Virtualisation Intro

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Based on notes by Joel Jaeggli
For AFNOG SS-E 2014

What is it?

- An abstraction that allows for easy subdivision an allocation of resources
- What Computing/Network resources can be virtualized?
  - OS virtualization
  - Application virtualisation
  - Service virtualisation
  - Network virtualisation
  - Storage virtualisation
  - And much more...

Anything?

- In the context of this course. We're interested in virtualization along two dimensions:
  - Resource virtualisation
  - OS virtualisation

Resource/Service virtualization

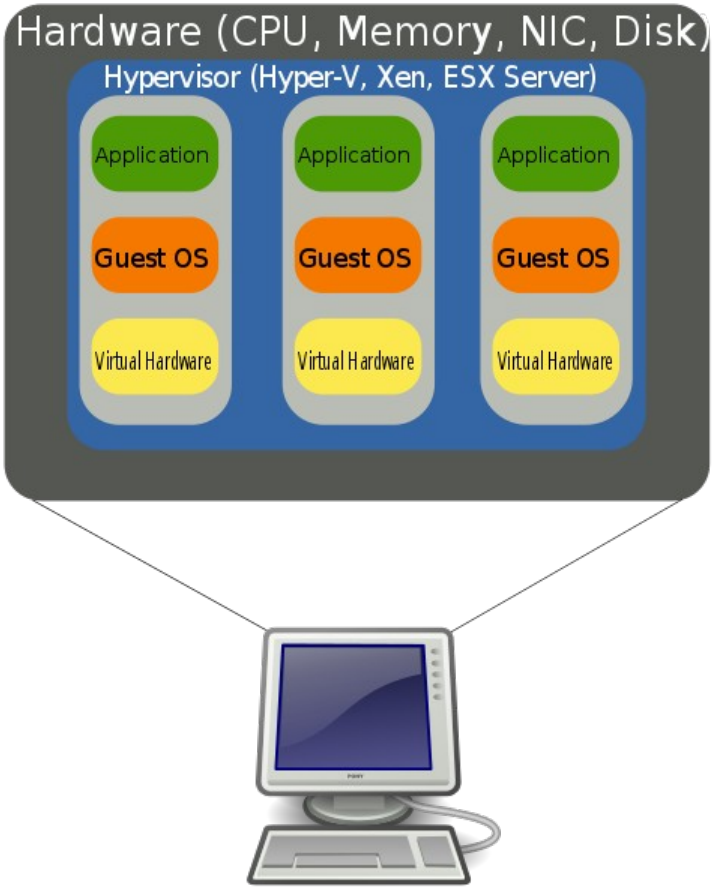
- Examples:
  - Load-balancers
  - DNS Based GLB
  - HTTP(S) Virtual Hosting
  - MX records
  - Virtual Switches
  - Virtual Routers
  - Virtual Firewalls

Resource Virtualization - Continued

- HTTP virtual hosts
  - Multiple websites on one system
- Load Balancing
  - One (or many sites or applications) across many systems
  - Can be done at Layer-3/4/7

Host Virtualization

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



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 discrete systems into a smaller number of servers provides savings along virtually every dimension.

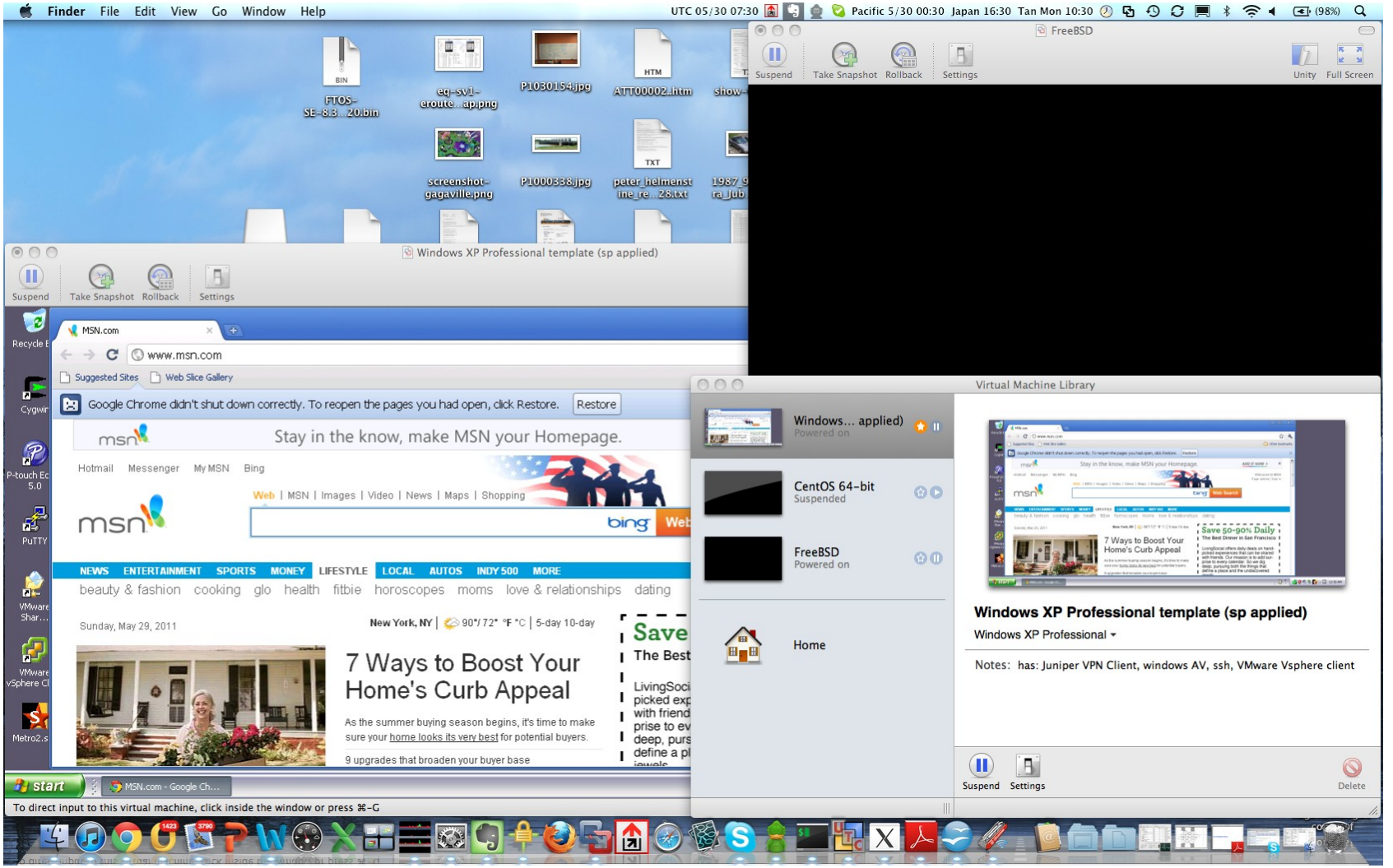
Problems - Continued

- 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.
- Abstraction may come at a performance cost however. (some workloads are more expensive than others)
  - See: http://blog.xen.org/index.php/2011/11/29/baremetal-vs-xen-vs-kvm-redux/

