Server Virtualization Peer Review
01-03-2007 cameron
1-24-2007: modified, cameron

Table of Contents

Server Virtualization Peer Review
01-03-2007 cameron
1-24-2007: modified, cameron

Objective

Investigate the use of server virtualization technology to reduce expenses for providing existing and future services. For pilot implementation I limited the scope to services I manage.

Definitions

Virtualization - In computing, to provides a logical rather than physical view of data, computing power, storage capacity, and other resources.

Virtual Machine - Software that mimics a hardware device, in this case a complete computer system.

Domain - Xen terminology for a Virtual Machine.

Private Server - OpenVZ terminology for a Virtual Machine.

Hypervisor - A base operating system which is dedicated to running virtual servers.

Paravirtualization - A virtualization technique that presents the abstraction of virtual machines with a software interface that is similar but not identical to that of the underlying hardware. This requires operating systems to be explicitly ported to run on top of the virtual machine monitor (VMM).

Objective discussion

Several factors led the undertaking of this peer review. Axely Congress in MIS touted the advantages of the virtual server approach and showed off implementations he manages. Computer science students demonstrated a proof of concept for running lab workstations under virtual machines. We used virtual servers to test calendaring software for the calendaring trade study. We used a virtual machine to implement and test the Windows XP staff workstation clone for the Microsoft roll out. A well attended talk at 2006 Educause showcased lessons learned by a few years of experience migrating to and running a virtual server environment. The Educause speaker touted 90 virtual servers running on an HP blade system. The system described could replace all of our Linux and Microsoft servers with a single 4U rack mounted unit and external storage arrays. All of our current x86 server needs easily fitting in one rack sounds pretty attractive. In our current Linux environment we have been placing more services per server to conserve hardware resources. With virtualization, we can segregate services between smaller virtual servers and still achieve hardware resource conservation. There are at least 41 products in the virtual machine product space.

Server Virtualization Peer Review
01-03-2007 cameron
1-24-2007: modified, cameron

Comparison criteria

a) Cost
- How affordable is the product

b) Ease of management
- How easy is the product to maintain

c) Disaster recovery
- Does the product have useful disaster recovery features

d) Hardware compatibility
- Will the product work with our current and future commodity hardware

e) VM Performance
- Is the virtual server performance sufficient

Added criteria:
f) User space hypervisor
- Can the VM manager run in user space, or does it require a dedicated OS

g) VM OS compatibility
- What variety of OS's are supported for running as virtual servers

h) Host OS compatibility
- What variety of OS's can function as the main server OS

Server Virtualization Peer Review
01-03-2007 cameron
1-24-2007: modified, cameron

Criteria weights

```
a) 5 Cost
b) 4 Ease of management
c) 2 Disaster recovery
d) 4 Hardware compatibility
e) 1 VM Performance
f) 2 User space hypervisor
g) 7 VM OS compatibility
h) 2 Host OS compatibility
```

Product scores

Scores, scale 1 - 3

	a	b	c	d	e	f	g	h	total
VMWare	15	12	4	12	1	6	21	6	77
Xen	15	8	2	8	3	2	14	2	54
OpenVZ	15	4	2	12	3	2	7	4	49
Microsoft	15	12	2	12	2	2	7	2	54
min	5	4	2	4	1	2	7	2	27
max	15	12	6	12	3	6	21	6	81

Server Virtualization Peer Review
01-03-2007 cameron
1-24-2007: modified, cameron

Criteria comparison discussion

a) Cost
All products considered are available at zero cost with commercial support options.

b) Ease of Management
VMWare has the best tools for ease of management. Creation of new a new VM and copying of existing VM's is easiest with this product. Creation of domains under Xen or private servers with OpenVZ is difficult, requiring an already installed OS to work from to create a guest OS. Additionally the VMWare GUI tools are available for Windows and Linux. Microsoft Virtual Server 2005R2 (VS2005R2)reportedly has easy to use management tools.

c) Disaster Recovery
The way VMWare operates allows for possible disaster recovery at the VM level using live snapshots with rsync or their paid for tools. Xen snapshots require a halt and restart of the domain. OpenVZ has no disaster recovery features and ties the private servers closely to the host OS. VS2005R2 did not appear to feature any special way to backup virtual servers for disaster recovery.

