Virtualization

Presentation by Greg Bosch
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Outline

I. Introduction to Virtualization
II. Virtual Appliances
III. Benefits to Virtualization
IV. Virtualization Products
An Introduction to Virtualization

What is ‘Virtualization’?

Technique for hiding the physical characterizes of computing resources from the way other systems, applications or end users interact with them

Two common functions:

- Making multiple physical resources appear to function as a single logical resource

  We’ve see this before...

- Making a single physical resource appear to function as multiple logical resources

  We’ll talk about this today...

http://en.wikipedia.org/wiki/Virtualization
An Introduction to Virtualization

What is a ‘Virtual Machine (VM)’?

Implementation of a machine that executes programs as if it were a real machine

Separated into two categories:

- **Process Virtual Machine**
  Runs as a normal application inside an operating system to abstract away the details of the underlying hardware

- **System Virtual Machine**
  Allows multiplexing (time sharing) of the underlying hardware between different operating systems

http://en.wikipedia.org/wiki/Virtual_machine
Virtual Machines

Process Virtual Machines

Designed to provide a platform-independent environment to a single process (i.e., program)

The environment is created when its associated process is started and destroyed when that process exits

Allows program to execute in the same way regardless of the physical platform it is running on; “Write once, run anywhere”

Source code compiled into Java Byte code

Byte code executed by Java Virtual Machine (JVM)

http://en.wikipedia.org/wiki/Virtual_machine
Virtual Machines

**System Virtual Machines**

- Designed to provide a complete platform which can support the execution of multiple, and different, operating systems.

- Allows for time-sharing of underlying hardware between virtual machines.

- Think of a scheduler that works on operating systems rather than processes.

- Operating Systems remain isolated from one another.

- The Instruction Set Architecture (ISA) provided by the virtual machine can be different from that of the real machine.

http://en.wikipedia.org/wiki/Virtual_machine
Virtual Machines

System Virtual Machines

Implemented through the use of a Virtual Machine Monitor (VMM) also-known-as a Hypervisor

Two classifications of Hypervisors:

- **Native** (Hardware-Level): software runs directly on top of a given hardware platform as a control program for operating systems

- **Hosted** (OS-Level): software runs within an operating system environment as a control program for other operating systems

http://en.wikipedia.org/wiki/Virtualization
Virtual Machines

Native System Virtual Machines

Is where virtualization began… In the time of the mainframe

IBM developed the first Native Hypervisor in the 1960s although ‘hypervisor’ hadn’t entered the lexicon yet…

They called it CP/CMS and it consisted of two main components

- **Control Program** (CP)
  Which served to create the virtual machine environment for instances of

- **Cambridge Monitor System** (CMS)
  A lightweight single-user operating system

http://en.wikipedia.org/wiki/Hypervisor
Virtual Machines

Hosted System Virtual Machines

- Virtual Machine Monitor layer is moved one level higher as compared to Native VM’s
- Runs within a Host operating system environment
- An operating system is installed first; as usual, on top of Hardware
- A Virtual Machine Monitor is then installed within the Host OS
- Guest operating systems can be installed on top of the VMM layer
- Host OS sees the VMM as a process
- VMM controls the allocation of time between Guest OSs
- Guest is segregated from the rest of the environment

http://en.wikipedia.org/wiki/Virtualization
Emulation or Simulation in Hosted System Virtual Machines

Virtual Machine provides a “guest” operating software the hardware environment it expects

<table>
<thead>
<tr>
<th>Advantage:</th>
<th>Guest Software need not be modified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disadvantage:</td>
<td>Must pay Performance Penalty</td>
</tr>
</tbody>
</table>

Software is unaware that it is really talking to a virtualized device

Each interaction between Guest device driver with the emulated device hardware requires transaction with VMM

The real hardware does its job as usual

But the VMM must now translate the result back to the guest

Virtual Machines

Paravirtualization

Application Programming Interface (API) is provided to the Guest OS by the VMM so the Guest may utilize the hardware

<table>
<thead>
<tr>
<th>Advantage:</th>
<th>Better Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disadvantage:</td>
<td>Guest software must be modified to use API</td>
</tr>
</tbody>
</table>

Guest interacts with VMM at a higher level of abstraction

Instead of supplying the specifics of how to use the hardware, software provides general requests to the VMM

Decreases the number of interactions between Guest and VMM for a specific operation

