Lesson Module Status

- Slides – draft
- Properties - done
- Flashcards - NA
- 1st minute quiz – done
- Web Calendar summary – done
- Web book pages – done
- Commands – done
- Howtos – done
- Skills pacing - NA
- Lab – done
- Surveys and PW sheet copied – done
- Depot (VMs) – done
- Special – check VMware revert on Frodo and Celebrian – needed new snap

Feel free to power on your station and login as:
user: cis 192
password: (on the whiteboard)

CIS 192AB uses CCC-Confer

- Class meets every Thursday night:
  - 5:30PM to 9:35PM, Feb 11th to May 27th
- Attend in person or online
  - Option 1: Go to room 2501 on the Aptos Campus
  - Option 2: Attend class online (except 1st and final exam)
- Final exam on June 3rd
  - Room 2501 only

Attending class online
www.cccconfer.org

Attend any class online except for the 1st class and the final exam

- http://www.cccconfer.org
- Click the ***Student Log In*** button under the ***Teach & Confer*** logo

Attending class online
www.cccconfer.org

- For the current date locate:
  Rich Simms – CIS 192AB Class
  and click **GO**
- Dial-in number and passcode are on the handout
- You screen name should be your first and last name.
- For registered students only.

Group Mug Shots

Email me (risimms@cabrillo.edu) a relatively current photo of your face for 3 points extra credit

Joe P.

Joe A.

Chuck


Rich

Ryan

Robert


Chris B.

Josh

John

Patrick

Chris H.

Lieven

Casady

Jack

Drew

Bill

Kay

Edwin

Julio

Junious

Brynden

Aaron

Randall

Joe B.

Class Activity
Log in to CCC Confer

- http://www.cccconfer.org
- Click the ***Student Log In*** button under the ***Teach & Confer*** logo
- For the current date locate:
  Rich Simms – CIS 192AB Class
  and click **GO**
- Dial-in number and passcode are on the handout

Course history and credits

Jim Griffin

- Jim created the original version of this course
- Jim's site: http://cabrillo.edu/~jgriffin/

Rick Graziani

- Thanks to Rick Graziani for the use of some of his great network slides
- Rick's site: http://cabrillo.edu/~rgraziani/

Introduction to TCP/IP and Network Access

Related Course Objectives	Agenda
• Use basic network terminology to describe the five layers of the TCP/IP Reference Model, and describe at least one major function of each layer. • Locate a specific Request For Comment (RFC) article on the Internet. • Install the device drivers and configure the network interface card (NIC) of a Linux system so that it may join a network.	• Introductions [A] • Pre-requisites, Linux Market, IT Jobs, Infrastructure • Baseline assessment [A] • [A] How this class works [A], Housekeeping • Equipment [A], Virtualization, VMware 101 [A] [A] • Creating VMs [A], Cabling VMs, Taking VMs home • Fun with Treebeard [A] • SSH hopping [A] • Network basics • Standards • NIC inventory [A], NIC drivers, Managing drivers [A] • Configuring static IP (temp) • Configuring gateway and DNS • Configuring dynamic IP (temp) • IPv6 usage • Testing with ping • Lab • Wrap up

Introductions

Class Activity
Brief (**30 seconds**) Introductions

Go around the room starting with the instructor

1. Name
2. Brief summary of education/training
3. Brief summary of technical experience

Prerequisite Knowledge

CIS 81

Should have a high level understanding of the following:

IPv4 Addressing
Ethernet
Network stack (OSI layers)
Encapsulation
Subnetting
Utilities:
- Ping
- Wireshark

DNS
DHCP
NAT
Devices
- NICs
- Hubs
- Switches
- Routers

Routing

CIS 90

Should be comfortable with the following:

Navigating file tree
- ls, cd, pwd, find

File management
- cp, mv, rm, mkdir, rmdir

Edit configuration files
- vi

Working in a tty
- more, less, tty

Virtual terminals
- Ctrl-Alt-F1 ...

Getting info
- man, google

Miscellaneous
- ssh/Putty, su, chmod

Command line edits
- up arrow, tab

Showing file info
- cat, grep, head, tail, file, grep

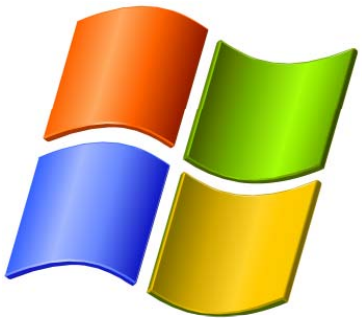
Redirection
- >,>>, < , |

Linux Market

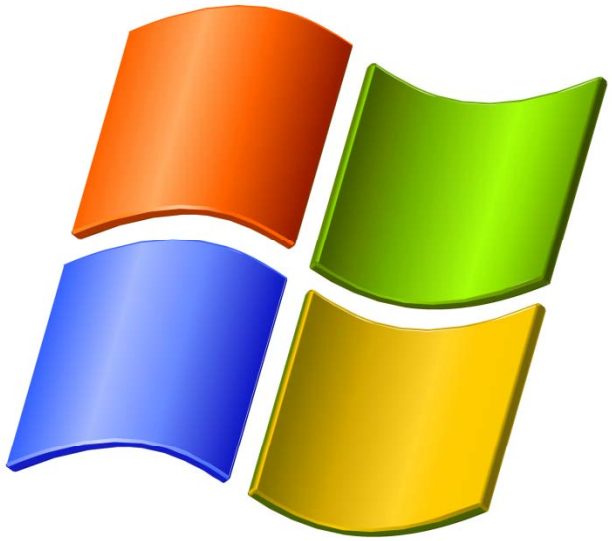
UNIX/Linux Overview

Server & PC markets

Servers

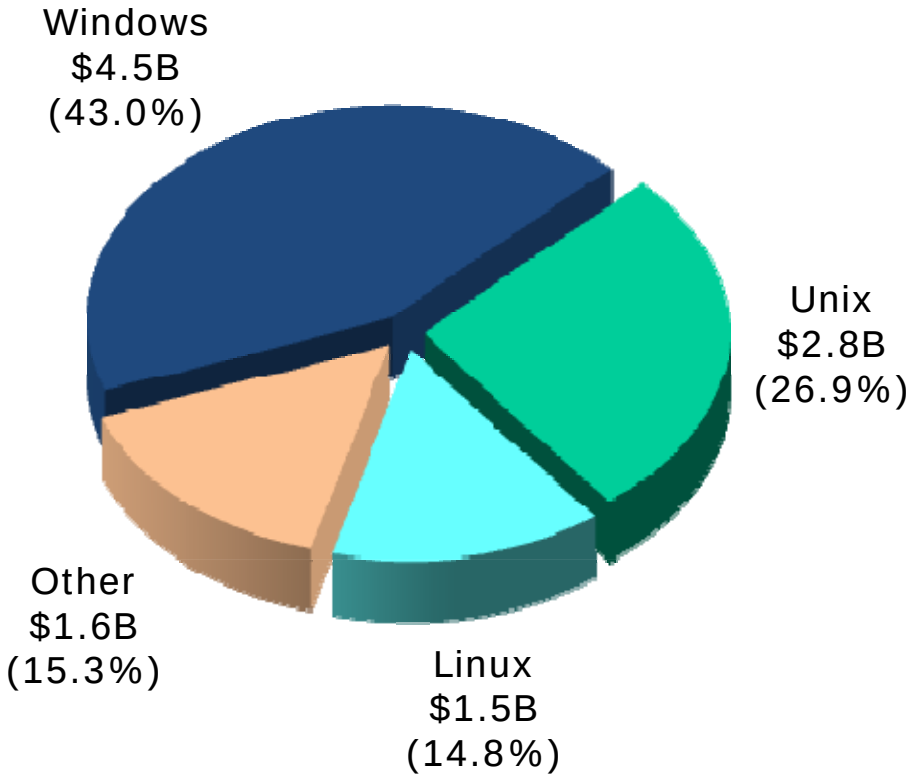


PC's

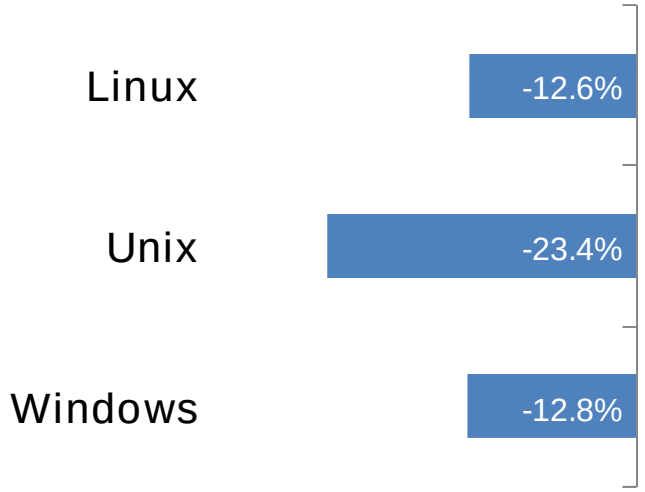


Worldwide Server Market

$10.4B Server Revenue 3Q 2009



Year over Year Change



Source: IDC, Dec 2009

Linux distros mentioned by top server vendors

Server market share source: IDC 3Q09 report

Vendor	HP (30.9%)	IBM (31.8%)	Dell (13.5%)	Sun (7.5%)
RedHat Enterprise	✓	✓	✓	✓
Novell SUSE	✓	✓	✓	✓
Debian/GNU Linux	✓			
Oracle EL	✓	✓		✓
Asianux	✓	✓		
Ubuntu	✓		✓	✓
CentOs	✓			
Fedora	✓			

UNIX/Linux Overview - Desktops

Dec 2009[1]

Operating Systems		
1	Windows XP	56.61%
2	Windows Vista	21.29%
3	Mac OS X	7.44%
4	Windows 7	6.80%
5	Linux	2.14%
6	Windows 2003	1.14%
7	iPhone OSX	0.64%
8	Windows 2000	0.50%
9	Windows 98	0.09%
10	Android	0.08%

Dec 2008[2]

Operating Systems		
1	Windows XP	72.17%
2	Windows Vista	13.44%
3	Mac OS X	5.24%
4	Linux	2.13%
5	Windows 2000	2.12%
6	Windows 2003	0.68%
7	Windows 98	0.55%
8	Windows ME	0.22%
9	SymbianOS	0.12%
10	WAP	0.04%

1-This report was generated 12/31/2009 based on the last 15,000 page views to each website tracked by W3Counter. W3Counter's sample currently includes 31,496 websites. The generation method was updated in July 2009 to ensure only visits during the month of the report are counted, resulting in a report that is more responsive to change.

2-This report was generated 12/31/2008 based on the last 53,892,847 unique visits to all tracked websites at that time. W3Counter's sample currently includes 19,174 websites. The last 25,000 page views to each website are analyzed to identify unique visits. Some visits may occur before the month of the report.

distrowatch.com

Top Ten Jan 2010

1. Ubuntu 9.10
2. Fedora 12 ⬆
3. openSUSE 11.2 ⬇
4. Debian 5.0
5. Mandriva 2010
6. Linux Mint 8
7. PCLinuxOS 2009.2
8. Slackware 13.0
9. Gentoo 10.1
10. CentOS 5.4
11. FreeBSD 8.0

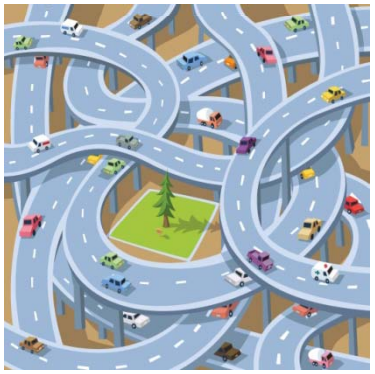
Top Ten Jan 2009

1. Ubuntu
2. openSUSE
3. Fedora
4. Debian
5. Mandriva
6. Linux Mint
7. PCLinuxOS
8. Slackware
9. Gentoo
10. CentOS
11. FreeBSD

CentOS is a clone distro of Red Hat Enterprise

IT Infrastructure

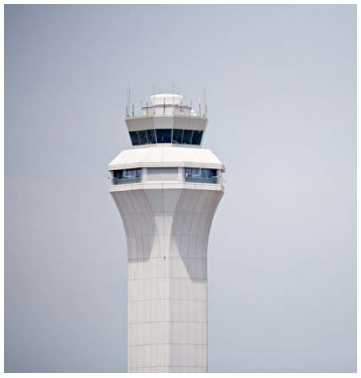
You use **Public Works Infrastructure** every time you drive, fly, turn on the lights or drink a glass of water



Roads

Water

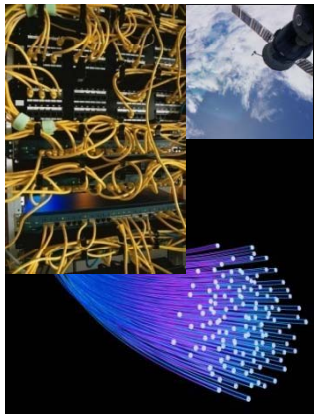
Bridges



Airways

Power

You use **IT Infrastructure** every time you send an email, surf the net or make an online purchase



Network

Servers

Storage

Desktops

Mobile

Software

IT

(Information Technology)

Jobs

2009: The 10 hardest jobs to fill in the U.S. are:

1. Engineers
2. Nurses
3. Skilled/Manual Tradesmen
4. Teachers
5. Sales Representatives
6. Technicians
7. Drivers
8. IT Staff
9. Laborers
10. Machinist/Machine Operators

2008: The 10 hardest jobs to fill in the U.S. were:

1. Engineers
2. Machinists/Machine Operators
3. Skilled Manual Tradesmen
4. Technicians
5. Sales Representatives
6. Accounting & Finance Staff
7. Mechanics
8. Laborers
9. IT Staff
10. Production Operators

Even as thousands of IT jobs continue to be offshored each year, demand for software developers, systems engineers and network administrators is strong, according to the Manpower survey.

"One of the challenges that IT departments face is finding people who are well-rounded, can communicate with the lines of business and can manage," says Melanie Holmes, a vice president at Manpower North America.

Source: Manpower Inc.

Baseline

CIS 192 will expand your knowledge and skills for deploying network based IT infrastructure

Some tools we will use:

- VMware virtual machines and networks
- Wireshark
- Putty
- New UNIX/Linux commands

Some technologies we will deploy:

- Linux based router
- Firewalls
- Custom NAT
- DHCP server
- DNS server
- NFS server
- Samba server
- NIS server
- FTP server
- Web server

Some infrastructure skills we will pick up:

- Adding and removing NIC drivers
- Configuring TCP/IP settings
- Configure routing protocols
- Configure PPP using a serial connection
- Access SMTP, POP and IMAP servers
- SSH tunneling
- Network troubleshooting
- Mount a remote directory
- Examining information in different network layers
- Automate the installation of a "bare-metal" computer with PXE
- Modifying firewall and SELinux settings

Class Activity
Baseline Knowledge Survey

Please browse to and complete the survey at:

http://www.surveymonkey.com/s/KD7RDFW

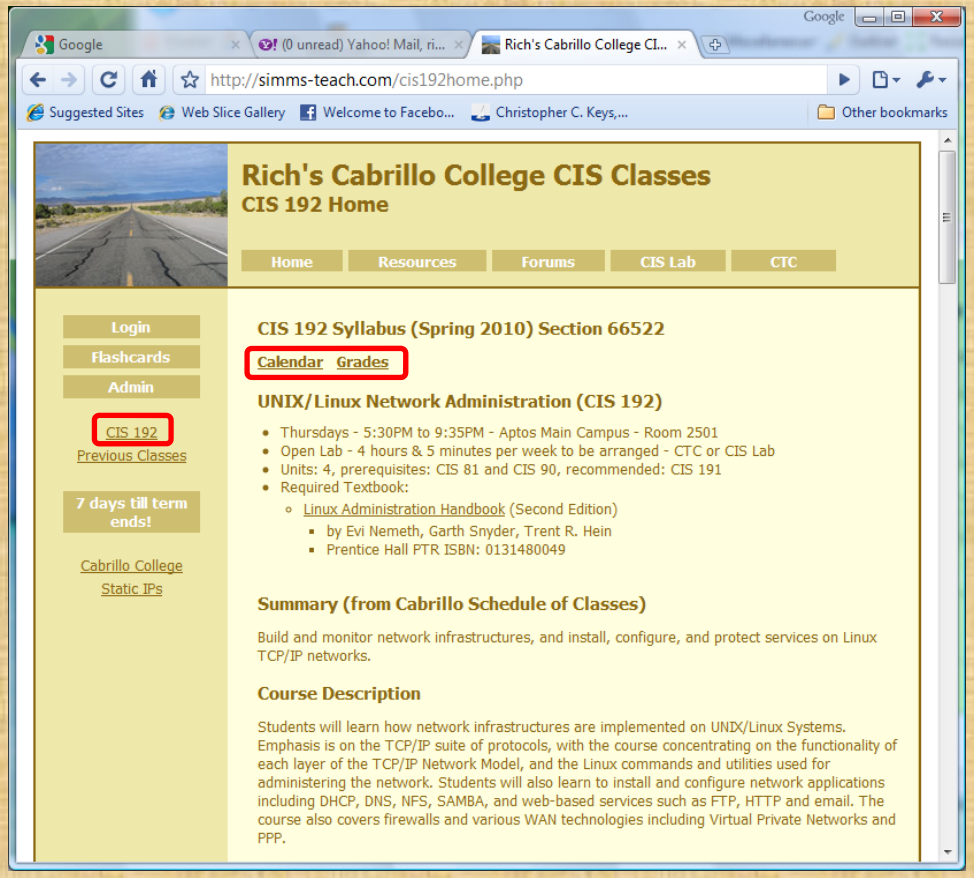
100% ANONYMOUS

The information gathered will be used to calibrate the lessons

How this Class Works

Class Activity (continued)

Class Website



1. Browse to:
   `http://simms-teach.com`

3. Click on CIS 192 on left panel to see the syllabus

4. Use links at top of content area to toggle between Course Home, Calendar and Grades.

5. The **syllabus** is on the Course Home page.

Course syllabus walkthrough

It is a good idea to read through the syllabus carefully to avoid any surprises and get a good idea how this course works.

We will cover some important syllabus highlights in the next several slides.

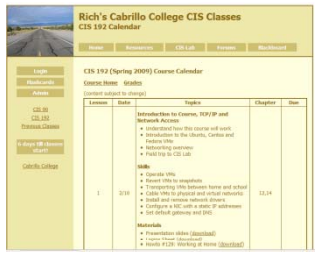
Weekly Cycle

http://simms-teach.com

Use Forum to ask and answer questions

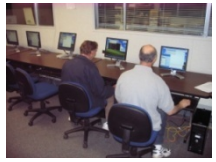
Thursday

"First Minute" Quiz
Lecture on new material
Class Activities
Lab assignments due midnight

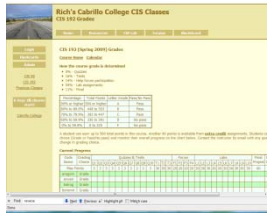


Calendar Page

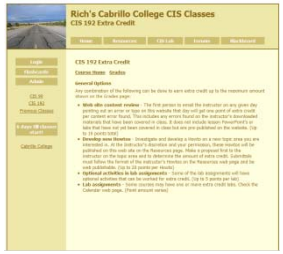
Friday
is grading day



Work Lab Assignments for TBA portion of class (4 hours 5 min) in CIS Lab or CTC



Grades Page



Extra Credit Page

Course outline and syllabus

Two important course policies to remember

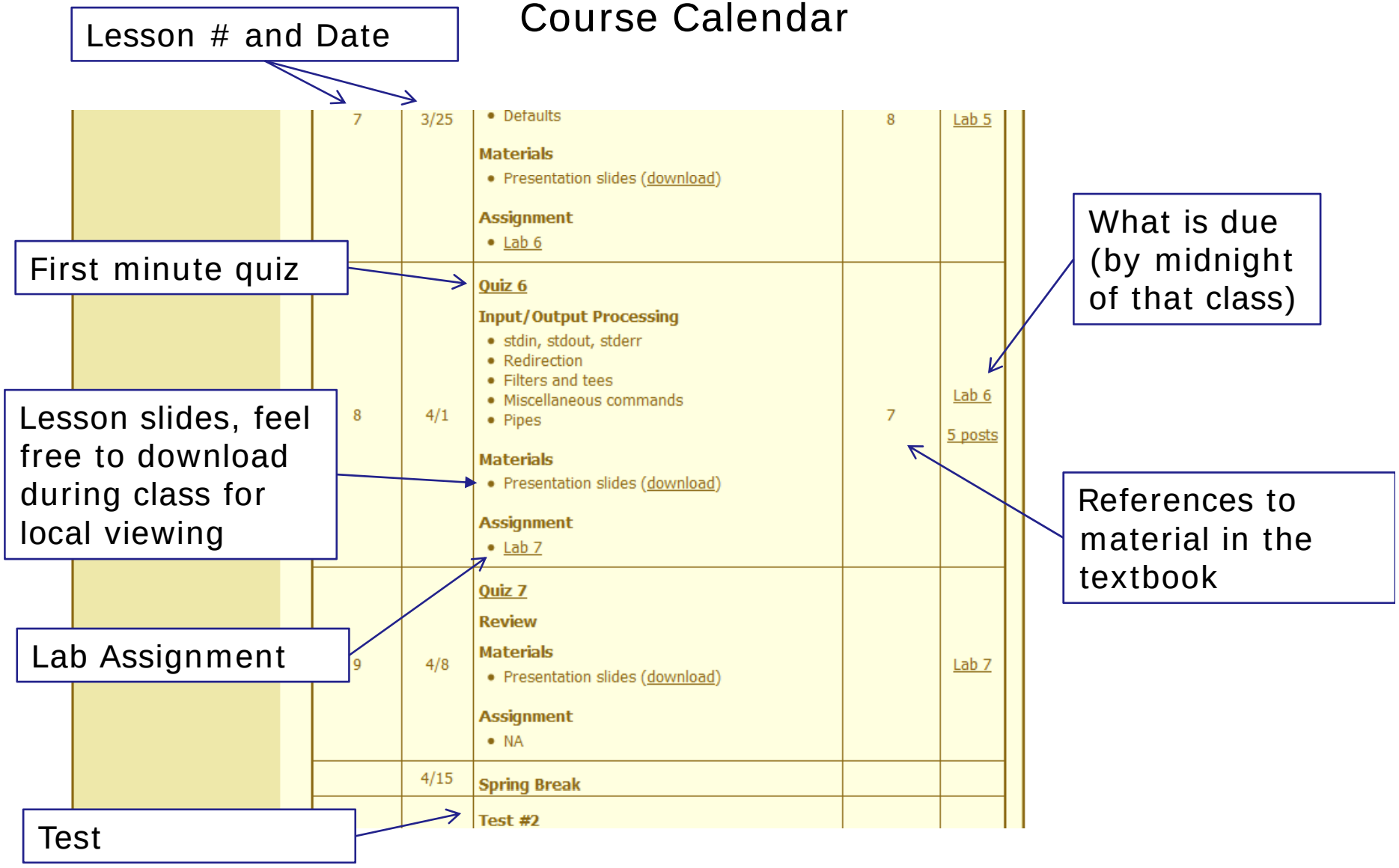
In order to start classes on time, keep the class paced moving, keep my own sanity, and to avoid log jams at the end of the term:

1) ***No makeup's for missed quizzes***
2) ***Late work (Labs 1-10) will not be accepted***

If you have not completed a lab assignment, **please turn in what you have done for partial credit**

Don't worry though -- there are **ample extra credit opportunities** for students wanting or needing any extra points.

Course Calendar



Rich's Cabrillo College CIS Classes

CIS 192 Grades

Home | Resources | Forums | CI

CIS 192
How grading works

Monitor this page to track your progress in the course.

CIS 192 (Spring 2010) Grades

Course Home Calendar

Points can be earned from the following activities:

- First minute quizzes - 30 points
- Final - 60 points
- Help forum participation - 80 points
- Tests - 90 points
- Lab assignments - 300 points

CIS 192
Previous Classes

4 days till term ends!

Cabrillo College
Static IPs

How your grade is determined:

A student can earn up to 560 total points doing the activities listed abo
number of points earned.

Percentage	Total Points	Letter Grade	Pass/No Pass
90% or higher	504 or higher	A	Pass
80% to 89.9%	448 to 503	B	Pass
70% to 79.9%	392 to 447	C	Pass
60% to 69.9%	336 to 391	D	No pass
0% to 59.9%	0 to 335	F	No pass

Your grade is based solely on the number of points you earn. It offers flexibility and gives you control.

For some flexibility, personal preferences or family emergencies there is an additional 90 points available of extra credit activities.

Use extra credit to earn additional points

Choice of Grade or Pass/No Pass

You indicate your grading choice on the Student Survey form passed out during the first class. You can verify your grading choice selection on the table below. Contact the instructor by email with any questions or to request a change in grading choice.

Indicate on the class survey if you want to take the course for a grade or P/NP. You may change you mind later by contacting the instructor

Recommendations

The instructor may provide letters of recommendation upon request. When writing a recom
instructor will include both graded and non-graded areas of performance. Non-graded perf
include teamwork, helping others, quality, planning & organization skills, communication, a
motivation, and the desire to go above and beyond expectations. The forum is an excellent
teamwork and communication skills.

Don't forget to post! When racking up points the forum is "low hanging fruit"

Current Progress

Each student will be assigned a secret code name so they can monitor their progress on the table below. It is a good idea to check this table frequently and decide whether doing some extra credit activities would be beneficial

Code Name	Grading Choice	Quizzes & Tests													Forum				Labs										Final	Extra Credit	Total	Grade
		Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	T1	T2	T3	F1	F2	F3	F4	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10				
Max Points		3	3	3	3	3	3	3	3	3	3	30	30	30	20	20	20	20	30	30	30	30	30	30	30	30	30	30	60	90	560	
aragorn	Grade																															
arwen	P/NP																															

Each student is assigned a secret LOR code name

Contacting the instructor

- Use the forum for the fastest response on technical or class related questions.
- Use email for personal matters.
- Weekly office hours right before and after class (Th 4:45-5:30, 9:35-10) in room 2501
- The instructor will be available in the CIS Lab five hours (TBD) every week to help students with lab assignments or to better understand class material.

- Leave a message on voice mail if you have no network access. Checked rarely so don't expect a fast response.

CIS 192 - How this class Works

The TBA portion of this course is required

Requires spending on average of 4 hours and 5 minutes every week applying the skills learned during the lecture portion of the class.

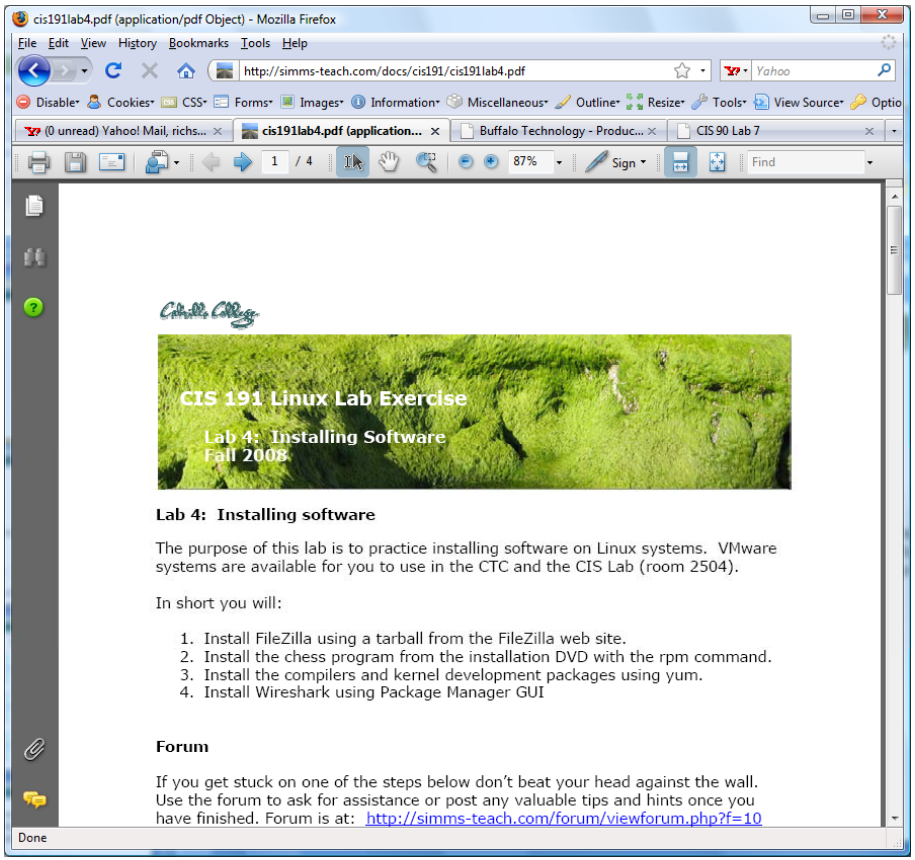
Computer Lab locations

CIS Lab (room 2504)

CTC (building 1400)

CIS 192

Lab Assignments



Pearls of Wisdom:

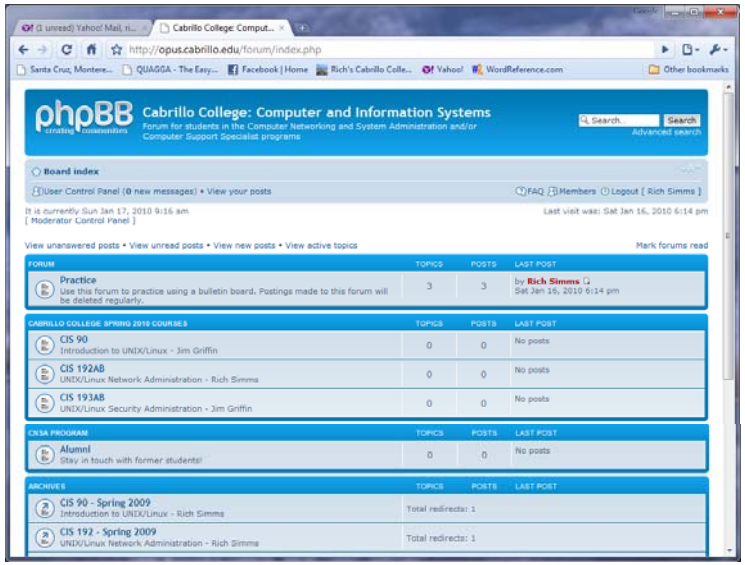
- Don't wait till the last minute to start.
- The *slower* you go the *sooner* you will be finished.
- A few minutes reading the forum can save you hour(s).
- Line up materials, references, equipment and software ahead of time.
- Use Google when trouble-shooting
- Late work is not accepted so submit what you have for partial credit.

