

*Application for
The Northwest Academic Computing Consortium
Joanne R. Hugl Excellence Award*

Data Center Server and Storage Virtualization

Pacific Northwest National Laboratory
IT Services Division

Abstract:

Virtualizing server infrastructure and shared storage results in benefits ranging from cost savings to improved business continuity. The Pacific Northwest National Laboratory (PNNL) has firsthand experience with virtualization technologies and has established approaches and practices in IT Infrastructure to fully realize the potential benefits. In 2006, PNNL virtualized 69 servers into 12 physical servers. With elimination or avoidance of 46 physical servers, we realized a 4:1 reduction. In addition to lower hardware and administration costs, datacenter power and cooling demand was reduced at 7%. During 2007 we plan to virtualize another 60-70 servers.

Description of the Practice:

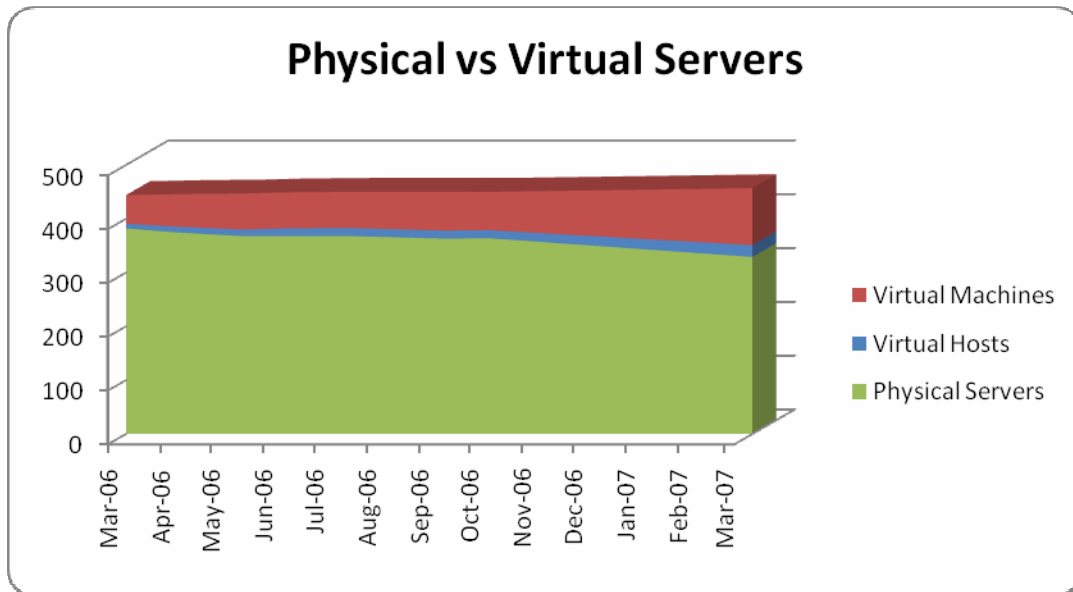
IT Services is responsible for providing the computing and network infrastructure to manage and operate the Pacific Northwest National Laboratory (PNNL). One of the best practices implemented to manage this infrastructure is the use of virtualization technologies for both servers and storage. IT Services provides a robust Virtual Infrastructure and SAN Virtual Storage environment to provide computing and information resources for PNNL management systems (e.g., HR, Payroll, Finance, Procurement Health and Safety). Primary drivers for this practice include the following:

- Cost savings related to reduction in rack space, power, cooling, and hardware lifecycle, and higher use of server resources.
- Improved server management by provisioning from templates, consolidated monitoring and viewing of resource use and performance, and reduced time to provision new servers.
- Enhanced server uptime, disaster recovery options, and improved capability to pursue business continuity objectives.

These primary drivers remain valid today as we experience the benefits of this best practice. We continue to refine our approach and are gradually exceeding our anticipated expectations. Over the last year our virtual infrastructure has more than doubled and will continue to grow as we lifecycle servers and continually improve our ratio of virtual servers hosted on each physical host. A year ago we averaged four virtual servers to each physical host. Today our ratio is approximately 5:1 and should approach 6:1 by the end of the year.

We anticipate that within the next two years our virtual servers will outnumber the physical servers. Many of our database servers and application servers with high IO requirements are not good virtual server candidates today, but may become good candidates as the underlying virtualization technologies and hardware mature.

The chart below illustrates the growth of our Virtual Infrastructure in comparison to the physical servers that we also managed during the past year.



PNNL has virtualized 25% of its servers to date, and expects server virtualization to exceed 50% by 2009.

