Systems Administration

Introduction to Virtualization

Objectives

- To revise the core concepts
- To ensure we are using the same terminology

What is it?

- Virtualization -- the abstraction of the a resource from the actual physical instance of that resource.
- What Computing/Network resources can be virtualized?
  - Virtually anything! :)

Anything?

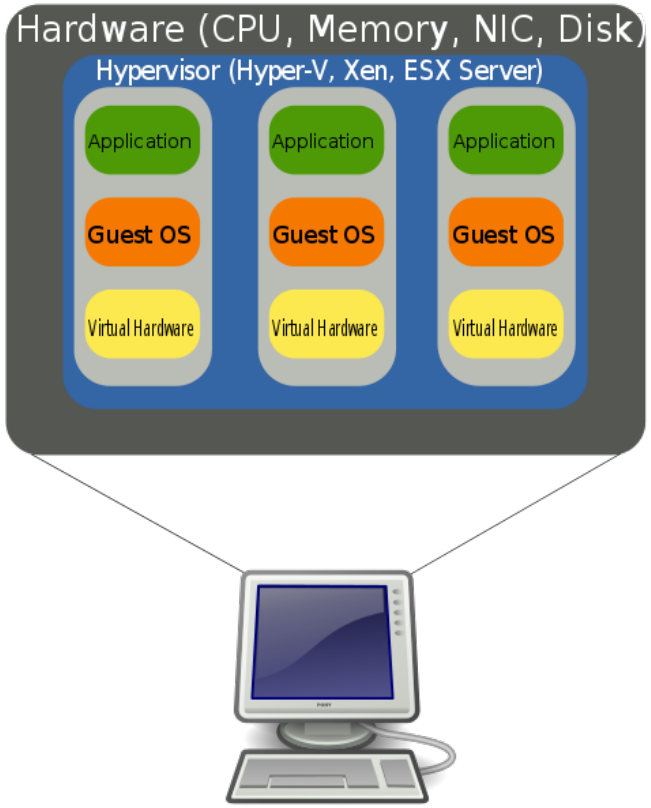
- In the context of this course. We're interested in virtualization along two dimensions:
  - Services
  - Hosts

Resource/Service virtualization

- Examples:
  - Load-balancers
  - DNS Based GLB
  - HTTP(S) Virtual Hosting
  - MX records
  - Virtual Switches
  - Virtual Routers
  - Virtual Firewalls

Host Virtualization

- Examples
  - Vmware
  - Virtual-Box (used in class)
  - KVM
  - XEN
  - FreeBSD and Linux Jails
  - Windows Hyper-V
  - Solaris Zones



What problem are we attempting to solve with host virtualization.

- Problem 1 – Idle capacity.
  - Most of the machines in your datacenter are idle most of the time.
  - Capacity you're not using:
    - Cost money up front
    - Cost money to operate
    - Reduces you return on capital
  - Packing discreet systems into a smaller number of servers provides savings along virtually every dimension.

