Introduction to Dynamic Infrastructure

By Alan G. Labouseur

MARIST SCHOOL OF COMPUTER SCIENCE & MATHEMATICS

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IBM

MODULE NINE

VIRTUALIZATION

Introduction to Dynamic Infrastructure

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Contents

Remarks

Woa... is it Wednesday already? (Or even Thursday? What?)

Nice comments on Stuxnet last week. How very convenient that a world-wide security incident should be prominently reported just as we're getting to that module in this class. I don't know whether to be scared or proud of the developments in that area. Perhaps both.

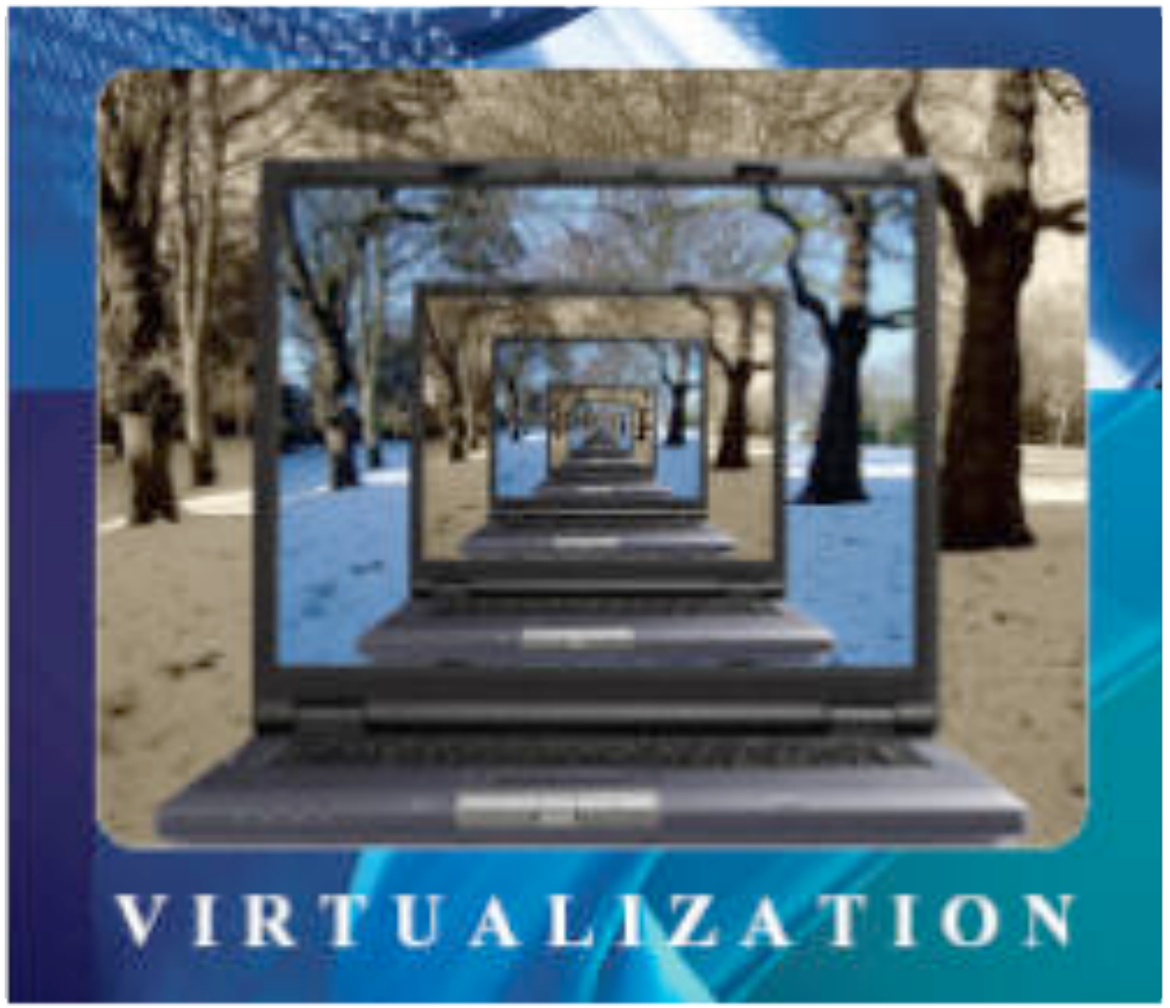
Great comments and idea about social engineering as well. Some of those schemes are very clever. And now we all know about them. Which is good. And bad. Remember: you must use your powers for good and not for evil.

Remember: Our field trip to IBM's Green Data Center is as week from Friday, on March 25th. Details can be found in our Meta forum topic. I'm looking forward to (finally) meeting you all in person.