CIS 192

First Minute Quizzes

- The purpose of the quiz is to start each class on time
- 10 quizzes worth 3 points each
- Each quiz has three questions that are given out a week in advance.
- Prior to the actual quiz, students may work together and use the forum to discuss the answers.
- The quiz will start right at the beginning of class. They are closed book/notes/computer and no one may ask for or give assistance during the quiz.
- There are no makeups if you are late or miss class. Of course there are always ample extra credit opportunities!

Online Help Forum for Students

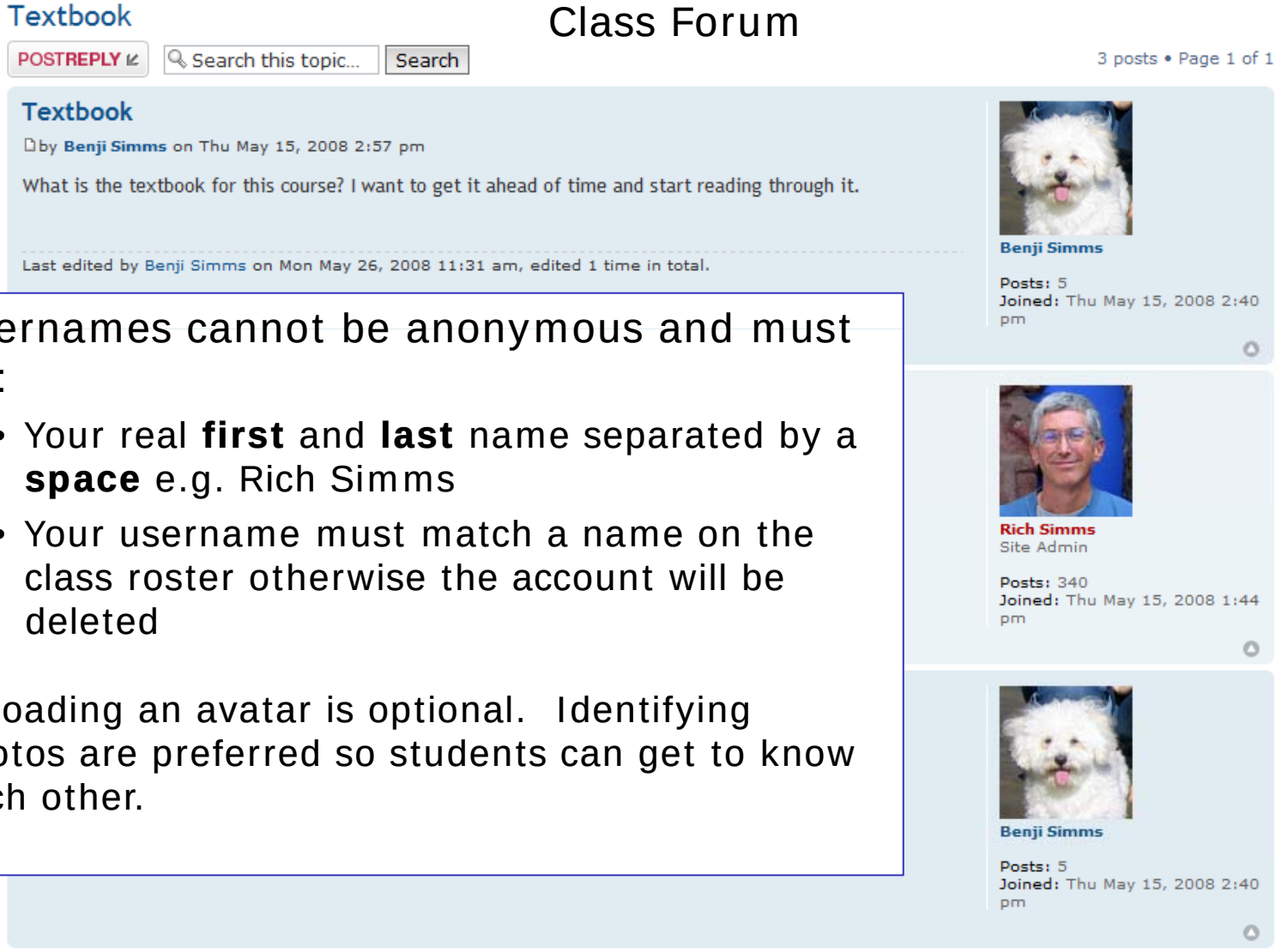


- Post questions and answers
- Share Linux information
- Post class notes for classmates who miss class
- Get clarifications
- Share Linux information

As an incentive to use the forum - students can earn 4 points per CIS 192 forum post (capped at 20 points for each ¼ of the course calendar)

CIS 192

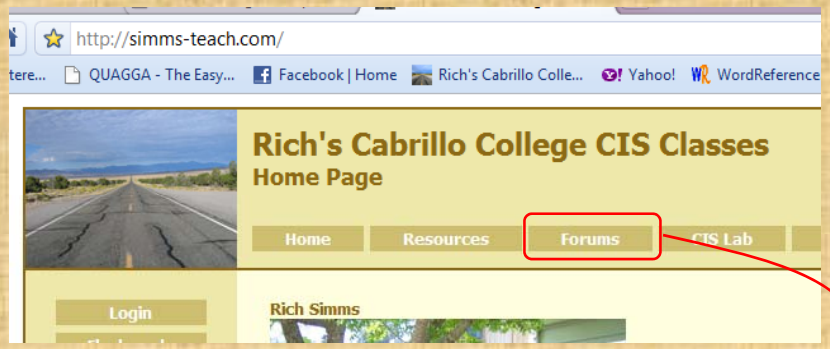
Class Forum



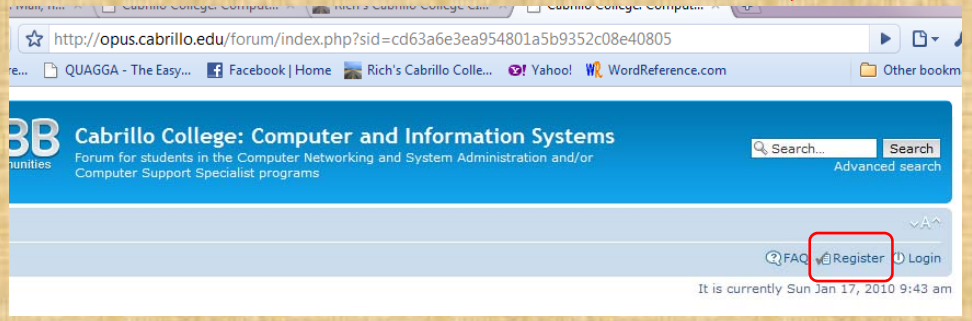
- Usernames cannot be anonymous and must be:
  - Your real **first** and **last** name separated by a **space** e.g. Rich Simms
  - Your username must match a name on the class roster otherwise the account will be deleted
- Uploading an avatar is optional. Identifying photos are preferred so students can get to know each other.

Class Activity
Forum Registration

There is a Forums link on **simms-teach.com**



Or browse to **opus.cabrillo.edu /forum**



To Register:

1. Browse to the forum
2. Click on the Register link
3. Review and agree to terms
4. For your **Username** to be accepted it **must** be:
   - your first and last name separated by a space e.g. Rich Simms
   - match a name on the class roster

Note: Anonymous or incomplete user account names will be deleted!

Housekeeping

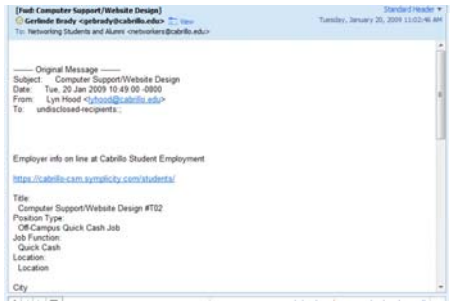
- Roll Call
- Add Slips
- Last day to add is 2/19
- CIS 180 - Capstone Class

  See: http://www.cabrillo.edu/~grollinson/

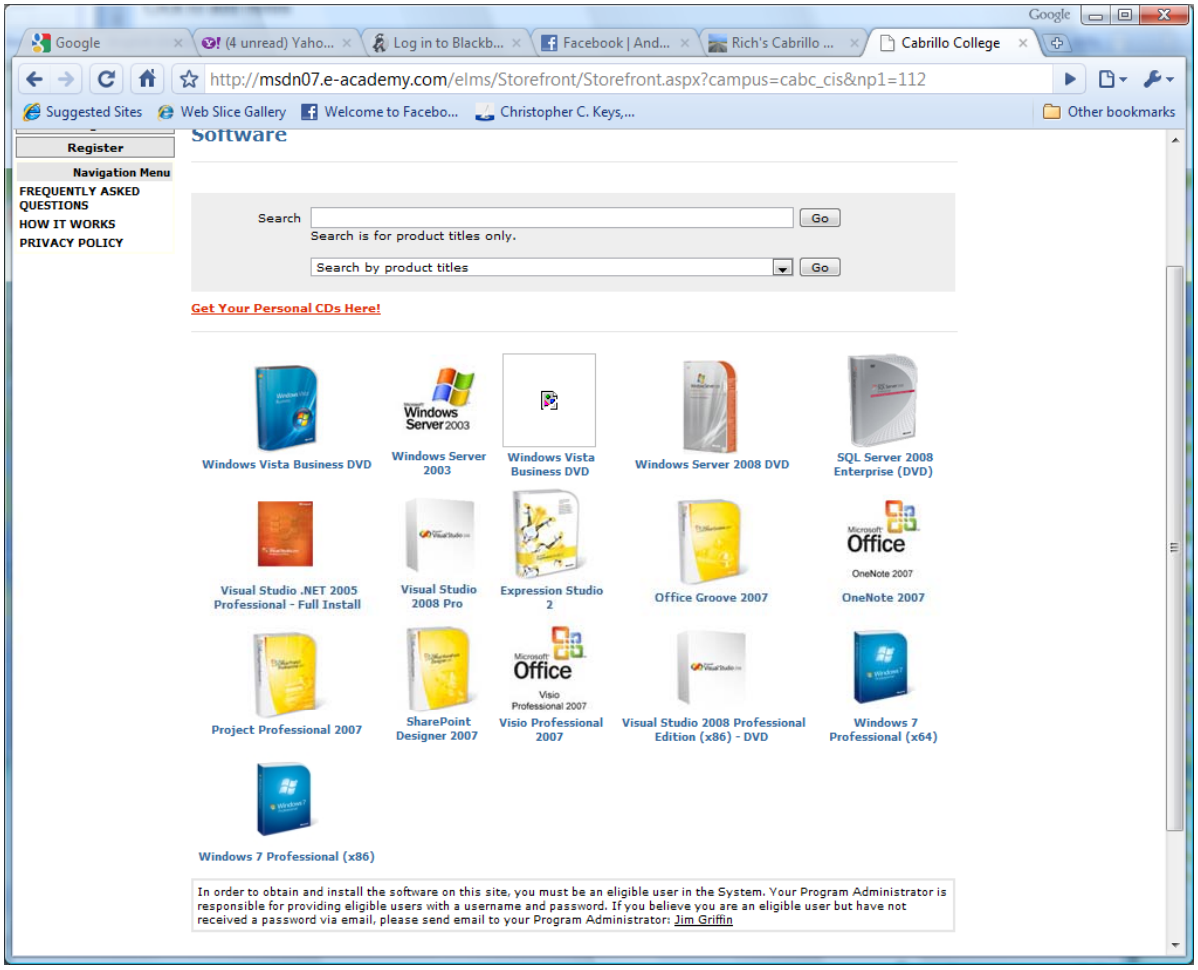
Cabrillo Networking Program Mailing list

Subscribe to (no subject or body):

- **networkers-subscribe@cabrillo.edu**
- Program information
- Certification information
- Career and job information
- Short-term classes, events, lectures, tours, etc.
- Surveys
- Networking info and links



MSDN Academic Alliance



- Microsoft software for students registered in a CIS or CS class at Cabrillo
- Available after registration is final (two weeks after first class)

http://msdn07.e-academy.com/elms/Storefront/Home.aspx?campus=cabc_cis

Cabrillo GNU/Linux Users Group
(CGLUG)

Come Alive!

From: Jim Griffin <jimg@Opus.cabrillo.edu> Add to Contacts
To: Cabrillo GNU/Linux Users Group <cglug@cabrillo.edu>

Hello CGLUG Community,
I am going to inject a little activity into the Cabrillo GNU/Linux
user community by inviting my new Linux students to an event this
Friday, Feb. 12, 2010 in Room 2504 (The networking lab) at 6:00 PM
for a showing of the Revolution OS video and to help students install
Linux on their laptops or at least VMware so they can run Linux. We'll
see what kind of enthusiasm there is, and who knows - maybe the campus club
will revitalize?
I'm looking forward to seeing some of you wizened wizards. Remember, that's
Friday, February 12, on Cabrillo Campus - Room 2504. We can talk about
whether this lsit serv is suiting our needs, or weather we want to create
a forum to discuss and keep abreast of GNU/Linux issues.
'Till then!

Jim Griffin

Tomorrow at 6:00 PM if you are interested

Student Survey and Logins Sheet

UNIX/Linux Network Administration (CIS 192AB-66522)

Spring 2010 -- Student Survey

Student Information

- First Name: _____ Last Name: _____
- Date: _____ Email address: _____
- Grading choice: ❑ Pass/No pass ❑ Grade (choose one, you may change your mind later)
- CCC Confer will be used to record each class. There is a video cam option which may be used which could record student's faces. Do you give permission to post on the web any recordings that show your face? ❑ yes ❑ no

Computer Background

- Previous computer classes or training taken:
- Work or other experience using computers:

Home equipment

- Do you have a computer/phone headset (earphones & microphone)? ❑ yes ❑ no
- Do you have a computer with at least 2GB of RAM? ❑ yes ❑ no
- Do you have Internet access? ❑ no ❑ modem ❑ dsl/cable

Course Objectives

- What are you hoping to learn in this class?
- Other comments or special learning needs?

Logins and Passwords for CIS 192

Class Computer Stations (room 2501)

Username: _CIS 192_____ Password: _____

CCC Confer (http://www.cccconfer.org)

Dial-in: _888-886-3951_____ Passcode: __439080_____

192 Linux VMs:

Username: _cis192_____ Password: _____

Username: _root_____ Password: _____

Opus (opus.cabrillo.edu)

Username: _cis192_____ Password: _____

Username: _____ Password: _____

Help Forum (http://opus.cabrillo.edu/forum/)

Username: _____ Password: _____

CIS-Lab-xx Systems (Room 2504 and CTC):

Username: _CIS 192_____ Password: _____

Other:

System: _____ Username: _____ Password: _____

System: _____ Username: _____ Password: _____

System: _____ Username: _____ Password: _____

System: _____ Username: _____ Password: _____

Equipment

Assembling components into solutions

Who likes building things?

Assembling components into solutions

Servers and Clients

Rack

Routers

cables

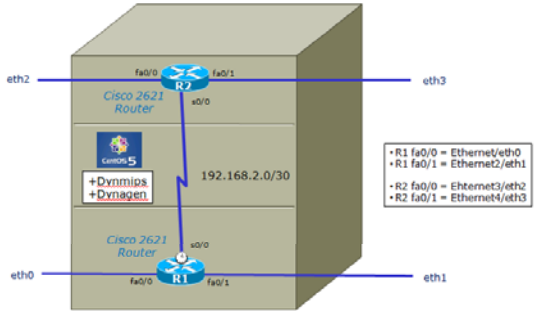
Switches

If you like building things, you will like this course!

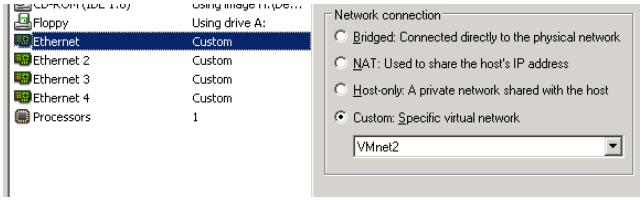
Assembling components into solutions

Systems
(using VMware Linux VMs)

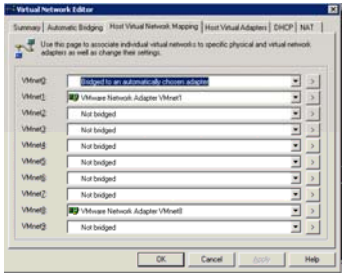
"Rack"
(Using one PC)



Routers
(Using Dynamips emulator
on a Linux VM)



Cables
(using VM Ethernet Settings)



Switches
(Using VMnets as Hubs)

We will use virtual equipment in this course so every student has lots of building blocks to play with!

Meet the CIS 192 Systems

The servers boot to run level 3


Arwen


eth0 eth1


Elrond


eth0 eth1


Celebrian


eth0 eth1


Legolas


eth0 eth1

Servers

4 CentOS 5.4
1 CentOS 5.3
2 Ubuntu 9.10
1 OpenSUSE 11.2
1 RH9
1 Fedora 12
1 Windows XP

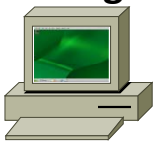
ethx = interface


Frodo

eth0


Sauron

eth0


Fang

eth0


William

Local Area Connection

Clients


Treebeard


eth0 eth1


Nosmo

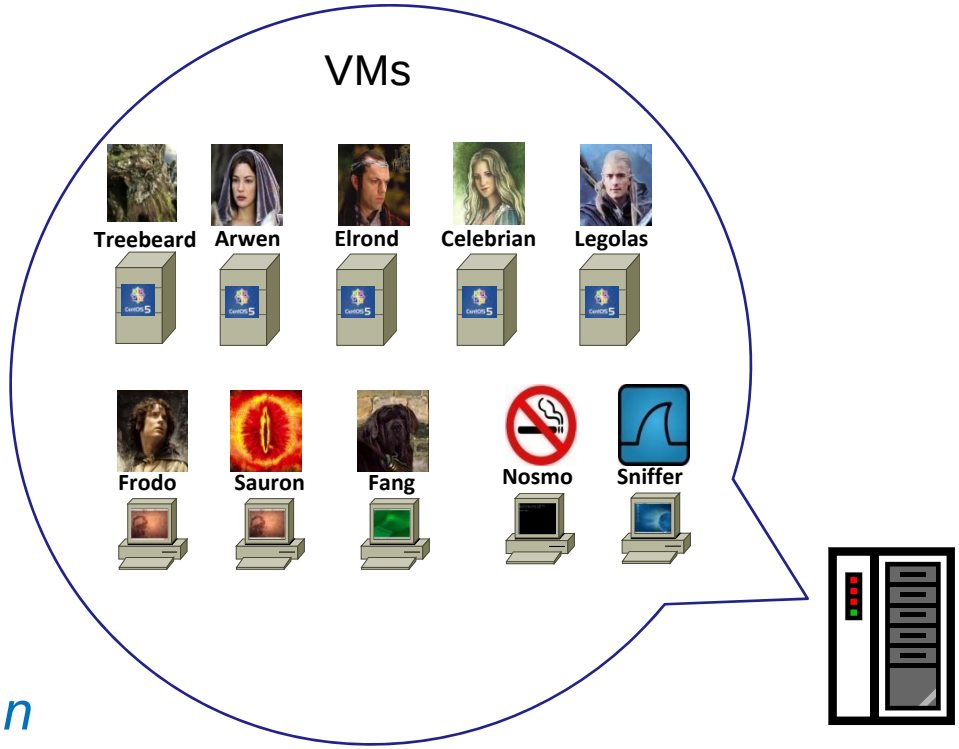
eth0 eth1


Sniffer

eth0
eth1
eth2
eth3

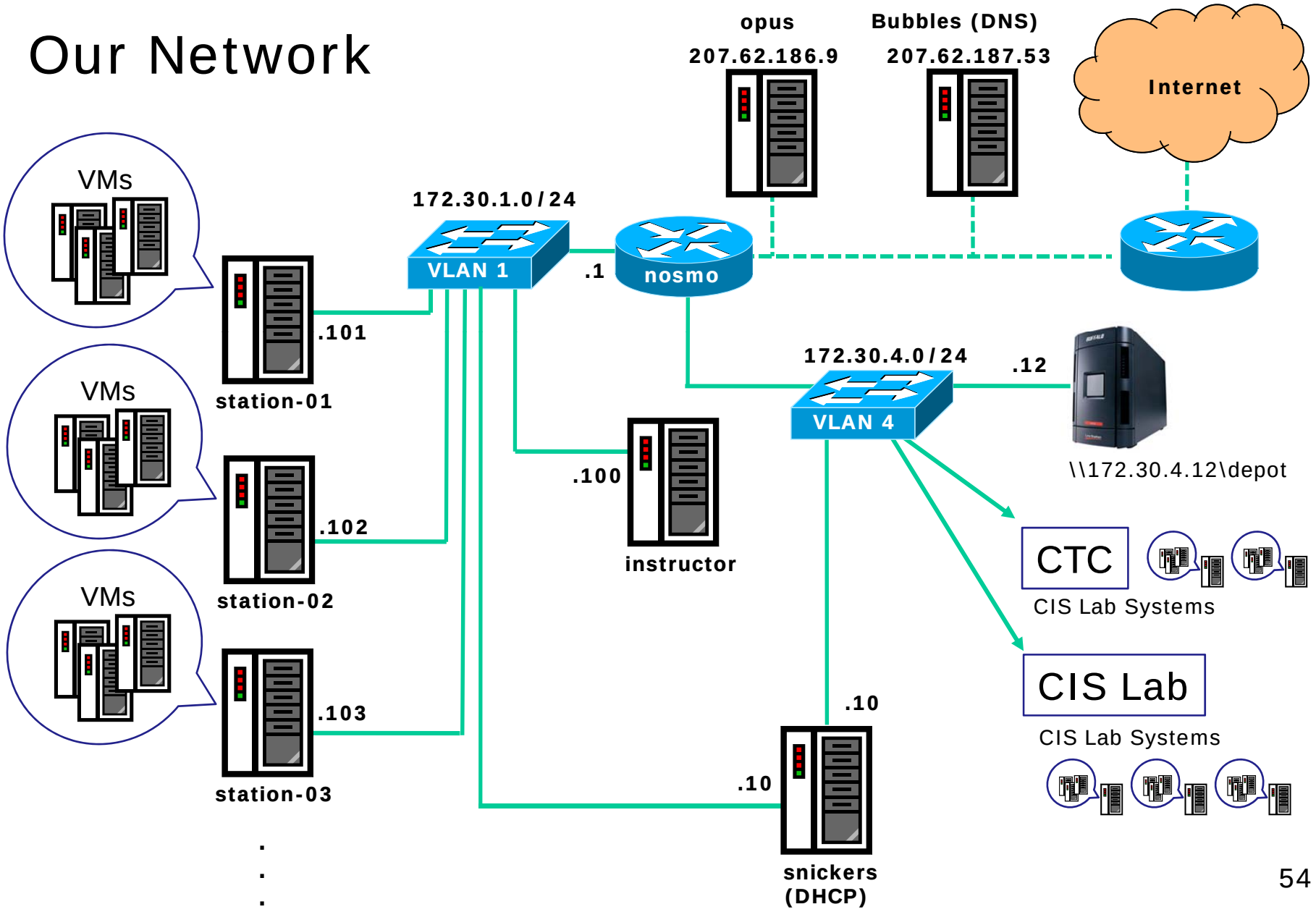
Special

*These systems are all **virtual machines** and they can be found on all the lab and classroom PCs.*



*The virtualization layer is provided by **VMware Server***

Our Network


opus
207.62.186.9
Bubbles (DNS)
207.62.187.53
Internet
VMs
VMs
VMs
172.30.1.0/24
VLAN 1
.1
nosmo
.101
station-01
.102
station-02
.103
station-03
.100
instructor
172.30.4.0/24
VLAN 4
.12
\\172.30.4.12\depot
CTC
CIS Lab Systems
CIS Lab
CIS Lab Systems
.10
.10
snickers
(DHCP)

Lab Resources

CTC Building 1400

There are several **VMware Server stations** (labeled CIS-Lab-XX) in the corner with the Linux VMs for students to use at the CTC.

These systems are labeled as CIS-Lab-*XX*

Hours posted at: http://www.cabrillo.edu/services/ctc/hours.html

Lab Resources

CIS Lab Room 2504

There are several **VMware Server stations** (labeled CIS-Lab-XX) along the wall in the CIS lab

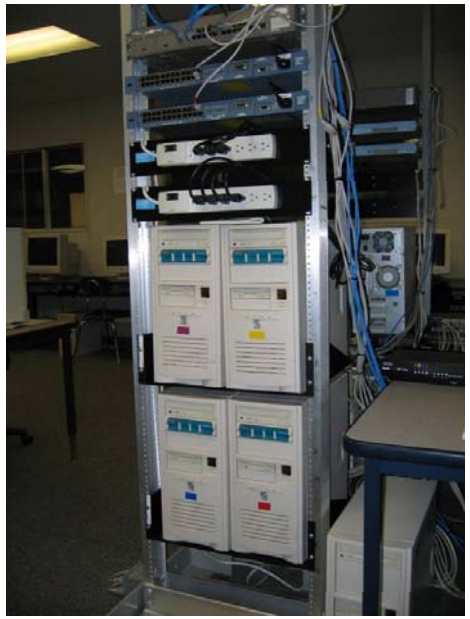
These systems are labeled as CIS-Lab-*XX*

Hours posted at: http://webhawks.org/~cislab/

Lab Resources

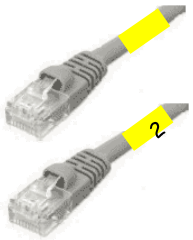
CIS Lab Room 2504

For real cabling practice, use the older PC's in the system pods. They have Trios switches for hard drive selection. Push in the second button *before* turning on the machine to run a local version of Red Hat Linux. Great way to practice your cabling skills.



System Pod

Windows Client (CIS 196) | **Linux (CIS 192)** | **Windows Server (CIS 196)**



2 NICs per server. Patch cables are color coded to match server:

- "2" indicates cable to 2nd NIC (eth1)
- Other cable goes to Intel NIC (eth0)

Hours posted at: http://webhawks.org/~cislab/

CIS Lab – Room 2504

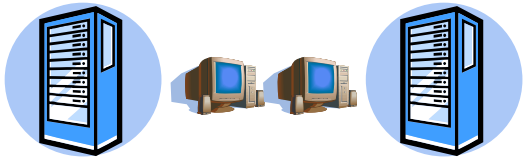
http://webhawks.org/~cislab/

Network Pod

Network Pod

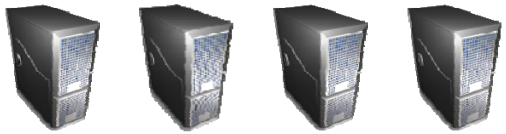
System Pod Student Project Pod

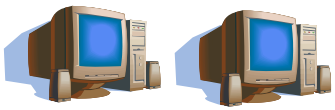
Pod Consoles



System Pod System Pod

CIS 170 work area

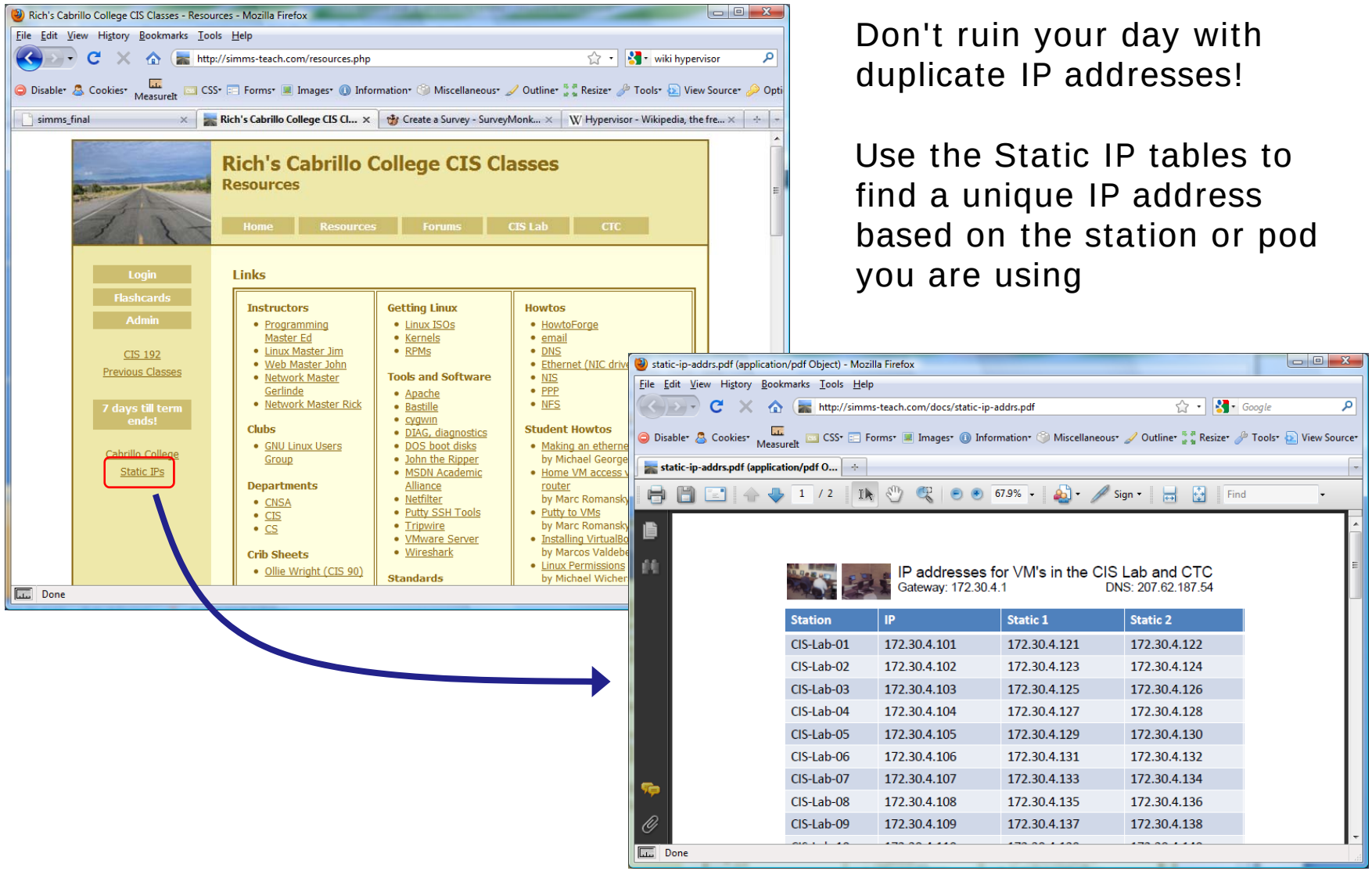




Crash & Burn
Installation Systems

New VMware Stations (CIS-Lab-01 to CIS-Lab-06)

Static IP addresses are one click away:



Don't ruin your day with duplicate IP addresses!