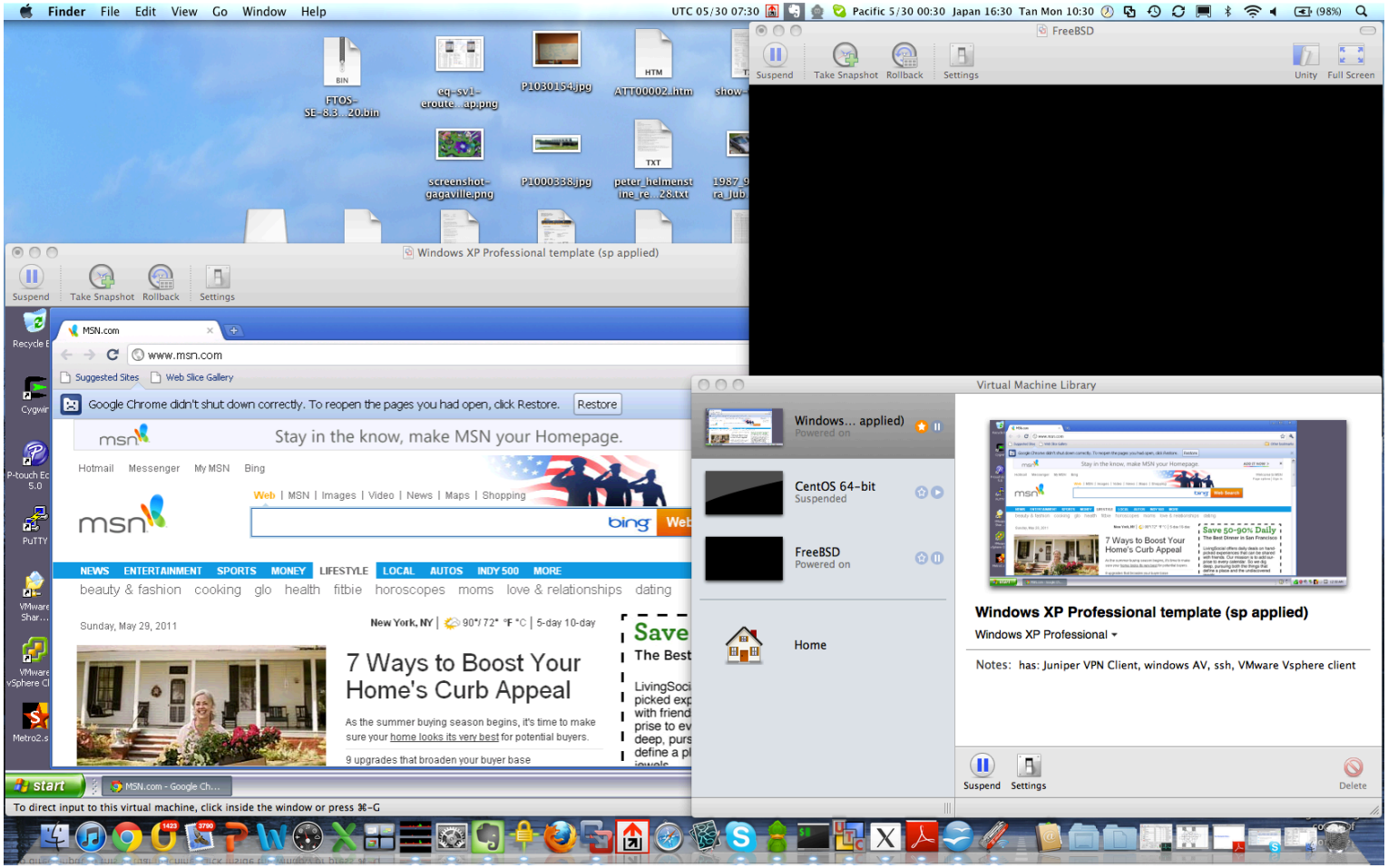
Problems - Continued

- Problem 2 – Provisioning
  - Spinning up a new service involves:
    - Acquiring the hardware
    - Building the server
    - Integration with existing services
  - With virtualization we're aiming to short-circuit that
    - Capacity is a resource
    - Machine instances my be cloned or provisioned from common basic images
    - Resources are purchased in bulk and assigned to applications as necessary

Problems - Continued

- Problem 3 – Hardware abstraction
  - Operating systems, servers, and applications evolve at different rates.
  - Providing a common set of infrastructure resources means, virtualized systems are portable across servers
  - Hardware failure can more easily be managed.