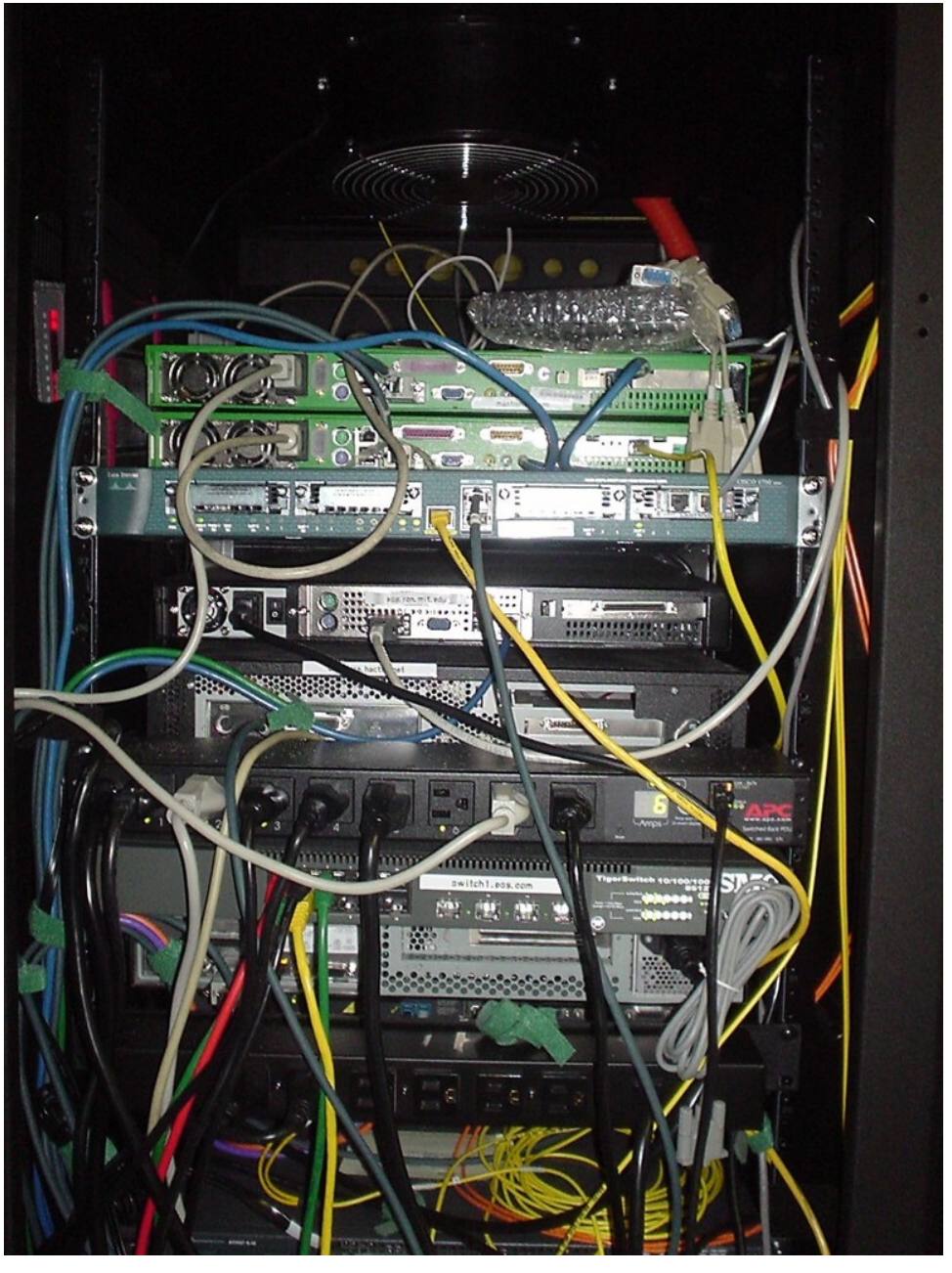
Examples – Desktop Virtualization



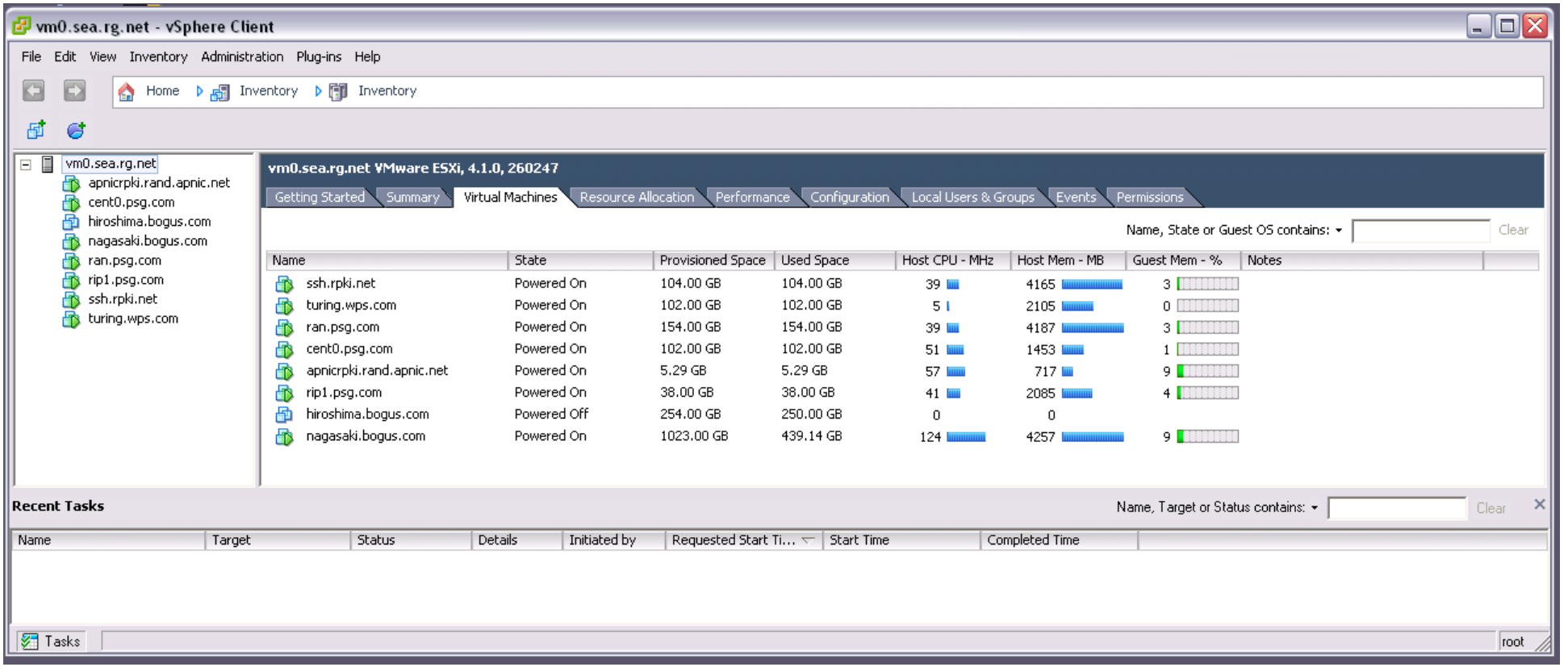
Desktop Virtualization

- 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-

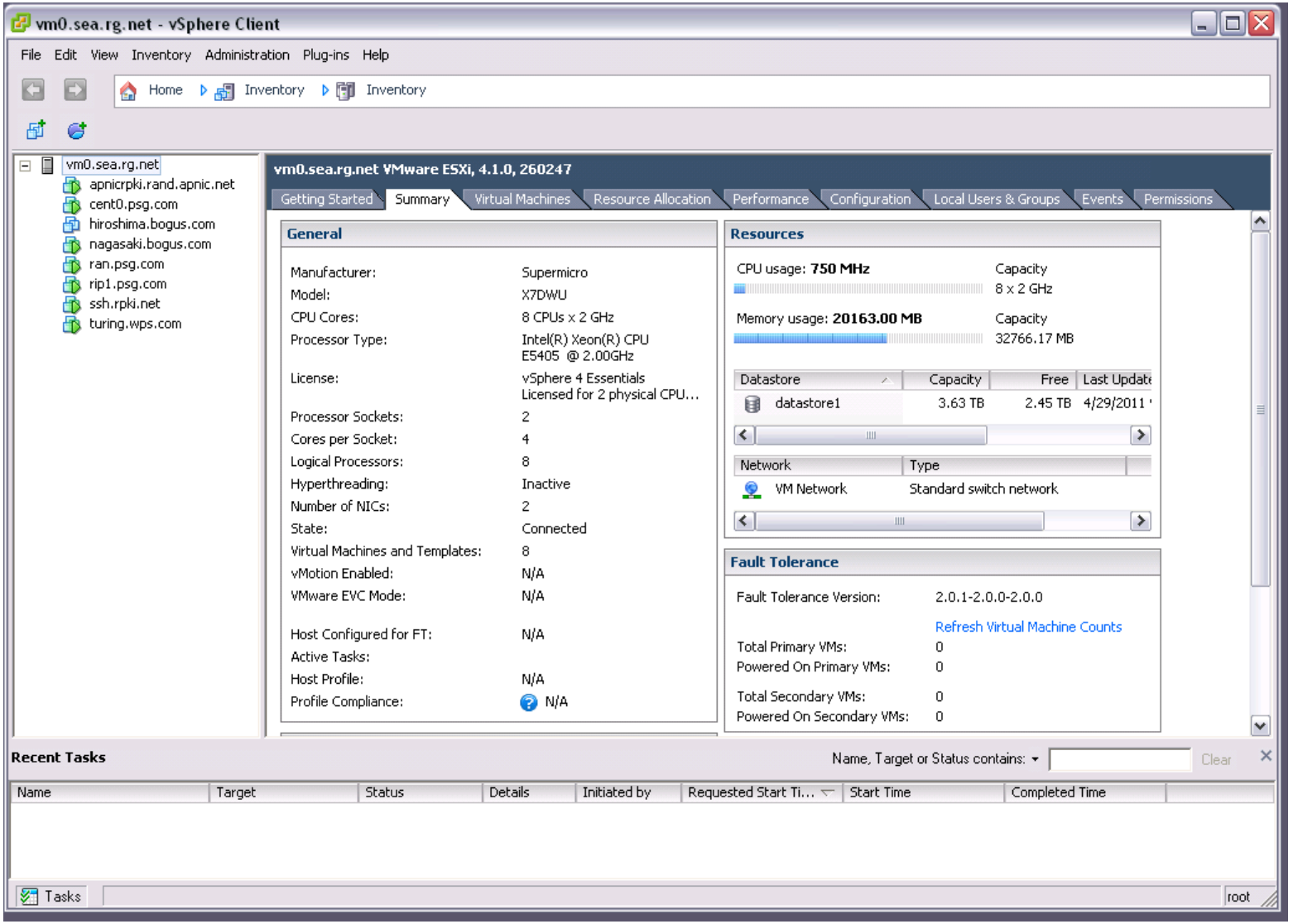
Examples – Server Virtualization



Server Virtualization - Continued



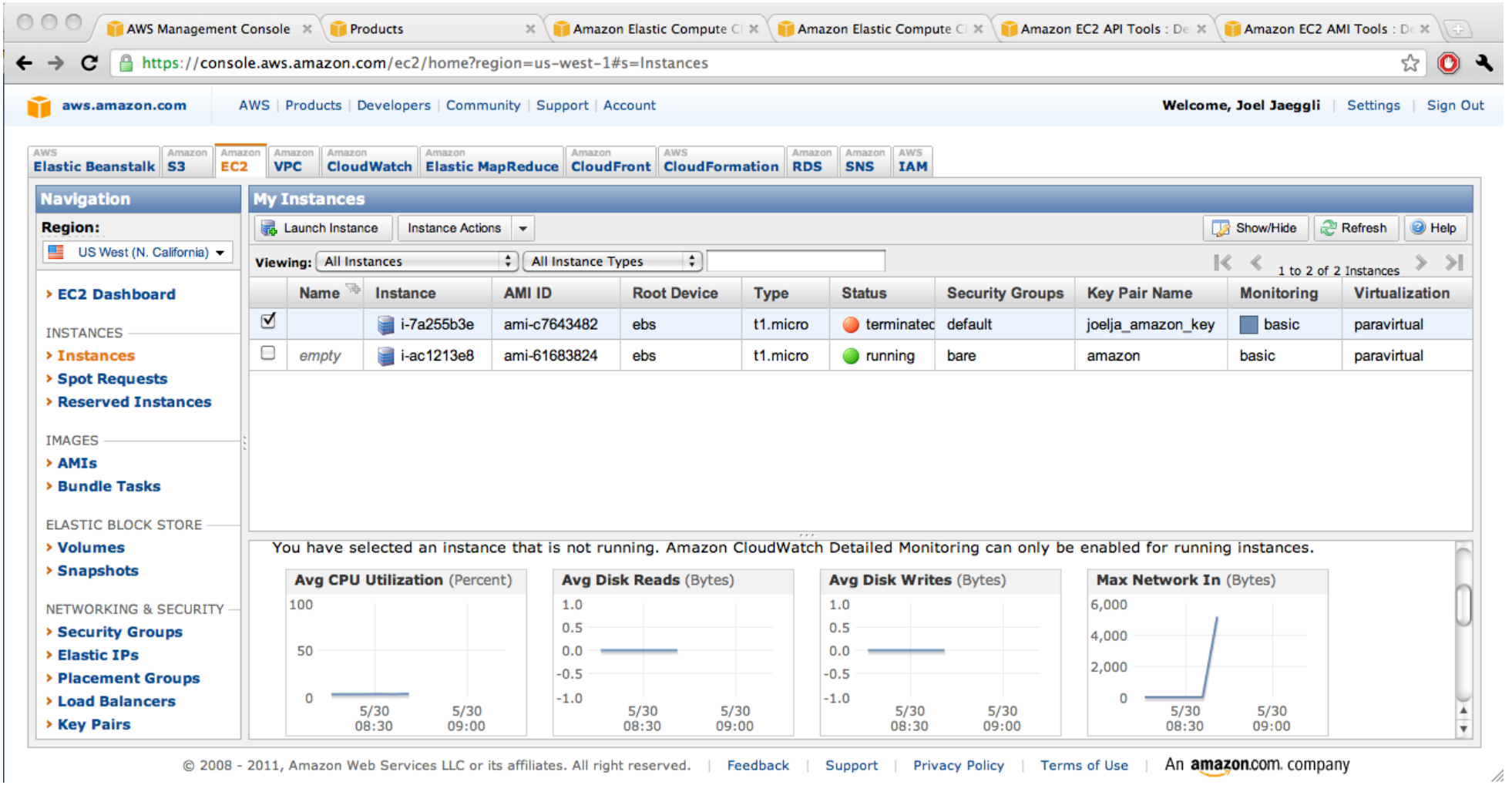
Server Virtualization



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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Feedback
Support
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Terms of Use
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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
- Which is not to say that, at scale EC2 is particularly cheap, (It isn't)
  - Limited capital at risk is in the context of prototyping or experimentation however.