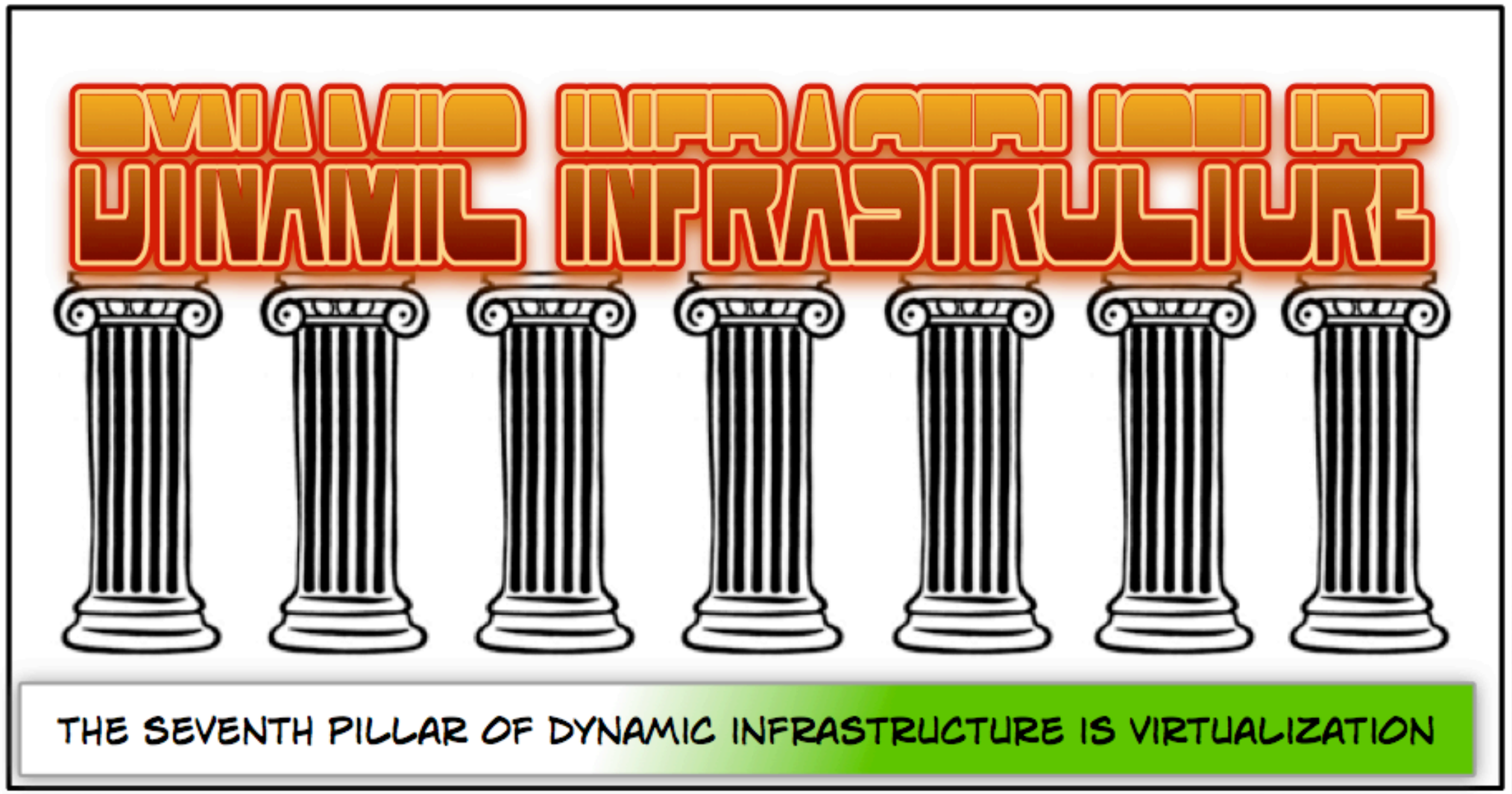
Review

Let's review. Last time our intrepid (and secure) DI Gurus discovered . . .

- Security should be performed though audit, local security, corporate security and external security. It is essential that it be done through workstations, network and servers.
- To help make your company less vulnerable to attacks, penetration tests, such as scanning and hands-on attempts to try to break into systems, should be performed.
- Open source tools such as Nessus are used to scan systems to test for vulnerabilities.
- Security policy verification is an agent that runs on servers to verify that security settings and patches are implemented.
- Message integrity ensures that messages are not altered without detection.
- ESP (Encapsulations Security Protocol) proves authentication, data integrity and confidentiality and is more widely used then AH protocol.
- Cybercrimes include things such as hacking, social engineering, virus technologies, online extortion, and industrial spying.



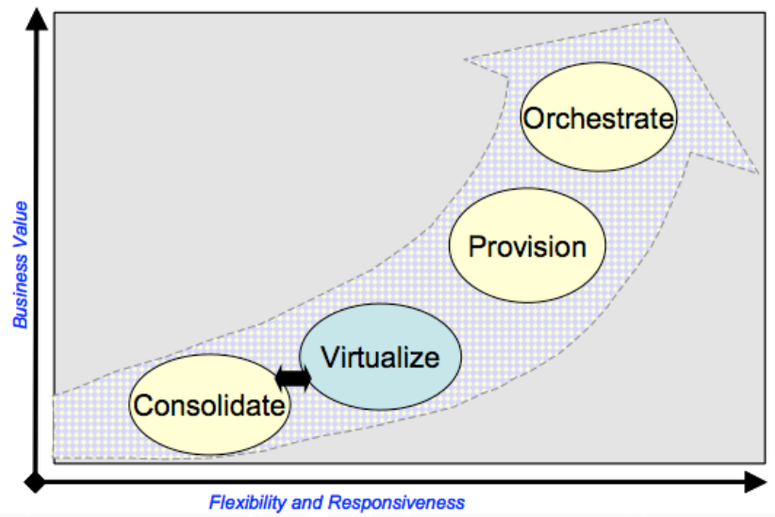
Virtualization



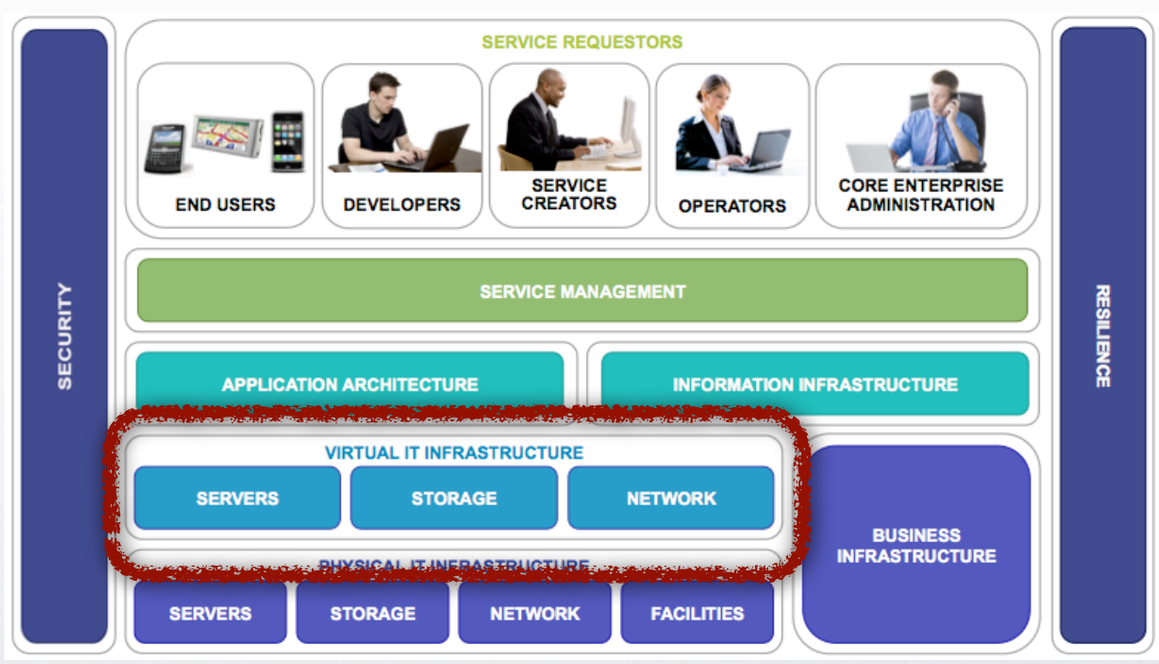
Virtualization

Our Plan

- Why / Preparation
- How
  - Introduction
  - Hardware
  - Categories
  - Configuration



Virtualization supports everything which requires servers, storage devices, network devices... all virtualized to the infrastructure to ensure the highest possible utilization. Additionally, fully-instrumented and managed facilities infrastructure ensures that the resources are properly used.