Examples – Desktop Virtualization



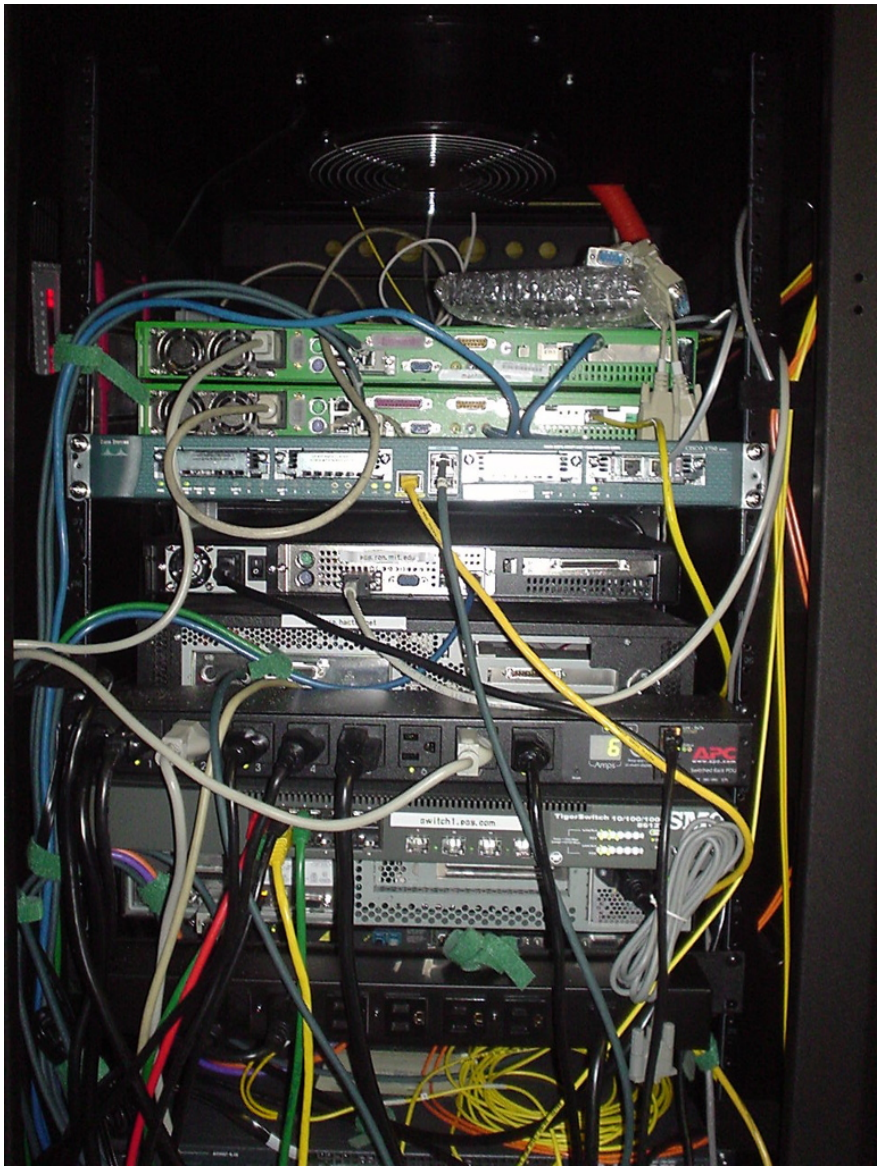
Desktop Virtualization

- Uses
  - Prototyping services or applications before deployment
  - Utilities that don't run on your operating system
  - Isolation of sandbox environments from your desktop
  - Maintaining multiple versions of an environment for support purposes.
  - Staying familiar with unix while running windows (consider compared to the alternative (dual-booting)
- Issues
  - Emulating multiple computers on your laptop/desktop is somewhat resource intensive
- Vmware player and VirtualBox are free.
  - http://www.virtualbox.org/wiki/Downloads
  - http://downloads.vmware.com/d/info/desktop_downloads/vmware_player/3_0?ie=UTF-8&q=vmwareplayer