Use the Static IP tables to find a unique IP address based on the station or pod you are using

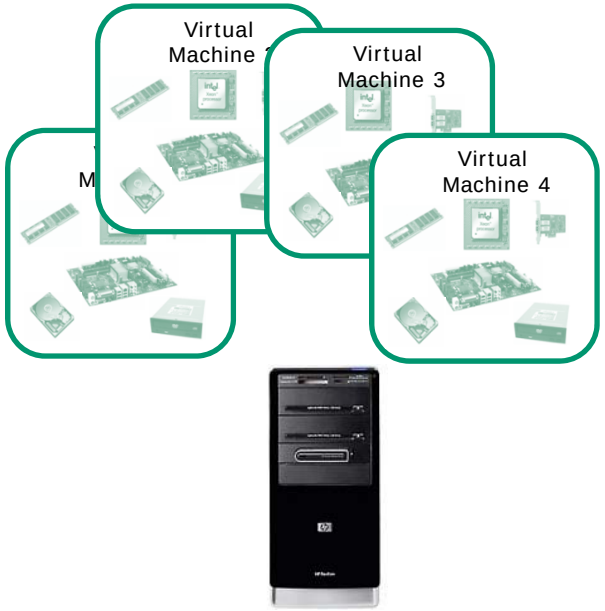
Field Trip

CIS lab – Room 2504

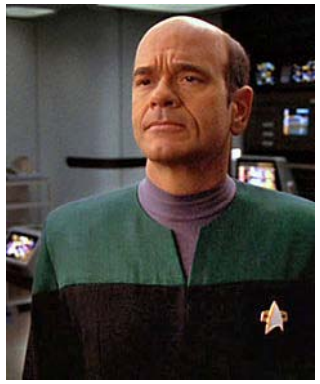
Virtualization

What is a virtual machine?

- **Virtual Machine Monitors** or **Hypervisors** allow a real computer to create and simulate multiple virtual computers.
- The simulated computers are called **virtual machines** or **VMs**.
- VMWare, MS Virtual Server, VirtualBox, Xen and KVM are all examples of **Hypervisors**.



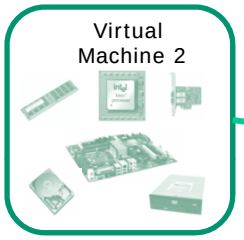
- You load an OS (operating system) and applications on a virtual machine just like you would any other computer.
- The OS and apps do not even know they are not running on a "real" computer.
- Over the network the virtual machines appear just like any other computer.



The EMH doctor on Star Trek Voyager was a simulation

Virtual Machines

Multiple OS's on one computer
... running at the same time
... sharing the same physical hardware



.
.
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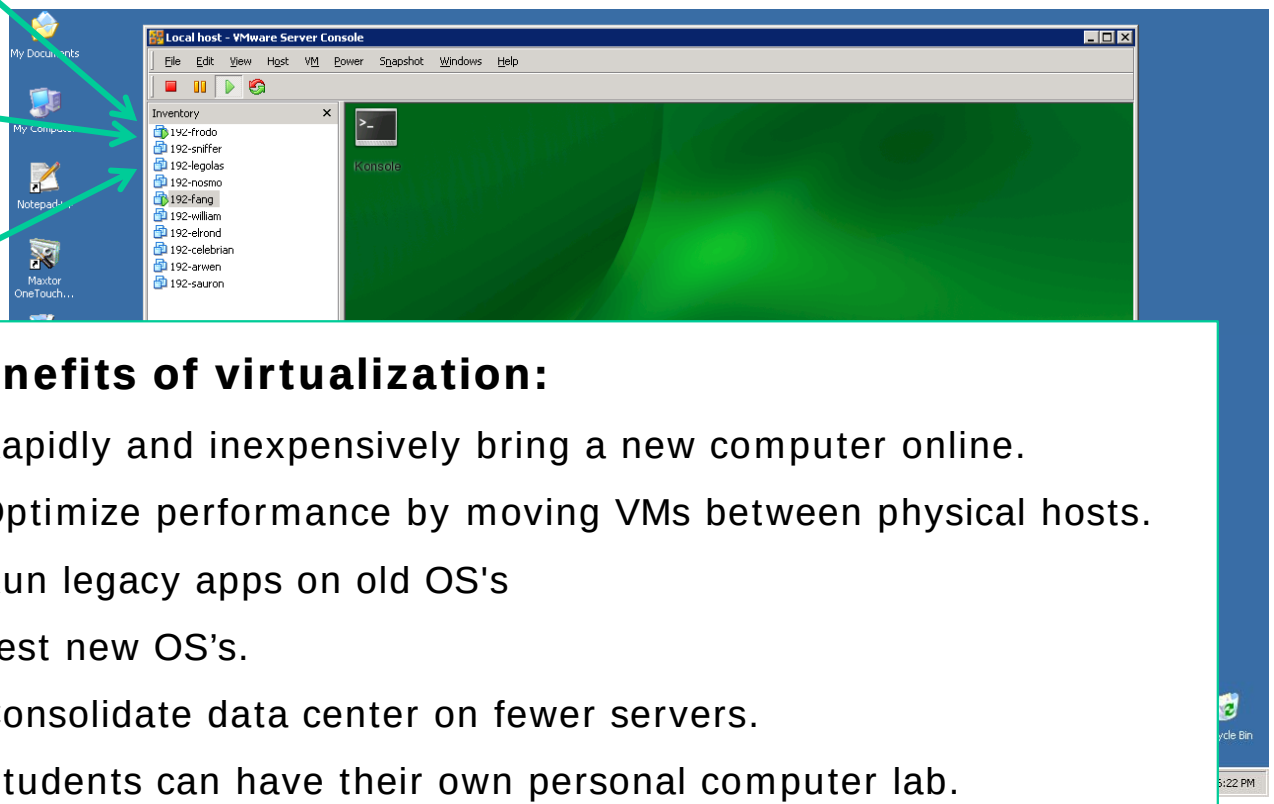
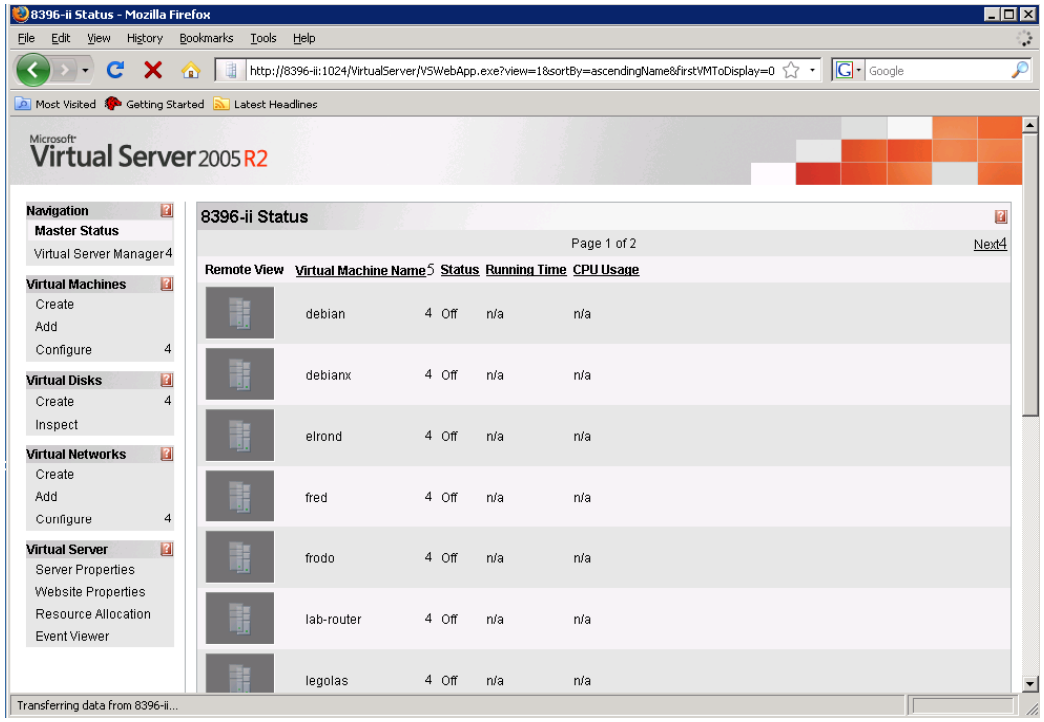


Benefits of virtualization:

- Rapidly and inexpensively bring a new computer online.
- Optimize performance by moving VMs between physical hosts.
- Run legacy apps on old OS's
- Test new OS's.
- Consolidate data center on fewer servers.
- Students can have their own personal computer lab.
- But, when the physical host goes down so do all the VMs!

Microsoft Virtual Server 2005



For Jim's CIS 192 I used MSVS to simulate each of the stations that used to be in the CIS Lab.

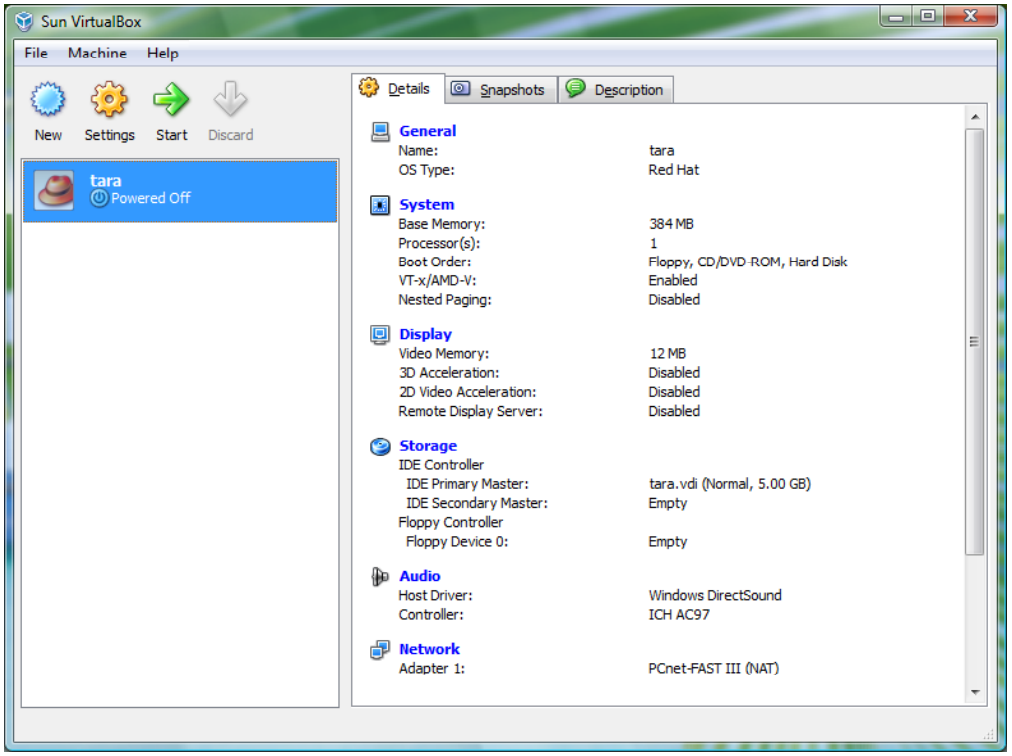
For Ed's CIS 165ph I used MSVS to installed Apache, PHP, MySql and PHPMyAdmin on a VM (XAMPP for Linux)

*Note: MS **Hyper-V** is the new CLI-based virtualization product going forward. It is part of Win Server 2008 and available stand-alone as a free download.*

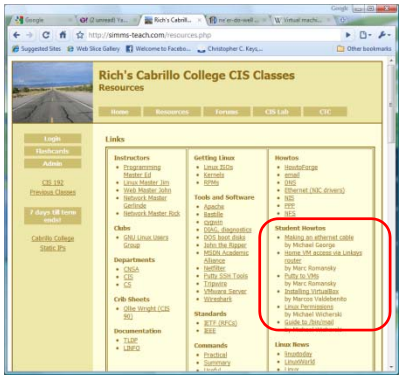
- ✓ Free download
- ✓ Multiple virtual networks
- ✓ Virtual serial ports

But … I did have some initial video problems installing some Linux distros

Sun VirtualBox 3.1.4

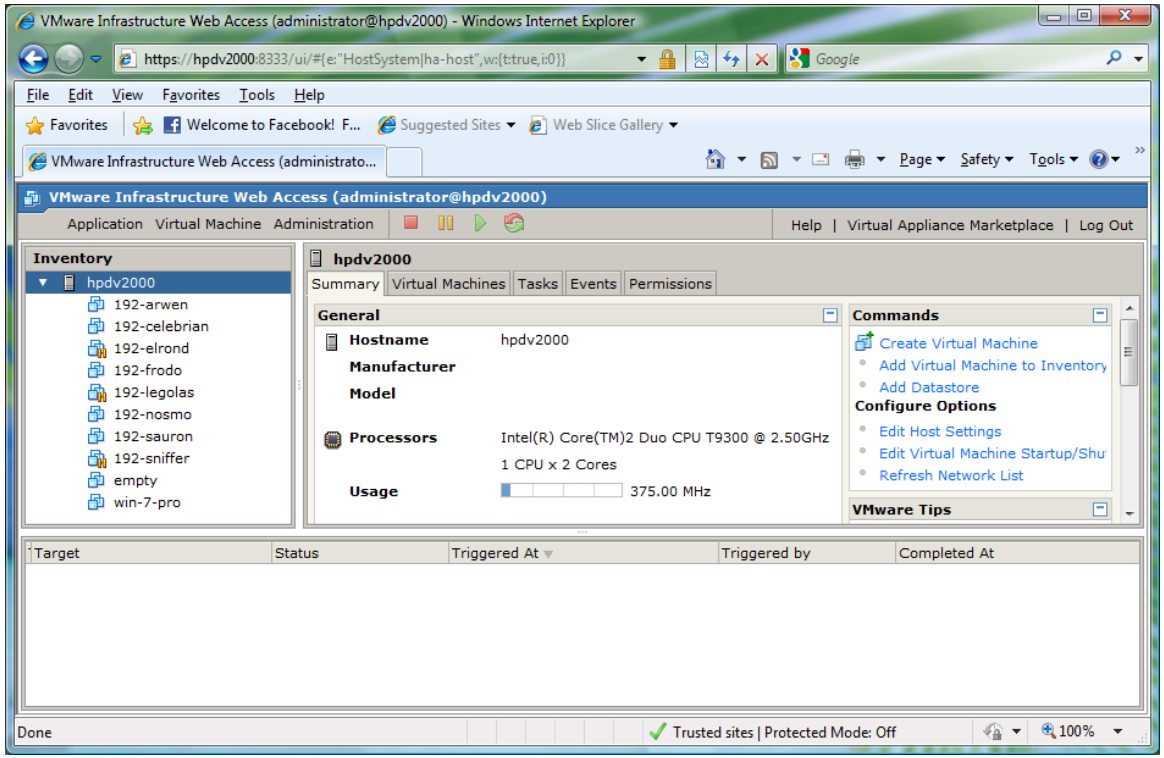


Marcos did a Howto on VirtualBox which is on the Resources page of the web site in the Student Howtos section



- ✓ Free download
- ✓ Virtual serial ports
- ✓ Has multiple internal networks
- ✓ Supported on Windows 7 (unlike VMware Server 1.x)

VMware Server 2.x

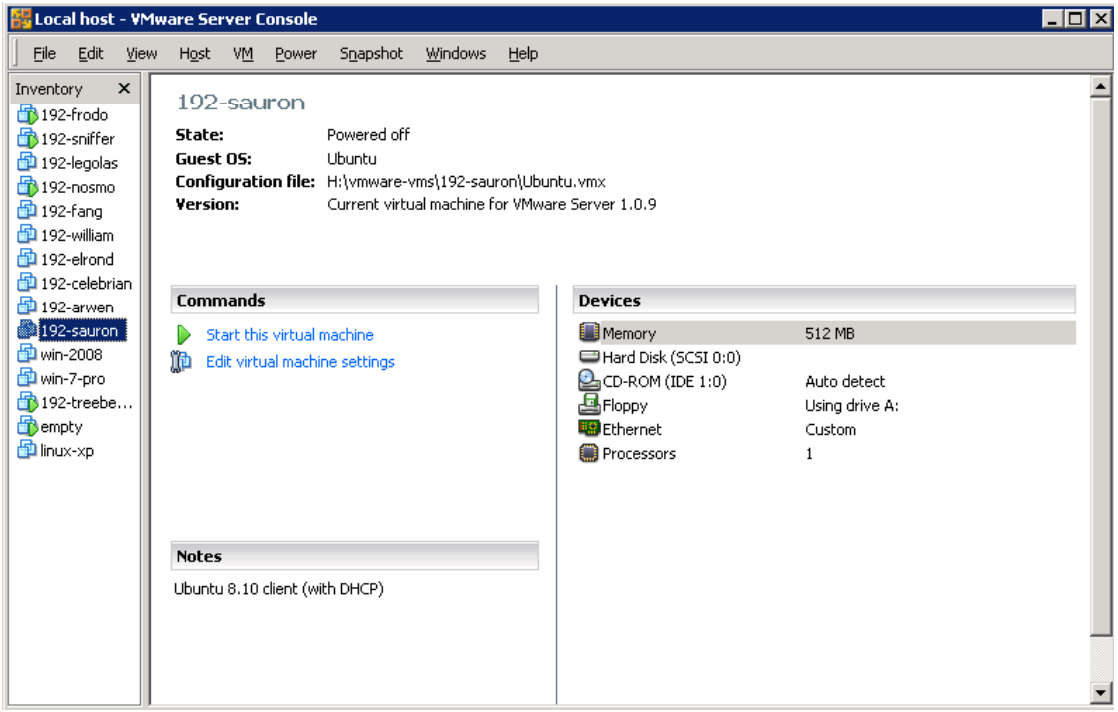


I use this on my Vista-64 notebook computer (4GB RAM)

- ✓ Free download
- ✓ Multiple virtual networks
- ✓ Virtual serial ports

but ... first-time install much more complicated than VMware Server 1.x

VMware Server 1.x



We use VMware Server in the classroom and lab

- ✓ Free download
- ✓ Multiple virtual networks
- ✓ Virtual serial ports

but ... not supported on Vista and on Windows 7. Must disable certificate checking on every boot-up

VMware ESXi

This is a "bare-metal" hypervisor

It is not installed on another OS

- ✓ Free download
- ✓ Multiple virtual networks
- ✓ Virtual serial ports

Looks very interesting!

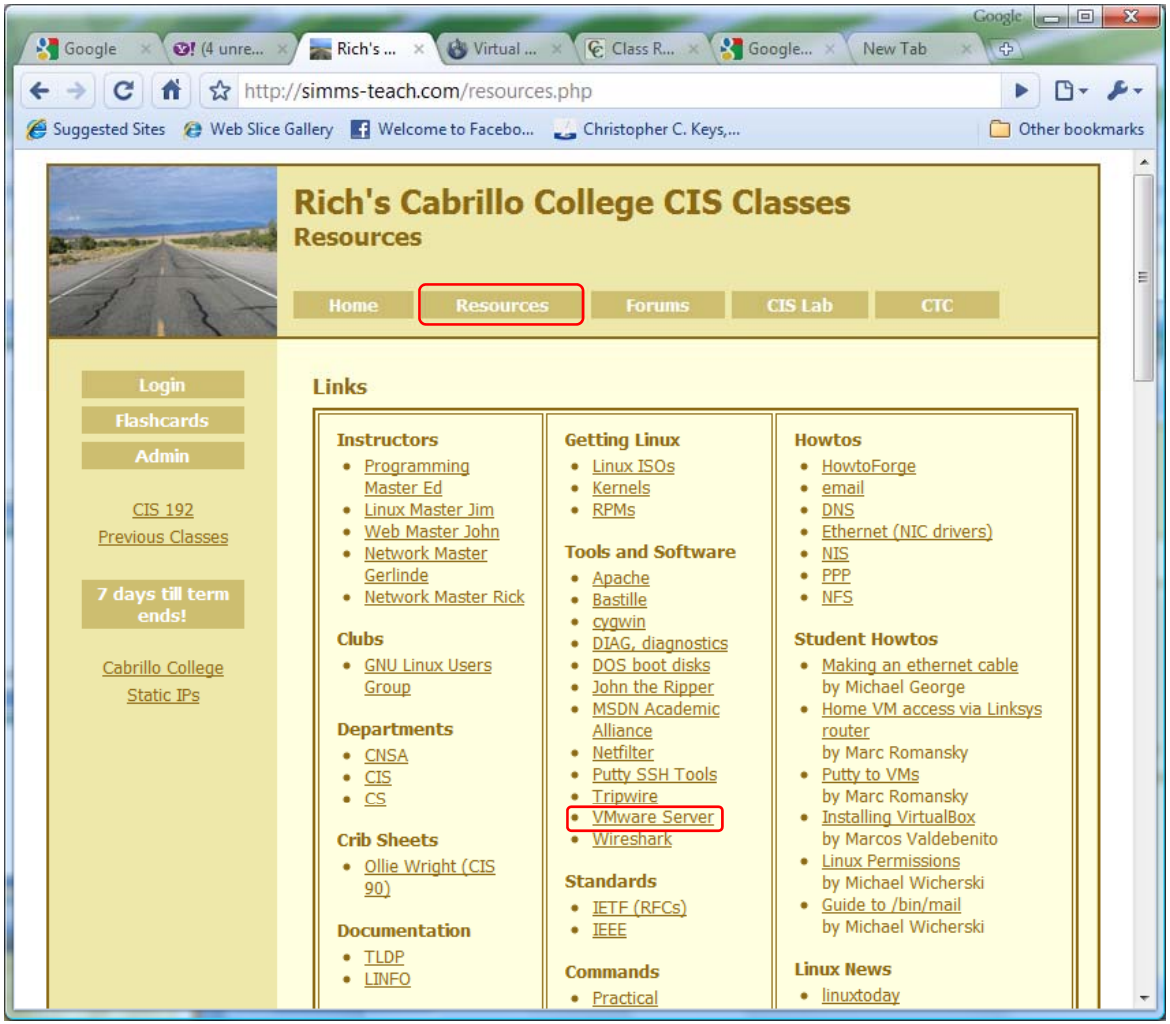
Xen and KVM (Kernel-based Virtual Machine)

- Xen is a bare-metal hypervisor. It is the foundation for XenServer from Citrix
- KVM is a new serious alternative. Supported by Red Hat and Canonical (Ubuntu)

I haven't tried these two yet

✓ Free download
✓Open source
? Multiple virtual networks
? Virtual serial ports

They both look very interesting!



There is a link on the Resources Page for downloading VMware Server

Look in the Tools and Software section

Virtualization within virtualization

Dynamips and Dynagen

Options for learning to use a router

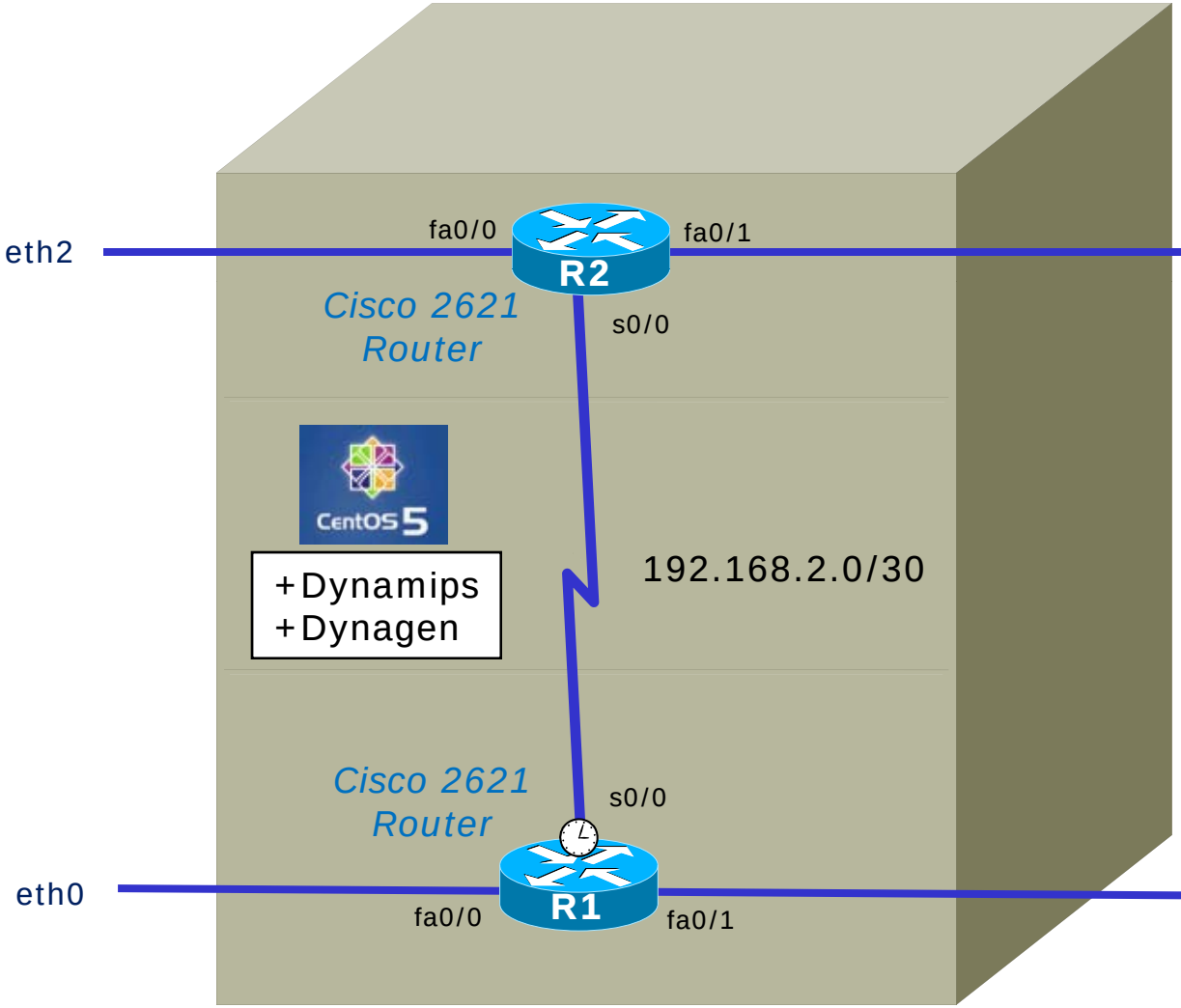
- A real router (hands on)
- Net Lab (remote access)
- Packet Tracer 5.2
- Dynamips/Dynagen emulator
  - on a real PC
  - on a VM

You can think of Dynamips/Dynagen as "VMware for routers." IOS runs on the emulator just like a Linux OS runs on a VM.

See the Dynamips/Dynagen tutorial at http://dynagen.org/tutorial.htm

The Dual-c2621s VM

Located in: D:\cis192\My Virtual Machines\192-Dual-c2621s



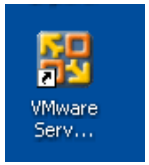
- R1 fa0/0 = Ethernet/eth0
- R1 fa0/1 = Ethernet2/eth1

- R2 fa0/0 = Ehternet3/eth2
- R2 fa0/1 = Ethernet4/eth3

A CentOS VM that runs Dynamips/Dynagen to emulate one or more Cisco routers

VMware 101

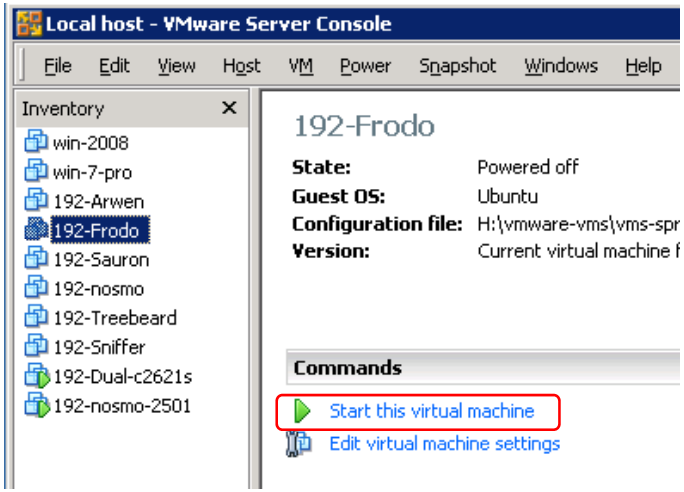
Power on a VM



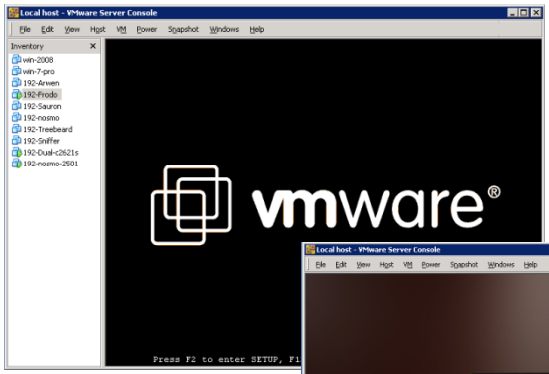
VMware Server icon on Windows desktop

Choose **Local host** to access local VMs.

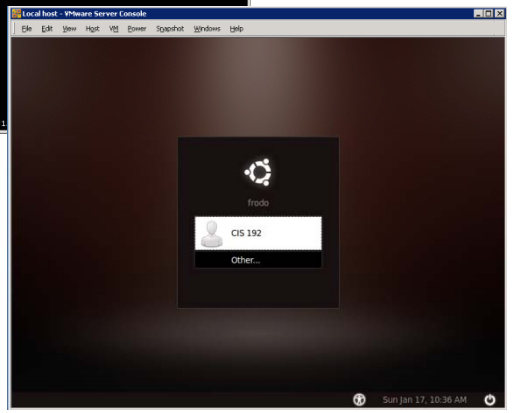
Note: If you don't see this choice, wait a minute or two and try again. This can happen if you just booted up the PC and not all the VMware services have started up.



