Systems Administrators

Impact on Security

Scitor Corporation

- **Security is of vital importance to government organizations**
  - Due to the sensitivity of government information, security requirements are more stringent for intelligence and defense agencies than for commercial industries
    - Requiring multiple security domains (e.g., Unclassified, Secret, Top Secret) demands physical separation of equipment, which limits virtualization gains
    - The only industries that come close to the level of security requirements seen in the government are banks and medical centers
- **Because virtualization is a new process for most government organizations, security testing and Certification and Accreditation (C&A) can be very time consuming**
  - According to many subject matter experts, initial C&A and security testing can take from six months to a year
  - This type of delay can offset the initial gain from the rapid deployment of virtual machines (VM's)

Impact on Security (cont'd)

- **Many agencies that are developing virtualized environments to host multiple applications are attempting to mitigate this time delay by establishing "tenant/host" agreements with security departments**
  - ◦ The IT architecture itself only needs to go through the C&A process once
  - ◦ When new programs/applications transfer to the virtualized environment, only the application must go through the security approval process
    - Each program must be very aware of security levels and concerns because each application will no longer be the only one on a server
  - ◦ While the up-front security approval process can be slow, tenant/host agreements allow for more expeditious transitions in the future

Impact on Time Savings

Scitor Corporation

- **One benefit from virtualization is disaster recovery and the minimization of down-time**
  - Rapid disaster recovery is crucial for many government programs
    - Lengthy service disruptions can be crippling for programs with real-time or near-real-time requirements
  - In this area, government and commercial organizations appear to benefit equally from virtualization
    - Example: An application in a virtualized environment (government program) experienced the same problem on separate occurrences both before and after virtualization
      - Before virtualization, the issue led to **10 hours** of down-time
      - After virtualization, the issue led to **4 minutes** of down-time
      - The decrease is attributable to the ability to migrate virtual machines and isolate problems in a virtualized environment
    - Other programs have experienced similar time savings
- **Government organizations also benefit from decreased server deployment time**
  - Due to the complexity of the government acquisition process, it can take from 6 weeks to several months to procure and provision a new physical server
 - Deploying a new virtual machine can take as little as half an hour

Impact on Applications

Scitor Corporation

- **Most government programs must invest in a certain amount of recoding for applications to be virtualization-compatible**
  - The difficulty of this effort varies according to the type of code in the application and the hardware that has been used in the past
    - JAVA, XML, and PERL are easier to prepare for a virtualized environment than C++ and FORTRAN (age of language)
    - The more similarities there are between the current hardware and the hardware in the virtualized environment, the easier it will be to transition the application

- **Establishing a standard factor for use in predicting the development effort required to accommodate a transition to virtualization is difficult (and may not be applicable to all programs)**
  - Once again, the unique nature of each program makes the use of a standard factor questionable
    - Potential independent variables for factors:
      - Type and size of Code
      - HW type
      - Age of program
      - Chosen vendor for virtualization
  - In many cases, programs will take this opportunity to update and correct code that isn't part of the transition effort
    - This helps the application but reduces the assessed cost benefits of virtualization

Impact on Server Procurement

⌶ Scitor
Corporation

- **The most visible benefit from virtualization is server consolidation, which can lead to**
  - Fewer physical servers
  - Higher utilization rates
    - Most servers are only running at about 30% of their capacity
    - Some run as low as 5%, and very few ever reach utilization rates of around 80%
    - Engineers will use this information to develop a a plan for consolidating servers
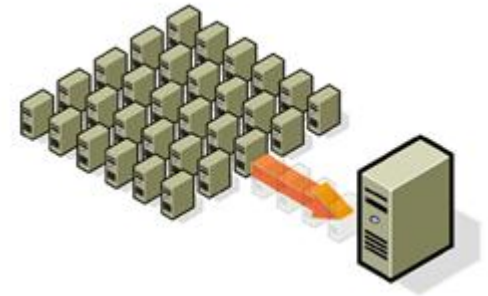
- **Virtualization vendors typically advertise a consolidation rate of ~10:1**
  - Each program can expect to see a slightly different consolidation rate due to the unique requirements of the program
  - Government programs may be likely to see a lower consolidation rate than the ones advertised by different companies because of issues listed earlier in the presentation (i.e., security, mission criticality, age of programs), as well as program size, unique/developed hardware, and COTS software
  - It is important to remember that an X:1 decrease in the number of physical servers does not equate to an X:1 decrease in server costs