Virtual Machines

Performance: Emulation vs. Paravirtualization

VMware publishes “A Performance Comparison of Hypervisors” January 31, 2007

XenSource retaliates with “A Performance Comparison of Commercial Hypervisors” two months later

“Independents” cite issues with both reports but note VMware didn’t fight fair

Interestingly, VMware allows XenSource to publish performance results pertaining to VMware products in its report (atypical of VMware policy & EULA)

Benchmarks Run:
- SPECcpu2000 (CPU Intensive)
- Passmark (Memory Intensive)
- Netperf (Network specific)
- SPECjbb2005 (Java application server workload)
Virtual Machines

SPECcpu2006 (CPU Intensive)

Figure 3 – SPECcpu INT 2000 results compared to native (higher values are better)

Virtual Machines

Passmark (Memory Intensive)

Figure 5 – Passmark – Memory results compared to native (higher values are better)

Virtual Machines

Netperf (Network Specific)

Figure 7 – Netperf results compared to native (higher values are better)

Virtual Machines

SPECjbb2005 (Java Application Server Workload)

Figure 9 – SPECjbb2005 results compared to native (higher values are better)
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Virtual Appliance

Virtual Appliance is a virtual machine prepackaged with the necessary components to serve its intended purpose.

Aimed to eliminate the installation, configuration and maintenance costs associated with complex stacks of software.

For instance

LAMP Appliances (Linux + Apache + MySQL + PHP)

http://www.vmware.com/appliances/directory/465
Virtual Appliance

MediaWiki

Software that runs wikipedia.org
Freely available to organizations
Packaged as a Virtual Appliance by www.rPath.com
Uses a Just Enough Operating System (JeOS) that installs within supported VMM
And includes all other necessary software packages
TRULY a Turn-Key system

Lets take a quick look if we aren’t behind schedule:
http://www.vmware.com/appliances/

http://www.vmware.com/appliances/directory/465
Virtual Appliance

Step 1: Install VMware’s Player available from vmware.com and open the MediaWiki Virtual Machine available from rpath.com
Virtual Appliance

Step 2: Opening the Virtual Appliance
Virtual Appliance

Step 3: Just enough Operating System Loading (Red Hat variant) booting
Virtual Appliance

Step 3: Configuration of MediaWiki through web interface

![MediaWiki 1.11.0 Installation - Windows Internet Explorer](image)

MediaWiki 1.11.0 Installation

* Don't forget security updates! Keep an eye on the log.

Checking environment...

Please include all of the lines below when reporting installation

- PHP 5.2.5 installed
- Found database drivers for MySQL
- PHP server API is apacheD handler, ok.
- Using pretty URLs is on.
- XUL/Latin1-UTF-8 conversion support.
- Warning: re�age/parseMagic has been saved in session data, but it's a valid path which is not referenced.
- PHP's memory limit is 128MB.
- Could not find Turku MMCache, eAccelerator, APC or XCache.
- Found GNU diff in /usr/bin/diff.
- Found ImageMagick in /usr/bin/convert, image.thumbnail.
- Found GD graphics library built.
- Script URI path: /wiki
- Installing MediaWiki with php file extensions (Environment checked. You can install MediaWiki).

Site config

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wiki name</td>
<td>myWiki</td>
</tr>
<tr>
<td>Must not be blank or &quot;MediaWiki&quot;</td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>en</td>
</tr>
<tr>
<td>Contact e-mail</td>
<td>root@localhost</td>
</tr>
<tr>
<td>Copyright/license</td>
<td>No license metadata</td>
</tr>
<tr>
<td>Admin username</td>
<td>WikiSysop</td>
</tr>
<tr>
<td>Password</td>
<td>Cannot be blank</td>
</tr>
</tbody>
</table>

Selected the language for your wiki's interface. Some localizations aren't fully complete. Unicode (UTF-8) is used for all localizations.

An admin can lock/delete pages, block users from editing, and do other maintenance tasks. A new account will be added only when creating a new wiki database.

The password cannot be the same as the username.
Virtual Appliance

More configuration
Virtual Appliance

Having some fun

This may seem off topic, but isn’t that one of the points of a virtual appliance?