AWS - Continued

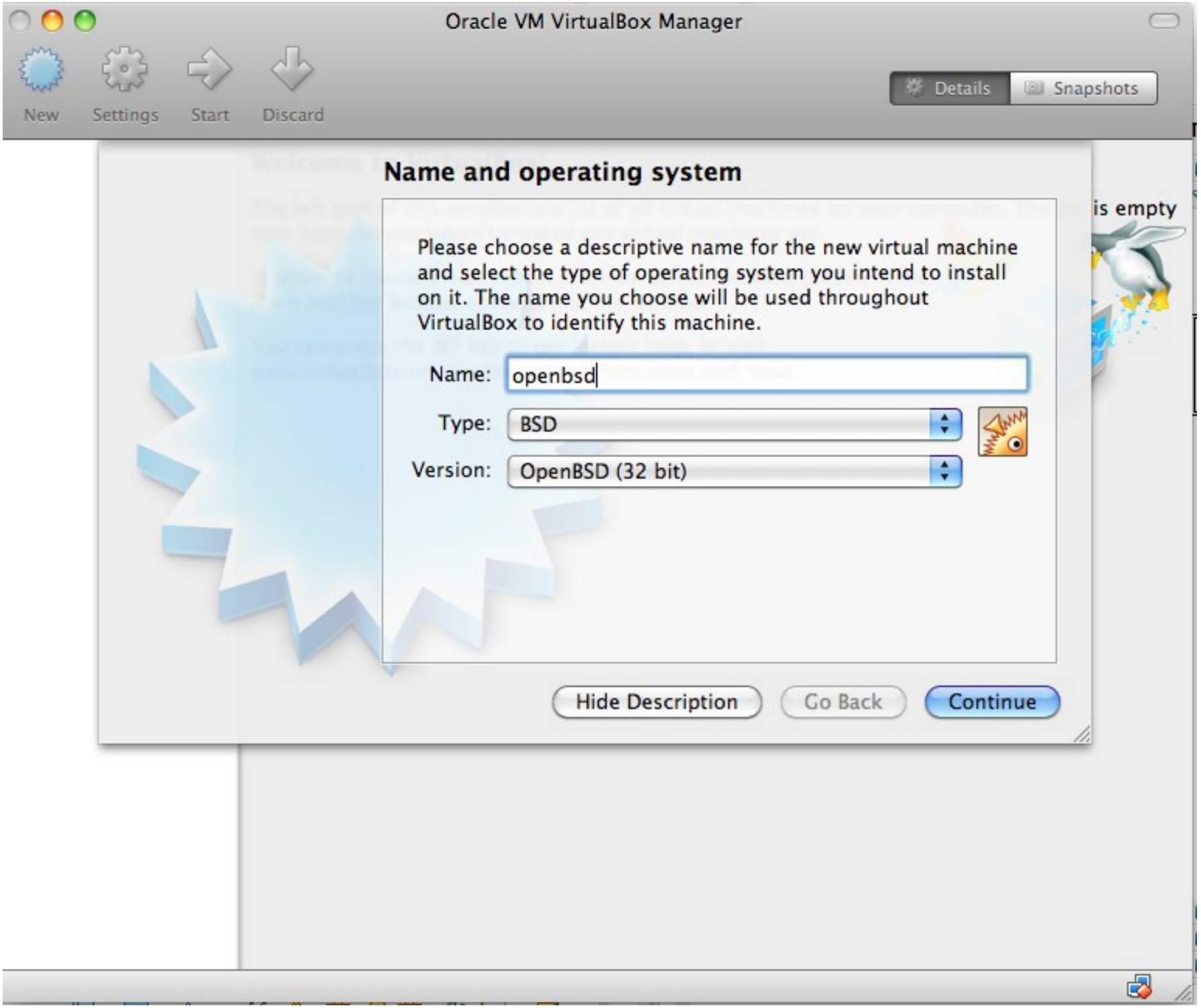
- For provisioning purposes cli interaction is possible:
  - http://aws.amazon.com/developertools/351
- Along with tools to support the provisioning and destruction of virtual machines.

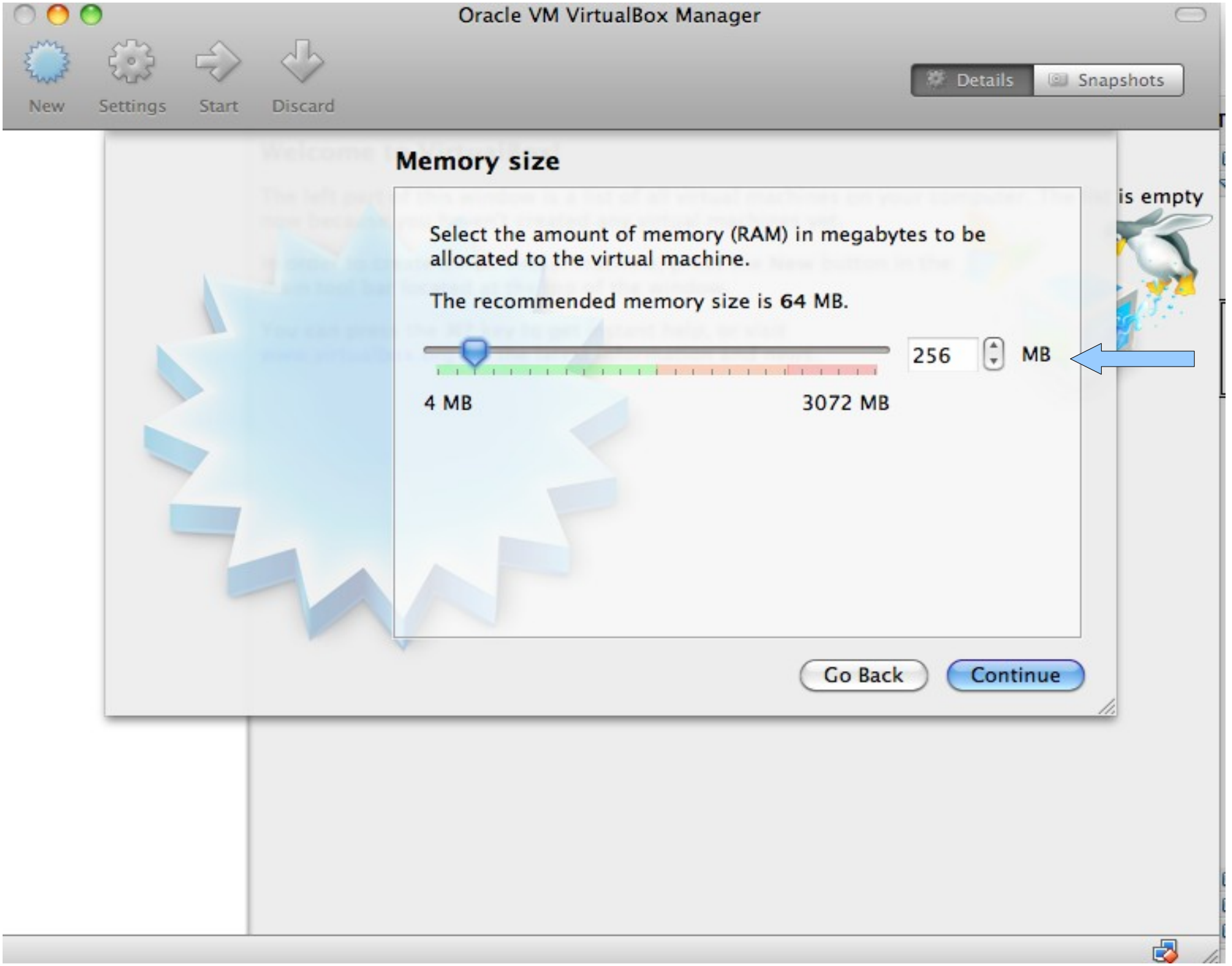
Provisioning and management

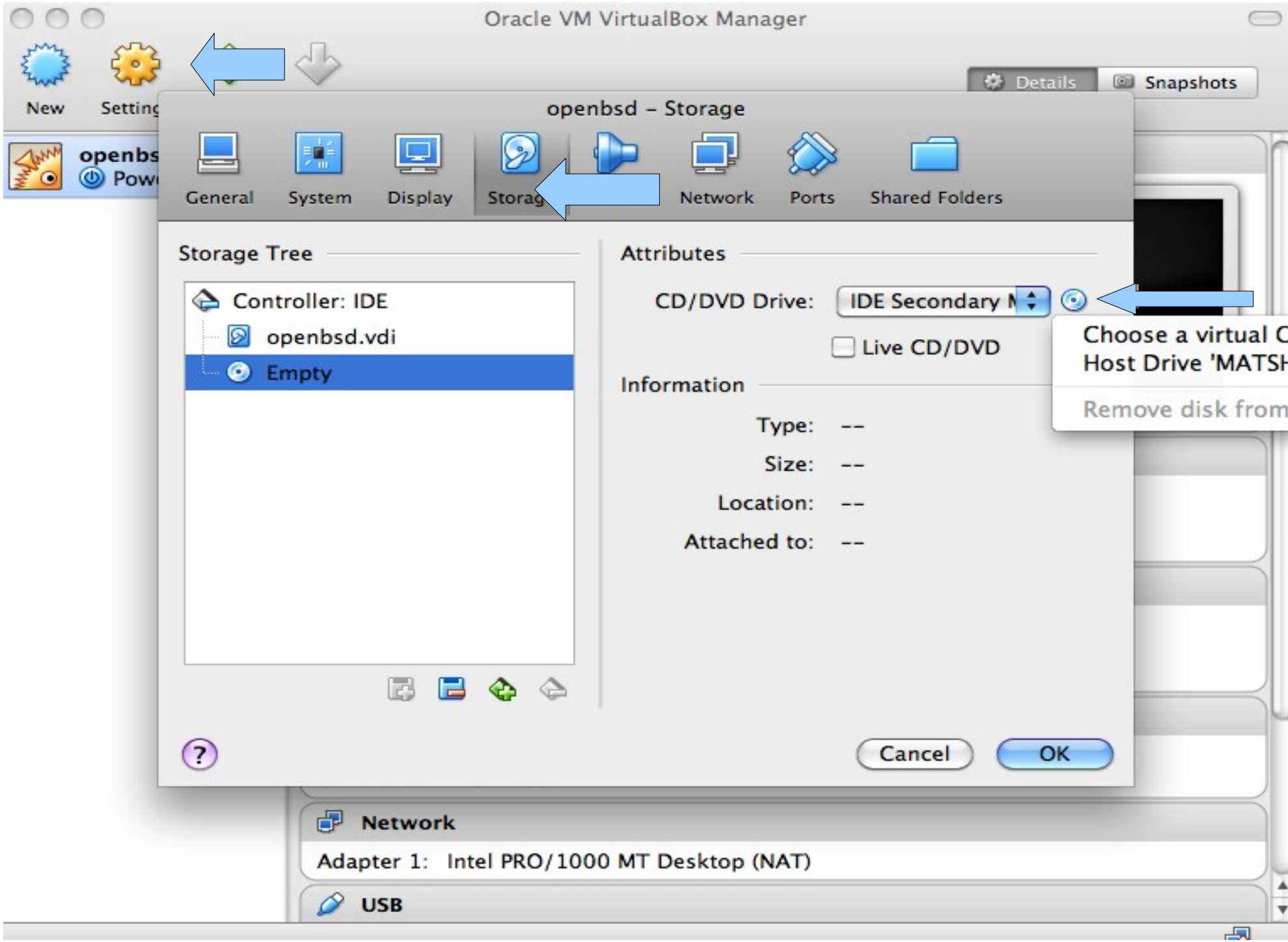
- Is the glue that makes virtualization usable
- In commercial virtualization environments the provisioning/management toolkits represent the bulk of the licensing cost (VMware) and the secret sauce (VMotion, disaster recovery, backup, etc)
- Examples:
  - XEN tools – a collection of perl scripts for spinning VMs http://www.xen-tools.org/software/xen-tools/
  - KVM tools - http://www.linux-kvm.org/page/Management_Tools
  - Cloud.com/cloud-stack (orchestration) - http://www.cloudstack.org/
  - Rightscale – (orchestration multiple public/private clouds) http://www.rightscale.com
  - Puppet (host / configuration management) - http://puppetlabs.com/puppet/
  - PDSH – (Parallel Shell execution) http://code.google.com/p/pdsh/
  - Salt/chef/ansible/parallel-ssh/libvirt.....