Select a VM, then **Power On** or **Start this virtual machine** to start the VM



Initial BIOS screen



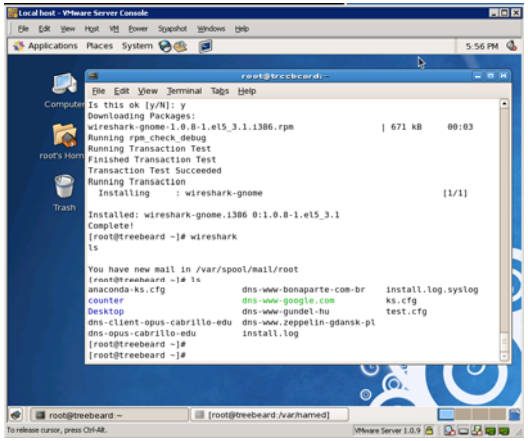
Login after start-up is complete

Keyboard and mouse

Which computer has the keyboard and mouse?

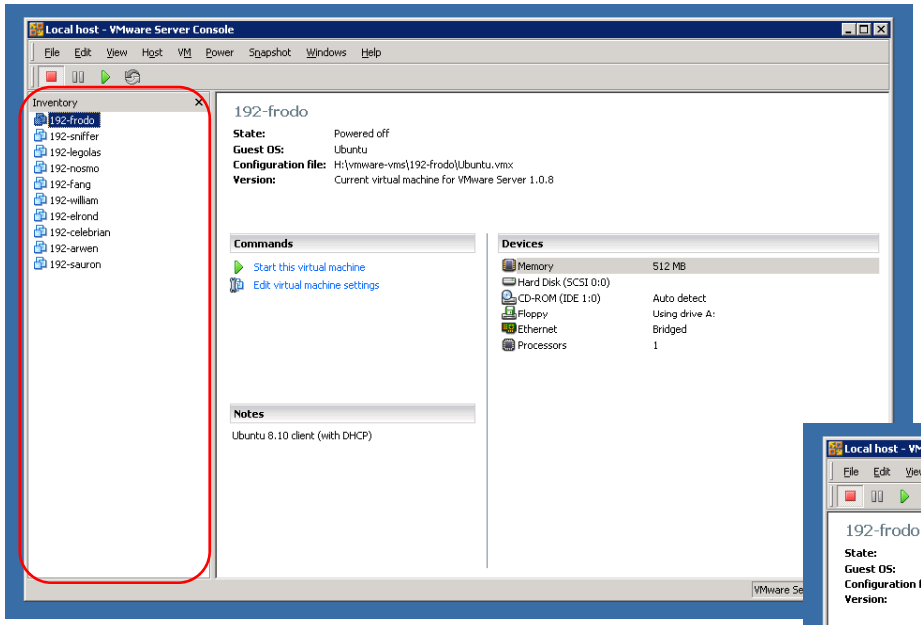
the Host?

the VM?

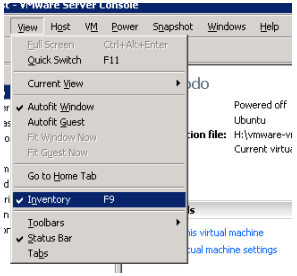


- **Click inside the VM** to let the VM use the keyboard/mouse
- Type **Ctrl-Alt** keys, at the same time, to release keyboard/mouse back to the host computer. See the hint on the lower left corner of the VM if you forget this.

Toggle Inventory View

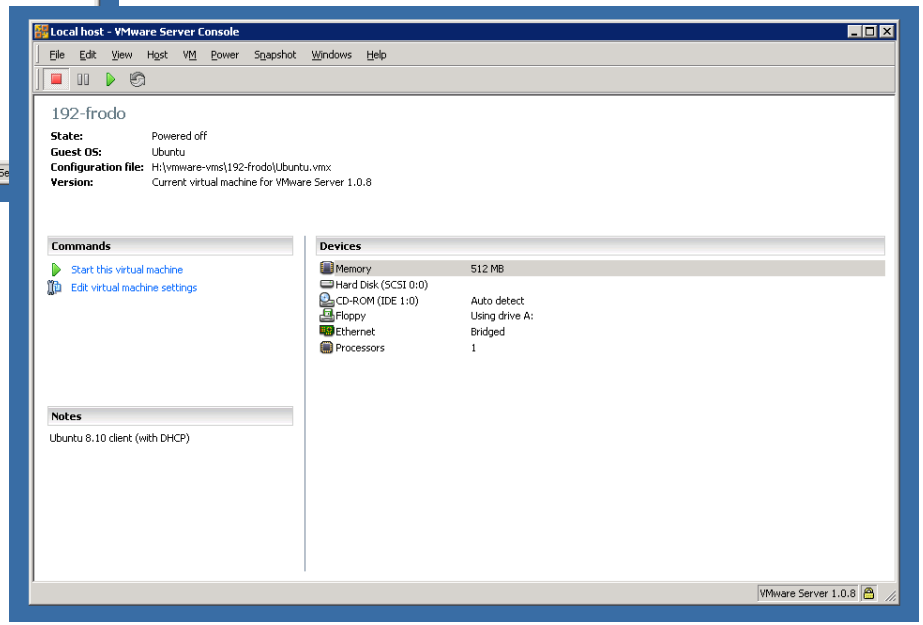


Inventory pane visible



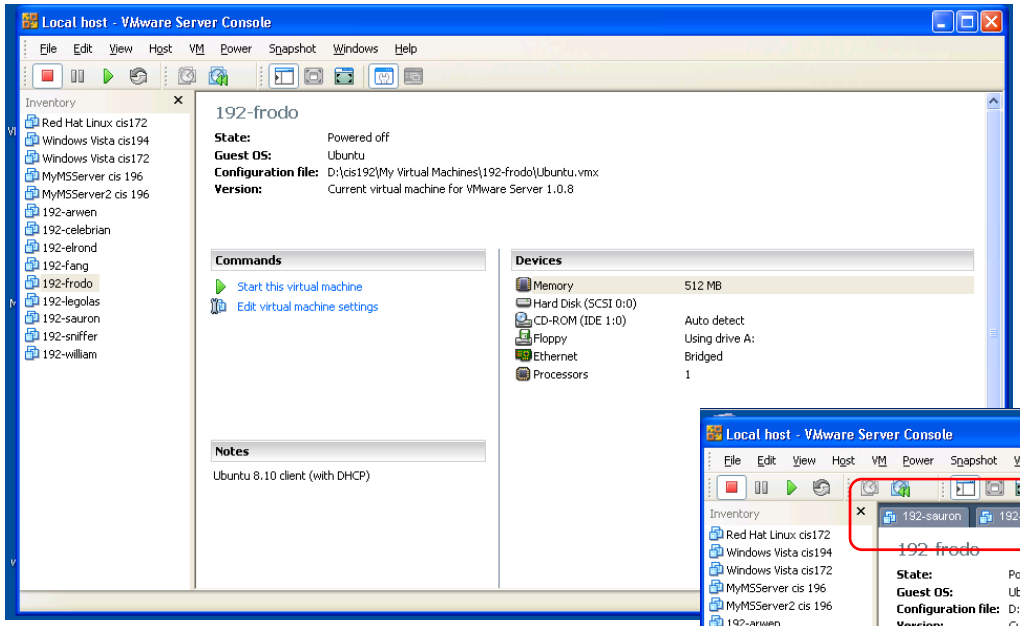
Use:
View > Inventory
or ***F9***
to toggle the Inventory pane view

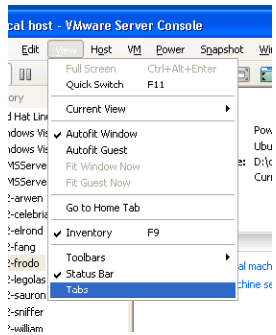
The inventory pane shows available VMs that are available for use.



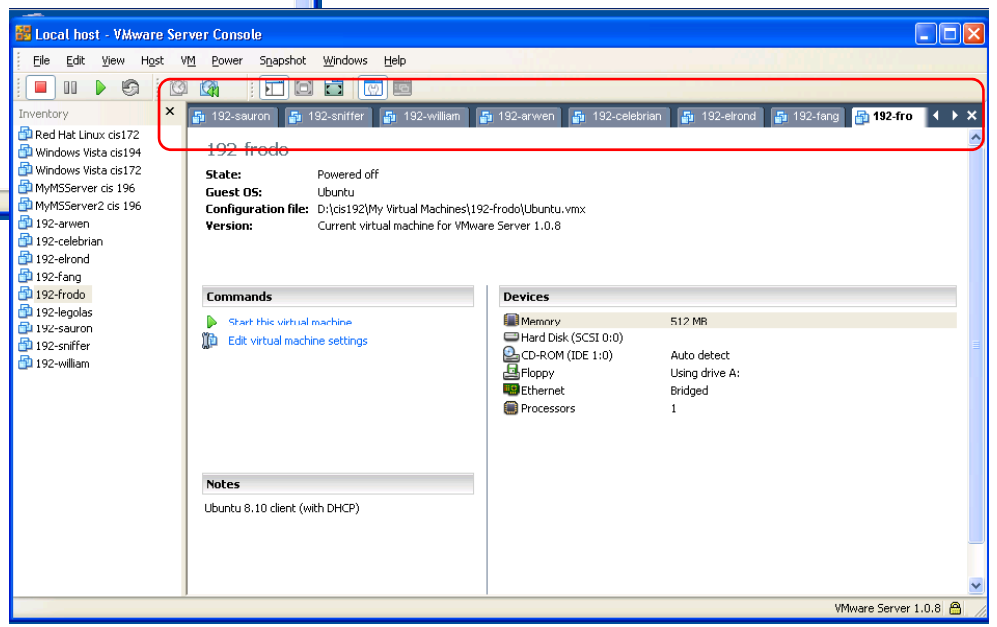
Inventory pane hidden

Toggle Tabs View



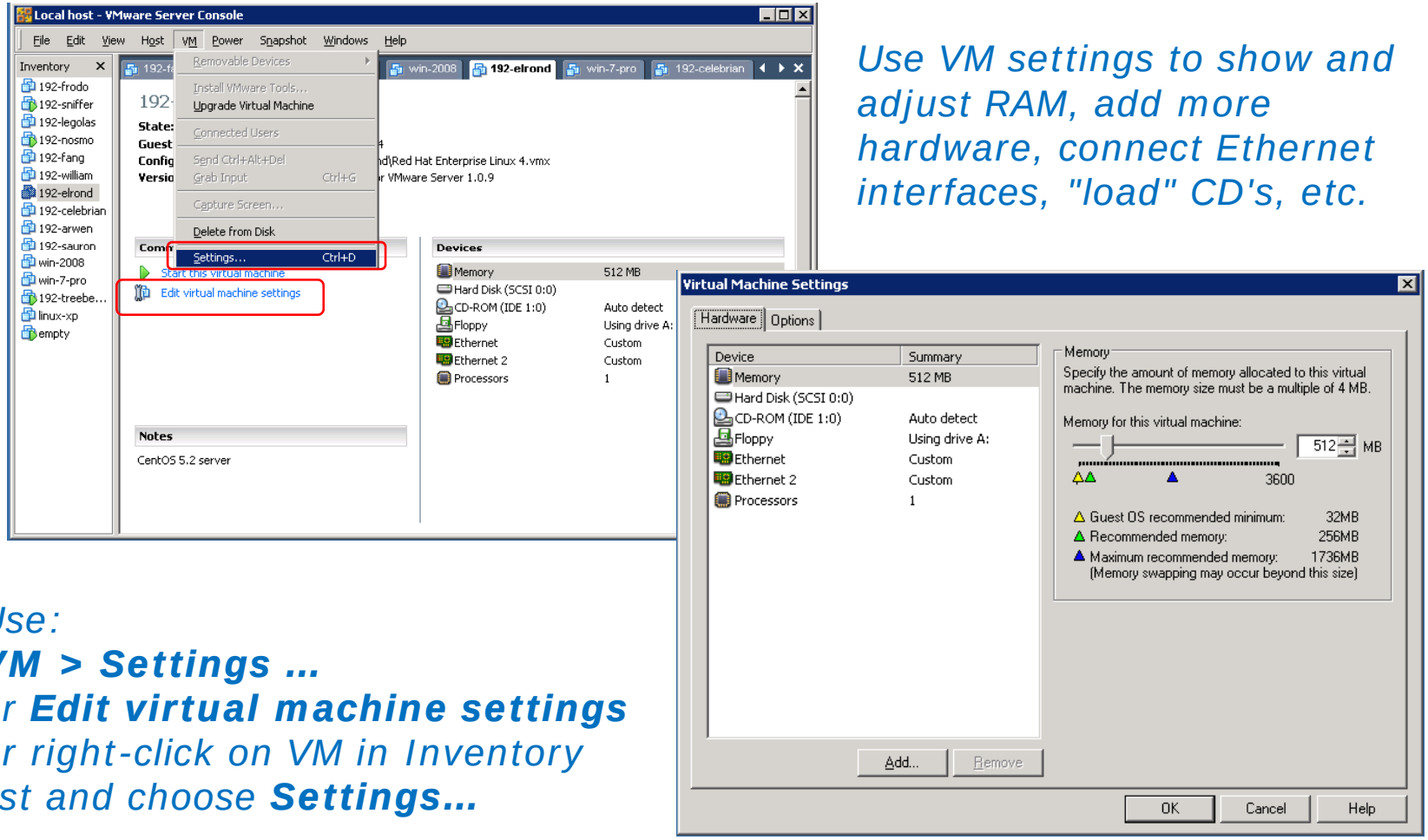


Use:
View > Tabs
to toggle



Disable Tabs if you need more vertical screen real estate

Configure VM Settings

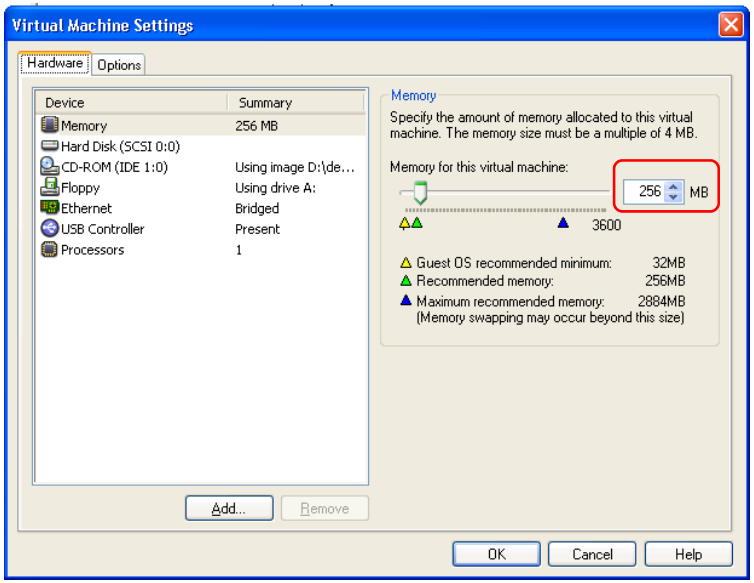


Use VM settings to show and adjust RAM, add more hardware, connect Ethernet interfaces, "load" CD's, etc.

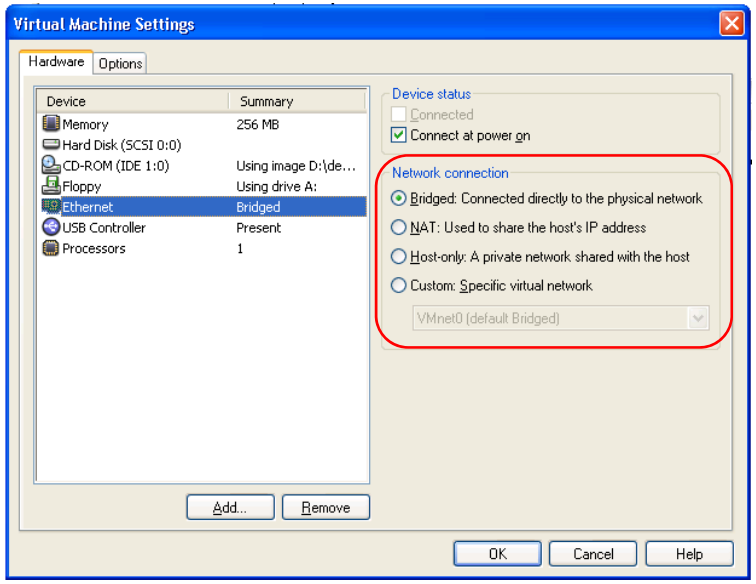
Use:
VM > Settings ...
or ***Edit virtual machine settings***
or right-click on VM in Inventory list and choose ***Settings...***

VM Settings Dialog Box

VM Settings Dialog Box



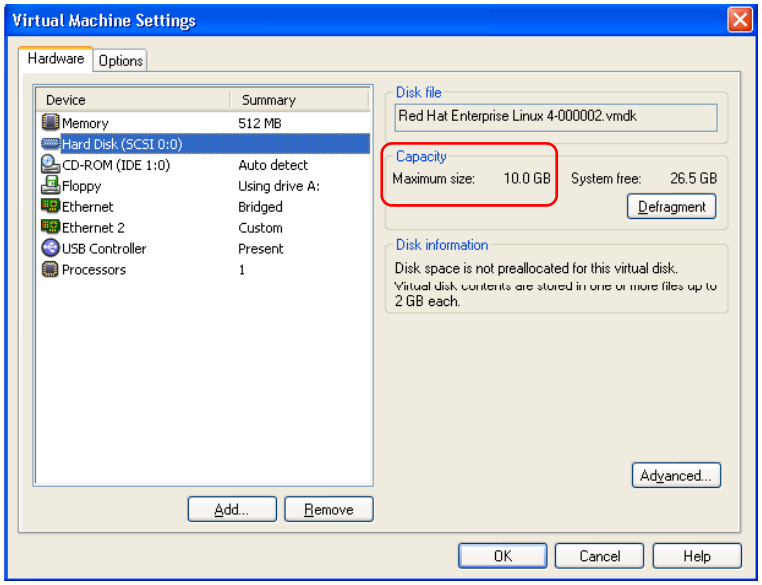
Showing RAM size



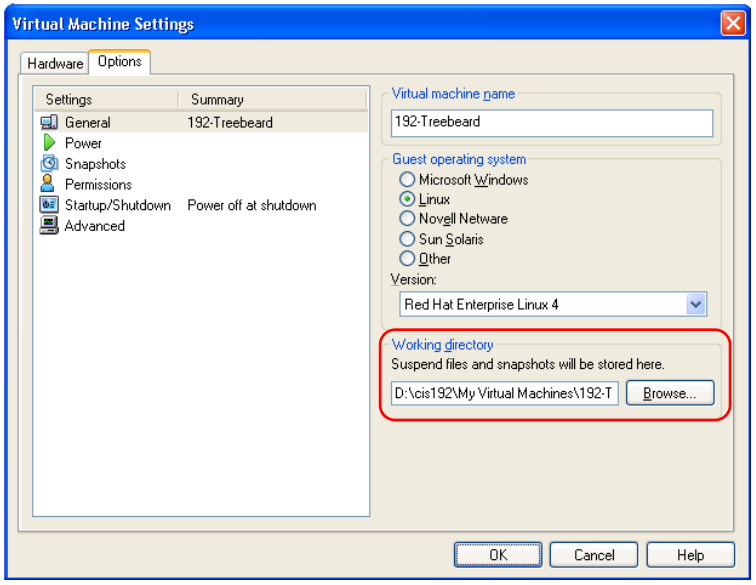
Showing NIC connection
(Bridged or specific VMnet)

Note: You will be using VM Settings to do the VM hardware inventory in Lab 1

VM Settings Dialog Box



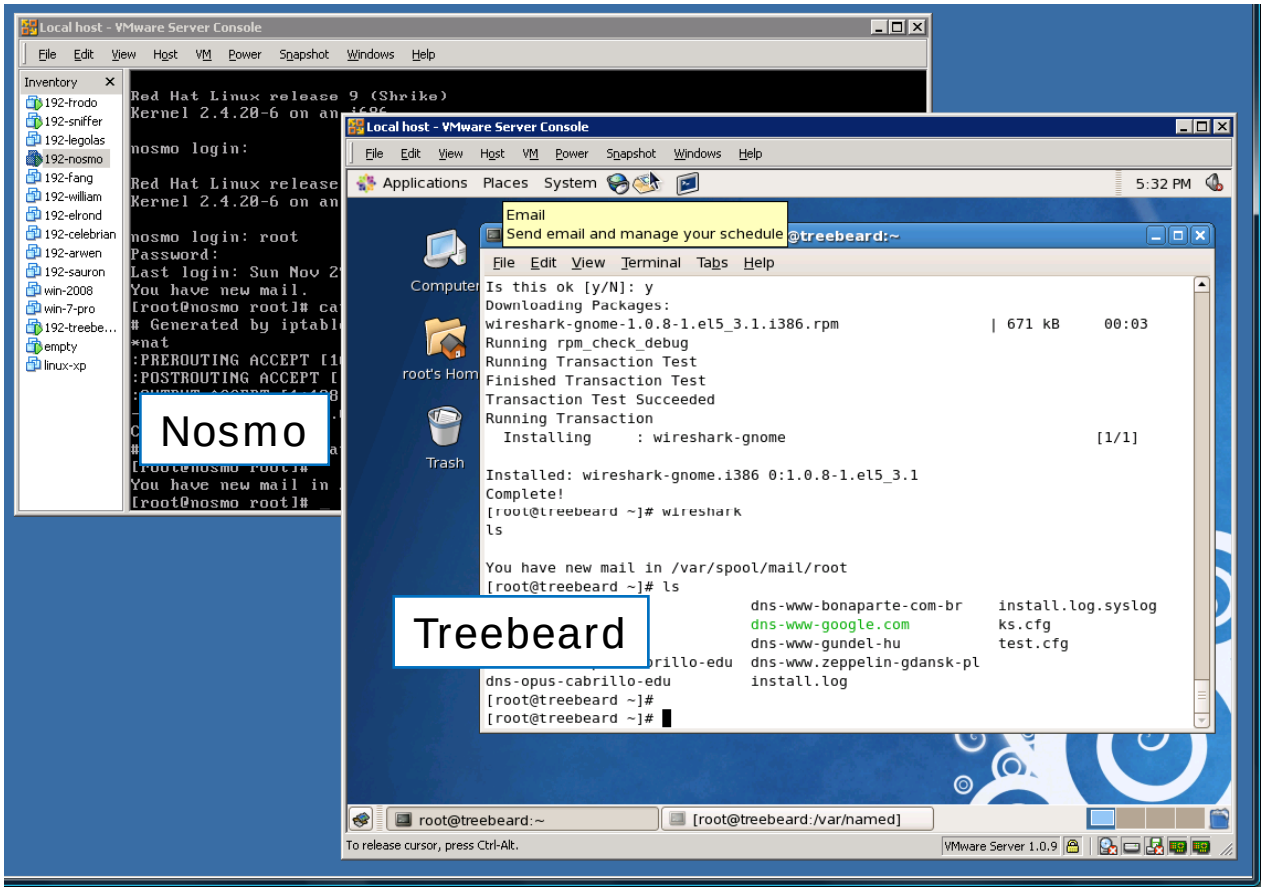
Showing hard drive capacity



Showing location of VM files on host VMware station

Note: You will be using VM Settings to do the VM hardware inventory in Lab 1

Multiple consoles

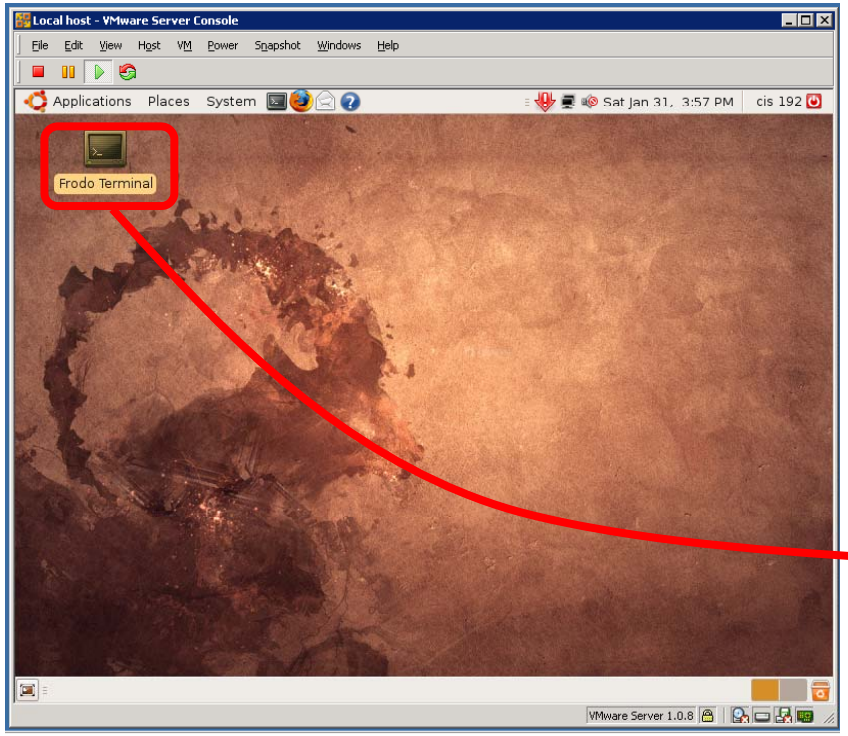


*The **Nosmo VM** is shown in one console*

*The **Treebeard VM** is shown in a second console*

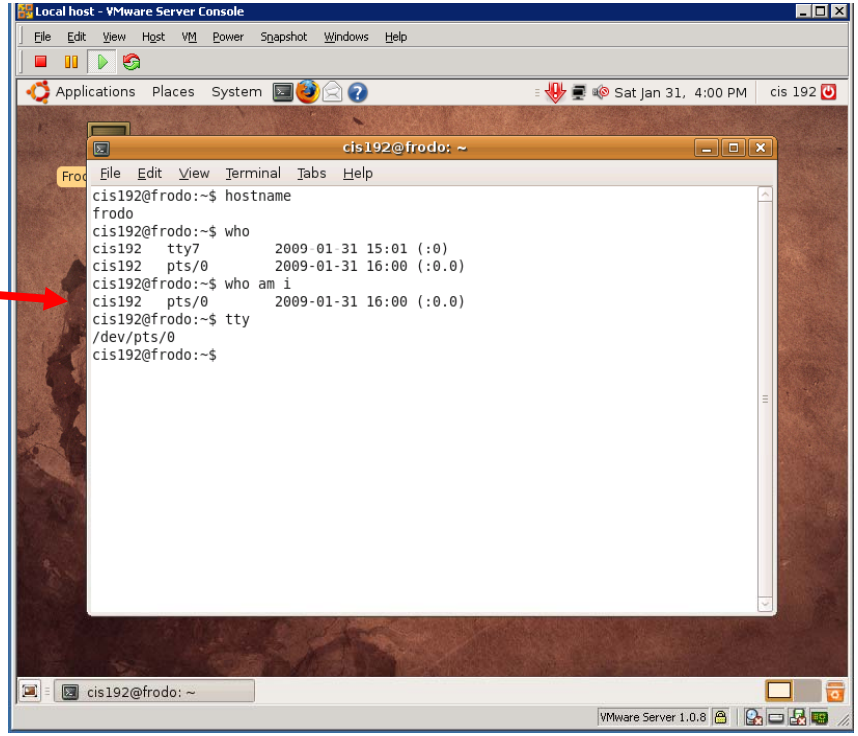
If your screen is big enough you may want to use a different console for each VM

Bringing up a graphical terminal



Open graphical terminal on Frodo by double clicking on icon

The Terminal program is also found under the Application menu of Gnome desktops



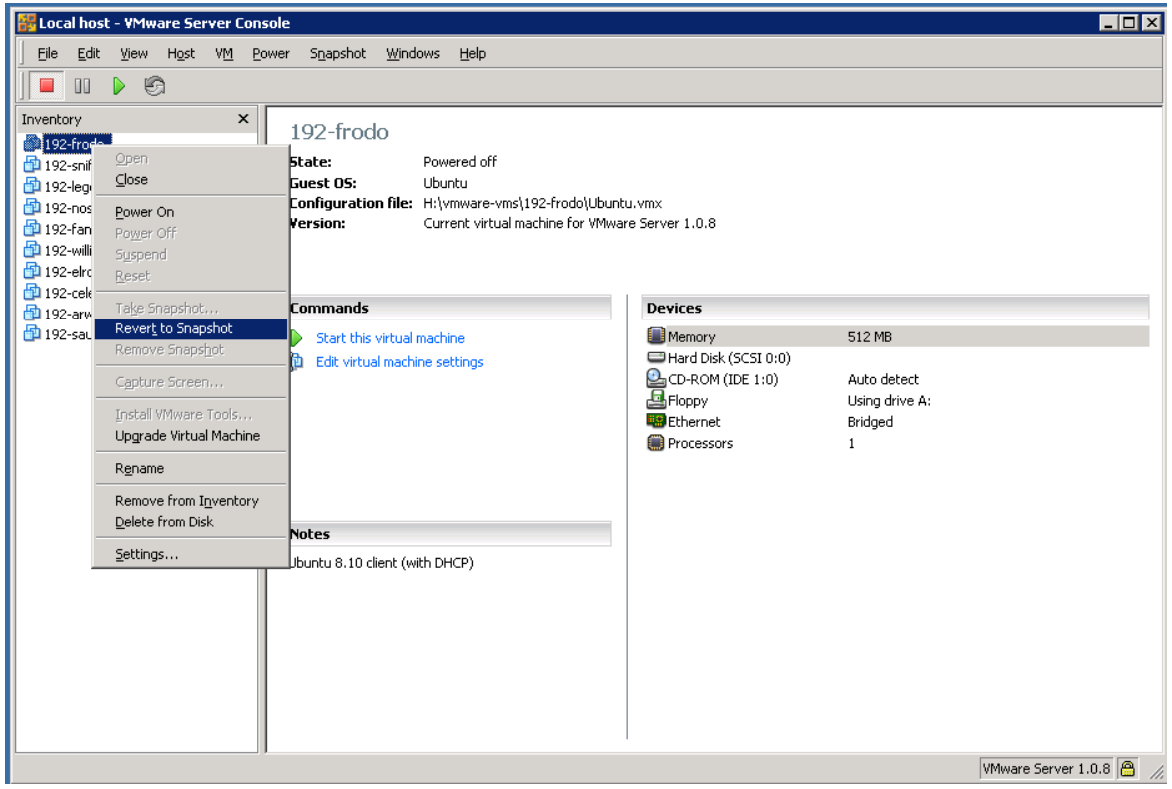
Type commands

Treat VMs as real computers

- Powering off a VM is the same as holding down the power button on a real computer. Any pending drive writes will be lost and open files may become corrupted.
- Shutting down your host VMware station before shutting down running VMs can also result in corrupted files for the same reason as above.
- The fastest way to shutdown Linux is to use: **init 0**
- Closing the VMware Server Console does not shut down the VM which will continue to run.