Why Virtualization?

In an increasingly connected world . . .

- the number of transactions and volume of information put ever increasing demands on your IT infrastructure.
- Customers are seeking a flexible IT infrastructure that can keep pace with demand.
- On a Smarter Planet, organizations with a Dynamic Infrastructure are deploying virtualized infrastructures to improve their business agility.

. . .success demands agility.

- You need to adjust to changes in your business, from your customers, and in the world.
- Virtualization helps your business be more agile so you can . . .
  - **Consolidate resources** with a choice of virtualization technologies to improve efficiency and reduce ongoing costs – do more with less
  - **Manage workloads** simply to make it easier for your IT staff to support the key business priorities
  - **Automate processes** to reduce management costs and make execution of key tasks more consistent
  - **Optimize delivery** of services so that applications can quickly respond to the demands of the business.

Why Virtualization?

Success also demands you address many frustrations of today's systems

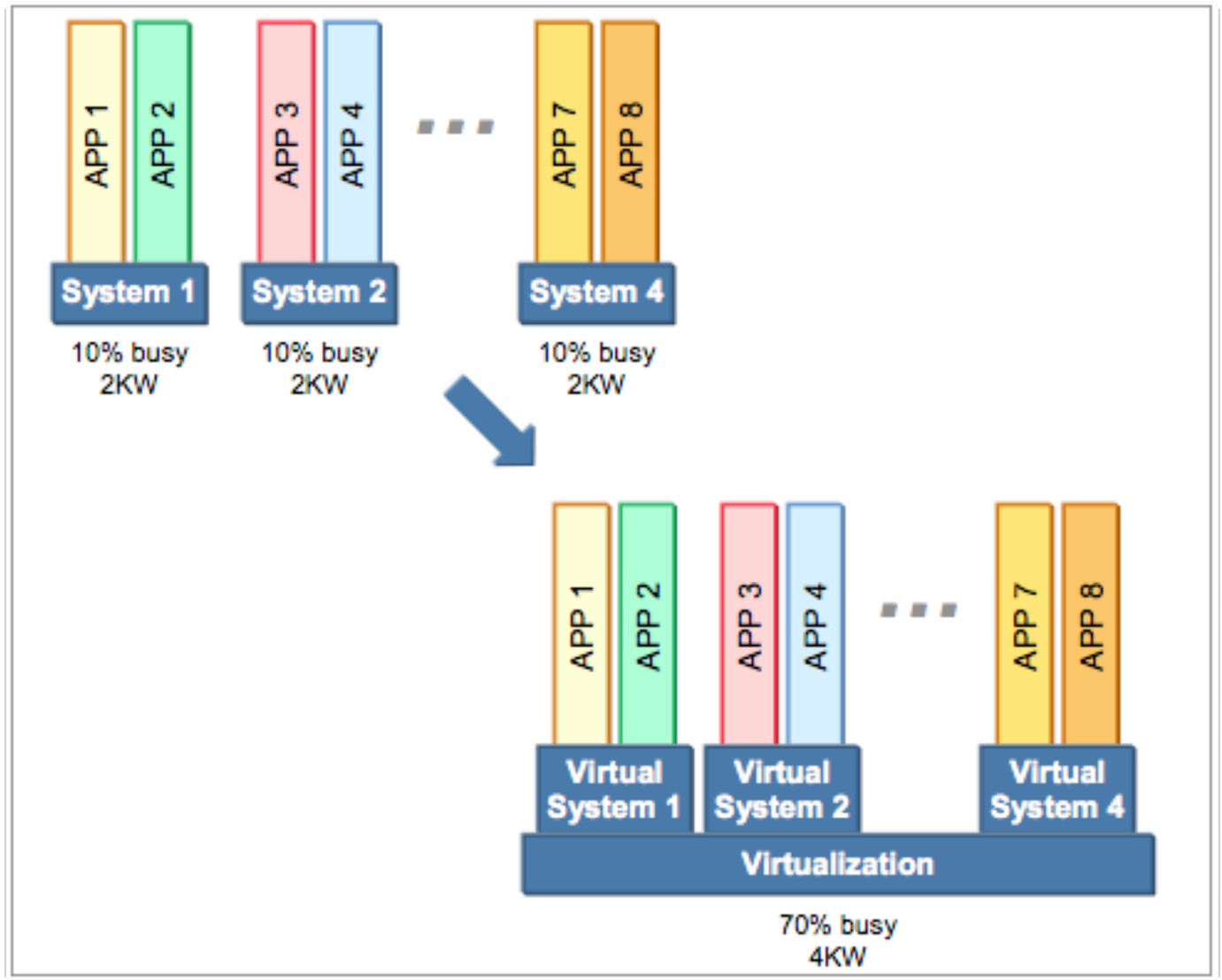
- Increasing number of applications and servers but fewer people to run them.
- Some of your servers are "red hot" busy while others are only used a little.
- Change requests are stacking up in a waiting queue.
- Unused computer cycles are in the wrong place, being wasted.
- Machine outages cause system outages that cost the company money and reputation, and you sleep.
- Inability to consolidate small older workloads.
- The power requirements for heating and cooling are killing you, as are the costs of all that power.

IDC reports

- For every $1.00 spent on new [physical] servers, the average enterprise spends $0.50 on power and cooling, regardless of weather the server is operating at 10% utilization or 75% utilization.

Why Virtualization?

Virtualization is the Greenest of Technologies



Virtualization > Preparation Questions

Do you have an enterprise wide virtualization strategy?

Does your virtualization strategy cover all workloads?

Is your virtualization strategy limited to servers?

How is your virtualization efforts affecting your support strategy?

How are your user communities affected by virtualization?

Do you know the watts per transaction for your critical applications?

Virtualization > What do we want?

Business Resiliency through Virtualization

- Virtualization offers a strategy that transcends physical boundaries to improve service delivery, drive down infrastructure costs and help manage risk.
- Applications are only available if the underlying infrastructure is available. Virtualization can keep applications running through server, storage and application server failures.
- Consolidating onto virtualized servers means less physical machines to restore. Virtual machine configurations stored in networked files can be restored quickly to another site in the case of a disaster – as a part of your business resilience plan.
- Storage virtualization allows you to restore to different device types without having to have a mirror image of all your expensive storage at a disaster recovery site.