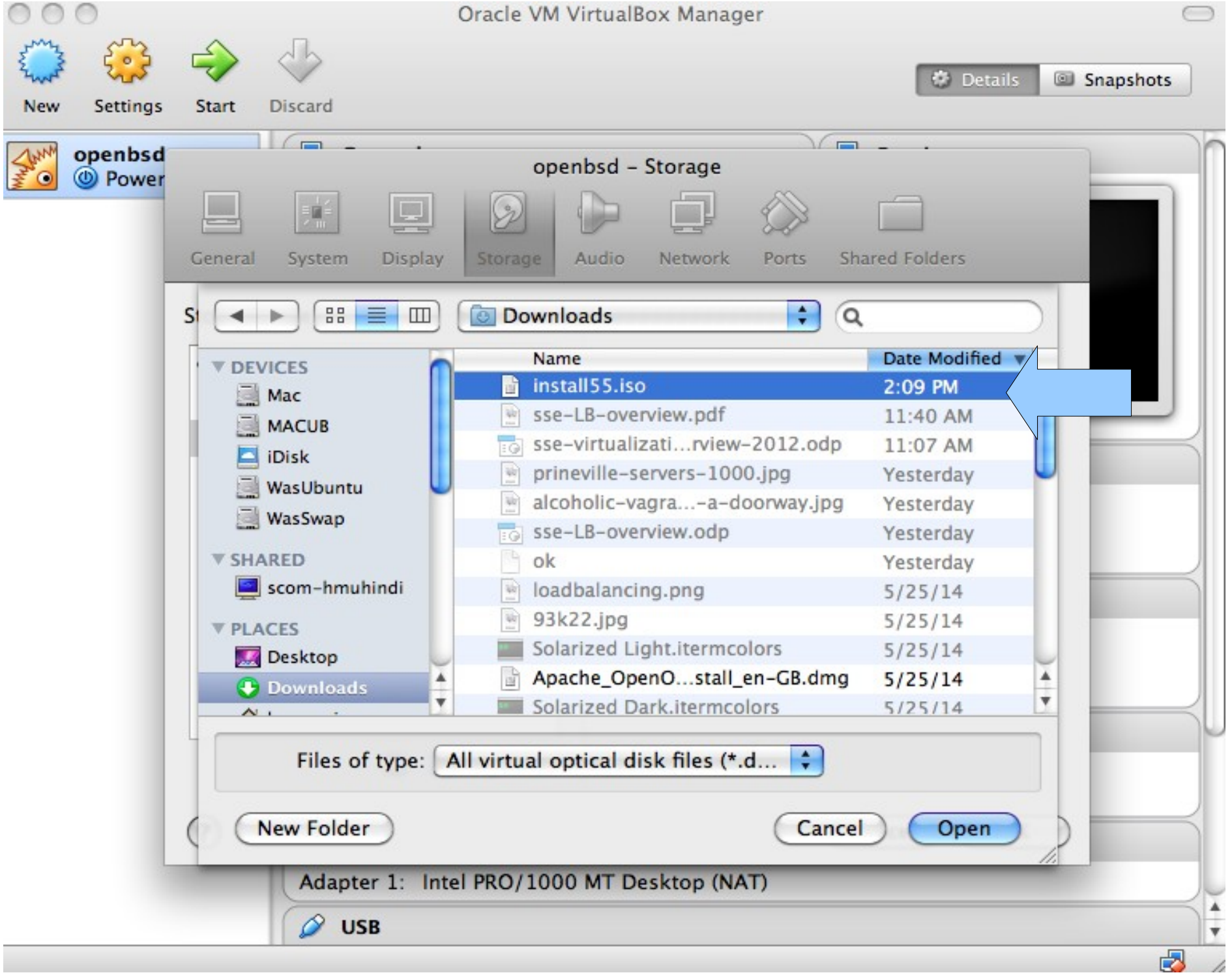
Virtualbox Exercise

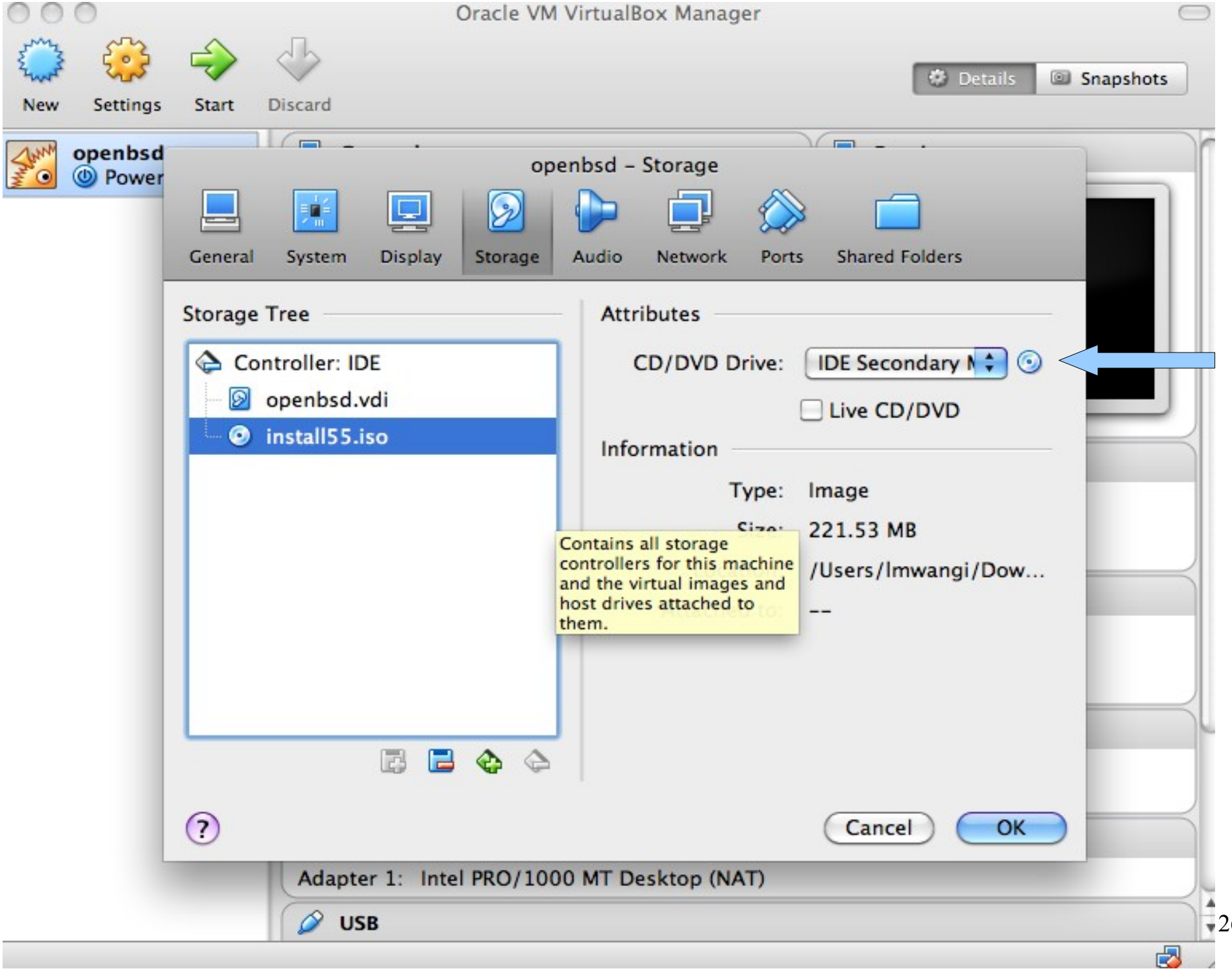
- Download virtualbox and install it.
- Dowload the openbsd install iso.
- Create an openbsd 32bit virtual machine.
- Adjust the virtual machine settings to boot off the iso.
- Install and accept the defaults at the prompts to install OpenBSD.
- After instalation, type reboot and then intercept the reboot by shutting down the vm at the bios stage
- Change boot order in the VM settings (CD last)
- Boot into VM