Impact on Server Procurement (cont'd)

Scitor Corporation

- **Due to the differences inherent in each program, developing a single consolidation factor to apply in multiple cost estimates is a significant challenge**
  - Example:
    - A small application might only utilize 20% of two servers
    - A large application might utilize varying percentages of over 50 servers and require the use of a database application that is not virtualization-compatible
  - In some cases, organizations will procure more servers than they need to accommodate future expansion
    - In this case, virtualization really leads to a cost avoidance rather than a cost savings
- **The table below presents several examples of server consolidation ratios**

Organization	# Physical Servers Before	# Physical Servers After	Consolidation Ratio
Scott County, MN	45	5	9:1
Transplace	40	4	10:1
BEA	10	5-7	2:1 to 1.4:1
Snohomish County, WA	30	4	7.5:1

Closest Analogy for Gov't Programs:
BEA (now Oracle), develops COTS software packages of a complexity level that is, in some cases, similar to the federal government

Subject matter experts indicate that a decrease in physical servers of around 25% seems like a reasonable estimate when estimating virtualization efforts

Impact on Power, Space, and Cooling

Scitor Corporation

- **Because fewer physical servers are needed in a virtualized environment, organizations often experience savings on power, space, and cooling (PSC) costs**
  - Every watt used to run a server produces heat that must then be removed from the data center at about the same cost
    - A server using 400 watts costs the equivalent of 800 watts to run
- **All subject matter experts consulted in this research indicated that PSC is the area in which government agencies realize the largest cost savings and avoidances**
  - One government agency saw a combined power and cooling savings of **87.2%**
  - Programs at three different government agencies experienced space reductions of **50%, 74.5%,** and **85%**
  - Facility choice matters when determining benefits of virtualization (particularly in cooling):
    - Some of the virtualization-capable blades produce so much heat, that water cooling is necessary in the data center to fully realize virtualization gains
    - If a facility is already equipped to accommodate water cooling, then a reduction in the number of physical servers will lead to a decrease in cooling costs
    - If water cooling does not exist or is not easily attainable, it may be necessary to build a new facility or radically overhaul an existing one

Given the dominance of Acquisition costs in Government programs, it is important to note that the largest savings for many programs (PSC) come in the O&M phase of virtualized programs

Impact on Personnel

Scitor Corporation

- **Several papers and advertisements suggest that server virtualization can lead to a decrease in the number of System Administrators (SA)**
  - Fewer physical servers might require fewer system administrators
  - Trade studies indicate an SA to Server ratio of **1:100** in a completely homogenous environment
    - A standardized environment = more automation
    - A highly customized environment = more manual labor
- **In many cases, the magnitude of gain in this area is much lower than expected**
  - There may be fewer physical servers in a virtualized environment, but there are still many virtual machines, and they are now in a more complex environment
    - System administrators now require an expanded skill-set (thus becoming more specialized, increasing labor costs)
  - The transition to a virtualized environment lends itself to the creation of a more homogenous environment, but many government programs still require unique equipment
    - One agency found that 80%-90% of their hardware baseline could be virtualized
    - Other agencies require more specialized equipment that cannot be virtualized at present
- **Case study examples:**
  - Oracle achieved an administrator to server ratio of **1:30** through virtualization
  - One government organization hoped to achieve a ratio of **1:50** through virtualization, but they have yet to see much of a change from their original ratio of around **1:12** after almost two years
    - As the new environment progresses, they plan to reach about **1:20** in the near term, with a revised final goal of **1:40**
  - A second agency has not seen a reduction in staff after 3 years but expects to experience decreases in a few years