Consolidation through virtualization

- Virtualizing an infrastructure can help enable the flexible and dynamic delivery of shared IT resources as services.
- Virtualization and consolidation helps organizations do more with fewer physical assets, reducing the energy demands of infrastructure while expanding capacity and enabling greater flexibility.
- Highly virtualized systems increase utilization of IT resources as well as improving service delivery speed, TCO, resiliency and flexibility.
- While cost is always important, virtualization also has the advantage of preparing the foundation for a truly **Dynamic Infrastructure**.

Virtualization > What do we want?

Virtualized Networking

- Virtualization can help you position your network to better meet the high-availability, high-performance and security requirements.
- Satisfy dynamic networking demands with a flexible, robust and resilient network design and implementation.

Virtualization supports Cloud Computing

- More and more organizations are viewing virtualization as an enabler to move from managing individual resources to managing resource pools as if they were a single server, storage device or application.
- Virtualization, together with a strong service management platform, can help lower the cost of adding more IT resources to the cloud.

Virtualization supports Energy Efficiency

- Optimizing the energy efficiency of the IT infrastructure requires a holistic approach that encompasses energy management, virtualization, IT and data center facility services, along with server and storage products that are designed to be green.
- Virtualization enables organizations to increase utilization rates of their computing resources while managing them in ways that offer more resource flexibility.

Virtualization > How do we get it?

Virtual Machines

- can run their own OS as though it were running on a dedicated computer
- support multiple OSs on a single computer
- need virtualization software for managing computer environments

Virtualization Software

- Works by emulating a separate hardware environment in an existing OS environment.
- Runs within OS of a physical computer (host computer) to create emulated computer environments called virtual machines.
- Creates a separate environment for each virtual machine
  - Configuration file contains settings for virtual hardware.
  - Virtual disk file contains a boot loader along with OS files and user data.
- Major Requirements for running virtualization software
  - Having a lot of RAM and disk space on the host computer
  - At least 1 to 2 GB for each virtual machine

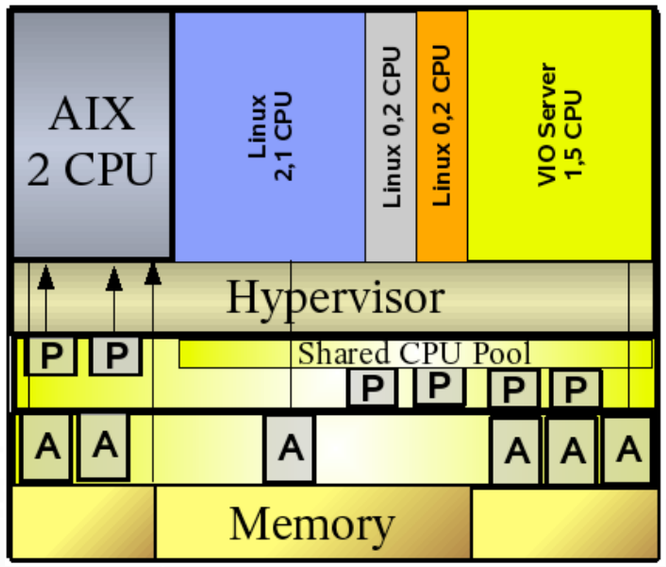
Licensing Requirements

- Installing an OS or application on a virtual machine is the same as installing the product on a physical computer.
- Running multiple copies of the same virtual machine might violate the license agreement for software installed on the virtual system.

Virtualization > How does it work?

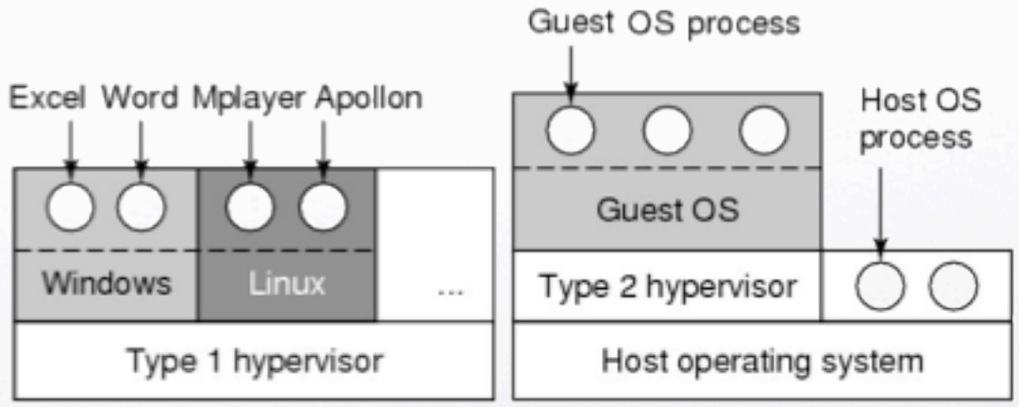
Hypervisors

- HYPER + superVISOR
  - A supervisor with a little too much sugar near bed time.
- A Hypervisor is a tiny software layer that sits very close to the “bare metal” hardware, just above the actual hardware and just below the operating system(s). In some sense it can be seen as extended BIOS.
- The Hypervisor divides the hardware in pieces and makes it visible for logical partitions so that the virtual machines see only the hardware (I/O channels, memory, cpu cycles) they have been assigned.
- Common Hypervisor services include, CPU virtualization, I/O virtualization, and Network virtualization (via virtual network switch functionality)



Two Types of Hypervisor

- Type 1, and (wait for it . . .)
- Type 2.



Type 1: hypervisor runs on “bare metal”

Type 2: hypervisor runs on a host OS

- Guest OS runs inside hypervisor

Both VM types act like real hardware

Virtualization > Categories

Workstation Virtualization

- Common Uses:
  - Running user desktop environments
  - Running virtual appliances
  - Software development
  - Help desk support
  - Classroom training

Server Virtualization

- Common Uses
  - Reduced hardware costs, server clustering, and improved disaster recovery
  - Ability to create specialized servers to run different services
  - Reducing “server sprawl”
    - Server sprawl increases costs of computer hardware and maintenance and increases power consumption.