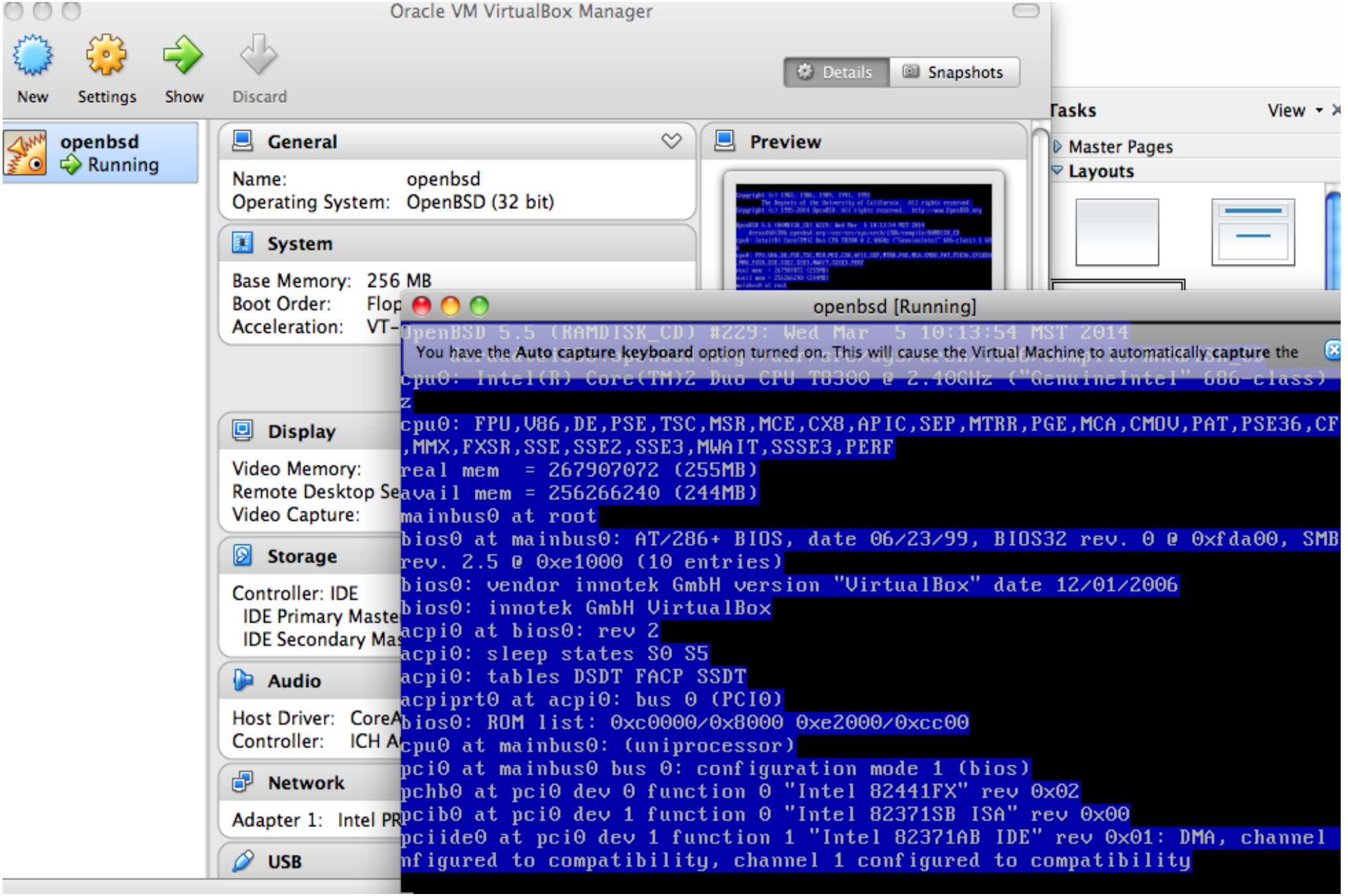

Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
Name and operating system
Please choose a descriptive name for the new virtual machine and select the type of operating system you intend to install on it. The name you choose will be used throughout VirtualBox to identify this machine.
Name:
openbsd
Type:
BSD
Version:
OpenBSD (32 bit)
Hide Description
Go Back
Continue
is empty


Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
is empty
Memory size
Select the amount of memory (RAM) in megabytes to be allocated to the virtual machine.
The recommended memory size is 64 MB.
256
MB
4 MB
3072 MB
Go Back
Continue

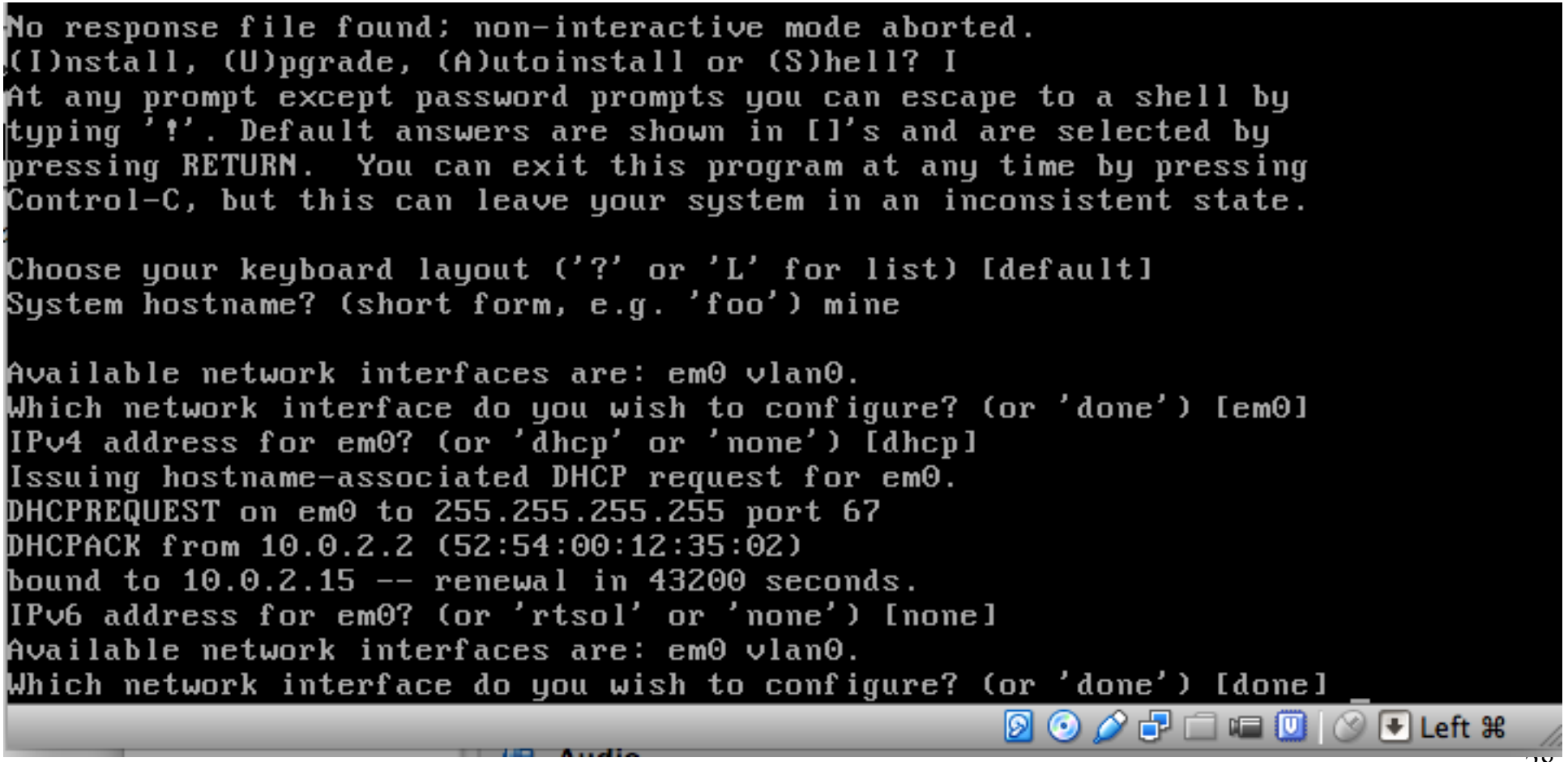

Oracle VM VirtualBox Manager
New
Setting
Details
Snapshots
openbsd – Storage
General
System
Display
Storag
Network
Ports
Shared Folders
Storage Tree
Controller: IDE
openbsd.vdi
Empty
Attributes
CD/DVD Drive:
IDE Secondary M
Live CD/DVD
Information
Type: --
Size: --
Location: --
Attached to: --
Choose a virtual C
Host Drive 'MATSH
Remove disk from
Cancel
OK
Network
Adapter 1: Intel PRO/1000 MT Desktop (NAT)
USB


Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
openbsd
Power
openbsd - Storage
General
System
Display
Storage
Audio
Network
Ports
Shared Folders
Downloads
DEVICES
Mac
MACUB
iDisk
WasUbuntu
WasSwap
SHARED
scom-hmuhindi
PLACES
Desktop
Downloads
Name
Date Modified
install55.iso
2:09 PM
sse-LB-overview.pdf
11:40 AM
sse-virtualizati...rview-2012.odp
11:07 AM
prineville-servers-1000.jpg
Yesterday
alcoholic-vagra...-a-doorway.jpg
Yesterday
sse-LB-overview.odp
Yesterday
ok
Yesterday
loadbalancing.png
5/25/14
93k22.jpg
5/25/14
Solarized Light.itermcolors
5/25/14
Apache_OpenO...stall_en-GB.dmg
5/25/14
Solarized Dark.itermcolors
5/25/14
Files of type:
All virtual optical disk files (*.d...
New Folder
Cancel
Open
Adapter 1: Intel PRO/1000 MT Desktop (NAT)
USB

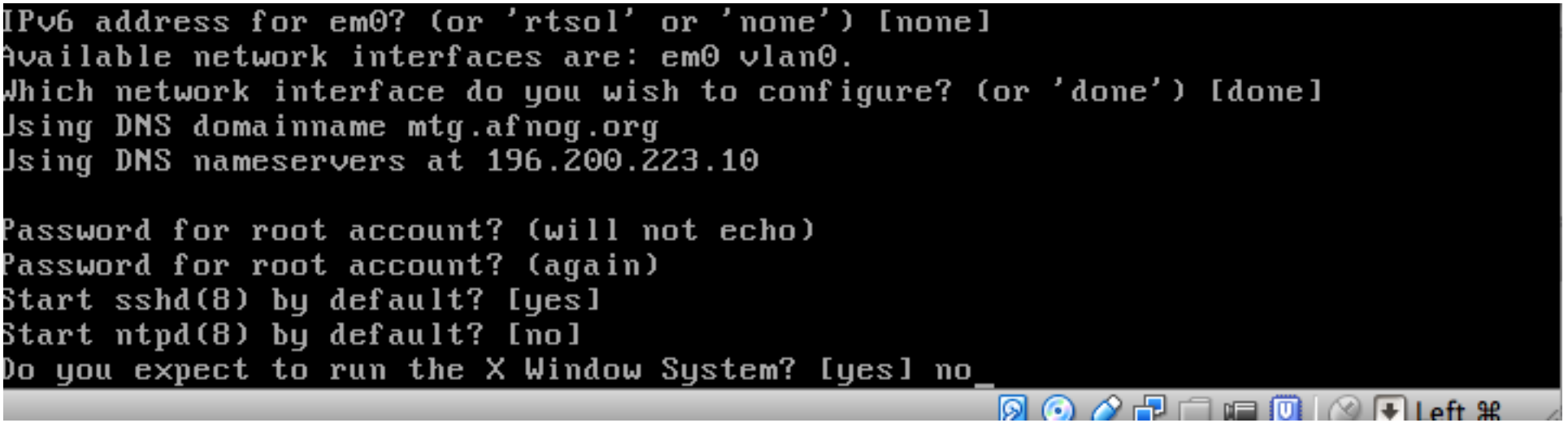

Oracle VM VirtualBox Manager
New
Settings
Start
Discard
Details
Snapshots
openbsd
Power
openbsd – Storage
General
System
Display
Storage
Audio
Network
Ports
Shared Folders
Storage Tree
Controller: IDE
openbsd.vdi
install55.iso
Attributes
CD/DVD Drive:
IDE Secondary M
Live CD/DVD
Information
Type: Image
221.53 MB
/Users/lmwangi/Dow...
--
Contains all storage controllers for this machine and the virtual images and host drives attached to them.
Cancel
OK
Adapter 1: Intel PRO/1000 MT Desktop (NAT)
USB