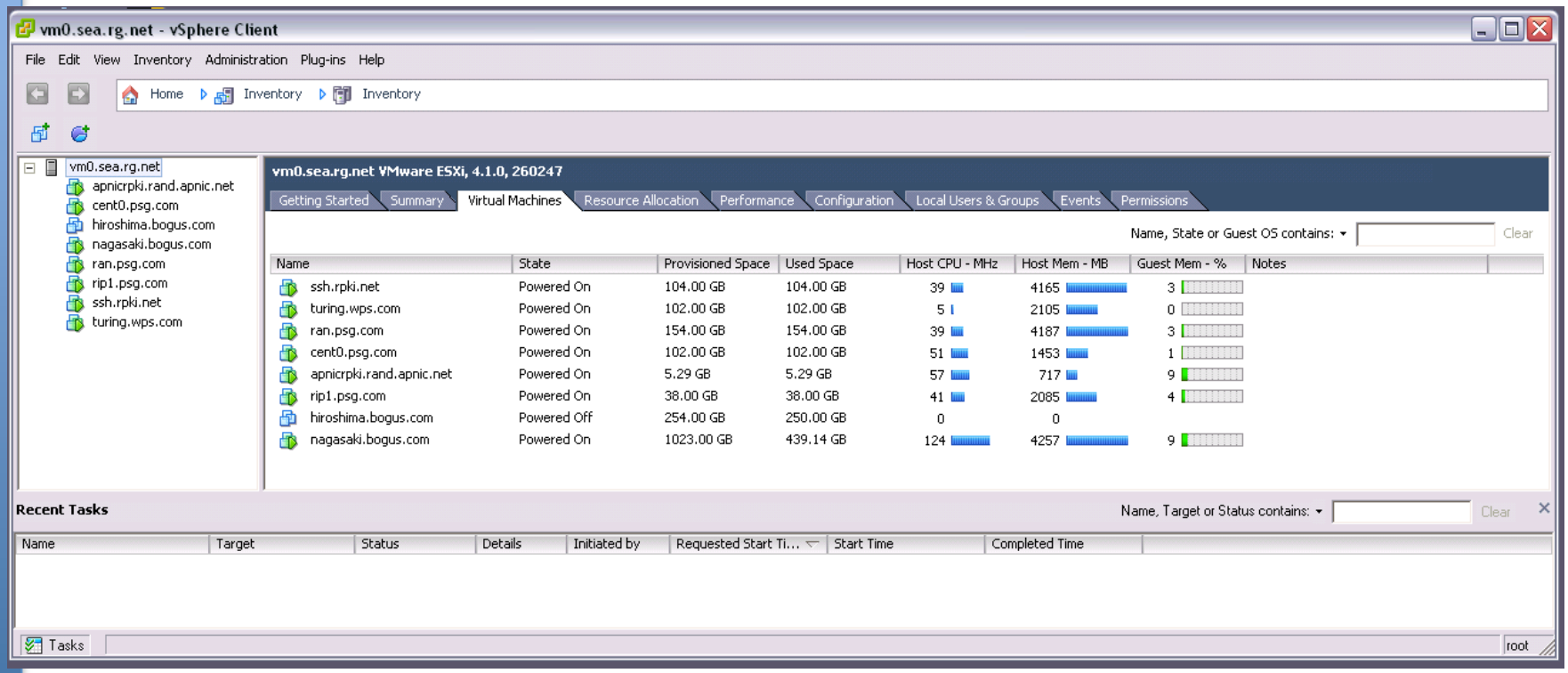
VirtualBox Extensions

- VMWare has similar “VMWare Guest Tools”
- These are extra drivers installed in the guest to support added functionality from within the VM
- VirtualBox Extension Pack adds:
  - USB 2.0 Support
  - RDP Support (remote desktop)
  - RDP Remote Media via local USB
  - PXE Boot Support