Virtualization > Categories

Server Virtualization - Server Sprawl Gone Wild

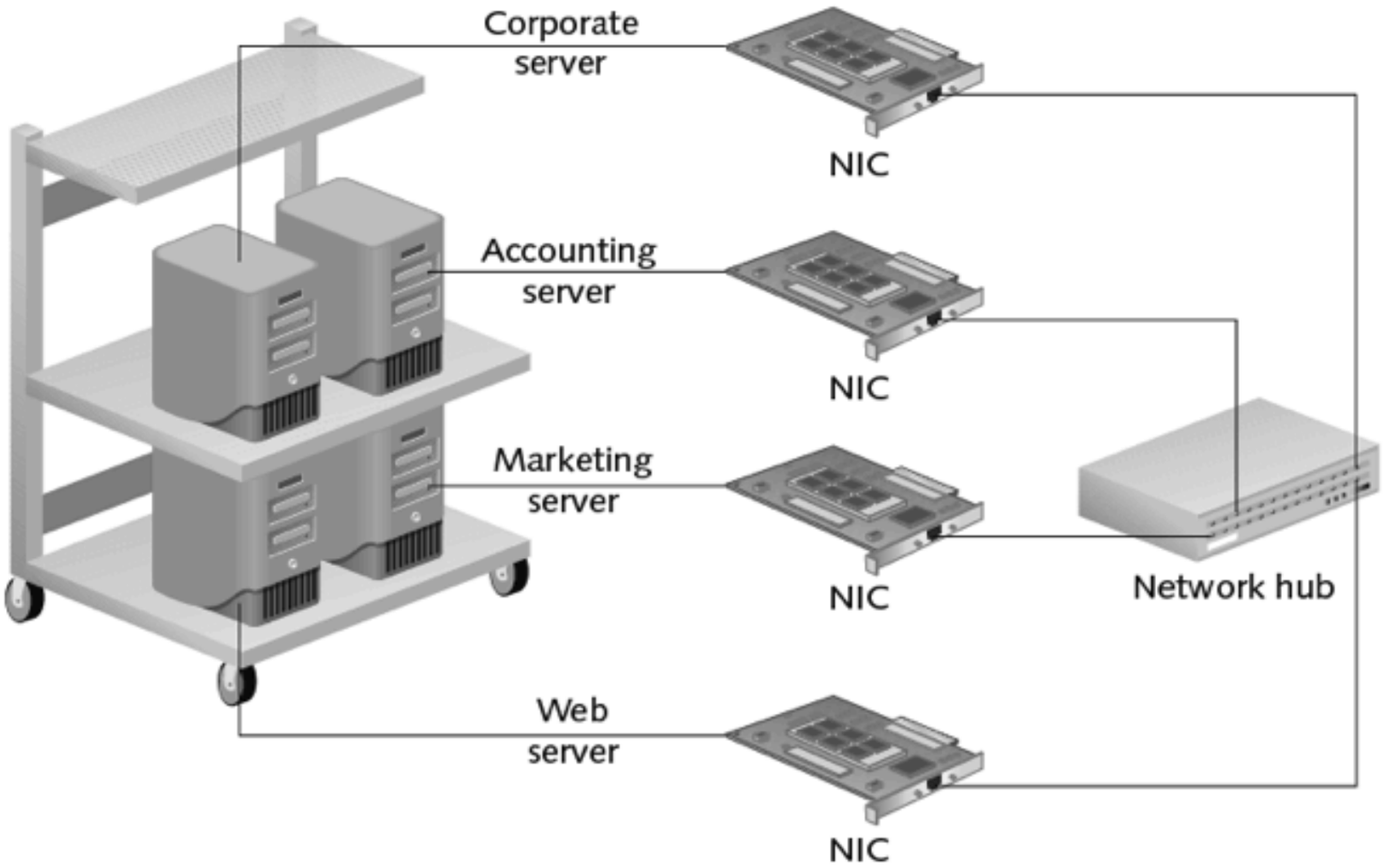


Figure 1-3 Server sprawl

Virtualization > Categories

Server Virtualization - No More Server Sprawl

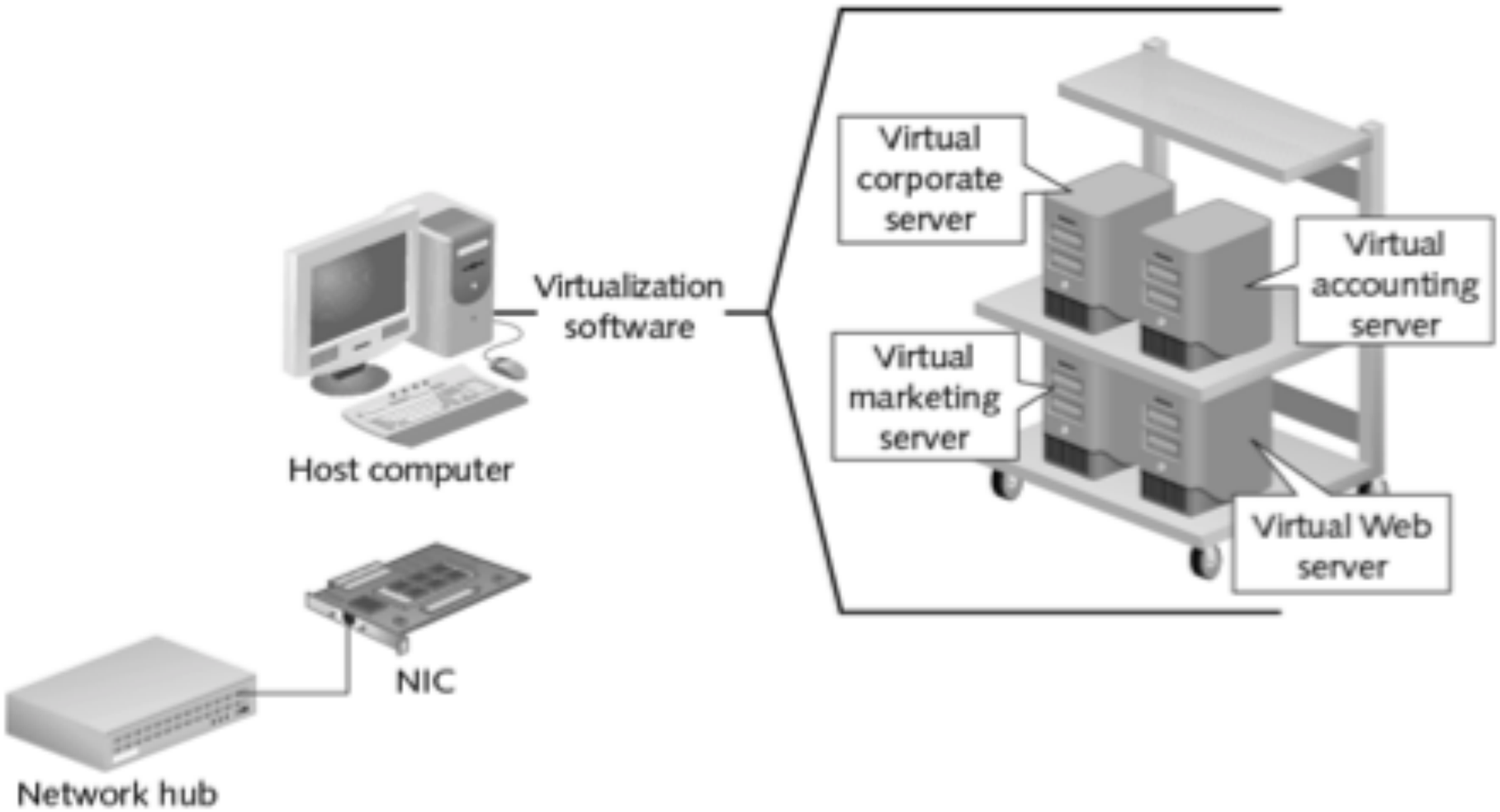


Figure 1-4 Consolidating several servers into a single system

Virtualization > Categories

Hardware Virtualization

- Helps solve performance issues by performing part of the virtualization process inside the processor chip
- Intel and AMD now have built-in support for virtualization in their processors
- VMware Server and Hyper-V use hardware virtualization to improve performance

Application virtualization

- Allows each application to have its own Registry and file system
- Virtual applications leave no footprint in the host computer's Registry or file system
- Products include:
  - VMware Thinapp
  - Softricity SoftGrid Desktop
  - Altiris Software Virtualization Solution (SVS)

Storage Virtualization

- Insures continuous access to information and business flexibility.
- Increases efficiencies and a competitive advantage via consolidation.

Virtualization > Types

Emulation

- The virtual machine emulates (simulates, really) complete hardware.
- Unmodified guest OSs can be run, albeit slowly
- Products
  - VirtualPC, QEMU, Bochs

Full or Native Virtualization

- The virtual machine simulates (emulates, really) just enough of the hardware to allow unmodified guest OSs to run in isolation on the same physical hardware.
- More common these days than emulation, mainly because it's far faster.
- Products
  - IBM VM family
  - VMware
  - Apple's Parallels

Virtualization > Hardware

Processor and motherboard chipset

- Virtualization software provides emulated motherboard and chipset that are compatible with guest OS

Memory settings

- Virtual machines use physical memory (RAM) from host computer for each virtual environment that is currently running
- To improve virtual machine performance, just add RAM to the host computer