Oracle VM VirtualBox Manager
New
Settings
Show
Discard
Details
Snapshots
openbsd
Running
General
Name: openbsd
Operating System: OpenBSD (32 bit)
System
Base Memory: 256 MB
Boot Order: Flop
Acceleration: VT-
Preview
Display
Video Memory:
Remote Desktop Se
Video Capture:
Storage
Controller: IDE
IDE Primary Maste
IDE Secondary Ma
Audio
Host Driver: CoreA
Controller: ICH A
Network
Adapter 1: Intel PR
USB
Tasks
View
Master Pages
Layouts
openbsd [Running]
OpenBSD 5.5 (RAMDISK_CD) #229: Wed Mar 5 10:13:54 MST 2014
You have the Auto capture keyboard option turned on. This will cause the Virtual Machine to automatically capture the
cpu0: Intel(R) Core(TM)2 Duo CPU T8300 @ 2.40GHz ("GenuineIntel" 686-class)
z
cpu0: FPU,V86,DE,PSE,TSC,MSR,MCE,CX8,APIC,SEP,MTRR,PGE,MCA,CMOV,PAT,PSE36,CF
,MMX,FXSR,SSE,SSE2,SSE3,MWAIT,SSSE3,PERF
real mem = 267907072 (255MB)
avail mem = 256266240 (244MB)
mainbus0 at root
bios0 at mainbus0: AT/286+ BIOS, date 06/23/99, BIOS32 rev. 0 @ 0xfda00, SMB
rev. 2.5 @ 0xe1000 (10 entries)
bios0: vendor innotek GmbH version "VirtualBox" date 12/01/2006
bios0: innotek GmbH VirtualBox
acpi0 at bios0: rev 2
acpi0: sleep states S0 S5
acpi0: tables DSDT FACP SSDT
acpiprt0 at acpi0: bus 0 (PCI0)
bios0: ROM list: 0xc0000/0x8000 0xe2000/0xcc00
cpu0 at mainbus0: (uniprocessor)
pci0 at mainbus0 bus 0: configuration mode 1 (bios)
pchb0 at pci0 dev 0 function 0 "Intel 82441FX" rev 0x02
pcib0 at pci0 dev 1 function 0 "Intel 82371SB ISA" rev 0x00
pciide0 at pci0 dev 1 function 1 "Intel 82371AB IDE" rev 0x01: DMA, channel
nfigured to compatibility, channel 1 configured to compatibility

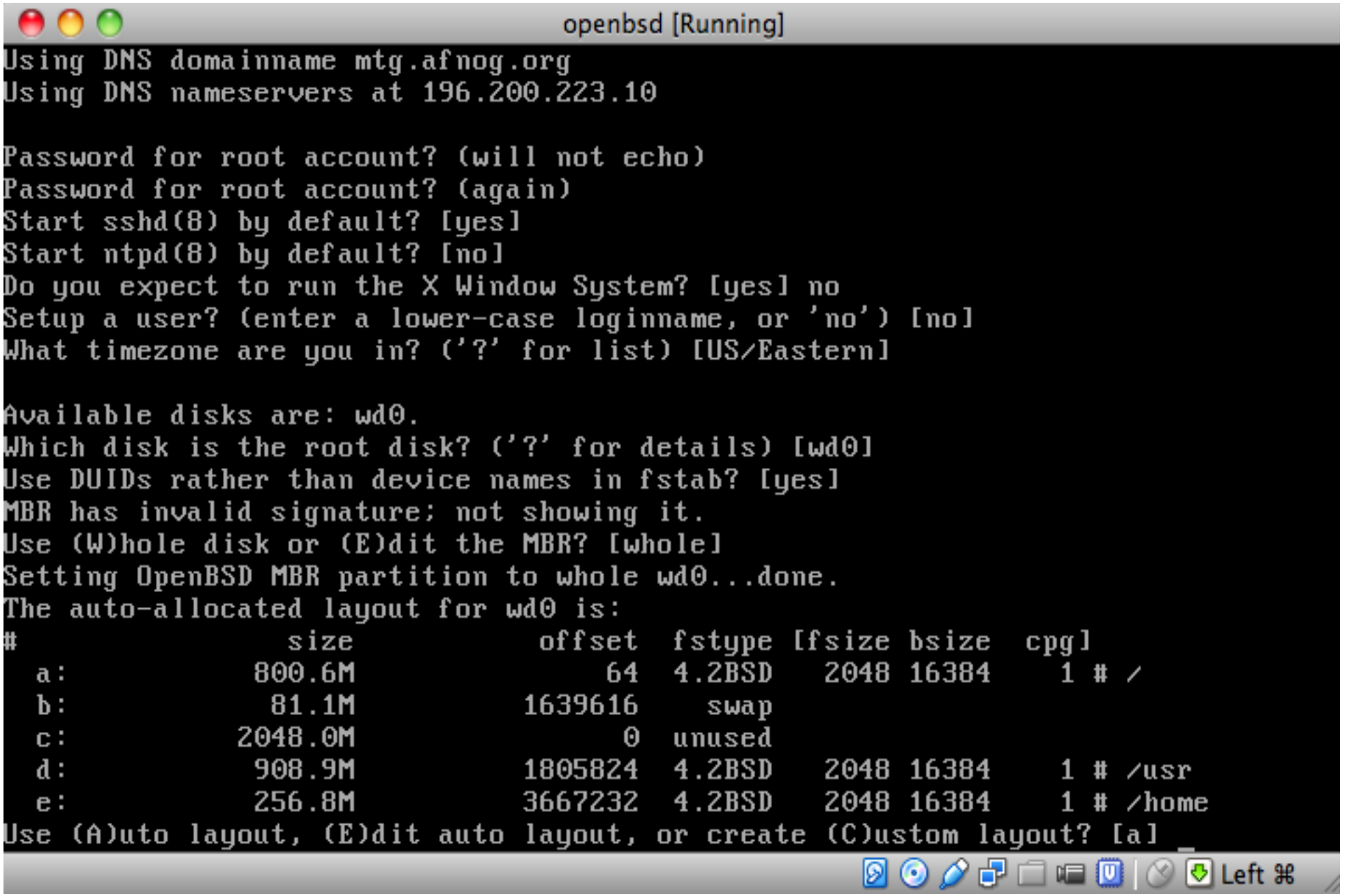
- Choose interactive install (I)
- Choose defaults by pressing <enter> on the prompts below
- Note that we configured the default interface to acquire an address via DHCP



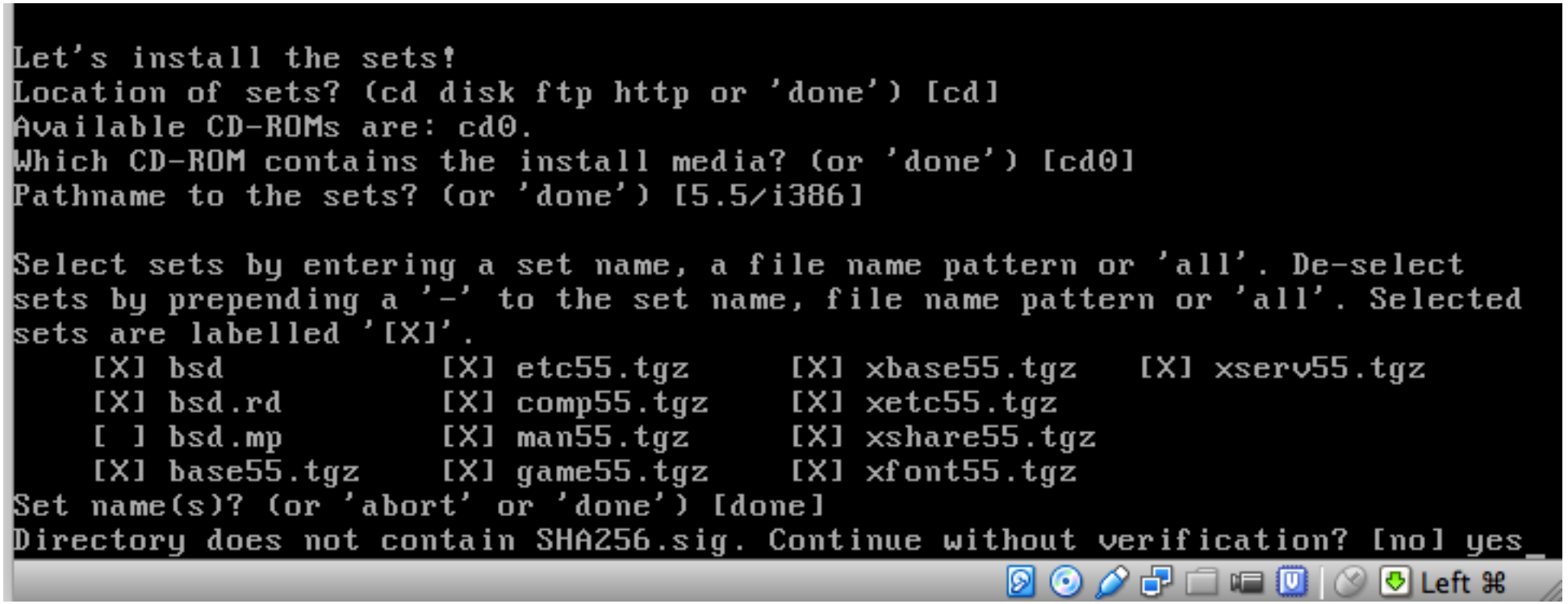
- Elect not to run X windows
- Elect to enable ssh
- Type in a root password (afnog). You will need this password to log in once the installation is complete.