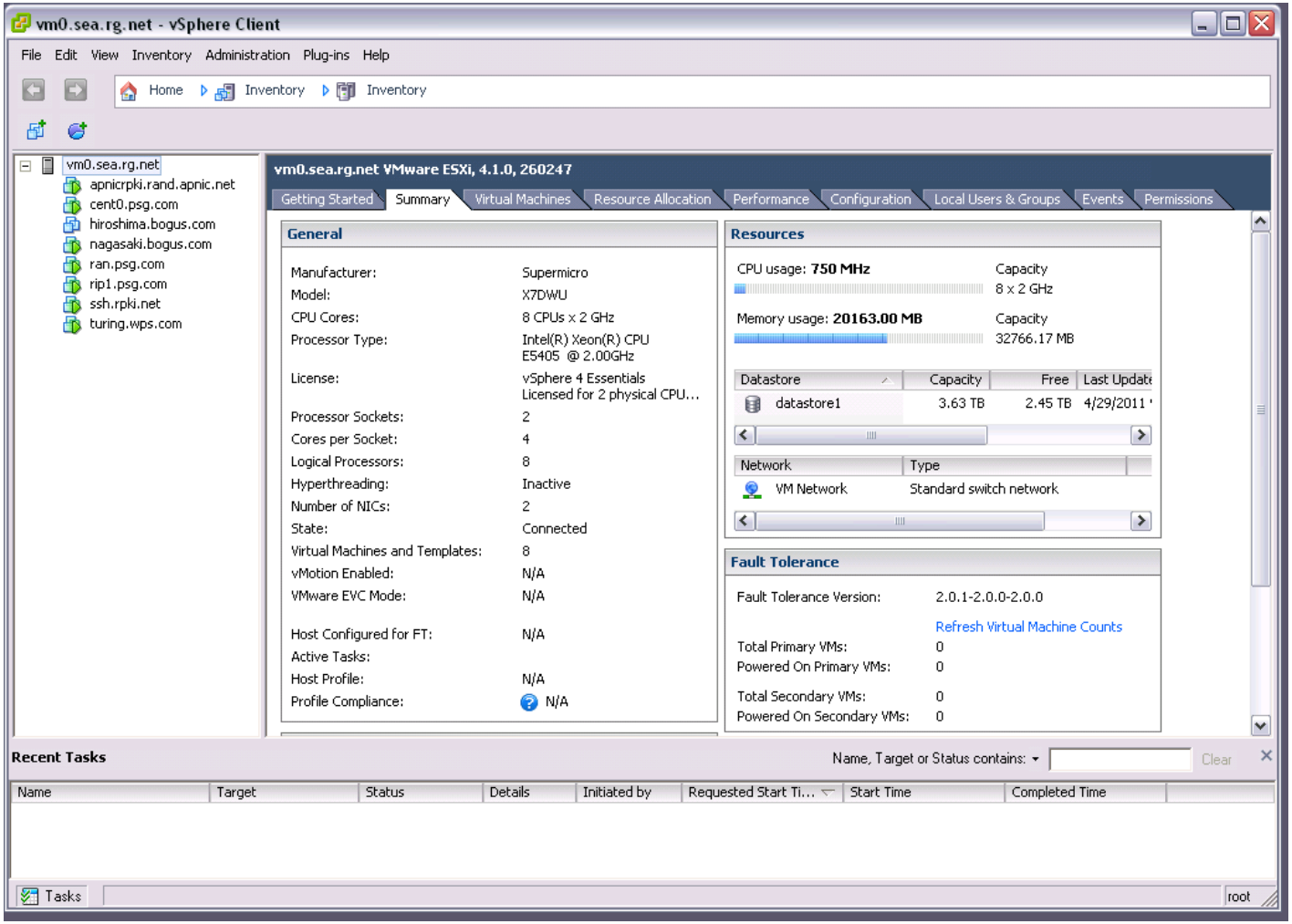
Examples – Server Virtualization



Server Virtualization - Continued