COM and LPT ports

- Administrative console can be used to configure a virtual machine to use standard COM and LPT ports

USB ports

- USB has become the standard interface for many peripheral devices

CD/DVD devices on a virtual machine

- Virtual machine can be configured to have virtual CD/DVD devices that can be linked to the host computer's physical CD/DVD-ROM drive

Virtualization > Hardware

Disk Support

- With virtualization software, a virtual machine can use a specially formatted file (virtual disk) on the host computer as though it were an entire drive
- When you create a virtual machine, you specify:
  - Type of virtual disk
  - Amount of disk space (fixed or dynamic) to reserve for it on the host computer

Network Support

- With virtualization software, the virtual machine can have one to four simulated network adapters (NICs)
  - The virtual network adapter can be configured in a number of ways, including local, bridged, or shared (NAT).
    - When a virtual machine is in local mode (called “host-only mode” in VMware) it’s emulated NIC is plugged into a virtual switch
    - Bridged mode is discouraged, especially in testing environments
    - Shared (NAT) mode
      - ✓ Allows access to outside networks yet isolates the virtual machine, preventing it from sending and receiving packets across the physical network

Virtualization > Hardware

Network Virtualization

- Virtualization software Emulates a NIC's functions and provides the guest OS with a software driver for this virtualized NIC (virtual network adapter).
- Frames include a Media Access Control (MAC) address used to identify the sender and receiver.
- To send and receive frames, network adapters, both physical and virtual, must be assigned MAC addresses.

Virtual Switches

- Devices that use ports to connect multiple NICs to the same network
- Three basic types of virtual switches
  - External or a bridged switch
  - Internal or a host-only switch
  - Private switch