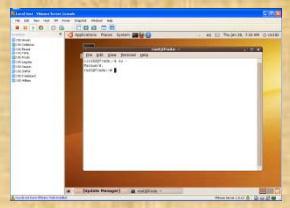
Always shutdown any running VMs when you are finished

Revert to Snapshot



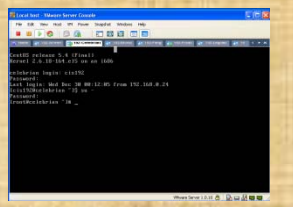
Revert to Snapshot *will restore the VM back to its pristine state.*

Very useful if you trash your system by mistake using your rootly powers!



Class Activity

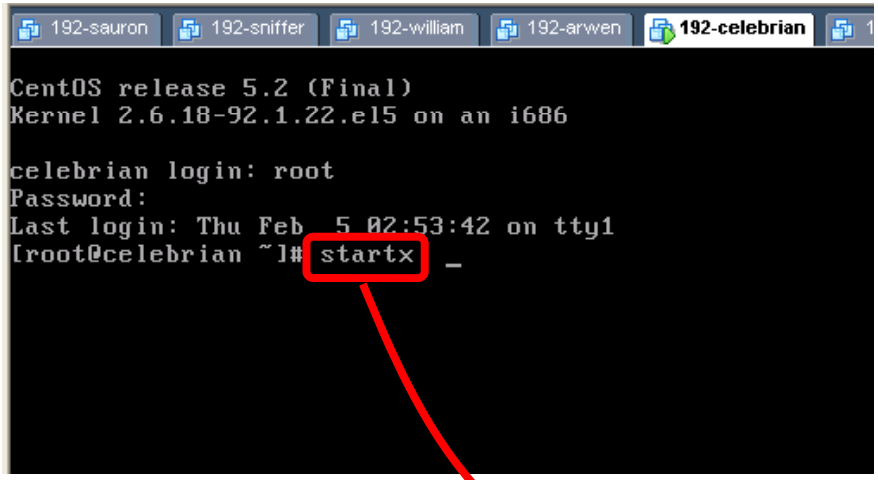
Fire up Frodo and Celebrian



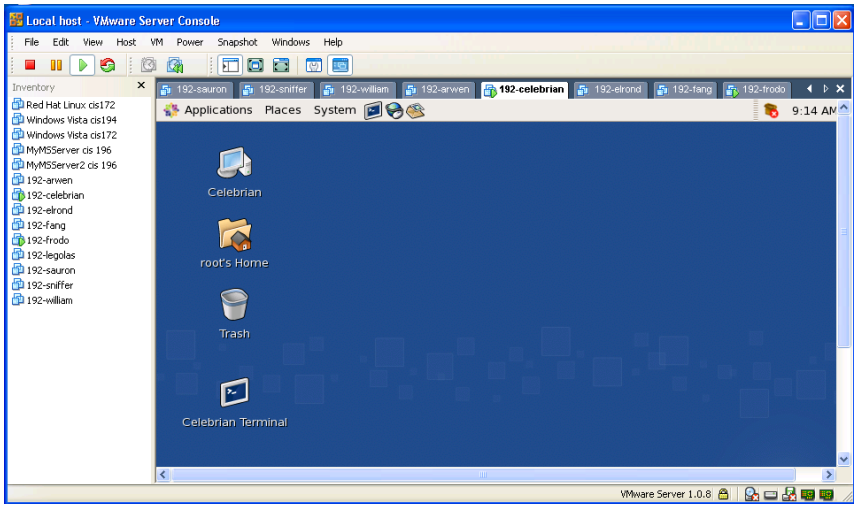
1. Explore the memory and Ethernet settings for the Frodo and Celebrian VMs (use **Edit virtual machine settings**)
2. Startup both Frodo and Celebrian VMs in two separate consoles.
3. Log in as **cis192** on both VMs,
4. On Celebrian, use **su –** to become root user.
5. On Frodo, start a graphical terminal and **su –** to become root user.
6. On Frodo, show the Inventory panel but no Tabs.
7. On Celebrian, show the Tabs but no Inventory panel.
8. Use the Inventory panels and Tabs to switch the two open consoles to a different VM.
9. Use **Ctrl-Alt-F1** on Frodo to get a virtual terminal and log in as root.
10. Shut down both VMs with **init 0**
11. After shutting down, revert both VMs back to their snapshots.

Click inside VM for it to capture the mouse, press Ctrl and Alt keys at the same time to release the mouse

Changing run levels

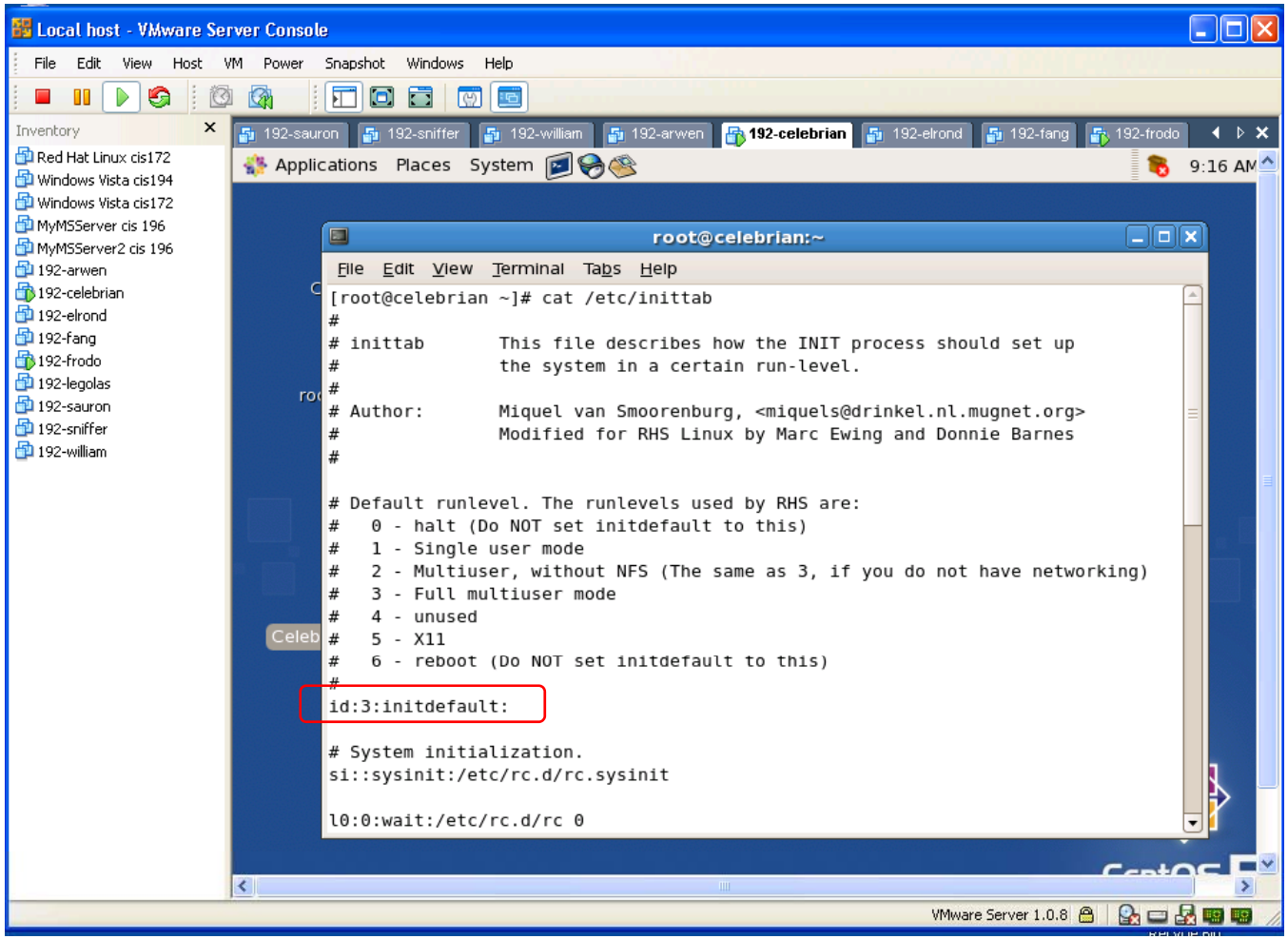


Most of the CentOS VMs are configured to boot up into runlevel 3.



startx *or* ***init 5*** *can be used to get to runlevel 5 (graphics)*

Tangent: Run levels (learn more in CIS 191)



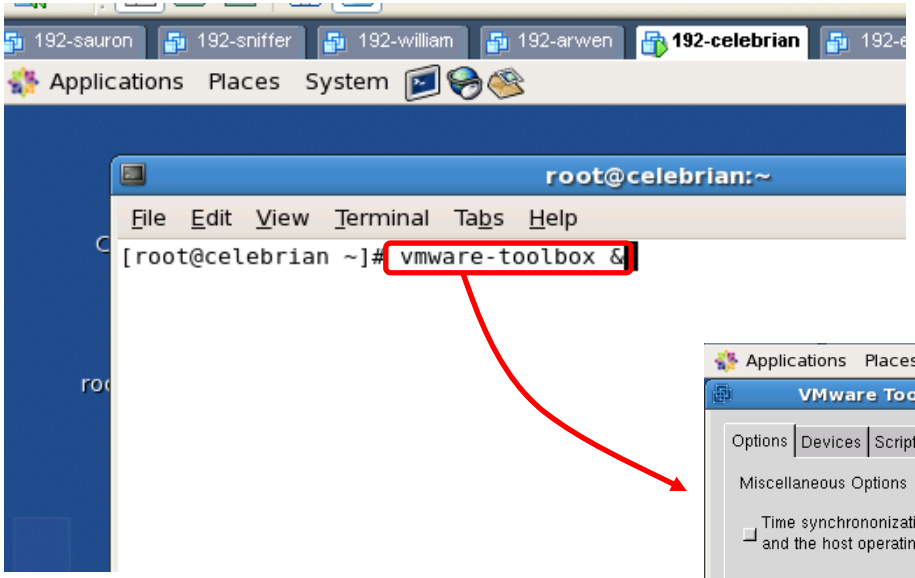
The initial run level is determined by a setting in /etc/inittab

Celebrian is configured to boot up into runlevel 3

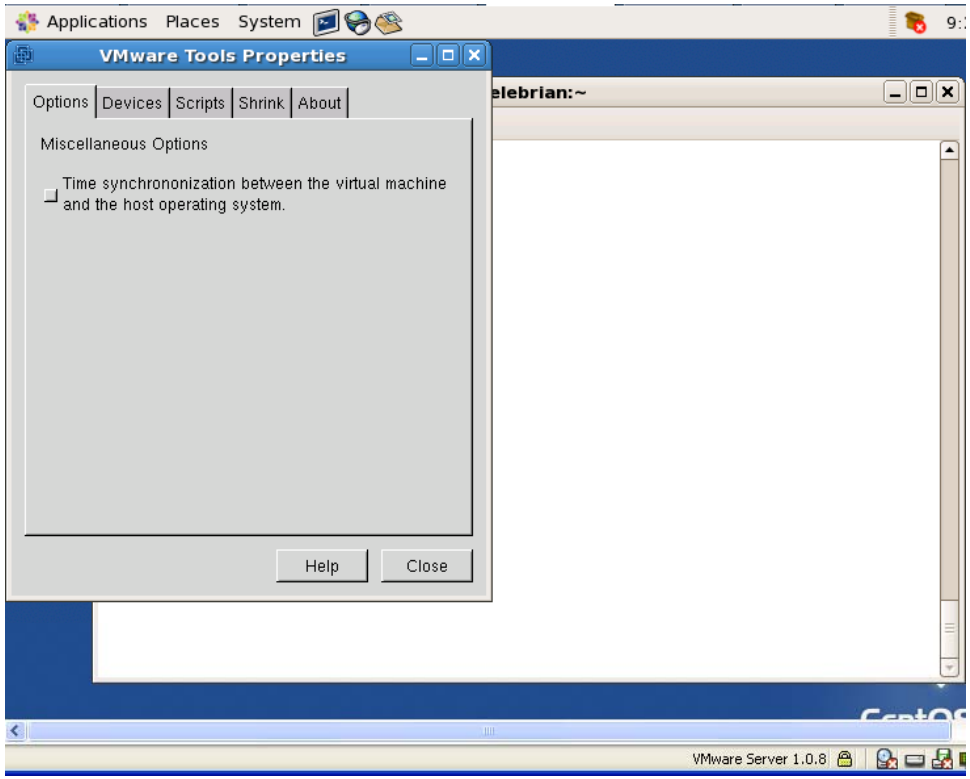
Copy and paste between VM and host

- Copy and paste between a virtual and host computer requires VMware Tools to be installed.
- VMware tools makes it easier to use and control VMs
- You only need to install VMware Tools on a VM once.
- After VMware Tools has been installed you must run a program called **vmware-toolbox** from the command line of a graphical terminal to enable copy & paste between systems.
- Append the command with a **&** so it runs in the background.

Copy and paste between VM and host

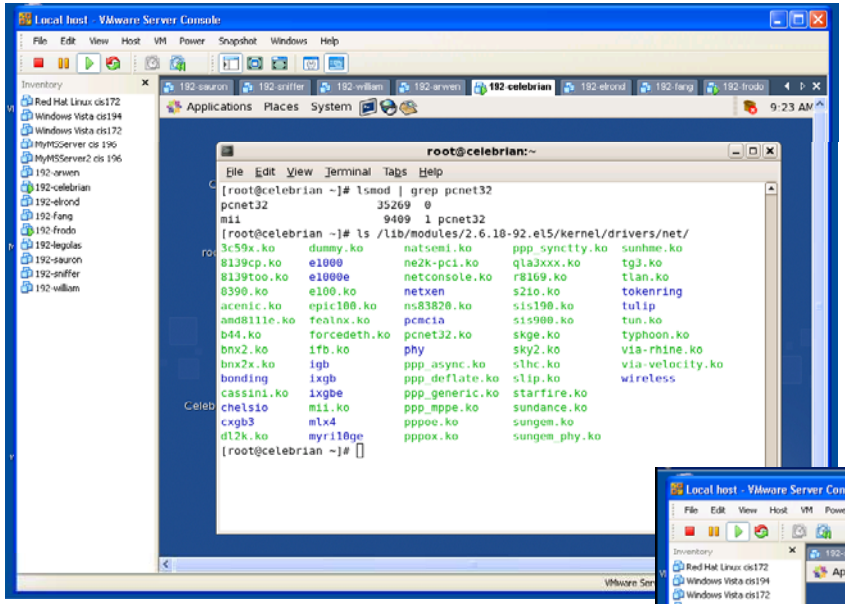


Enter the ***vmware-toolbox &*** *command*



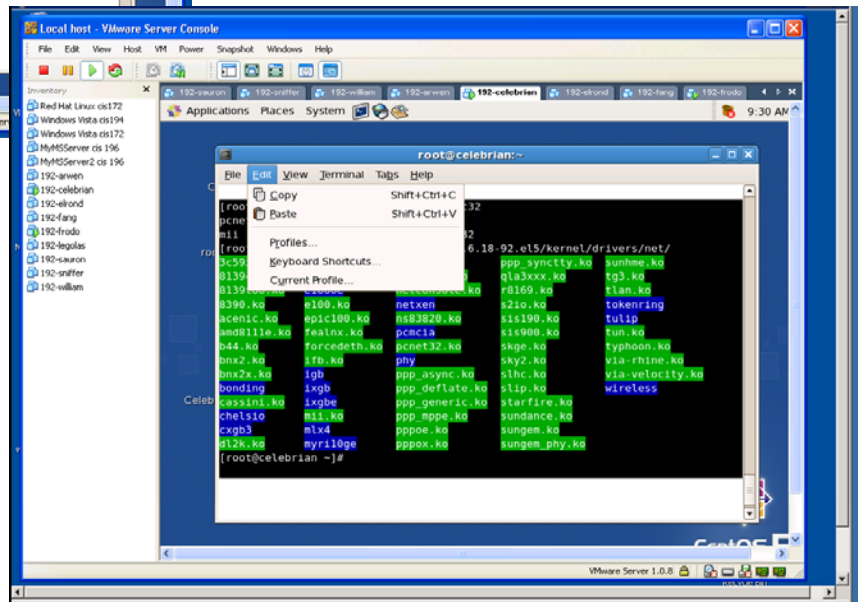
Minimize the resulting VMware Tools Properties box

Copy and paste between VM and host



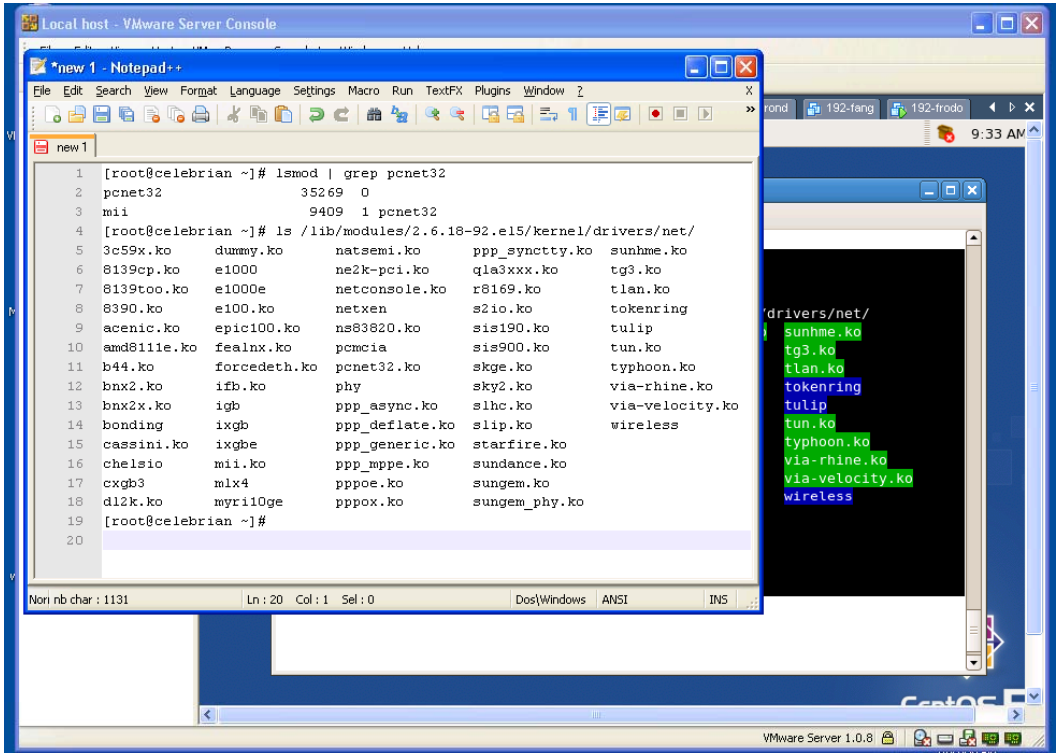
Type some example commands to test copy and paste with.

Note: These are commands we will be using in Lab1.



Select the text and copy it to the Linux clipboard

Copy and paste between VM and host



Open a program like notepad or notepadd++ on Windows and paste in the text

This is one way to exchange data with the Windows host. Putty (SSH), (p)scp and Filezilla (SFTP) are other methods we will learn later

Class Activity

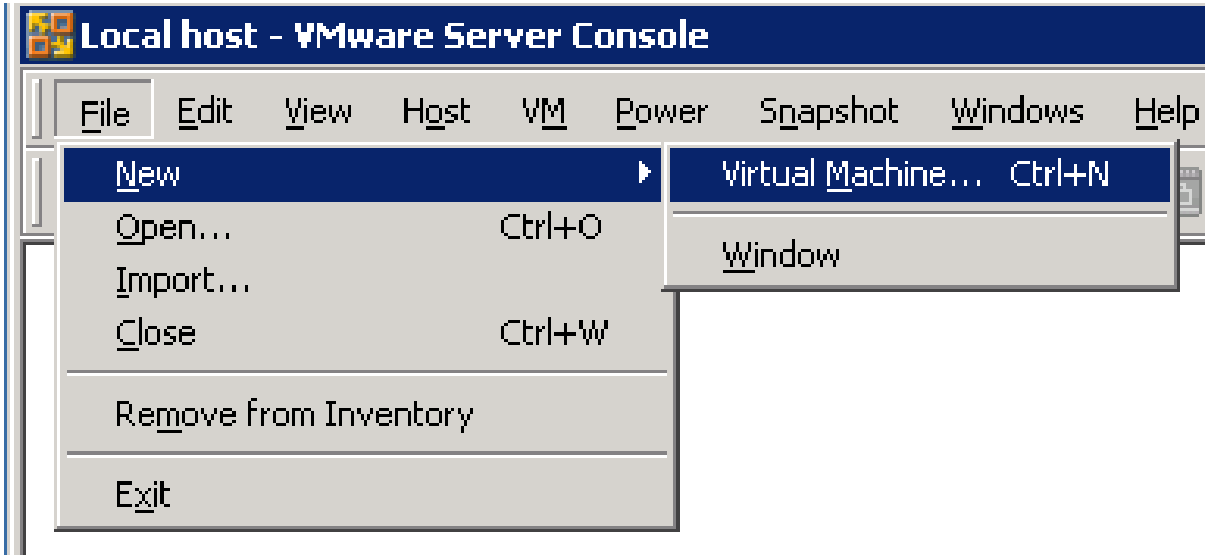
1. Start up **Celebrian** as cis192 and **su –** to root.
2. Change Celebrian to run level 5 (use **startx**)
3. Start up a graphical terminal on **Celebrian**
4. Use **vmware-toolbox &** and then minimize the property box that pops up.
5. Type **lspci** and **lsmod** commands to list hardware devices and loaded kernel modules.
6. Start up notepad++ on your Windows station (pinned to your start menu).
7. Copy and paste the lspci and lsmod output on Celebrian into Notepad++ on Windows.

Creating VMs

Creating a new VM

VMware Server 1.08

We are going to make a brand new virtual computer with one CPU, a 5 GB SCSI drive and 512 MB of RAM



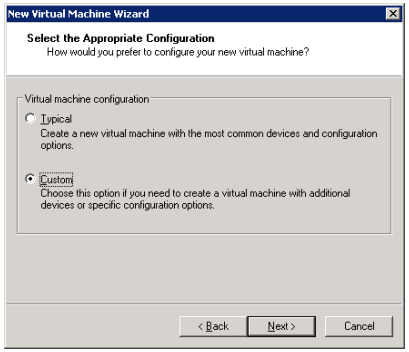
File > New > Virtual Machine

Don't' try it yet, we will first walk through how its done then everyone will make one in the next activity

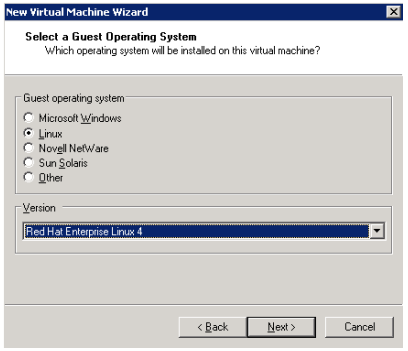
Creating a new VM

VMware Server 1.x

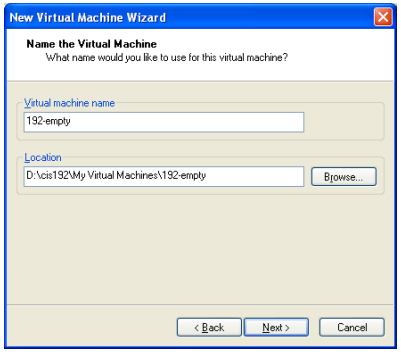
Next



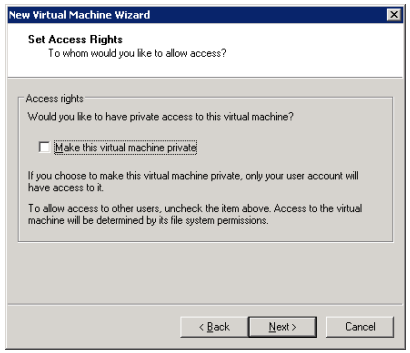
Custom



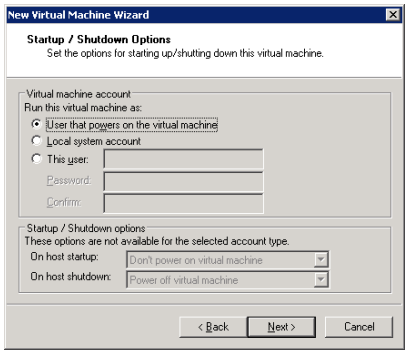
Linux
Red Hat Enterprise 4



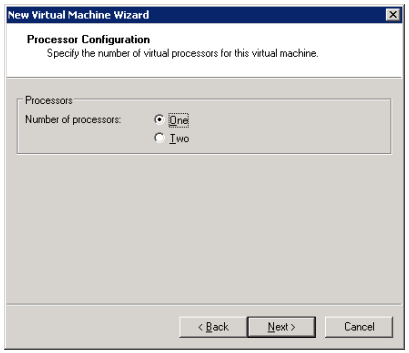
192-Empty
D:\cis192\My Virtual Machines\192-empty



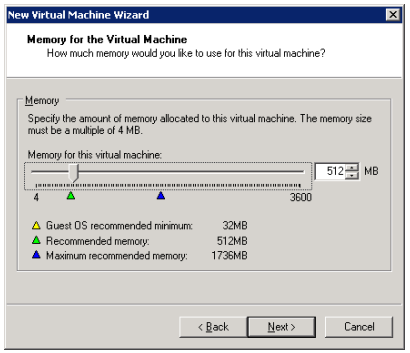
Not private



User that powers …



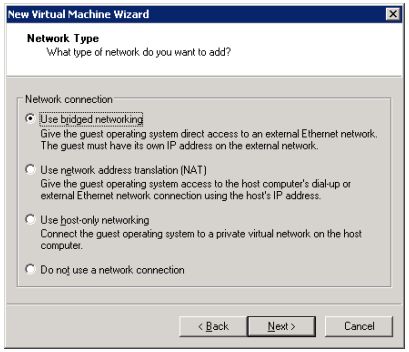
One



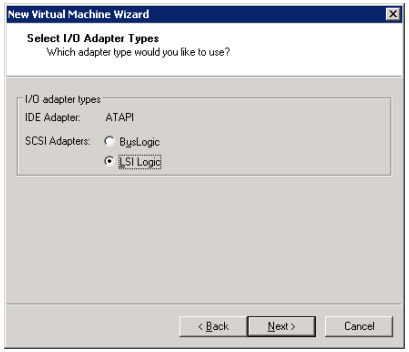
512 MB

Creating a new VM

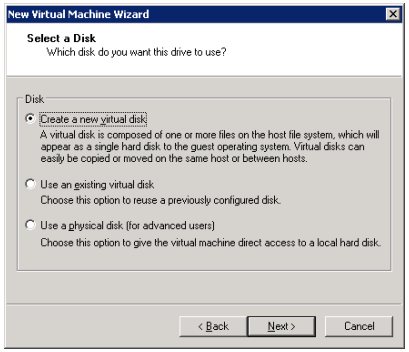
VMware Server 1.x



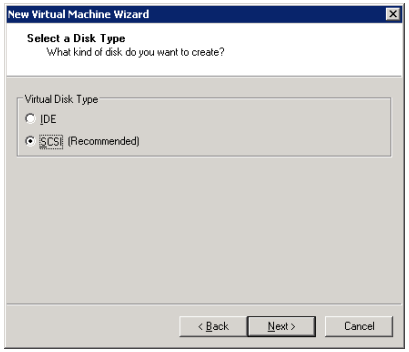
Bridged



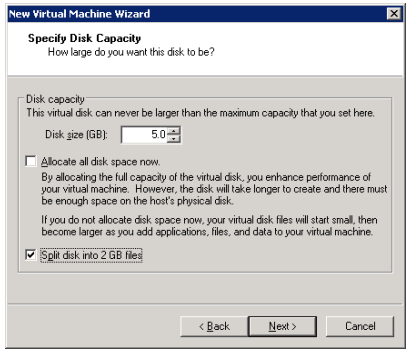
LSI Logic



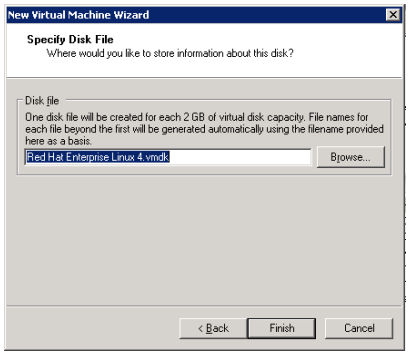
Create a new virtual disk



SCSI



5 GB
Don't allocate space now
Split into 2GB files

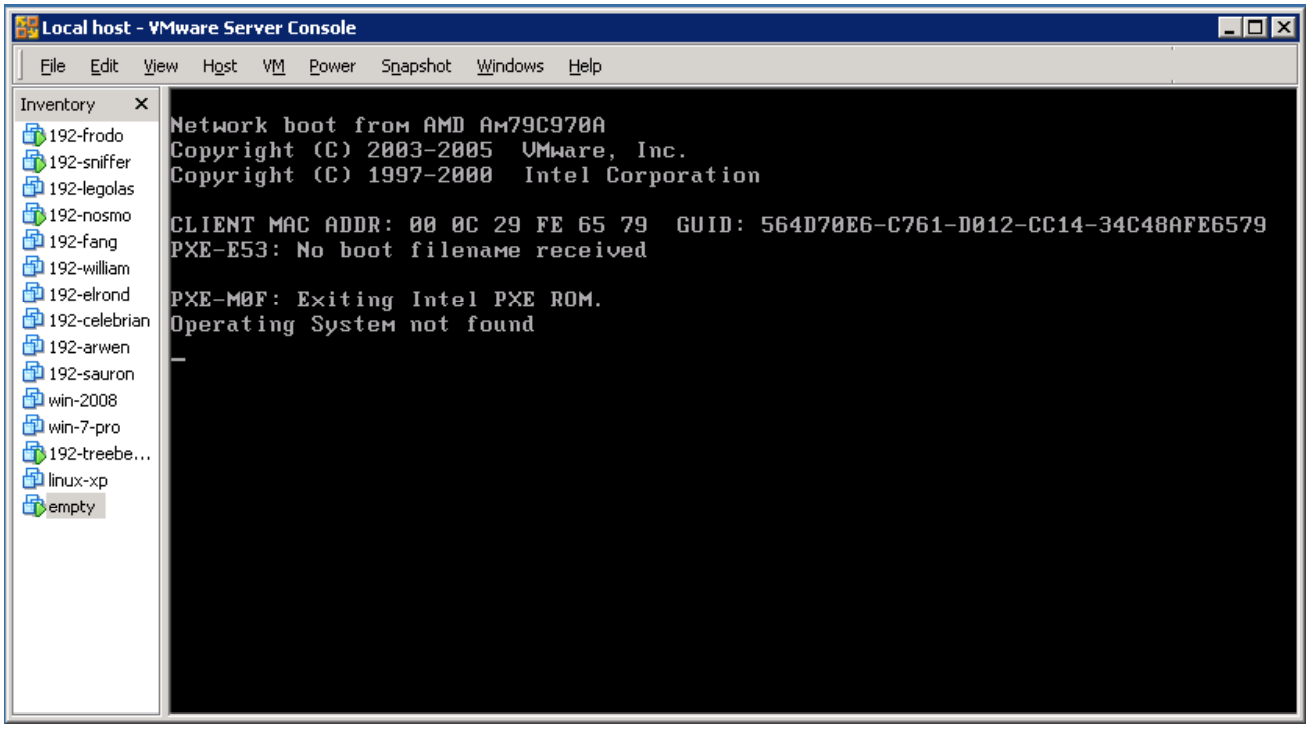


Red Hat Enterprise 4.vmdk

Creating a new VM

VMware Server 1.x

Powering on a new VM. Note the boot-up fails because there is no OS on the new hard drive.