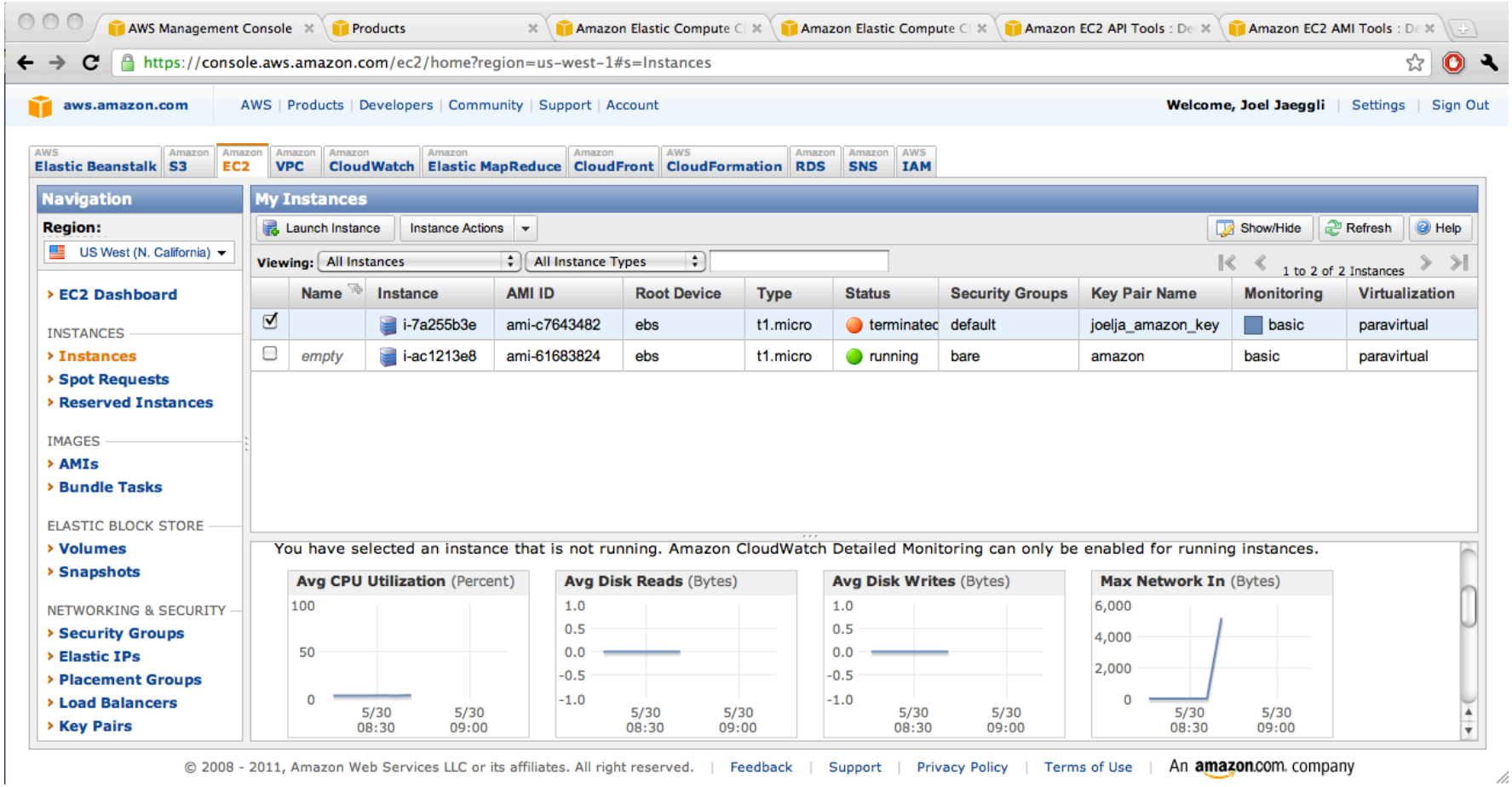
Server Virtualization



Virtualized Servers as a Service (Amazon Web Services)