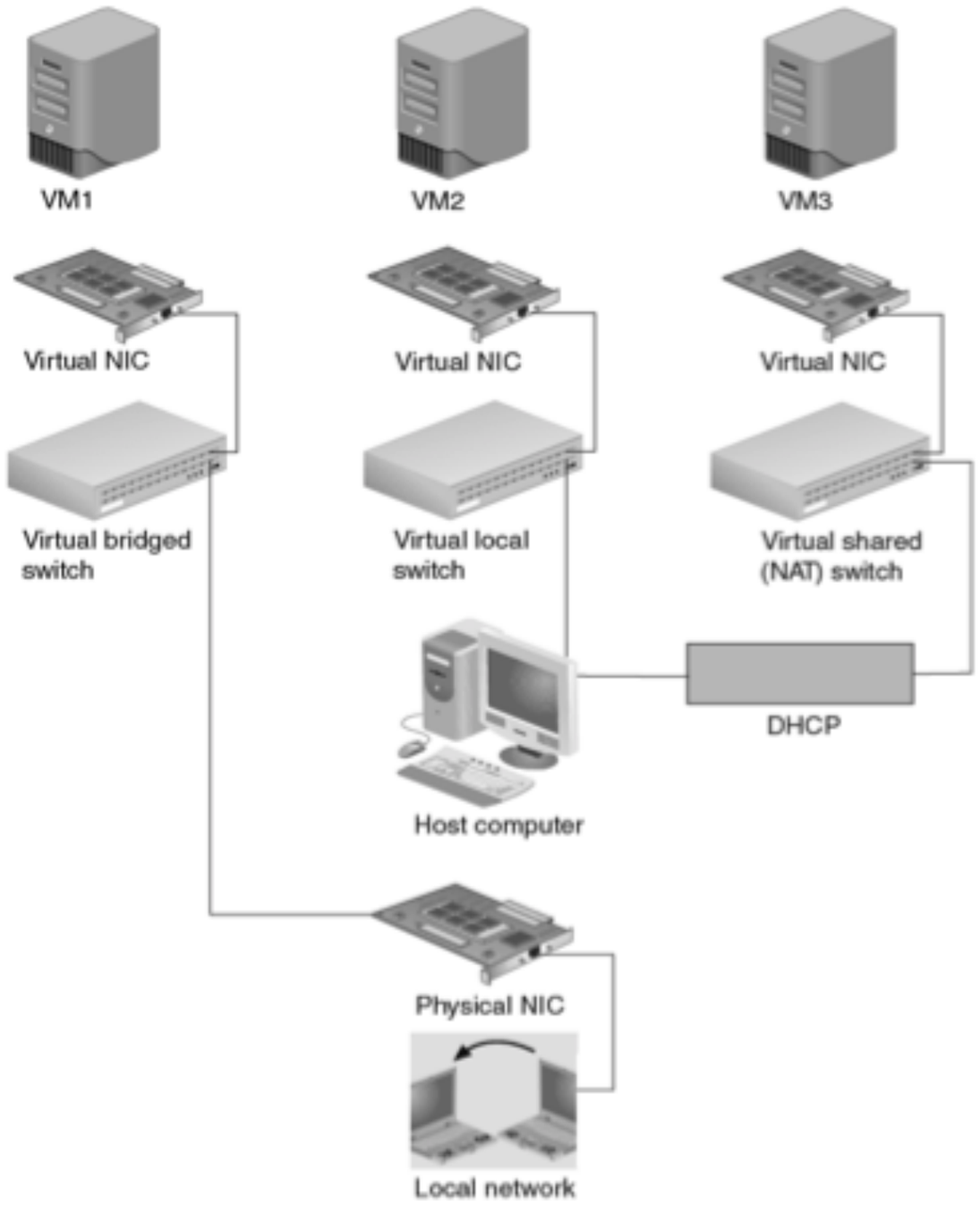


Figure 1-12 Virtual network adapter options

Virtualization > Products

VMware Workstation

- Built-in support for most guest OSs
- Snapshot Manager
- Being able to capture screens from virtual machines
- Unity view
- Teams of virtual machines connected across a LAN
- Capability to create a virtual machine from a physical computer
- Ability to map drive letters from the host computer to a virtual hard disk

VMware Server

- Reduced overhead to improve server performance
- Free downloadable product and serial number
- Capability to run and manage virtual servers from a remote location
- Web-based user and administrative consoles

VMware Player

- Free, but has more limited configuration options than VMware Workstation or VMware Server
- Often used for running virtual appliances

Virtualization > Products

Microsoft Virtual PC 2007

- Contains many important features and is free and easy to us

Microsoft Hyper-V

- Available at no additional cost with all 64-bit versions of Windows Server 2008
- Runs as a service that can be managed through standard MMCs for both user and administrative consoles

IBM Virtualization Services

- http://idc.cycloneinteractive.net/ibmvirtual/
- http://www-03.ibm.com/systems/virtualization/

Virtualization > Key Terms

- Bridged Mode -A network mode in which the virtual NIC communicates with the physical network by using the host computer's NIC.
- Configuration file - A file that defines what virtual hardware a virtual machine has available, such as the amount of memory, number of CPUs, and location of the virtual disk file.
- dynamic virtual disk - A virtual disk file that uses only the amount of disk space on the host required to hold the virtual machine's files; it can expand up to the maximum size as needed. See also virtual disk file.
- fixed-size virtual disk - A virtual disk file that uses the entire amount of disk space on the host immediately for increased performance. See also virtual disk file.
- guest system - A virtual machine with an operating system running on it.
- host computer - The physical computer that runs virtualization software and virtual machines.
- ISO image file - A file that uses the ISO 9660 standard to store a CD or DVD's contents.
- LAN segment - A virtual network environment that VMware Workstation uses to simulate communication between members of a virtual team. See also teams.
- local mode - A Microsoft Virtual PC network mode in which the virtual NIC communicates only within the host computer's virtual network. No packets are sent to the physical network; called "host-only mode" in VMware.
- server sprawl - The result of hosting specialized applications on several underused servers.
- shared (NAT) mode - A network mode in which the virtual NIC is configured to send all packets for the outside network to the host computer, which then acts like a NAT router, forwarding packets to the outside network by using its own network address.

Virtualization > Key Terms

- teams - A VMware Workstation feature in which virtual machines are configured to work together as a group.
- virtual appliance - A virtual machine package that is specialized to run specific applications, which are usually already configured and installed on the appliance.
- virtual disk file - A file containing the boot sector, OS, and user files of an entire hard drive; it's used by a virtual machine on the host computer.
- virtual machine - An emulated computer environment that runs on a physical computer.
- virtualization software - Software that runs on the physical computer to emulate a separate hardware environment.

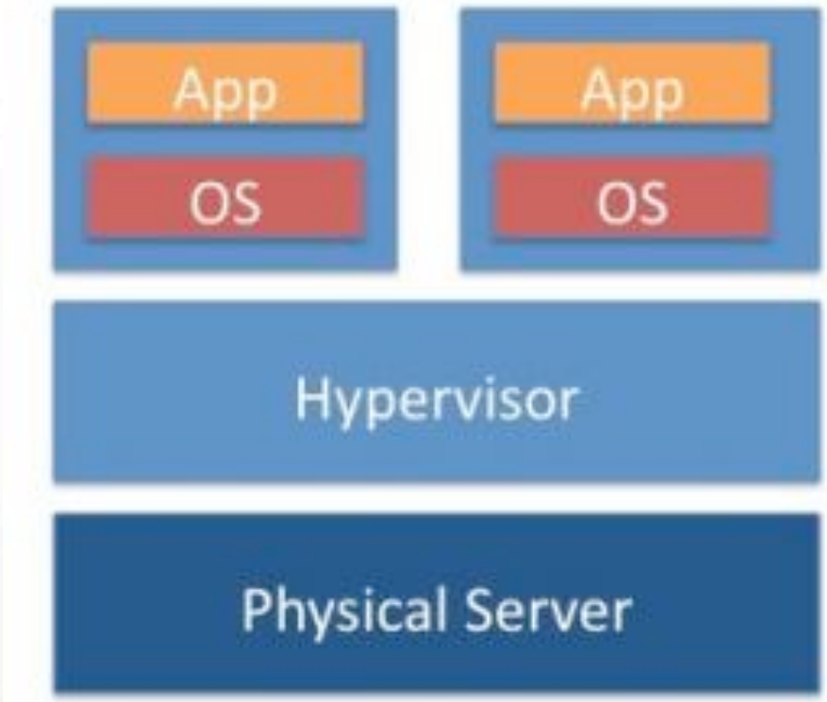
Virtualization > Summary of Goals

Goals

- Reduce Operating Costs
- Improve IT asset utilization.
- Create an available and resilient infrastructure.
- Enable rapid response to changing business requirements.
- Employ virtualization and system-management technologies to increase flexibility and responsiveness.
- Dynamically Adapt to the peaks and valleys of business.