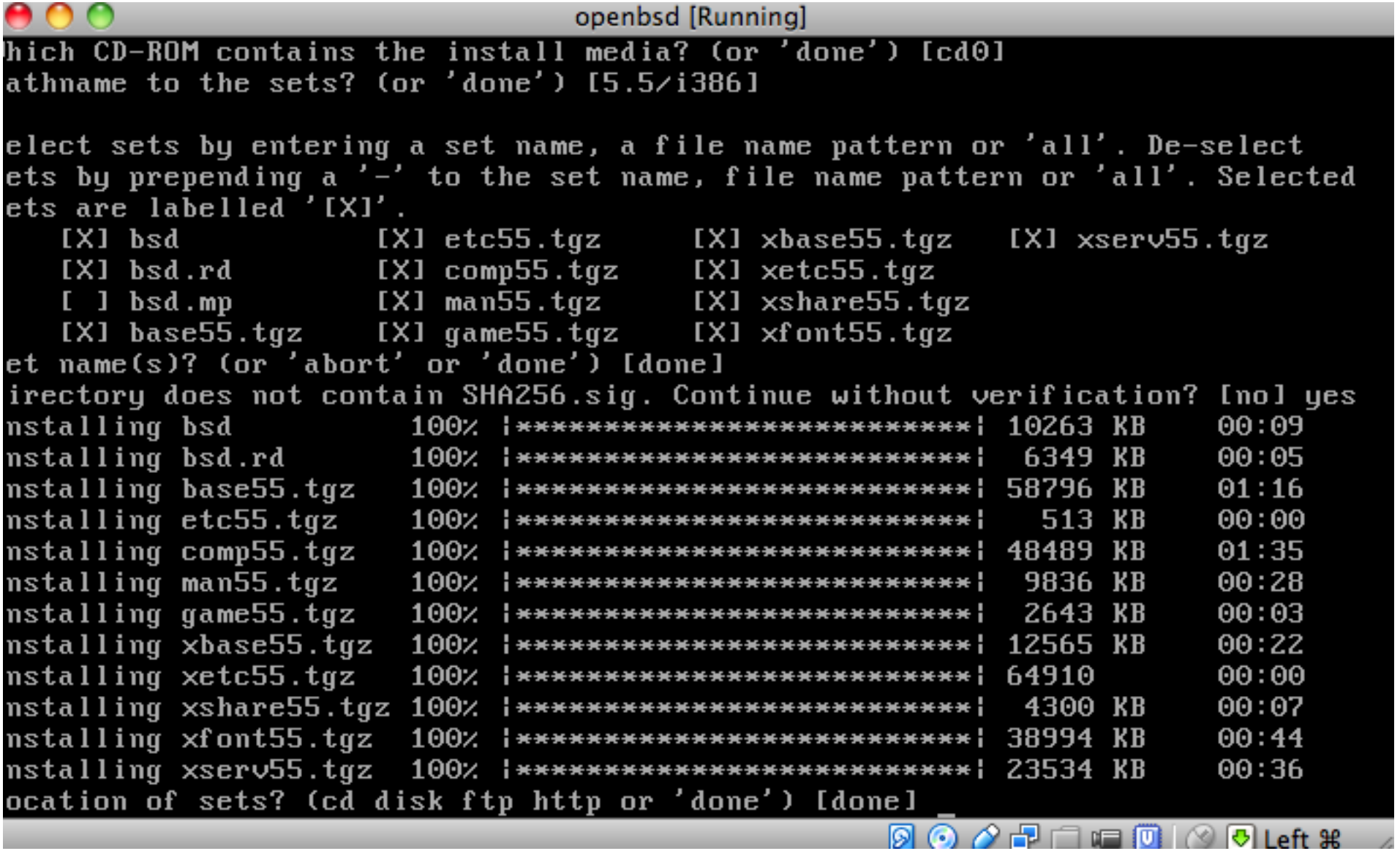
- Auto layout and auto partition...
- Note the resource consumption for OpenBSD is extremely low!



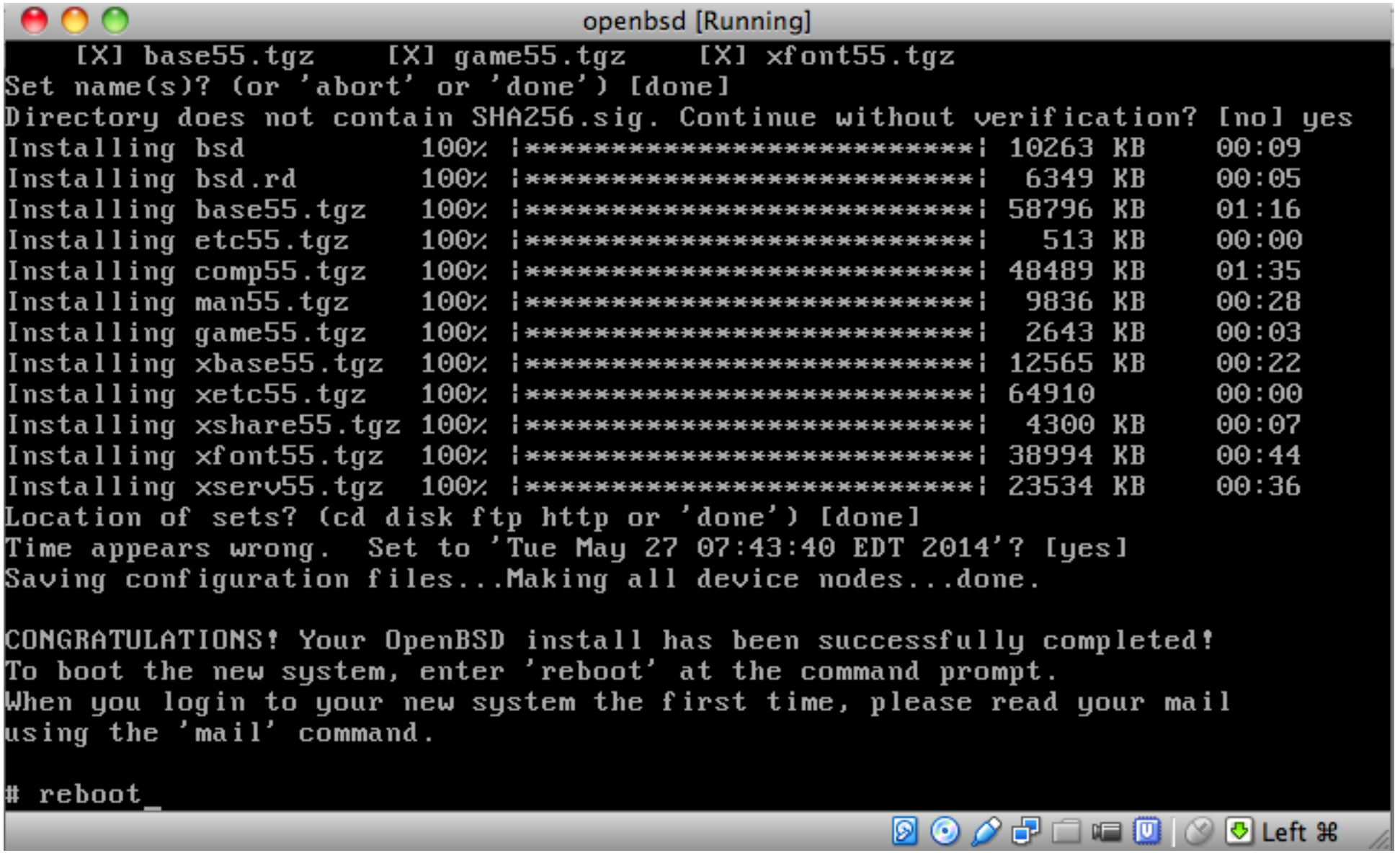
- Ignore the SHA256 signature verification prompt!
- Image below should give you an idea...



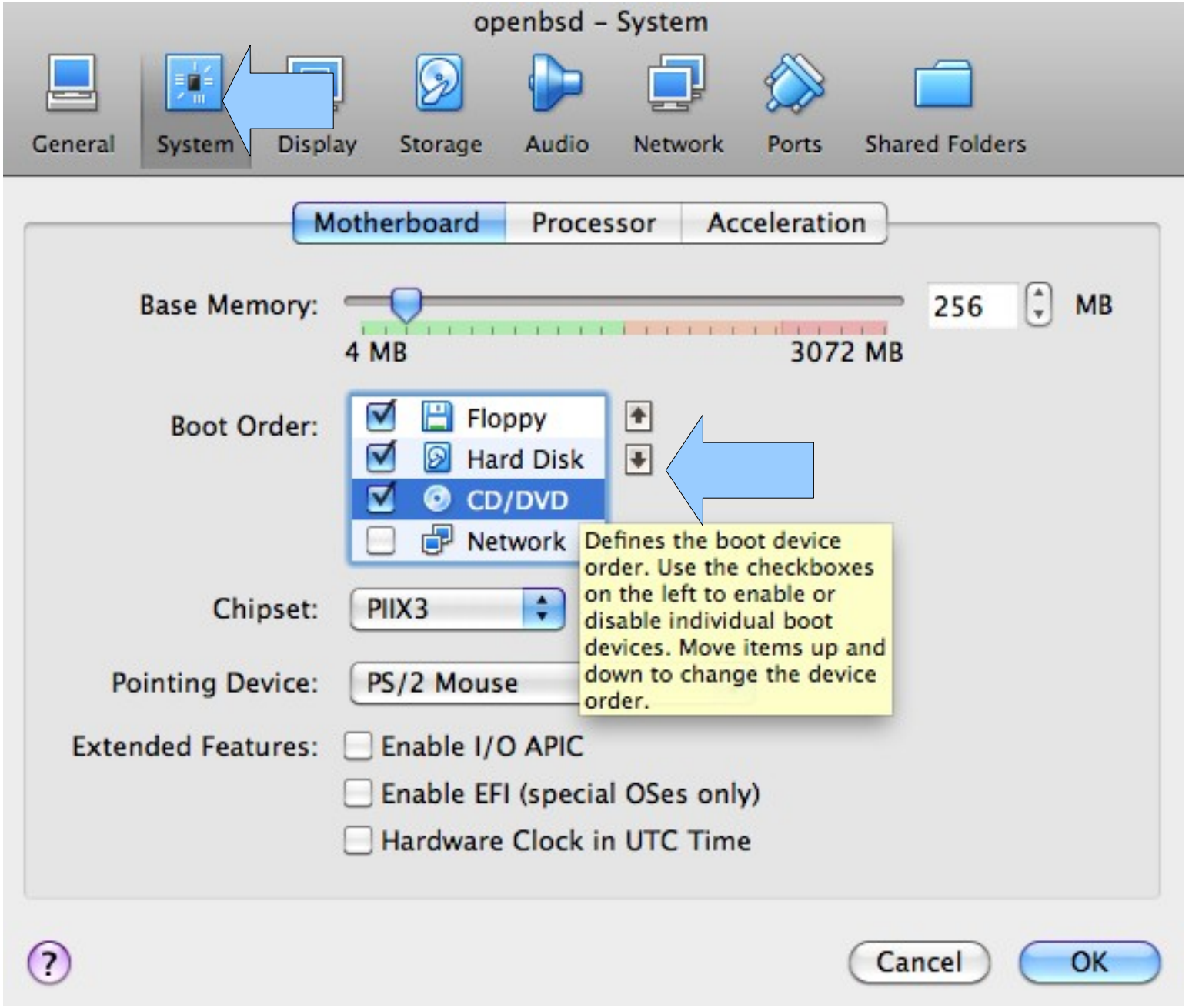
- Wait for the installation to complete.