- Much as colocated servers, are available from a hosting provider, virtual servers are also available.
- Model is:
  - You pay for what you use.
  - Flexibility, need fewer servers today then you used, yesterday.
  - Leverage other amazon tools (storage/map-reduce/load-balancing/payments etc)

AWS


AWS Management Console
Products
Amazon Elastic Compute C
Amazon Elastic Compute C
Amazon EC2 API Tools : De
Amazon EC2 AMI Tools : De
https://console.aws.amazon.com/ec2/home?region=us-west-1#s=Instances
aws.amazon.com
AWS | Products | Developers | Community | Support | Account
Welcome, Joel Jaeggli | Settings | Sign Out
Elastic Beanstalk
S3
EC2
VPC
CloudWatch
Elastic MapReduce
CloudFront
CloudFormation
RDS
SNS
IAM
Navigation
Region:
US West (N. California)
EC2 Dashboard
INSTANCES
Instances
Spot Requests
Reserved Instances
IMAGES
AMIs
Bundle Tasks
ELASTIC BLOCK STORE
Volumes
Snapshots
NETWORKING & SECURITY
Security Groups
Elastic IPs
Placement Groups
Load Balancers
Key Pairs
My Instances
Launch Instance
Instance Actions
Show/Hide
Refresh
Help
Viewing: All Instances
All Instance Types
1 to 2 of 2 Instances
Name
Instance
AMI ID
Root Device
Type
Status
Security Groups
Key Pair Name
Monitoring
Virtualization
i-7a255b3e
ami-c7643482
ebs
t1.micro
terminatec
default
joelja_amazon_key
basic
paravirtual
empty
i-ac1213e8
ami-61683824
ebs
t1.micro
running
bare
amazon
basic
paravirtual
You have selected an instance that is not running. Amazon CloudWatch Detailed Monitoring can only be enabled for running instances.
Avg CPU Utilization (Percent)
Avg Disk Reads (Bytes)
Avg Disk Writes (Bytes)
Max Network In (Bytes)
5/30 08:30
5/30 09:00
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AWS Steps

- Select availability zone
- Launch new instance
- Select appropiate ami
- Associate with ssh key
- Launch instance
- Add ip
- SSH into new machine instance.
- t1-micro-instances run $54 a year + bandwidth

Try it for free...

- Free tier for the first Calender year is (per month):
  - 750 hours of EC2 running Linux/Unix Micro instance usage
  - 750 hours of Elastic Load Balancing plus 15 GB data processing
  - 10 GB of Amazon Elastic Block Storage (EBS) plus 1 million IOs, 1 GB snapshot storage, 10,000 snapshot Get Requests and 1,000 snapshot Put Requests
  - 15 GB of bandwidth in and 15 GB of bandwidth out aggregated across all AWS services

AWS - Continued

- For provisioning purposes cli interaction is possible:
  - http://aws.amazon.com/developertools/351
- Along with tools to support the provisioning and destruction of virtual machines.

Provisioning and management

- Is the glue that makes virtualization usable
- In commercial virtualization environments the provisioning/ management toolkits represent the bulk of the licensing cost (VMware) and the secret sauce (VMotion, disaster recovery, backup, etc)
- One end of the spectrum:
  - XEN tools – a collection of perl scripts for spinning http://www.xen-tools.org/software/xen-tools/
  - KVM tools - http://www.linux-kvm.org/page/Management_Tools
- The Other:
  - Rightscale - http://www.rightscale.com/products/advantages/managing-systems-not-servers.php

Supporting Technology

- NIC teaming or Link aggregation
- Network attached storage and network centric filesystems
  - Example NFS
  - Hadoopfs
- Distributed databases
  - Example mysql cluster
  - OracleRAC

QEMU-KVM

- **Qemu Emulator – the foundation of a number of virtualization products (including VirtualBox)**
- **Emulates the Entire Machine Environment**
  - **BIOS**
  - **CPU(s) SMP-capable**
  - **IDE Controller**
  - **NICs, many types**
  - **Graphics**
  - **USB, Sound, Etc.**
- **qemu-img used to generate Virtual Disks**
  - **supports RAW disks, sparse disks, copy-on-write, and VMDK**