Realize Virtualization Benefits

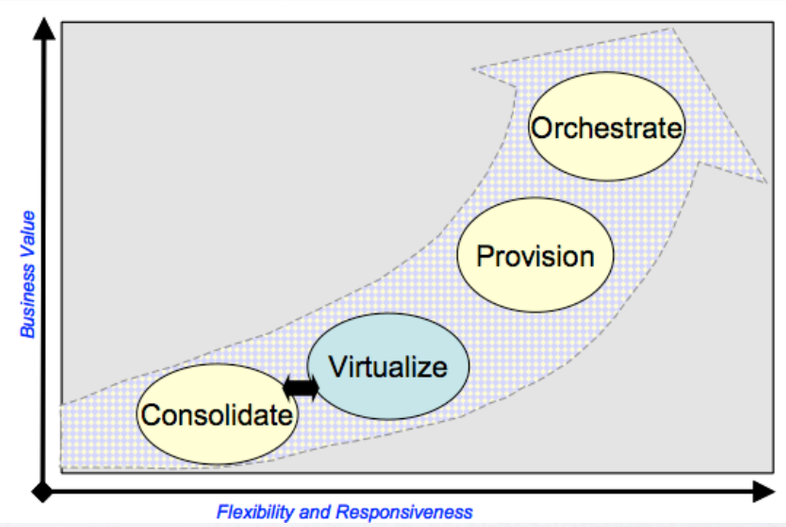
- Total Cost of Ownerships
- Return on Investment
- Standardization
- Flexibility
- Availability
- Increased User Density



Required Readings

Web Sites

- IBM Business Virtualization Portal at www-03.ibm.com/systems/virtualization
- Workstation Virtualization - www-03.ibm.com/systems/virtualization/infrastructure/client
- Server Virtualization - www-03.ibm.com/systems/virtualization/infrastructure/server/index.html
- Application Virtualization - www-03.ibm.com/systems/virtualization/infrastructure/application
- Storage Virtualization - www-03.ibm.com/systems/virtualization/infrastructure/storage



Papers

- IBM Virtualization Services [*pdf*]
- Virtualization Values [*pdf*]

Interactive Feature

- IBM Virtualization Services http://idc.cycloneinteractive.net/ibmvirtual/ (It's Flash, so don't try it on an iOS device.)

Optional Readings

Websites

- The future of Virtualization Technology- http://www.ece.neu.edu/conf/isca2006/docs/Herrod-keynote.pdf
- Global Virtualization and Cloud Computing portal- http://www.virtualization.net/
- Virtualization for small business: Where's the pay-off? http://www.channelregister.co.uk/2010/11/09/smb_virtualization/
- Intel Forms Open Data Alliance to Push Cloud Computing - http://www.pcmag.com/article2/0,2817,2371621,00.asp

Papers

- IBM Redbook: The Green Data Center: Steps for the Journey [*pdf*]
- Optimizing Enterprise IT Infrastructure through Virtual Server Consolidation- [pdf]
- Service Engineering: Linking Business and IT [pdf]
- High Performance and Scalable I/O Virtualization via Self-Virtualized Devices- [pdf]
- Network Virtualization: State of the Art and Research Challenges- [pdf]

Self-test

What does virtualization support?

How does virtualization help your business to be more agile?

How does virtualization help business resiliency?

What are virtual machines?

What is a hypervisor?

What are common uses of server virtualization?

Give three (3) ways a network adapter be configured?

What is the difference among those three ways?

Self-test Answers

What does virtualization support?

- It supports everything which requires servers, storage devices, network devices to ensure highest possible utilization.

How does virtualization help your business to be more agile?

- Helps to consolidate resources, manage workloads, automate processes and to optimize delivery of services.

How does virtualization help business resiliency?

- Help to keep applications running through server, storage and application failures. Less physical machines to restore.

What are virtual machines?

- They can run their own OS as though it were running on a dedicated computer. It can support multiple OS's on a single computer.

What is a hypervisor?

- A tiny software layer that sits very close to the "bare metal" hardware, it divides the hardware into pieces and make it visible for logical partitions so that the virtual machines see only the hardware they have been assigned.

Self-test Answers

What are common uses of server virtualization?

- It is used to reduce hardware costs, server clustering and improved disaster recovery, ability to create specialized servers to run different services, and to reduce server sprawl.

Give three (3) ways a network adapter be configured?

- Local, bridged or shared(NAT).

What is the difference among those three ways?

- Bridged is when the virtual NIC communicates with the physical network by using the host computer's NIC. Shared allows access to outside networks yet isolates the VM, preventing it from sending and receiving packets across the physical network. Local, it's emulated NIC is plugged into a virtual switch.

Discussions

How does virtualization support cloud computing?

Think about an online class about Virtualization and Cloud Computing. (I'm writing one.) Please help me out by making two lists:

- Which topics or areas are you **most** interested in?
- Which topics or areas are you **least** interested in?

You've been doing great all class, so I don't have to tell you to remember our discussion expectations and guidelines.

Acknowledgements

A fair amount of the material contained herein is adapted from **Hands-On Virtual Computing** by Ted Simpson and Jason Novak.

- Published by Course Technology | Cengage Learning, 2010
- ISBN-13: 9781435481008

Some of the earlier source material in this module came from the IBM World Wide Client Technology Centers's very own Frank De Gilio.

More additional material from:

- IBM Virtualization Portal at www-03.ibm.com/systems/virtualization/ and the may sub-sites found there.
- IBM PowerVM Wiki at www.ibm.com/developerworks/wikis/display/virtualization/Home
- IBM Redbook: The Green Data Center: Steps for the Journey [*pdf*]
- UMass CS677 Lecture 4, page 18 by Prashant Shenoy

Once again, Alan thanks his student Carley Keefe for her work in making these materials more accurate (and (a little) more tolerable).

Colophon

This work was authored in Keynote by Alan G. Labouseur in July 2010 from his home in Pleasant Valley, NY.

He still feels somewhat lost in space.

Distractions that made writing slower:

- The Classic Lost in Space project at Sci-Fi meshes at www.scifi-meshes.com
  - Specifically, “Avian” who rendered these control panels. That’s some cool virtualization instrumentation / HMC.
- “Manhattan Transfer” by John E. Smith

Music that made writing faster:

- iTunes Genius Mixes: Funk / Smooth Jazz / Blues
- Specific artists: Chickenfoot / Nils Landgren / Billy Ward and the Dominoes / Brian Bromberg / Lionel Hampton