Using your time to manage the application and not the system software
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Benefits to Virtualization

Cost Benefit

Traditional production servers (physical box) run a single application

Utilization of hardware by that appliance estimated at 5-10%

Reduction of physical assets reduces substantial expenses
  - Cost of hardware,
  - Data center footprint,
  - Electricity, and
  - others

Virtualization allows for consolidation of appliances at ratios between 10:1 and 20:1

Meaning an operation requiring 800 physical servers can be reduced to approximately 60 physical machines

http://youtube.com/watch?v=MnNX13yBzAU&feature=related
Benefits to Virtualization

Cost Benefit continued...

Man Hour Reduction too:

Instantiation of new virtual machine requires just minutes
(Many YouTube videos if you’re interested)

As compared to the “old fashioned way” involving
- Sourcing of new hardware (purchasing and installation)
- Installation of Operating System, Patching
- Installation of relevant Applications
- Testing
Benefits to Virtualization

Operational Benefits

Automation of Installation process from OS to Applications (i.e., Appliances)

Isolation (Sandboxing)
- Program Development and Testing
- Beneficial for running un-trusted Operating Systems or
- Un-trusted Applications

Provide legacy system support without allocating physical resources

Teaching environment for classes such as these

Check-pointing
  The state of the machine can be saved, paused, restarted, even migrated to another machine
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Xen

Originated as a University of Cambridge Project

Project lead to founding of XenSource, Inc.

Recently acquired by Citrix in October 2007 for $500 Million

Products include:

Express Edition
   A free starter package for bringing virtualization to every server

Standard Edition
   High-performance rich-featured server virtualization with multi-server management

Enterprise Edition
   A powerful platform management virtualization as a flexible aggregated pool of compute and storage resources

Xen

Requires modification to Kernel of pre-installed OS

Modification installs Xen VMM just above the hardware (Native System Virtual Machine)

Xen boots from boot-loader (GRUB) and then loads the modified Host OS into the privileged domain (Dom0)

Administrator can use Host OS to install and then start guest OSs in the unprivileged domain (DomU)

Scary moment during installation of Guest OS

However, taking a closer look Xen is doing it’s job
Xen

Sandbox Machine running Xen Linux Kernel

Virtualized CentOS environment within original Operating System
VMware

Proprietary virtualization software developer
x86-compatible architectures only

Both Desktop and Server space software packages:

**Desktop:**

- **VMware Workstation** (orig. 1999) allowed users to run multiple x86 operating systems
- **VMware Fusion** is the Mac-Intel platform product
- **VMware Player** allows users to run but not create VMs

**Server:**

- **VMware ESX Server** is an Enterprise marketed product
- **VMware Server** is the less optimized, freeware version

http://en.wikipedia.org/wiki/vmware
VMware Player

- **Open:** Browse for available virtual machines. When you select a virtual machine, it opens in this VMware Player window.
- **Download:** Download a virtual appliance from VMware Virtual Appliance Marketplace. You can then open it in VMware Player.

**Recent Virtual Machines**
- MediaWiki

**Featured Virtual Appliance**
- **Cobia:** Cobia, a Unified Network Platform, delivers critical network and security functions through a flexible delivery platform.
VMware Server
Other Technologies

- OpenVZ
- Xen
- Parallels
- SimOS
- Mac-on-Linux
- Boot Camp (std. on Leopard)
Kevin Kettler, CTO Dell on virtualization [Highly Recommended]
http://youtube.com/watch?v=nDiM19KShAA (10 minutes)

Dan Chu, Sr. Dir of Products VMware on cost/benefit of Virtualization
http://youtube.com/watch?v=MnNX13yBzAU&feature=related (4 minutes)

Dell Tech Center: Removes Blade from server and watches VMware recover
http://youtube.com/watch?v=ZUtmoGrGnTQ&feature=related (2 minutes)

Wikipedia: Virtualization, Virtual Machine and Virtual Appliance
www.wikipedia.org

The Complete Reference, FRHEL Chapter 33

XenSource
www.xensource.com

VMware
www.vmware.com
Works Cited (a little less serious)

VMware Advertisement, Mac vs. PC style
http://youtube.com/watch?v=EBsw5y5sDKQ&feature=related

VMware music video?!
http://www.youtube.com/watch?v=Dm8r45jeAzM&NR=1

Smart-Guy, Dumb-Guy style infomercial for VMware
http://www.youtube.com/watch?v=qWf_WiaFedc&feature=related

Sun xVM presentation and Live-Demo
http://www.youtube.com/watch?v=ojn5YEQhrDk&feature=related