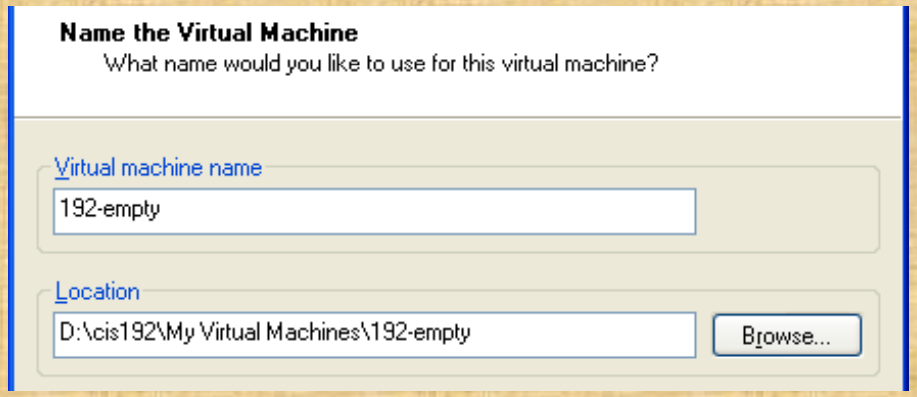
*A computer without an Operating System installed is sometimes called a **"bare-metal"** computer*

Class Activity – Make a computer

Now use the steps shown on the previous slides:

1) Create a new VM named **192-Empty** using the previous example exactly!

2) Don't take the default location for your new VM. Be sure you make it in the **D:\cis192\My Virtual Machines\192-empty** directory



3) Power it on when finished and observe what happens with a "bare metal" computer.

4) Power it off. We will use this VM again in another activity.

Cabling VMs

Cabling Devices on a Network

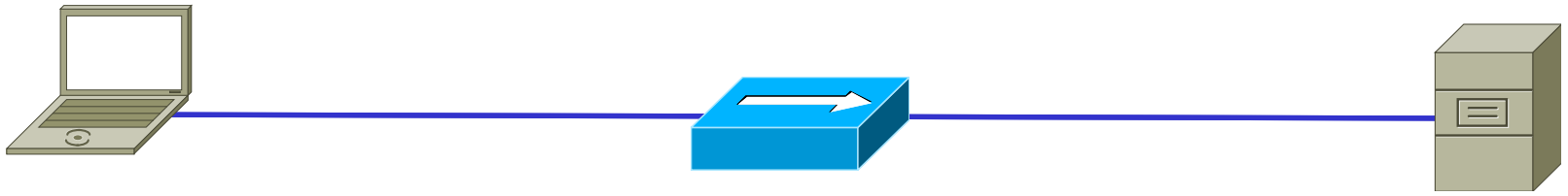
Desktop PC

Switch

Router

Cabling a PC to a router using a switch

Cabling Devices on a Network



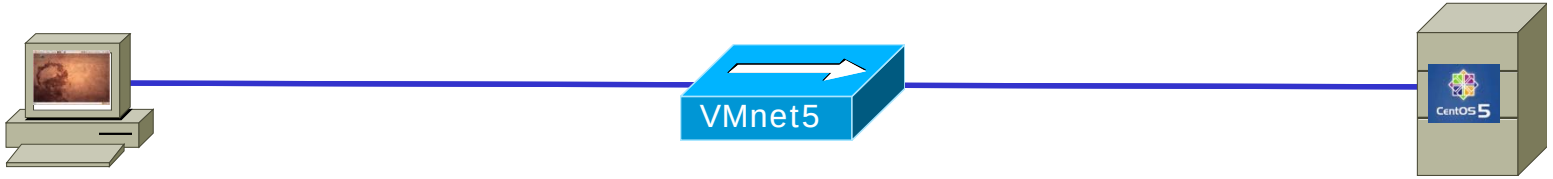
Notebook PC

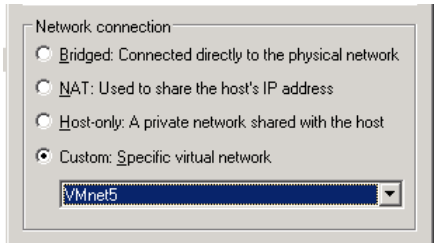
Hub

Server

Cabling a PC to a Linux router using a hub

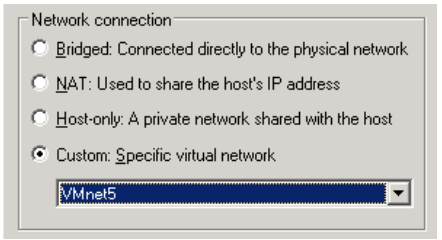
Cabling Devices on a Network





Network settings for the Ethernet device on the PC client VM

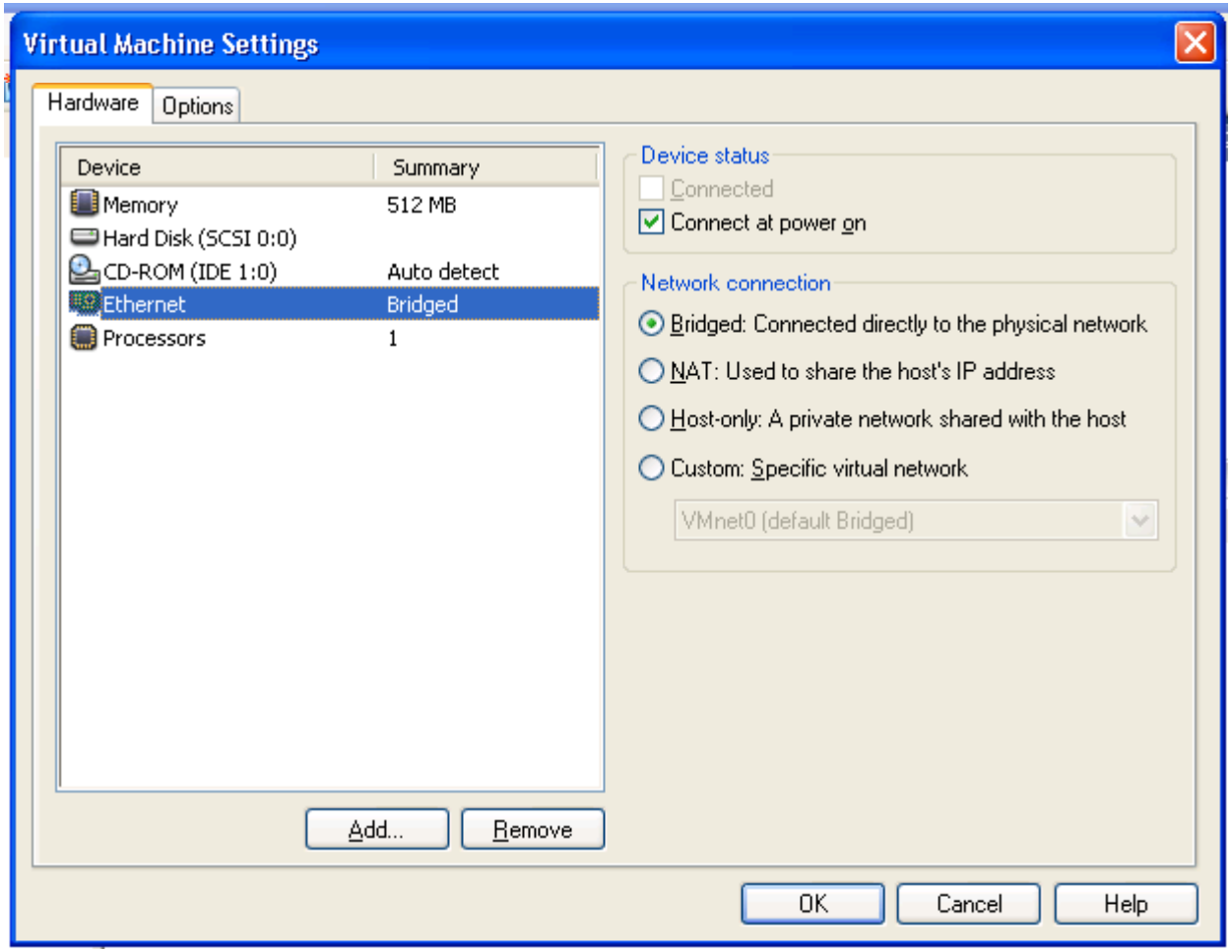
VMware provides multiple virtual networks. They function like virtual network hubs



Network settings for the first Ethernet device on the Linux router VM

Cabling a virtual PC to a virtual Linux router using a virtual hub

Cabling VMs

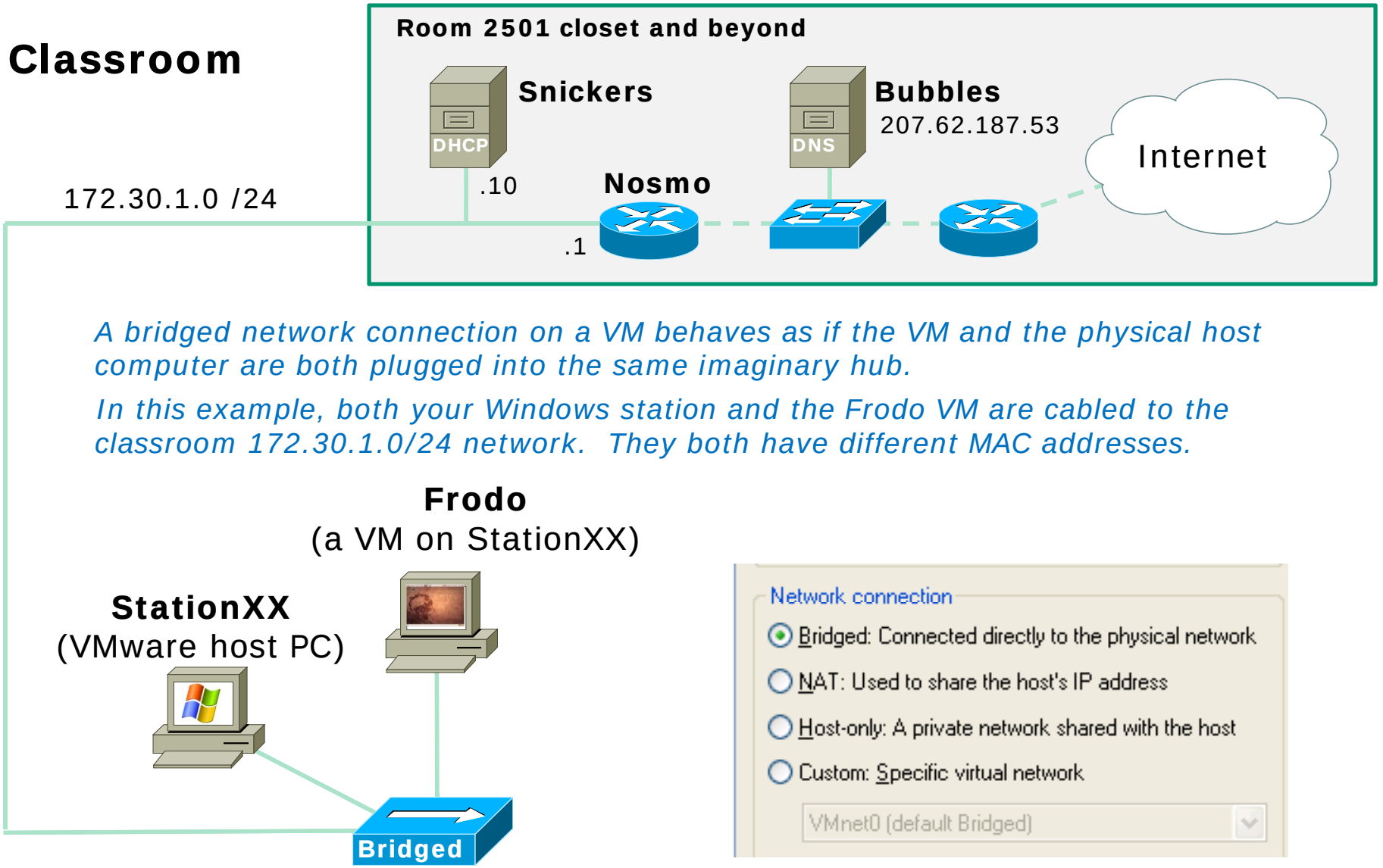


Cabling is done with the VM Settings for the Ethernet device (the NIC)

***Bridged** means the VM's NIC will use the host's physical NIC and be attached to the same network the host is. The virtual NIC will have its own MAC address.*

***VMnets** can be though of as virtual hubs the VM can be cabled to.*

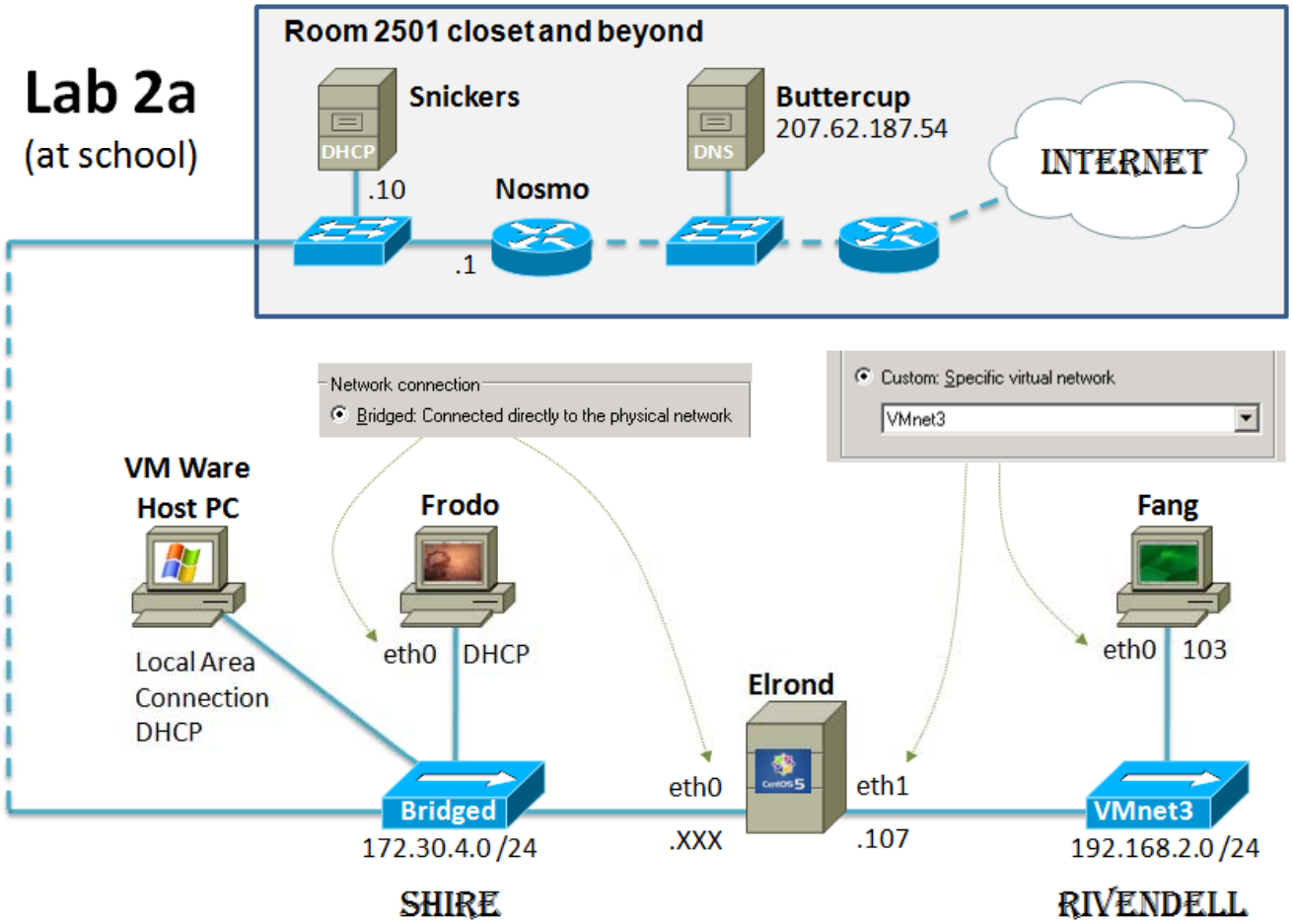
Cabling VMs – Example 1



A bridged network connection on a VM behaves as if the VM and the physical host computer are both plugged into the same imaginary hub.

In this example, both your Windows station and the Frodo VM are cabled to the classroom 172.30.1.0/24 network. They both have different MAC addresses.

Cabling VMs – Example 2



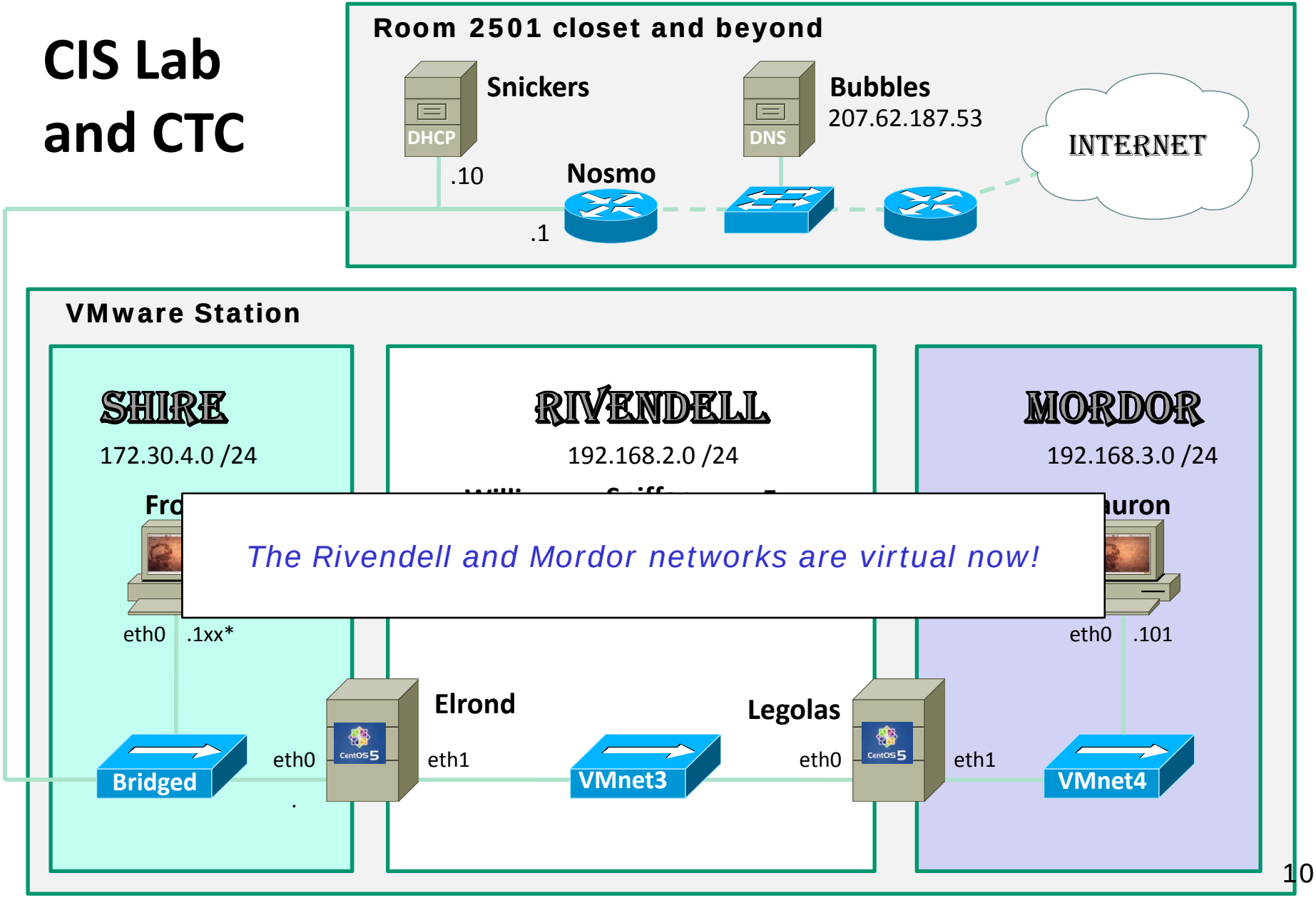
*Fang's NIC and Elrond's 2nd NIC are cabled to the Rivendell network. This is a **virtual network** using VMnet3.*

*Frodo and Elrond's 1st NIC are cabled to the Shire network (this is the physical network in the lab using a **bridged** connection)*

Lord of the Rings

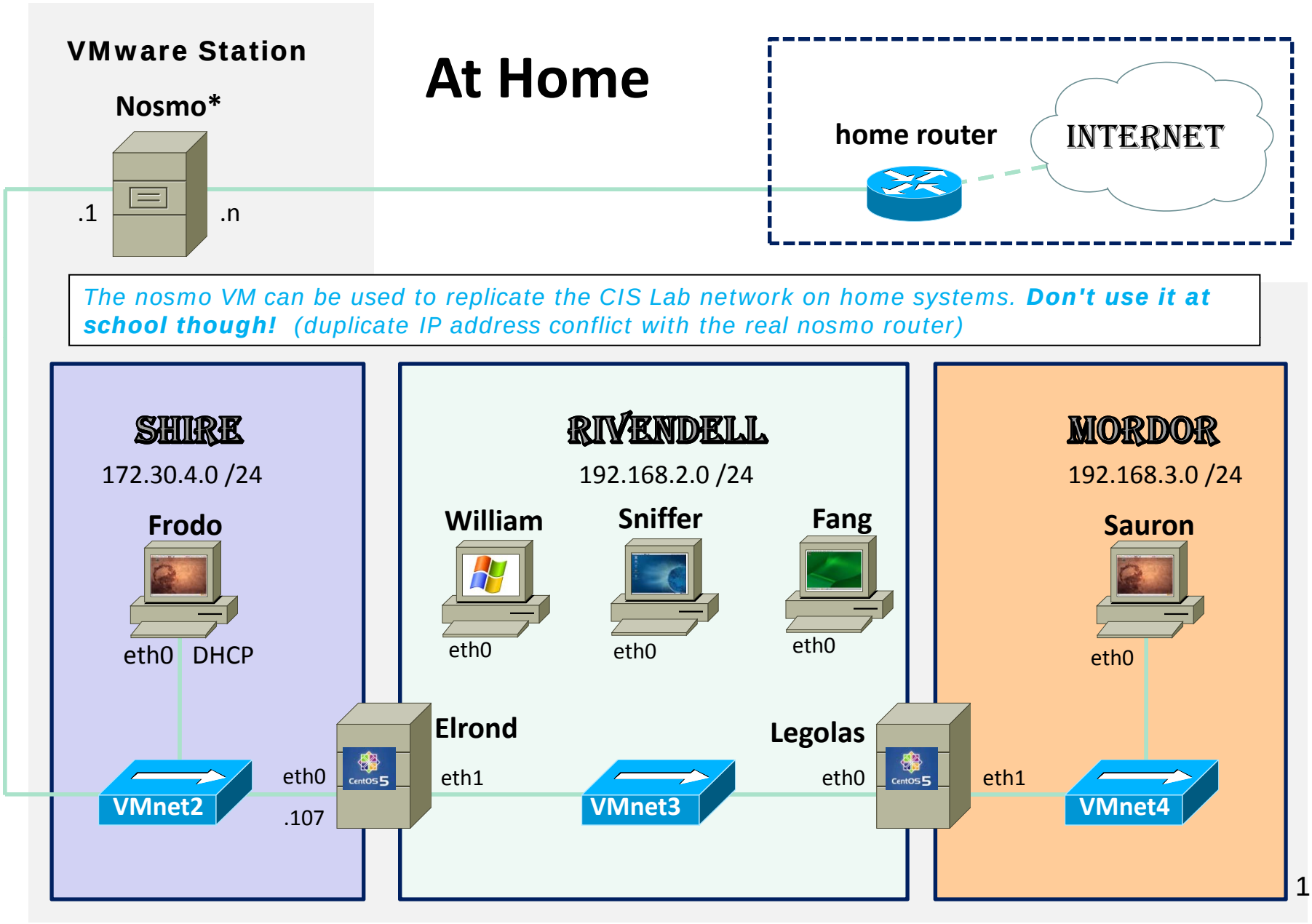
- Tradition is behind naming the networks used in the labs that goes back to when Jim created this course.
- The **Shire** network will refer to the physical LAN in either the classroom or the lab.
- The **Rivendell** network will refer to the network that is one hop away.
- The **Mordor** network will refer to the network that is two hops away.
- These networks used to be three physical networks in Room 2504 complete with banners hanging from the ceiling. Now the Rivendell and Mordor networks are virtual.