Other Virtualization Concerns

Scitor Corporation

- **Real-time Requirements**
  - Applications that require real-time or near-real-time responses require strict load balance monitoring
    - System clocks on some virtualized systems can temporarily lag as much as 5-10 seconds if virtual machines are under a heavy load
- **COTS Software Licensing and Maintenance**
 - In the past, many groups have been concerned that virtualization will lead to issues with COTS SW products, such as:
    - Product pricing uncertainty
    - Lack of guaranteed support
    - Large and complex applications that cannot be virtualized
  - This is still a concern for some software applications, but many vendors have made strides in accommodating virtualization trends
    - Sell SW licenses on a per Socket, Core System, or Virtualized Machine basis
    - Because virtualization is not about to disappear, vendors recognize that in order to remain competitive, they must develop SW that will function correctly on virtualized machines
- **Lack of Standards for Moving Data**
  - At present, there are no set standards for moving data from one virtualized environment to another
    - Changing vendors under competitive acquisition practices could be extremely challenging
- **Cost of Policy Changes and Implementation**
  - Configuration management and creating new policies can be expensive

Conclusions

Scitor Corporation
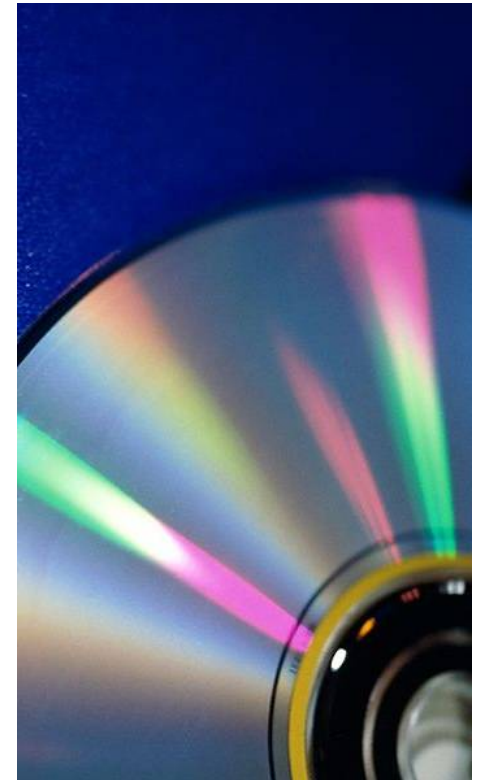
- **Government agencies can expect to see a savings from virtualization, but it may not be as high as industry statistics or vendor projections would lead decision makers to expect**
  - The unique nature of government programs may limit virtualization gains
  - Cost savings may not be realized immediately
    - Some groups found that there were significant up-front costs, especially if it was necessary to convert to SAN storage or buy additional new equipment
- **General cost estimating factors that will be used for virtualized programs can be difficult to establish**
  - Each program can be so different that one factor might not be applicable in all situations
  - However, such factors are necessary for estimating costs when programs are early in the virtualization process
  - Based on currently available information, the following assumptions are reasonable to apply until more detailed, program-specific information is available
    - Initial Certification and Accreditation will take about 6 months
    - Programs with more consolidation restrictions can still probably expect to see a decrease in physical servers of 25%
    - The ratio of System Administrators to servers will most likely be around 1:20 initially, with a gradual progression up to 1:30 or 1:40

Summary of Findings

Scitor Corporation

Attribute	Commercial Advertisements	IC Examples and Findings	Notes
Server Consolidation Ratio	10:1	2:1 analogy; 4:3 expert opinion	Can vary significantly by program
Power, Space, and Cooling	70%-80% savings	50%-87.2% savings	Facility building/modification can limit initial cost savings
System Admins to Server Ratio	1:100; 1:30	1:12	Potential to improve in future
Security		6-12 month C&A effort	Tennant/host agreements
Disaster Recovery		10 hours to 4 minutes downtime	Less quantifiable savings, but clear mission benefit
Application Porting		Varies by program	Future research
Server Utilization Change	From 5%-10% to 60%-70%		Could use this info to predict server consolidation rates