QEMU-KVM

- Why Qemu and not VMWare
  - 1) free open-source software
  - 2) supported by Redhat
  - 3) lots of features
  - 4) lots of support tools in development
- Why **NOT** QEMU-KVM
  - 1) documentation can be missing
  - 2) some features are buggy

KVM
http://www.linux-kvm.org

- **KVM (Kernel Virtual Machine)**
- **Kernel modules for accelerating Virtualization**
- **Also provides additional services and I/O functionality**
- **Fully Integrated with current QEMU-KVM Distributions**
- **CPU-Specific, i.e. “kvm_intel” or “kvm_amd”**
- **% cat /proc/cpu | egrep 'vmx|svm'**
- **NOTE: Intel VM Extensions may or may not be enabled in your BIOS by default. Check this before you install a Hypervisor.**

QEMU-KVM

- Can run in a number of display modes:
  - “SDL” VGA Graphics
  - curses” text graphics
  - VNC remote viewing
- Many Network NIC options
  - default is an internal DHCP with NO ICMP support
  - bridged mode support by “virtio” and “tap” interfaces

QEMU Examples

```
qemu -hda /vms/myimg -cdrom /isos/ub10.iso -m 512
qemu -hda img1 -hdb img2 -hdc img3
qemu -hda qemu linux.img \
-net nic,vlan=0 -net tap,vlan=0,ifname=tap0
qemu -hda img.qcow2 -m 512 -daemonize -vnc :5
```

NOTE: the cdrom device can be an ISO file within the Host filesystem, or the Host CDROM drive itself

qemu-img

- qemu-img is the tool used to generate qemu virtual disks
- qcow2 format
  - sparse disk storage
  - copy-on-write (c.o.w.), a.k.a. “snap-shot” support
  - copy-on-write: means freezing a disk image, and using a new file to hold any further writes to that disk. In this way the original disk image is preserved. To roll-back, throw away new file.
- Cabable of reading/converting VirtualBox and VMWare Disks
- Examples:

  qemu-img create myhd.qcow2 6G

  qemu-img convert old.vmdk -O qcow2 newimg

The Qemu Monitor

http://en.wikibooks.org/wiki/QEMU/Monitor

- builtin control console used to jump out of the guest OS and perform operations on the VM
- access with CTRL-ALT-1/CTRL-ALT-2

(Mac uses CTRL-OPT-1/CTRL-OPT-2)

- operations: stop, cont, system_powerdown, change, usb_add, vnc, etc.
- migration: live migration from one site to another

  On site B: % qemu -hda myimg -incoming tcp:0:4444

  On site A: (in monitor) migrate -b tcp:hostB:4444

virsh/virt-manager

- libvirt toolkit – API used to interface with the qemu-kvm (and other vm platforms, xen, etc.)
- provides a uniform interface for controlling VMs
- provides a more consistent management console
- requires user added to groups: kvm, libvirtd
- Examples:

  root/system-level: virsh -c qemu:///system

  user/sessions: virsh -c qemu:///session

  virsh# list -all
- virt-manager: GUI tool for building and controlling VMs

Virtualization - Issues

- “All your eggs in one basket” – a poorly implemented virtual environment can create a large single point of failure
- Virtualization does not magically manufacture additional resources
- High-performance often requires dedicated hardware, ex. 10GB networking, massive Database I/O systems
- Sometimes the virtualized environment does not have all the features of the real one

Virtualization - Summary

- Useful for creating and testing new OS's
- Excellent for creating a dual-head, fully redundant, highly-available set of services with live-migration for failover
- Considerable savings on physical resources: heating, cooling, rack space, etc.
- Copy-On-Write filesystems and Snapshots are useful as for de-duplication and as point-in-time versions of the OS
- Significantly reduces deployment time
- Provides a standard environment for services