CIS Lab and CTC

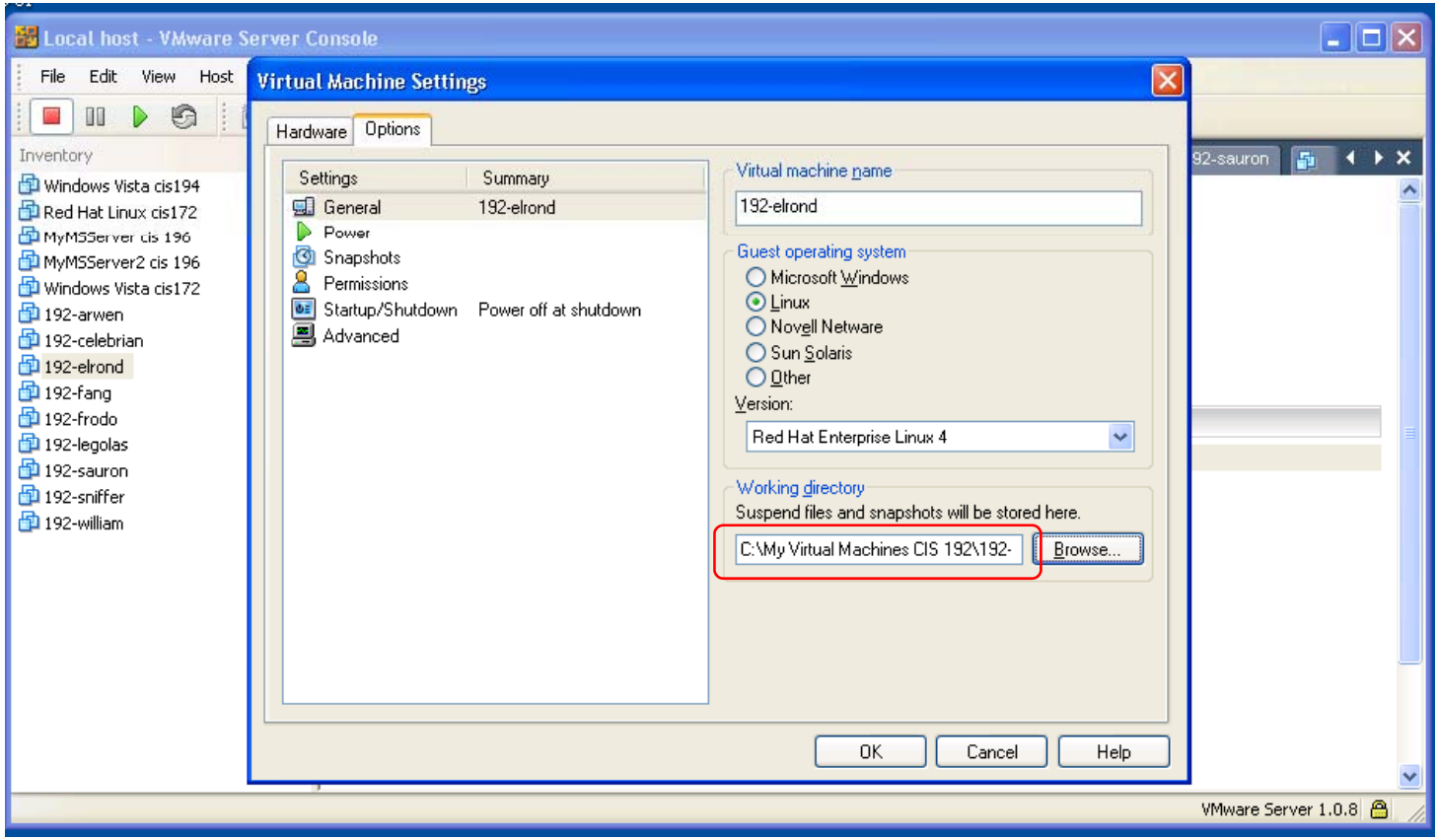


Taking VMs Home

At Home


VMware Station
Nosmo*
.1
.n
home router
INTERNET
The nosmo VM can be used to replicate the CIS Lab network on home systems. Don't use it at school though! (duplicate IP address conflict with the real nosmo router)
SHIRE
172.30.4.0 /24
Frodo
eth0 DHCP
RIVENDELL
192.168.2.0 /24
William
eth0
Sniffer
eth0
Fang
eth0
MORDOR
192.168.3.0 /24
Sauron
eth0
Elrond
eth0
.107
eth1
Legolas
eth0
eth1
VMnet2
VMnet3
VMnet4

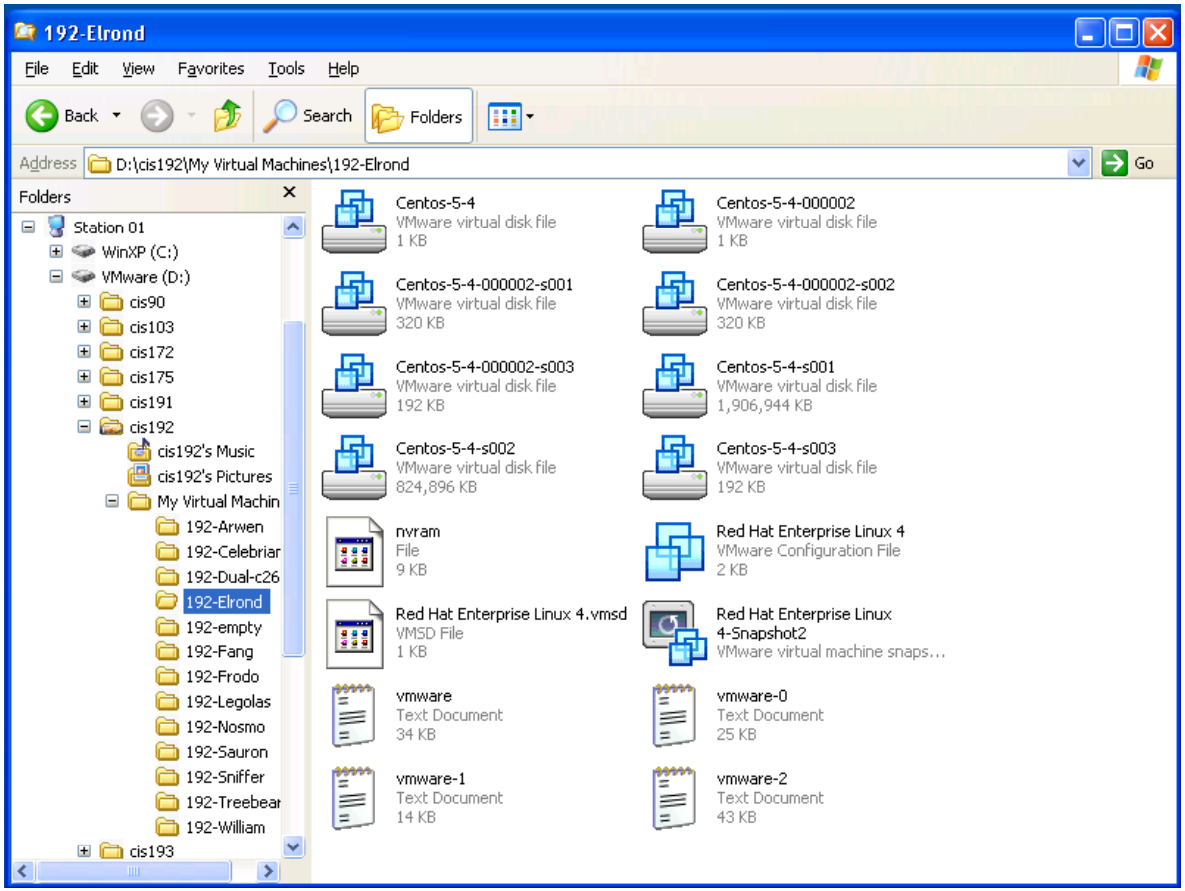
Copying a VM to another computer
Locating the VM files



Find the location of the VM you want to copy using the Virtual Machine Setting dialog box

Copying a VM to another computer
Locating the VM files

D:\cis192\My Virtual Machines\



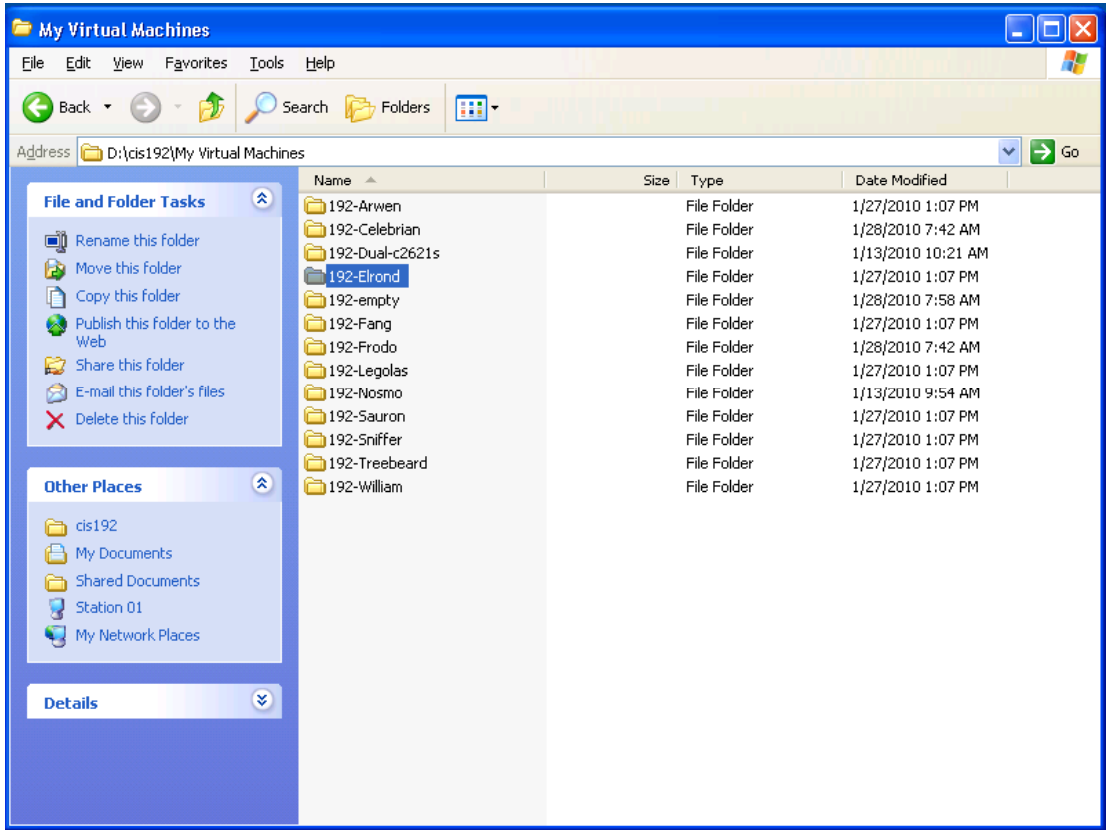
Copy the entire VM folder to your USB flash drive.

*For example, to bring home Elrond, you would copy the highlighted **192-Elrond** folder to your flash drive.*

Explorer view of Elrond on Station 01 in Room 2501 (2.6 GB when powered off)

Copying a VM to another computer
Locating the VM files

D:\cis192\My Virtual Machines\



*For example to bring home Elrond, you would copy the highlighted **192-Elrond** folder to your flash drive.*

All VMs use about 40GB (when powered off)

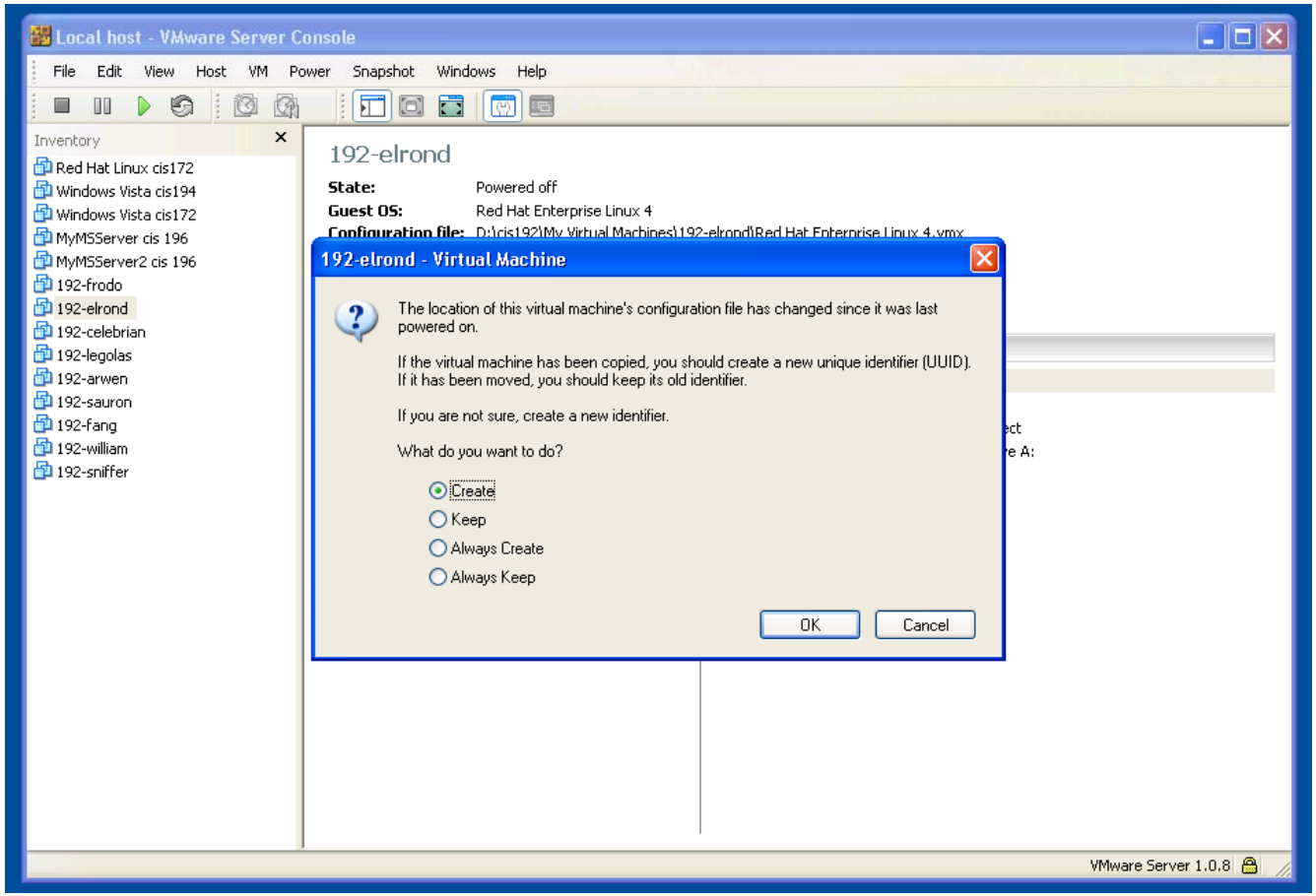
Elrond on Station 01 in Room 2501 (2.6 GB when powered off)

Copying a VM to another computer

On the home computer

- Install VMware Server
- Create a folder for your VMs or use the default My Virtual Machines folder.
- Copy the 192-Elrond folder from your USB flash drive to your home VM folder.
- Using the VMware Server Console
  - File > Open > Browse (to the .vmx configuration file inside the 192-elrond folder)
- Run the VM

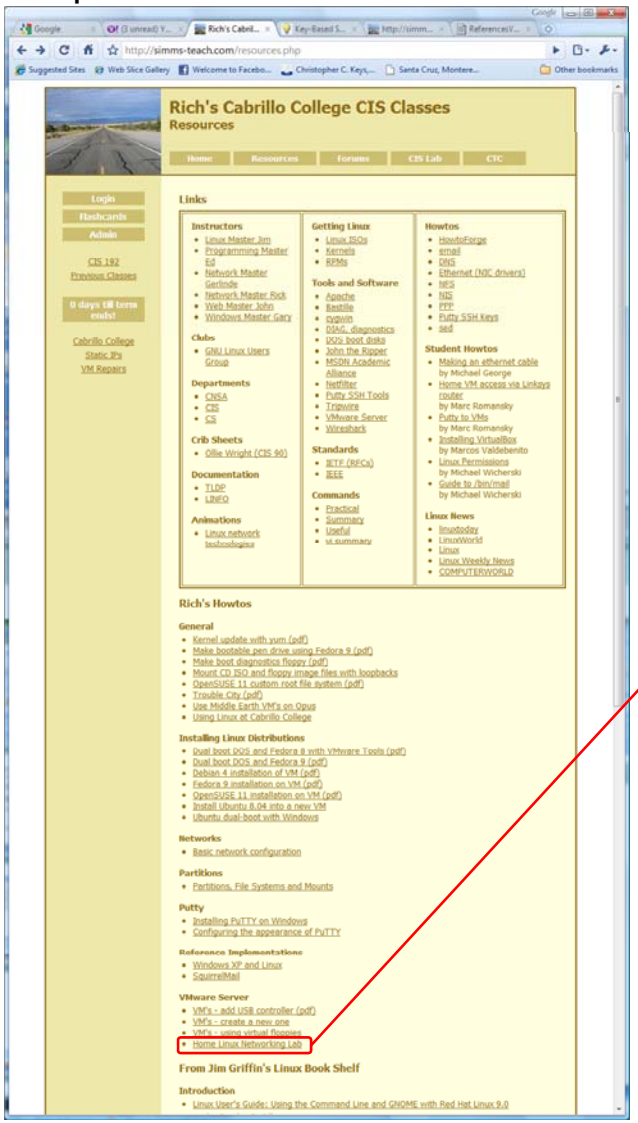
Copying a VM to another computer

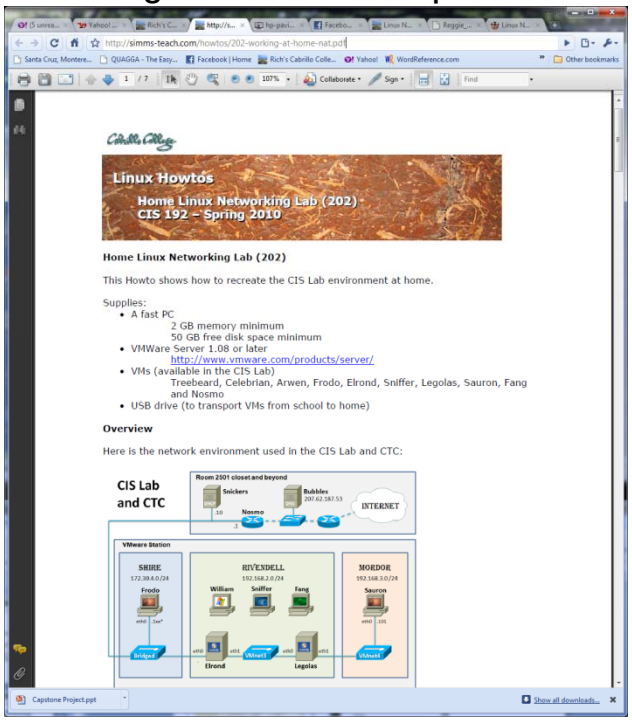


*You get prompted the first time you run a VM that has been transferred. Select **Create** so you get a new MAC address for your VM's interfaces.*

Howto for working at home

http://simms-teach.com/howtos/202-working-at-home-nat.pdf





You may want to wait a few lessons before attempting this at home. It involves firewalls, NAT, DHCP, static routes and configuring permanent network settings.

Some caveats regarding copying the 192 VMs

1. The Ubuntu and Fedora VMs may boot up with interfaces that don't start at eth0 because they use this file:

   /etc/udev/rules.d/70-persistent-net.rules

   - You can ignore this, edit the file and delete the previous eth entries, or use my /root/bin/init-network script to fix.

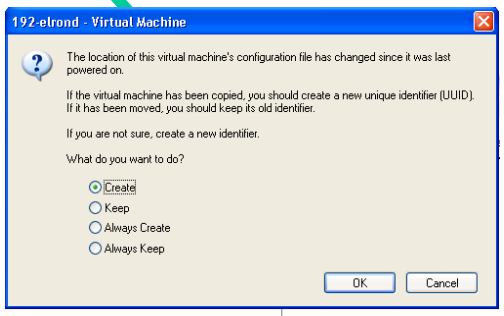
2. The CentOS VM's ifcfg-ethx files are modified by VMware to use DHCP settings. This can result in long annoying timeouts during start up.

   - You can ignore this, edit the files and remove the dhcp settings, use my /root/bin/init-network script to fix or grab the latest version of the VMs on \\172.30.4.12\depot.

An unwanted VMware “feature”

Original VM at school

```
[root@legolas ~]# cat /etc/sysconfig/network-scripts/ifcfg-eth0
# Advanced Micro Devices [AMD] 79c970 [PCnet32 LANCE]
DEVICE=eth0
ONBOOT=no
HWADDR=00:0c:29:20:5c:c9
[root@legolas ~]# _
```



Create *makes a new MAC address. But it also* ***modifies the network settings*** *on the CentOS VMs!!*

After copy and **create**

Note: Keep the new MAC address but change the other settings back to the original if you want the copied VM to behave like it did at school. You can use the /root/bin/init-network script to do this.

```
[root@legolas ~]# cat /etc/sysconfig/network-scripts/ifcfg-eth0
# Advanced Micro Devices [AMD] 79c970 [PCnet32 LANCE]
DEVICE=eth0
ONBOOT=yes
BOOTPROTO=dhcp
HWADDR=00:0c:29:3c:d5:fc
[root@legolas ~]# _
```

Footnote: A modified version of the CentOS VMs are available on \\172.30.4.12\depot. The MAC addresses have been removed from the ifcfg-ethx files which seems to work around the problem.

Fun with Treebeard

Treebeard

Treebeard

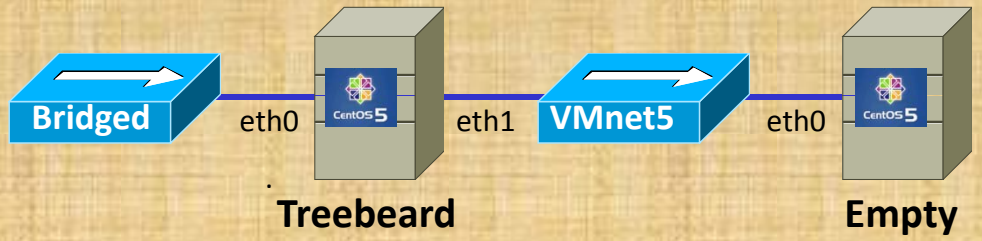
- Treebeard is a CentOS Linux server.
- It has been configured to provide TFTP, HTTP, DNS and DHCP services.
- The firewall has been modified so clients requests for these services will not be blocked.
- It has also been configured to do something else!

This is an example of the kinds of services we will learn to configure in this course.

Class Activity – Treebeard

Let see if we can figure the other service Treebeard provides!

1) Cable Treebeard and Empty as follows but don't power them on yet:



Note: you are cabling two VMs to a virtual LAN (using VMnet5)

2) Power on **Treebeard** first! Wait till it is fully up and running.

3) We just created the **Empty** VM. It is a "bare-metal" PC without any OS or applications installed. The hard drive has not even been formatted yet. What should happen if we power it on?

4) Power on **Empty**. Take any default choices you are presented with.

5) What **the heck** just happened?

See: http://simms-teach.com/howtos/201-pxe-install.pdf to learn how to do this

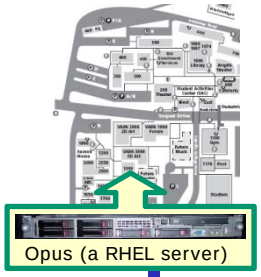
SSH Hopping

SSH (Secure Shell)

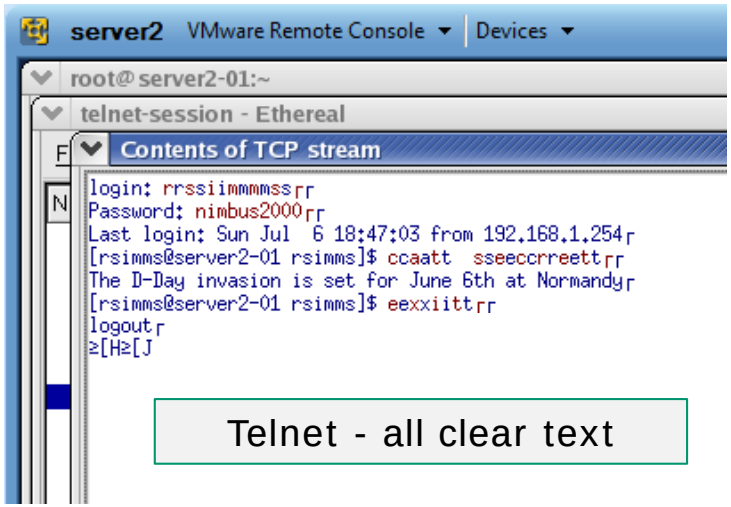
- SSH is a standard network protocol that lets data be exchanged securely (via authentication and encryption) by two computers on a network.
- On Linux and UNIX systems, SSH replaces Telnet for logging into remote system and issuing commands.
- SSH v2 is more secure than SSH v1. It is also incompatible.
- OpenSSH, found on most Linux distributions, is an open source implementation of SSH v2.
- On Linux, the **ssh** command is used to login and issue commands on another system. The **scp** command is used to securely copy files between systems.
- On Windows, the **Putty** software uses SSH. The Putty **pscp** command is the windows version of the Linux **scp** command.
- On Windows, **Filezilla** can copy files using SFTP which in turns uses SSH.

Telnet vs SSH (Secure Shell)

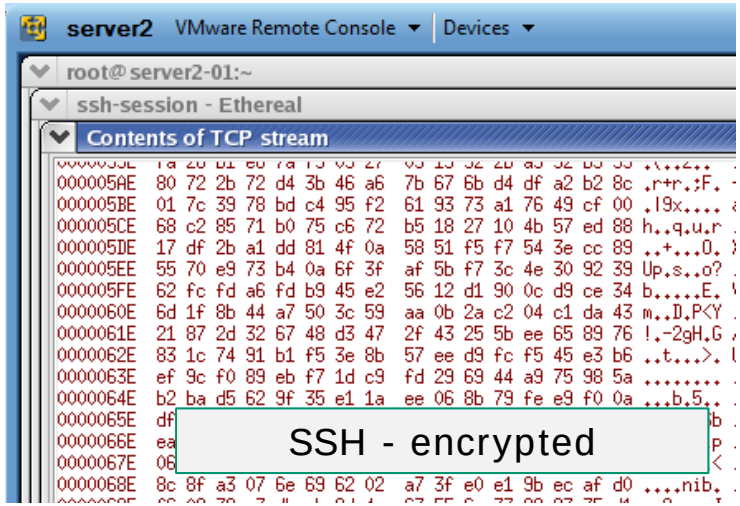
Remote computer



Sniffer view of a Telnet session



Sniffer view of a SSH session

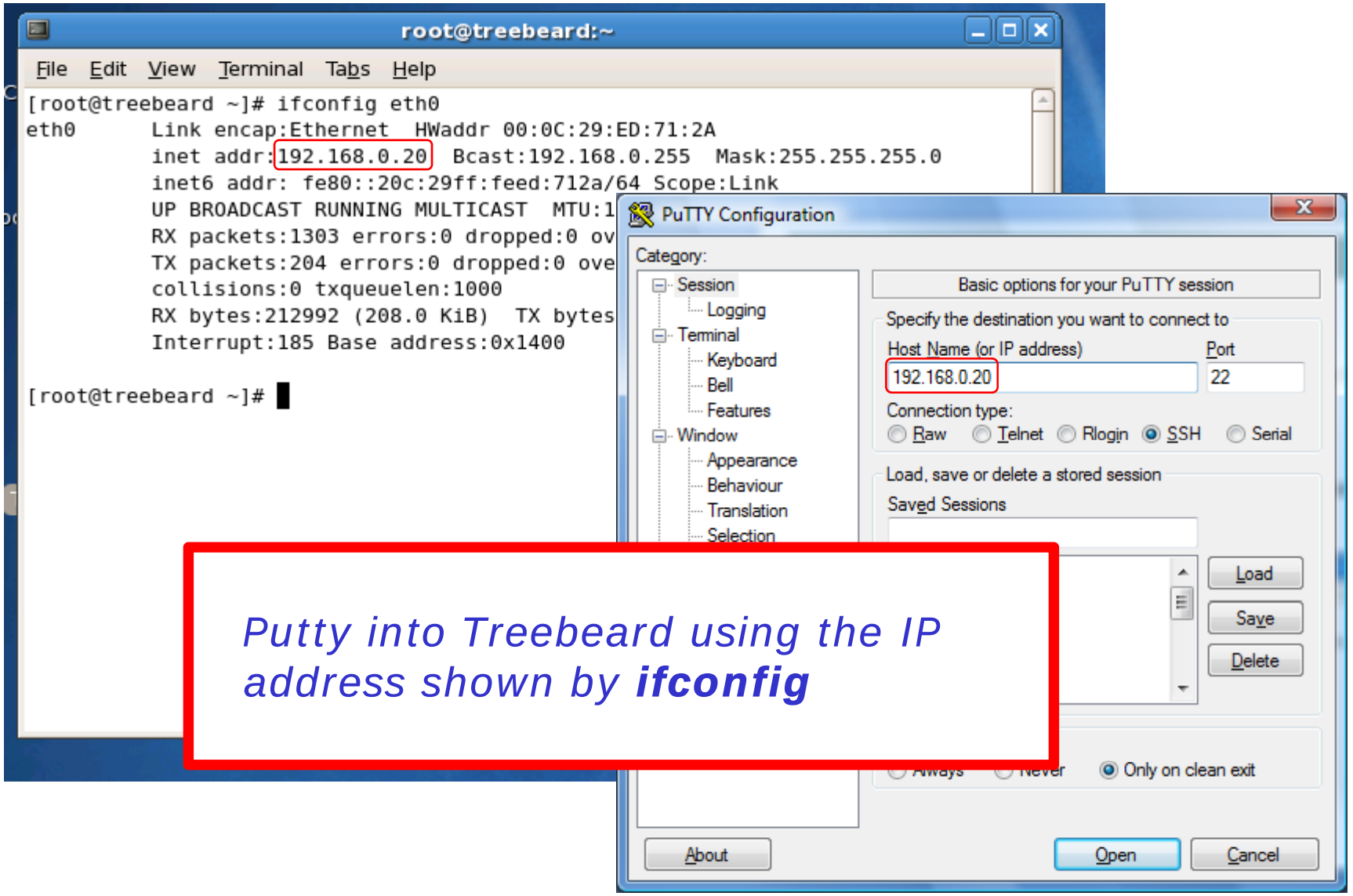


Local computer

With telnet, everything is transferred in clear text over the network

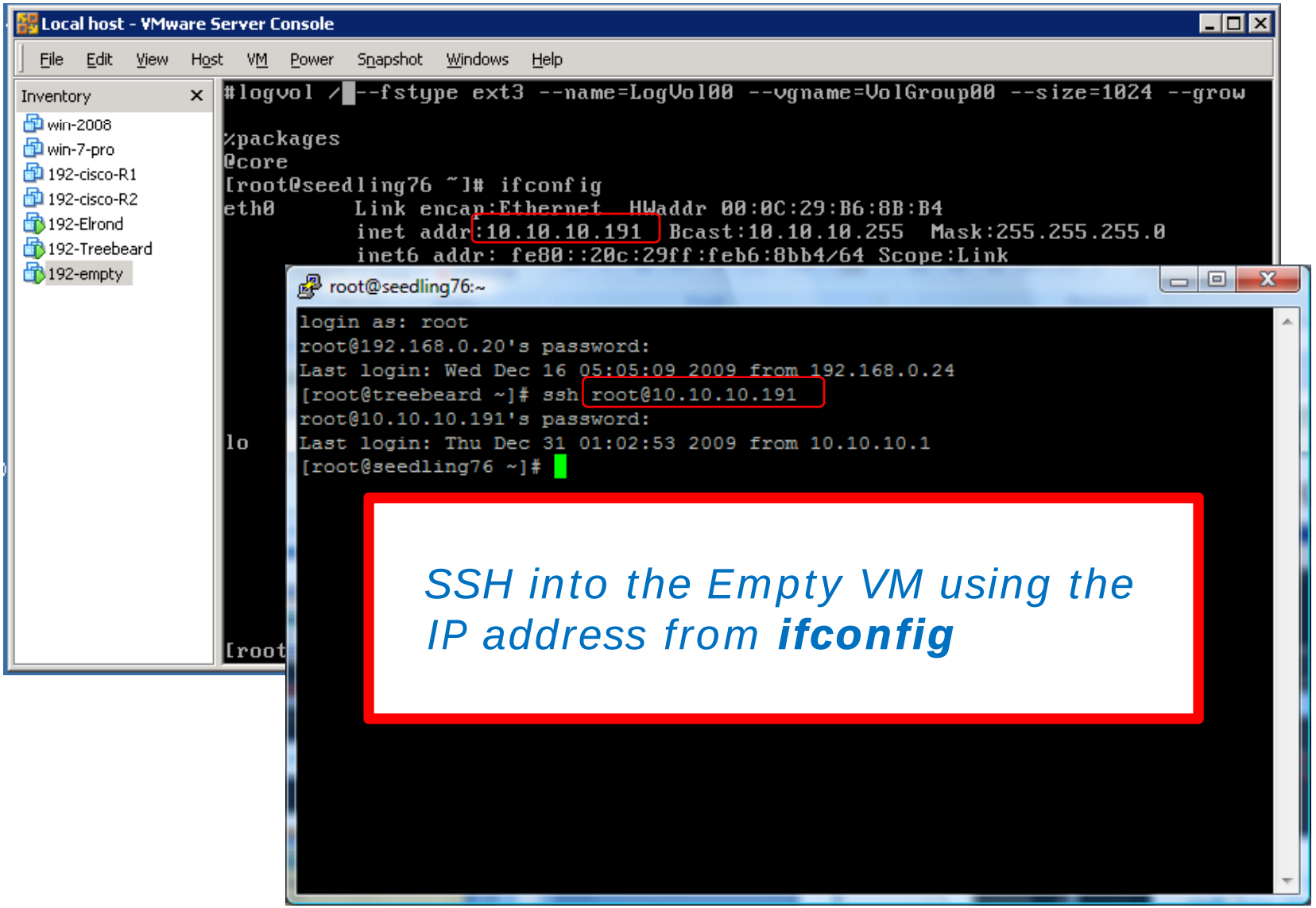
With ssh, it is encrypted.