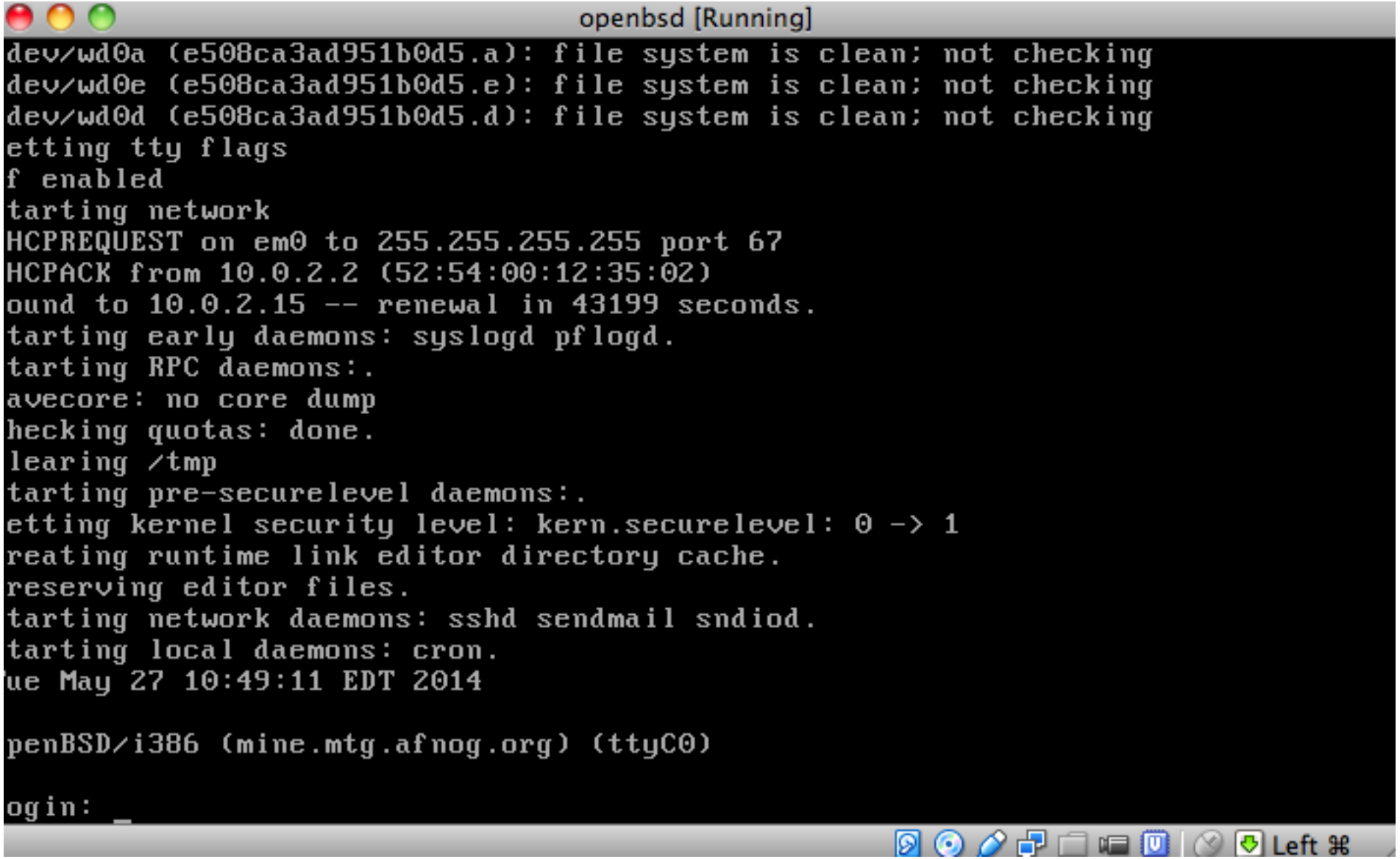


- Reboot the instance
- Intercept the reboot at the bios stage and shutdown the instance.



- Stop the instance and adjust the settings of the VM
- Make sure that CD/DVD comes after Hard disk as shown below
- Restart the instance




openbsd [Running]
dev/wd0a (e508ca3ad951b0d5.a): file system is clean; not checking
dev/wd0e (e508ca3ad951b0d5.e): file system is clean; not checking
dev/wd0d (e508ca3ad951b0d5.d): file system is clean; not checking
etting tty flags
f enabled
tarting network
HCPREQUEST on em0 to 255.255.255.255 port 67
HCPACK from 10.0.2.2 (52:54:00:12:35:02)
ound to 10.0.2.15 -- renewal in 43199 seconds.
tarting early daemons: syslogd pflogd.
tarting RPC daemons:.
avecore: no core dump
hecking quotas: done.
learing /tmp
tarting pre-securelevel daemons:.
etting kernel security level: kern.securelevel: 0 -> 1
reating runtime link editor directory cache.
reserving editor files.
tarting network daemons: sshd sendmail sndiod.
tarting local daemons: cron.
ue May 27 10:49:11 EDT 2014
penBSD/i386 (mine.mtg.afnog.org) (ttyC0)
ogin:
Left ⌘

Class Exercise

- Good engineers are lazy, lazy, lazy, lazy!
- vagrant profiter de la vie!!

Vagrant

- Install vagrant from the local server on your laptop
- Make a vagrant file by issuing vagrant init
- Edit the vagrantfile
- Change the line:
  - From: **config.vm.box = "base"**
  - To: **config.vm.box = "http://mini1.sse.ws.afnog.org/~inst/vagrant_boxes/hashicorp/precise32/version/1/provider/virtualbox.box"**

- Create a new dir and change to it
- Run vagrant init
- Run ee Vagrantfile to edit the generated file

```
lmwangi ~ > work > virts vagrant init
/Applications/Vagrant/bin/../embedded/gems/gems/vagrant-1.6.2/lib/vagrant/pre-rubygems.rb:31: warning: Insecure world writable dir /usr/local in PATH, mode 04
/Applications/Vagrant/embedded/gems/gems/bundler-1.6.2/lib/bundler/runtime.rb:222: warning: Insecure world writable dir /usr/local in PATH, mode 040777
A `Vagrantfile` has been placed in this directory. You are now
ready to `vagrant up` your first virtual environment! Please read
the comments in the Vagrantfile as well as documentation on
`vagrantup.com` for more information on using Vagrant.
lmwangi ~ > work > virts ls
Vagrantfile
lmwangi ~ > work > virts ee Vagrantfile
```

- Change the line config.vm.box to the one below
  - **http://mini1.sse.ws.afnog.org/~inst/vagrant_boxes/hashicorp/precise32/version/1/provider/virtualbox.box**

```
# Every Vagrant virtual environment requires a box to build off of.
config.vm.box = "http://mini1.sse.ws.afnog.org/~inst/vagrant_boxes/hashicorp/precise32/version/1/provider/virtualbox.box"

# Disable automatic box update checking. If you disable this, then
# boxes will only be checked for updates when the user runs
```

- Run vagrant up to start the instance

```
lmwangi ~ > work > virts vagrant up
/Applications/Vagrant/bin/../embedded/gems/gems/vagrant-1.6.2/lib/vagrant/pre-rubygems.rb:31: warning: Insecure world writable dir /usr/local in PATH, mode 040777
/Applications/Vagrant/embedded/gems/gems/bundler-1.6.2/lib/bundler/runtime.rb:222: warning: Insecure world writable dir /usr/local in PATH, mode 040777
Bringing machine 'default' up with 'virtualbox' provider...
==> default: Box 'http://mini1.sse.ws.afnog.org/~inst/vagrant_boxes/hashicorp/precise32/version/1/provider/virtualbox.box' could not be found. Attempting to find a
    default: Box Provider: virtualbox
    default: Box Version: >= 0
==> default: Adding box 'http://mini1.sse.ws.afnog.org/~inst/vagrant_boxes/hashicorp/precise32/version/1/provider/virtualbox.box' (v0) for provider: virtualbox
    default: Downloading: http://mini1.sse.ws.afnog.org/~inst/vagrant_boxes/hashicorp/precise32/version/1/provider/virtualbox.box
==> default: Successfully added box 'http://mini1.sse.ws.afnog.org/~inst/vagrant_boxes/hashicorp/precise32/version/1/provider/virtualbox.box' (v0) for 'virtualbox'
==> default: Importing base box 'http://mini1.sse.ws.afnog.org/~inst/vagrant_boxes/hashicorp/precise32/version/1/provider/virtualbox.box'...
==> default: Matching MAC address for NAT networking...
==> default: Setting the name of the VM: virts_default_1401192233099_60272
==> default: Clearing any previously set network interfaces...
==> default: Preparing network interfaces based on configuration...
    default: Adapter 1: nat
==> default: Forwarding ports...
    default: 22 => 2222 (adapter 1)
==> default: Booting VM...
==> default: Waiting for machine to boot. This may take a few minutes...
    default: SSH address: 127.0.0.1:2222
    default: SSH username: vagrant
    default: SSH auth method: private key
    default: Warning: Connection timeout. Retrying...
==> default: Machine booted and ready!
==> default: Checking for guest additions in VM...
    default: The guest additions on this VM do not match the installed version of
    default: VirtualBox! In most cases this is fine, but in rare cases it can
    default: prevent things such as shared folders from working properly. If you see
    default: shared folder errors, please make sure the guest additions within the
    default: virtual machine match the version of VirtualBox you have installed on
    default: your host and reload your VM.
    default:
    default: Guest Additions Version: 4.2.0
    default: VirtualBox Version: 4.3
==> default: Mounting shared folders...
    default: /vagrant => /Users/lmwangi/work/virts
```

- Run vagrant ssh to connect to the instance

```
lmwangi ~ > work > virts vagrant ssh
/Applications/Vagrant/bin/../embedded/gems/gems/vagrant-1.6.2/lib/vagrant/pre-ruby
/Applications/Vagrant/embedded/gems/gems/bundler-1.6.2/lib/bundler/runtime.rb:222:
Welcome to Ubuntu 12.04 LTS (GNU/Linux 3.2.0-23-generic-pae i686)

 * Documentation:  https://help.ubuntu.com/
Welcome to your Vagrant-built virtual machine.
Last login: Fri Sep 14 06:22:31 2012 from 10.0.2.2
vagrant@precise32:~$ uname
Linux
vagrant@precise32:~$ uptime
 12:06:58 up 2 min,  1 user,  load average: 0.72, 0.79, 0.34
vagrant@precise32:~$
```

- You just provisioned an instance in minutes
- You can now configure this instance for a service
- You can change to another directory and repeat the process to get another instance
  - Run: **vagrant init**
  - Edit the file: **Vagrantfile**
  - Run: **vagrant up**
- Exercise: Create a new FreeBSD vm using this box:
  - http://mini1.sse.ws.afnog.org/~inst/vagrant_boxes/chef/freebsd-9.2/version/1/provider/virtualbox.box

Other vagrant commands

- List instances: **vagrant global-status**
- Stop an instance: **vagrant halt**
- Suspend an instance: **vagrant suspend**
- Resume an instance: **vagrant resume**
- Terminate an instance: **vagrant destroy**
- Snapshot and store/share an instance**: vagrant package**