d) Hardware compatibility
VMWare runs on any x86 commodity server hardware. Xen requires newer Intel VMX capable processors for some functionality. OpenVZ runs on any x86 commodity server hardware. VS2005R2 appears to run on any x86 commodity server hardware.

e) VM Performance
Xen and OpenVZ have much higher performance than VMWare. Xen requires a dedicated hypervisor host OS and kernel patches in the guest OS or an Intel VMX capable processor to achieve this. OpenVZ private servers share the host OS patched Linux kernel to achieve their higher performance levels. With our system loads, we should see no performance decrease with any of the solutions. Performance reported in reviews of VS2005R2 is good.

f) User space hypervisor
The no cost VMWare server product runs in user space, rather than requiring a dedicated hypervisor kernel. Xen and OpenVZ do not support a user space virtual machine environment. VS2005R2 is supposedly hypervisor only, based on longhorn, yet requires Windows Server 2003 as the "host OS".

g) VM OS compatibility
Because VMWare is a true virtual machine, most x86 guest OS's will work, with any VMWare host OS. Xen allows for Linux and BSD, using patched kernels. Xen does have a working WindowsXP but it is not available for use, and they are working on Solaris x86 support. OpenVZ only supports Linux with OpenVZ patched kernels with private servers sharing that kernel. VS2005R2 is supported with Windows NT or better.

h) Host Os compatibility

Server Virtualization Peer Review
01-03-2007 cameron
1-24-2007: modified, cameron

VMWare supports Windows and Linux servers for the host OS, or their own hypervisor OS which is not zero cost. Xen runs on Linux with a patched kernel. OpenVZ recommends Redhat, Fedora, or CentOS Linux with their patched kernel. VS2005R2 recommends Windows 2003 Server as the host platform, and can run on Windows XP.

Server Virtualization Peer Review
01-03-2007 cameron
1-24-2007: modified, cameron

References

Wikipedia Virtual Machine comparison table:
http://en.wikipedia.org/wiki/Comparison_of_virtual_machines

XEN 3.0 Users Manual:
http://bits.xensource.com/Xen/docs/user.pdf

OpenVZ Users Guide:
http://download.openvz.org/doc/OpenVZ-Users-Guide.pdf

VMWare Server Admin Guide:
http://www.vmware.com/pdf/server_admin_manual.pdf

Microsoft Virtual Server 2005R2 FAQ:
http://www.microsoft.com/windowsserversystem/virtualserver/evaluation/virtualizationfaq.mspx

EWeek Labs Review, Microsoft Virtual Server:
http://www.eweek.com/article2/0,1759,1668556,00.asp

IT Reviews, Microsoft Virtual Server:
http://www.itreviews.co.uk/software/s290.htm

EWeek Xen 3.0 Review:
http://www.eweek.com/article2/0,1895,2015185,00.asp

TechWorld OpenVZ Review:
http://www.techworld.com/opsys/features/index.cfm?featureID=2764&pagtype=all

4SysOps VMWare server review:
http://4sysops.com/archives/review-vmware-server-beta/

EWeek VMWare server review:
http://www.eweek.com/article2/0,1895,1998812,00.asp

Educause 2006: Server Consolidation, A Story in Success
Audio MP3 in the office
My Educause Notes:
https://faculty.adams.edu/~cdmiller/educause-2006/educause-2006-writeup-cameron.pdf

Server Virtualization Peer Review
01-03-2007 cameron
1-24-2007: modified, cameron

Cost Estimate, 10 Virtual Servers

```
Assumptions:
The use of of the zero cost VMWare product and the use of linux for host and guest OS
are assumed.  The 10 virtual server number is based on my observations of current
VMWare server behavior.  Hot fail over for services and better disaster recovery
capability is added.

VMWare Server License: 0$
Server capable of running 10 Virtual Machines: ~$5000 - $6400
Dual Opteron or XEON
8 Gigabytes RAM
1.2 Terabytes of SATA Disk
4 Gigabit Network Interfaces
Dual hot swap power supplies
3 year next day on site service
The Opteron system is the cheaper buy.

6 Year cost cycle for 10 VM's:
1st year $6000, 1 new server for VM's, use existing old server(s) for fail over and
disaster recovery
2nd year $6000, 1 new server for hot fail over and disaster recovery of VM's.
4th year $6000, replace 1st year server
5th year $6000, replace 2nd year server

Total Cost:               $24,000
Per Year Cost:             $4,000
Total per Virtual Server:  $2,400
Annual per Virtual Server:   $400
```