Empty cells indicate data was not available

Future Research

Scitor Corporation

- **Continue to follow various government organizations as they proceed through the virtualization process**
    - Many groups are still in the early stages of virtualization, so more information may be available as the transition progresses
    - Will some virtualization savings change over time (e.g., number of System Administrators required, ability to consolidate servers, etc.)?
    - One study of 29 enterprises with revenues of $500 million or more indicated that after virtualizing between 10%-30% of their physical servers, the firms' virtualization efforts appeared to slow down
        - Despite achieving a rapid return on investment and being happy with results, many of the firms planned to only virtualize about 50% of their systems
        - Will government groups exhibit a similar virtualization deceleration?
- **Research additional gains from desktop and storage virtualization**
    - Many organizations make the change to desktop and storage virtualization around the same time as server virtualization
- **Use knowledge from server virtualization research to investigate green IT initiatives**
    - Virtualization is one aspect of many green IT initiatives
        - Decreases in power, space, and cooling can lead to significant decreases in carbon dioxide emissions
    - Due to the current state of the economy, government initiatives, and recent public attention on environmental conditions, environmentally-friendly shifts will be an important aspect of future IT changes

References

- **Contributors**
  - Andrew Boyd
  - Glenn Davis
  - Karen Walker
  - Carrie Gamble
  - Steve Wear
  - Brian Wells
  - Saunders Roesser
  - Tom VanHorn
  - Dan Matlick

- **Image Sources**
  - http://www.virtualizeitsolutions.com/_/rsrc/1230665392047/Home/virtualization_diagram.jpg
  - http://hosteddocs.ittoolbox.com/greenit.pdf
  - http://images.businessweek.com/ss/08/07/0716_recession_proof_jobs/image/software.jpg
  - http://www.imagine-net-tech.com/images/security.jpg

References

Scitor Corporation

- **Vendor Information and Commercial Examples**
  - http://www.vmware.com/solutions/consolidation/consolidate.html
  - http://www-03.ibm.com/systems/migratetoibm/reduceit/index.html
  - http://www.sun.com/solutions/virtualization/why.jsp#1
  - http://h30423.www3.hp.com/?rf=sitemap&fr_story=208b2e43b93e5762dfc59711d1a6649d8044406e&jumpid=reg_R1002_USEN
  - http://www.microsoft.com/virtualization/en/us/products-server.aspx
  - http://www.microsoft.com/casestudies/Case_Study_Detail.aspx?CaseStudyID=4000005374
  - http://multivu.prnewswire.com/mnr/microsoft/36562/
  - http://symbian.sys-con.com/node/1219305
  - http://www.tresys.com/virtualization-security.php
  - http://www.computerworld.com/s/article/9118659/Nationwide_works_to_cut_its_server_count_by_half_via_virtualization
  - http://itmanagement.earthweb.com/entdev/article.php/3815481

References

- **Reference Documents**
  - Roberts, Leah; Woolley, Jenny; Soles, Alisha; & Black, Will. *Cost Impacts of Server Virtualization.* 31 March 2009. SCEA Presentation 2009.
  - Bittman, Thomas J., & Enck, John. *Best Practices Before You Virtualize Your Servers.* 12 March 2008. Gartner Group (Article ID: G00153718). 6 November 2008 <http://www.gartner.com>.
  - Gammage, Brian, & Dawson, Phillip. *Server Workloads: What Not to Virtualize.* 26 March 2008. Gartner Group (Article ID: G00156214). 6 November 2008 <http://www.gartner.com>.
  - Forrester Consulting. *The Business Value of Virtualization.* July 2009.
  - CA. *Virtualization Best Practices.* 2 May 2008.
  - Feuless, Scott. *Virtualization and Staffing.* 7 January 2008. 20 November 2009 <http://searchservervirtualization.techtarget.com>.
  - *Virtualization Decisions 2009 Purchasing Intentions Survey Results.* 29 September 2009. 18 March 2010 <http://searchservervirtualization.techtarget.com>.
  - Barrett, Alex. *Oracle relents (a bit) on hypervisor support policy.* 7 May 2009. 18 March 2010 <http://searchservervirtualization.techtarget.com>.
  - Nucleus Research. *ROI Case Study: VMware Virtual Desktop Infrastructure IRMC.* April 2007. <http://www.NucleusResearch.com>.
  - Weiss, George J. *The Great Virtualization Dilemma of the Next Decade: What You Need to Know.* 11 February 2009. Gartner Group (Gartner RAS Core Research Note: G00164938). January 2010 <http://www.gartner.com>.
  - Woltman, Kathy. *The Next Wave, Vol. 17, No. 4, 2009.* 20 May 2009.