Responses to Evaluation Criteria:

Innovation

Successful implementation of our Virtual Infrastructure to support production servers within IT Services is an innovative combination of the following four approaches:

- IT Services engineers evaluated virtualization technologies and carefully architected an environment to support virtual servers. The VMware ESX server was chosen as the foundation of our virtual environment due to its maturity and feature set. The initial install and training to use the software was provided by consultants and focused on a specific set of servers. Experience gained during the initial implementation built confidence in the practice and paved the way for a more aggressive approach and a broader implementation.
- IT Services SAN engineers have been using storage virtualization for the last several years. The ability to snapshot, migrate, and mirror storage has been beneficial. The ability to provide “lean provisioning” has been key to consolidation and cost avoidance of wasted disk space. Lean provisioning is accomplished by being able to dynamically add storage to volumes without server downtime. This capability allows the team to provision just enough storage for a service to operate and dynamically add storage to a volume when requested. This practice allows our SAN team to provide cost effective storage to our infrastructure. The maturity and features of our SAN environment contributes strongly to the stability of Virtual Infrastructure.
- A trained support team with a diverse set of expertise is key to implementing and maintaining a stable virtual infrastructure. The IT Services Virtual Infrastructure team consists of several individuals who have all received some level of training on VMware ESX server. Team members were carefully chosen to have a mix of expertise: Storage Area Network engineering and support, Microsoft Windows system administration, Linux system administration, IT architecture design, project management, and communication skills.
- We have paid particular attention to drafting and implementing policies that clearly define the virtual environment as a strategic component of our architecture. For example, we carefully consider which server workloads to virtualize. The documented analyses help maintain stability and performance while simultaneously helping to minimize reluctance to participate in follow-on virtualization efforts. Our strategic approach also includes our policy to meet customer requirements via the following

prioritized means: hosting on existing physical or virtual servers, use of a repurposed server, and purchase of a new server.

Benefits

Benefits realized by virtualizing servers and storage are experienced by IT services as the steward of the resources and by individual users of the services hosted on virtual machines.

- The efficiency and effectiveness of hardware resources is increased by being able to consolidate diverse workloads onto clusters of virtualized resources. Provisioning of new server resources is also greatly reduced, thus improving the ability to respond to changing requirements.
- Individual users experience less downtime dedicated to hardware maintenance and benefit from features such as dynamic load balancing and automatic restart of virtual servers upon hardware failure.
- Disaster recovery and business continuity efforts are improved by the implementation of virtualization technology. Backing up and replicating virtual machines is easier and more flexible than physical hardware. Many options are available for mirroring virtual machines to an offsite location.

Replicability

Using virtualization technologies and applying them in a similar fashion should be easy to replicate in any organization. The degree of deployment and amount of cost savings is directly related to the number of servers to virtualize and the level of investment in hardware resources. Larger organizations similar to PNNL tend to reap the most benefit.

Costs

This practice is proving to be a cost-effective way to make better use of our current server hardware resources, reduce current hardware lifecycle costs, and greatly slow the cost of future lifecycle costs with the growth of new servers. Current resources invested in our Virtual Infrastructure include the following:

- Labor - Approximately 1 FTE in labor, to maintain the environment.
- Hardware - Approximately 22 physical servers, each with 16GB memory, support 105 virtual servers. This includes reserve capacity to handle new servers, failover upon hardware failure, and load balancing. The ratio is artificially lower than it might be due to our need to separate resources based on security requirements. Current server configurations are limited to 16GB of memory based solely on memory prices. As memory prices drop, our ratio of virtual to physical systems will continue to improve.

The table below is representative of the cost savings we have experienced and continue to experience as we virtualize more servers. The table represents a comparison of the costs to setup the infrastructure to support the 49 virtual servers we had running on March 2, 2006 versus the same servers if physical hardware configurations had been procured.

Table 1. Savings from Server Virtualization

As of March 2nd, 2006

Cost of Virtual Infrastructure	\$ 129,829
Physical Servers	66,829
Virtualization Software	63,000
Equivalent Cost of Physical Servers	\$ 211,087
(Actual procurement costs that would have been incurred if all servers were physical.)	
Net Savings	\$ 81,258 (38%)

Links

Anderson DL. 2006. "Virtualization." Presented by Daryl Anderson (Invited Speaker) at Scientific Computing Magazine Live Webcast, Blue Bell, PA on October 19, 2006. PNNL-SA-52343.

[The recorded webcast is available online at www.scientificcomputing.com/virtual/]

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