Server Virtualization Peer Review
01-03-2007 cameron
1-24-2007: modified, cameron

Expense Reduction

Assumptions:
A comparison with the Cost Estimate above, including hot fail over for services and better server disaster recovery capability for the virtual server environment. With our current service consolidation, assume a 2 to 1 ratio of current servers to virtual servers. So 5 physical servers becomes 10 virtual servers. This assumes linux as the host and guest OS.

For 5 Physical Servers:
6 Year cost cycle:
1st year: $30,000, 5 servers
4th year: $30,000, 5 replacement servers

Total Cost: $60,000
Per Year Cost: $10,000

Virtual Server Expense Reduction:
Total Expense Reduction: $36,000
Per Year Reduction: $6,000

Server Virtualization Peer Review
01-03-2007 cameron
1-24-2007: modified, cameron

Pilot

Load analysis
The program named Cacti uses SNMP and has tracked several of our servers during the Fall 2006 semester. A gross underutilization of resources appears on the tracked server CPU, RAM, and network bandwidth. Some servers now have underutilization of disk space due to the new backup NAS being available. The data points to a virtual server approach being feasible in our environment. Data can be viewed at the following URL: https://ghidrah.adams.edu/cacti/graph_view.php

Some average numbers from Fall semester:
Megalon www, portal, lists, ftp: CPU: .42% Network: 300Kbps

Rodan mysql, postgresql, bricolage: CPU: .75% Network: 200Kbps

Hedora mnogosearch, thin clients, php my/pg admin, mirrors: CPU: .15% Network: 200Kbps

Maximums are far higher than averages, ranging up to 50% CPU and 40Mbps of network traffic, but the complete set of numbers all show the systems could easily run as virtual machines on a single server.

Pilot systems
After experimentation during the calendaring trade study and reviewing the tracked system load data, I chose some non essential and some new services as targets for virtualization.

Current virtualized servers and services:
hedora : thin clients (lprng, xfs, tftp)
jetjaguar : linux mirrors (http), ftp.adams.edu
ghidra : load monitoring (cacti) syslog server (syslog-ng)
titanosaurus : php my/pg/ldap admin

The above servers are running on the web test system, using about 10% of it's resources. I am using the no cost VMWare server product to create and manage the virtual machines. The base VM's are lightweight, using ~2GB of disk space and allocated 256MB RAM. One VM is allocated only 128MB of RAM. All of them use Mandriva 2007, except for Ghidrah which is using the Ubuntu 6.10 LAMP version.

Server Virtualization Peer Review
01-03-2007 cameron
1-24-2007: modified, cameron

Future plan

```
1) Use a virtual server for each of these groups of services I manage:
      www, test2, one-stop, portal
      lists, forums, bbs
      mysql
      bricolage, postgresql
      openldap
2) Implement high availability fail over for services between physical servers
3) Set up XEN or KVM for experimentation on a test server
4) Attend server virtualization talks and training
```

Addendums

One area left out of the above criteria which proved to be of interest was emulated hardware support. A standard set of virtual hardware available makes server maintenance easier, but can sometimes be limiting. A couple of examples are that VS2005R2 lacks a gigabit ethernet device, and support for smp processors. Vmware offer each of these features.

The latest release candidate of the Linux kernel includes virtual server support. The Linux Kernel based Virtual Machine (KVM) is apparently capable of running QEMU style virtual servers using newer AMD and Intel processor virtual server support. This is the same XEN requirement for Intel VMX, but KVM does not use paravirtualization and so does not require a specially patched guest OS. Early performance numbers look good. All new AMD and Intel server hardware I looked at had the virtual machine processor extensions. My guess is that KVM will look pretty attractive for hosting virtual servers by at leas the second year into my deployment.