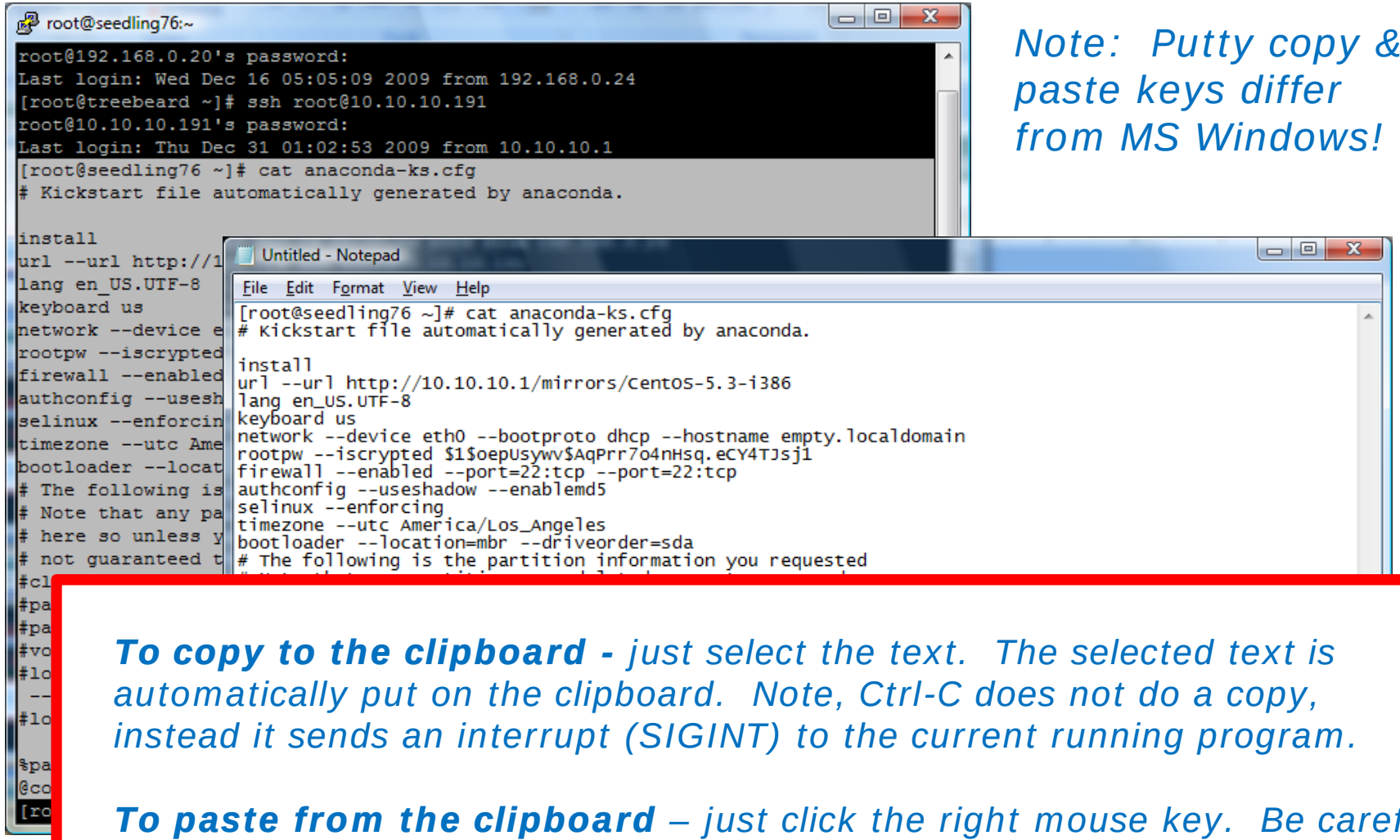
SSH Hopping – Putty into first system



Putty into Treebeard using the IP address shown by ***ifconfig***

SSH Hopping – ssh into next system





Note: Putty copy & paste keys differ from MS Windows!

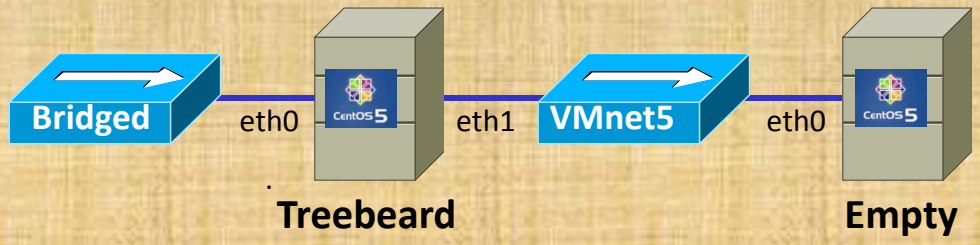
To copy to the clipboard - *just select the text. The selected text is automatically put on the clipboard. Note, Ctrl-C does not do a copy, instead it sends an interrupt (SIGINT) to the current running program.*

To paste from the clipboard *– just click the right mouse key. Be careful as you may inadvertently paste unwanted clipboard contents into your Putty session!*

Class Activity – SSH Hopping

Lets do some SSH hopping now!

1) Use **ifconfig** to get the eth0 IP addresses on both Treebeard and Empty



2) Putty from your Windows station into Treebeard using its IP address

3) On Treebeard, **ssh** into the Empty VM using its IP address

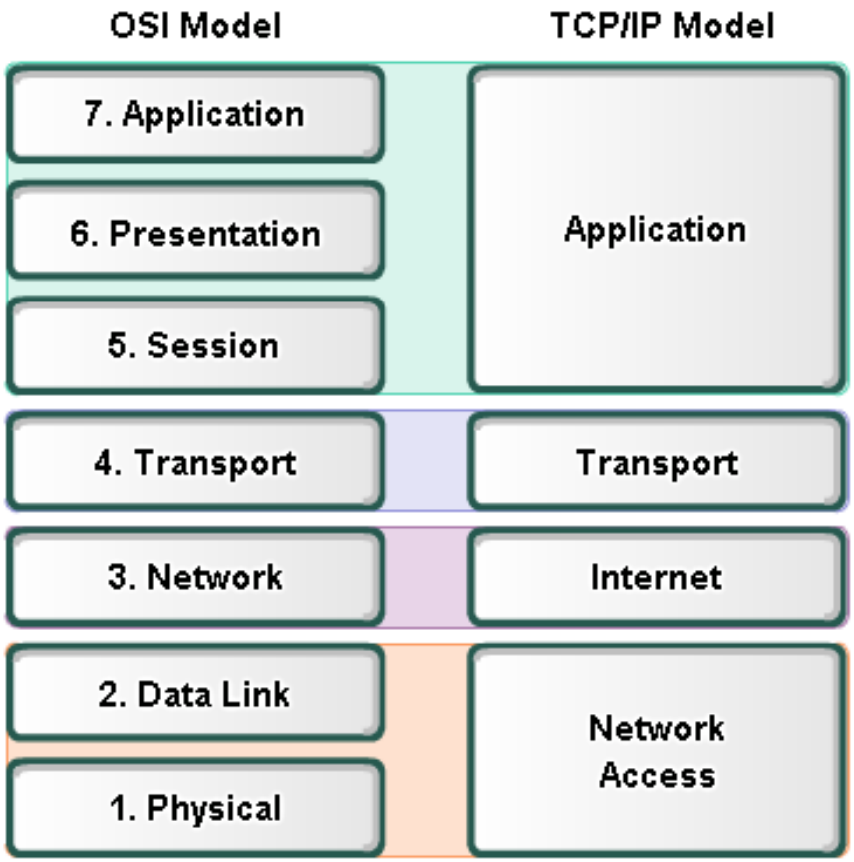
4) **cat** the file **/root/anaconda-ks.cfg** on Empty

5) Select the output in Putty, then paste the contents of the clipboard into Notepad++ on Windows.

Network Basics

Protocol Reference Models

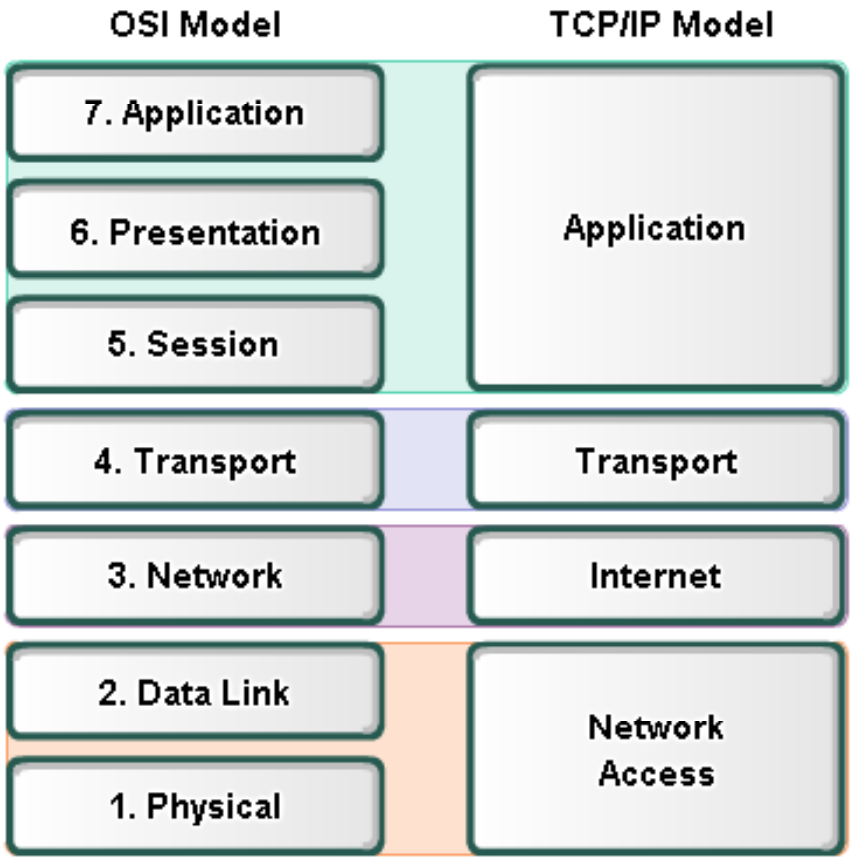
1977



1970's

The **OSI** (Open Systems Interconnection) and **TCP / IP** models are define various **abstraction layers.** Each layer serves a different role in the overall communication process.

Protocol Reference Models



Example Protocols

File Transfer Protocol (FTP), Simple Mail Transport Protocol (SMTP), Hyper Text Transfer Protocol (HTTP), etc.

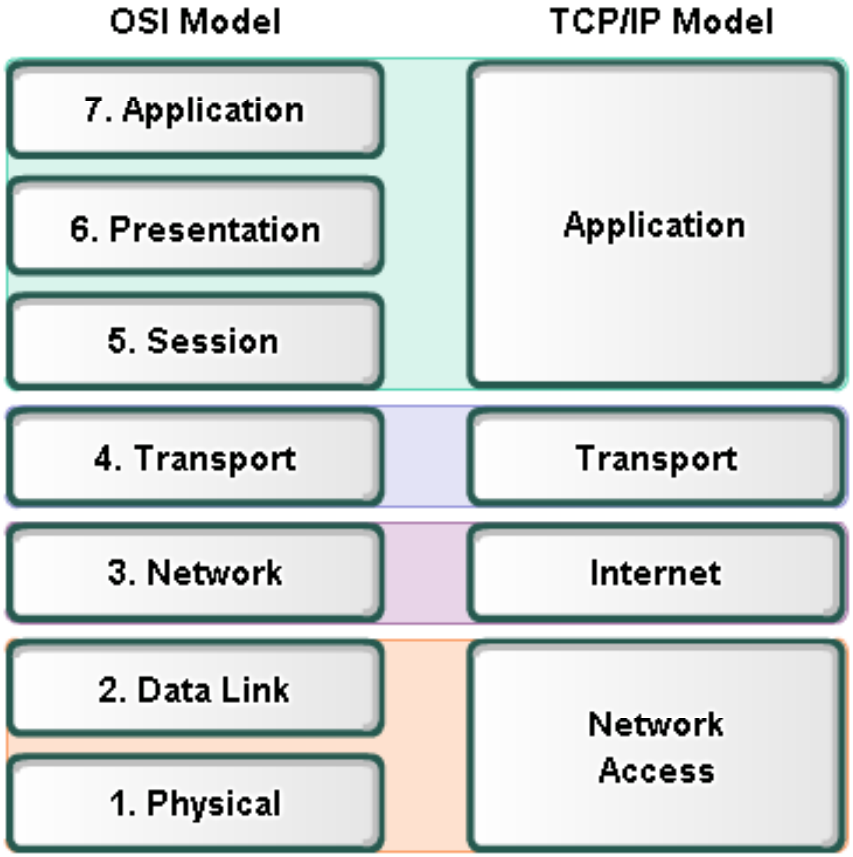
Transmission Control Protocol (TCP), User Datagram Protocol (UDP)

Internet Protocol (IP)

Ethernet, SLIP, PPP, X.25, Frame Relay, etc.

Showing how various **protocols** fit within the **OSI** and **TCP/IP** models. Each protocol is defined as a **standard** which enable multi-vendor solutions.

Protocol Reference Models



Example Products

Filezilla (FTP), Firefox (HTTP), Internet Explorer (HTTP), Exchange (SMTP), Sendmail (SMTP)

Network stacks

Routers, network stacks

Switches, NICs, network stacks

Hubs, NICs, cables

Each product must implement **standards** to enable multi-vendor **interoperability**.

Software implementations of network protocol layers are called **network stacks** and are built into OS's like Linux and Windows.

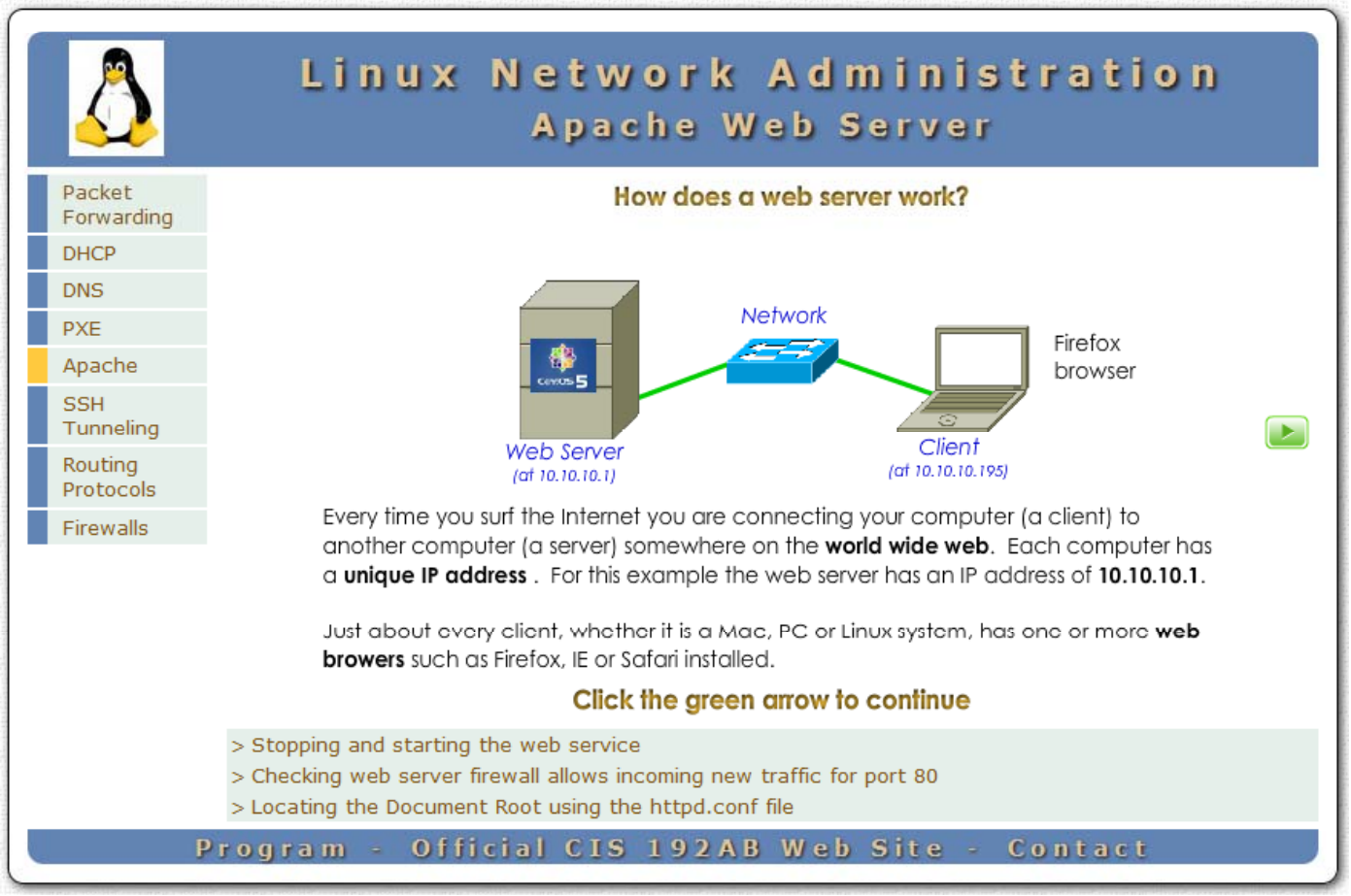
Reconciling the Layers

OSI	CIS 81	Nemeth Text	Wireshark	Source / Destination	Unit	Devices
7 - Application	Application	Application	SSH, HTTP, DNS, RIP, Bootstrap (DHCP), SMB	An application program or service	Data	
6 - Presentation						
5 - Session						
4 - Transport	Transport	Transport	TCP/UDP	Port	Segment, Datagram	
3 - Network	Internet	Network	Internet Protocol	IP	Packet	Router
2 – Data link	Network Access	Link	Ethernet II	MAC	Ethernet Frame	Switch, NIC
1 - Physical		Physical	Frame	RJ-45 Jack	Bits	Hub, NIC, cables

The terminology for the different layers may change and blur a little depending on the textbook, product, or organization

Putting it all together – web server example

http://simms-teach.com/animations/apache.html



Let's start with a web server example to see how the network is used

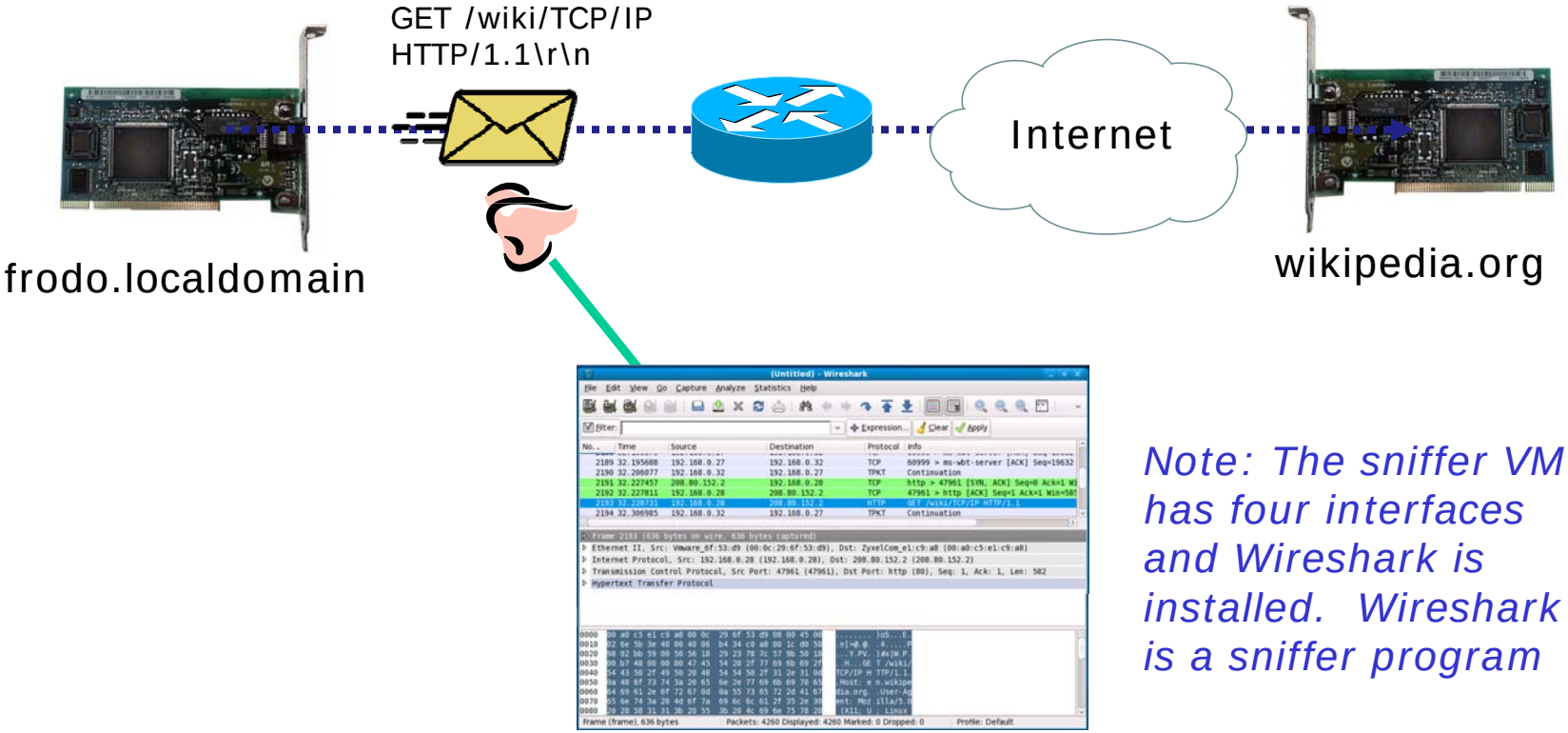
Deep dive into a single packet

*Now lets take a **deep dive** into a single network packet ... an "HTTP Get" sent from a browser to a web server*

This example is based on using the Firefox browser on the Frodo VM at home to view a Wikipedia article on the Internet Protocol Suite

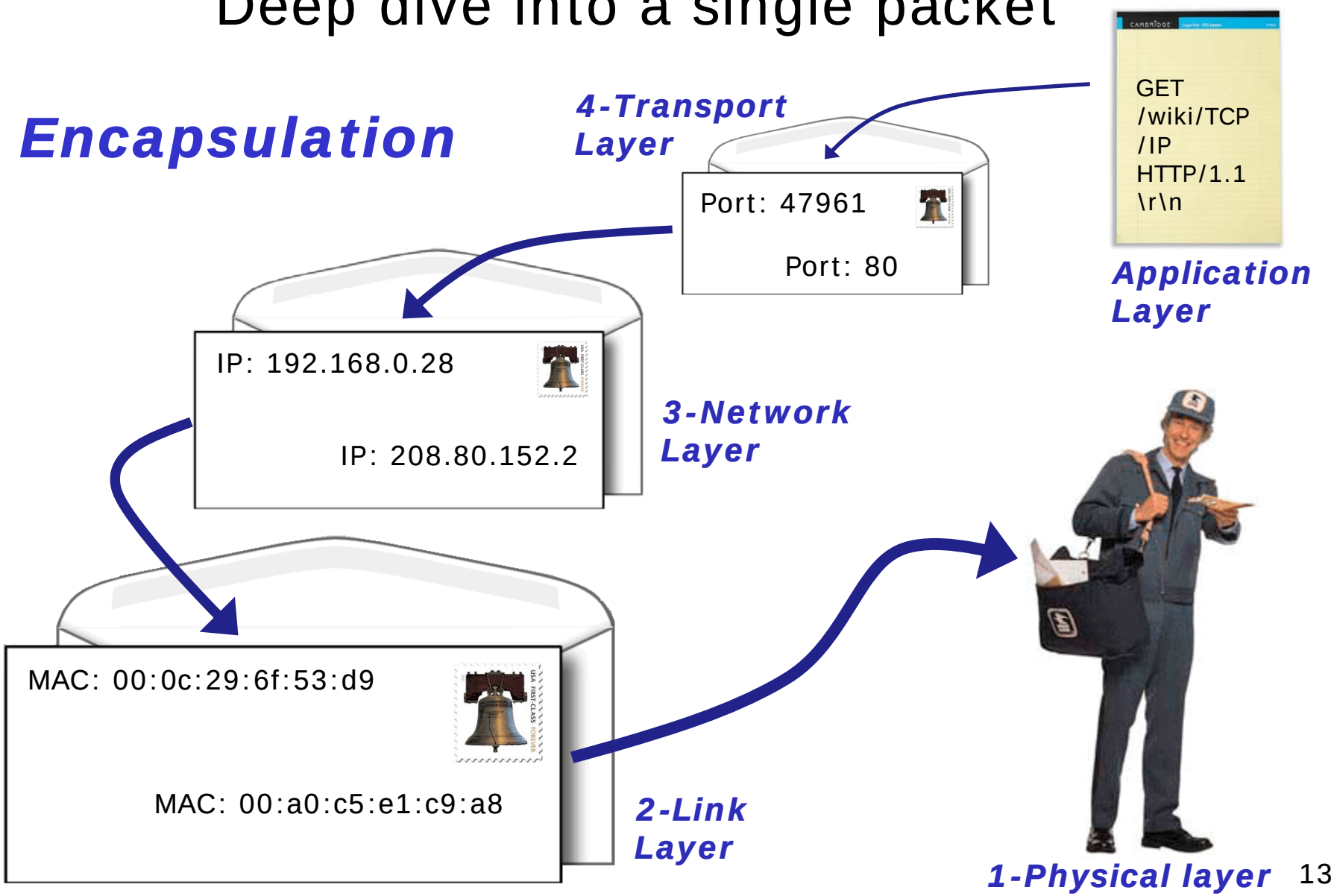
Deep dive into a single packet

We will use a sniffer to look at the "HTTP GET" packet sent out the NIC card on the Frodo VM to the home router (and from there it is forwarded out to the Internet)



Note: The sniffer VM has four interfaces and Wireshark is installed. Wireshark is a sniffer program

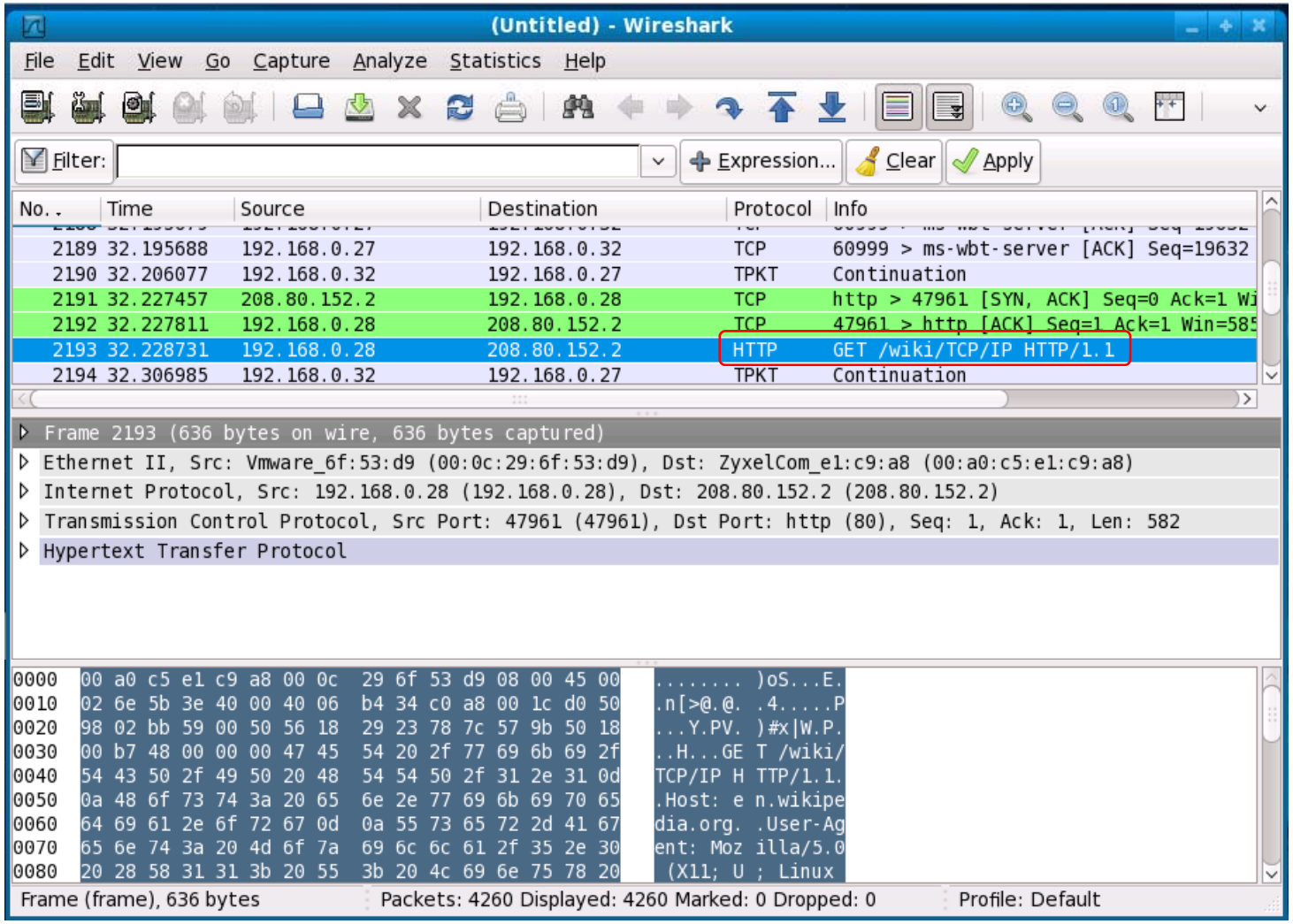
Deep dive into a single packet



Deep dive into a single packet

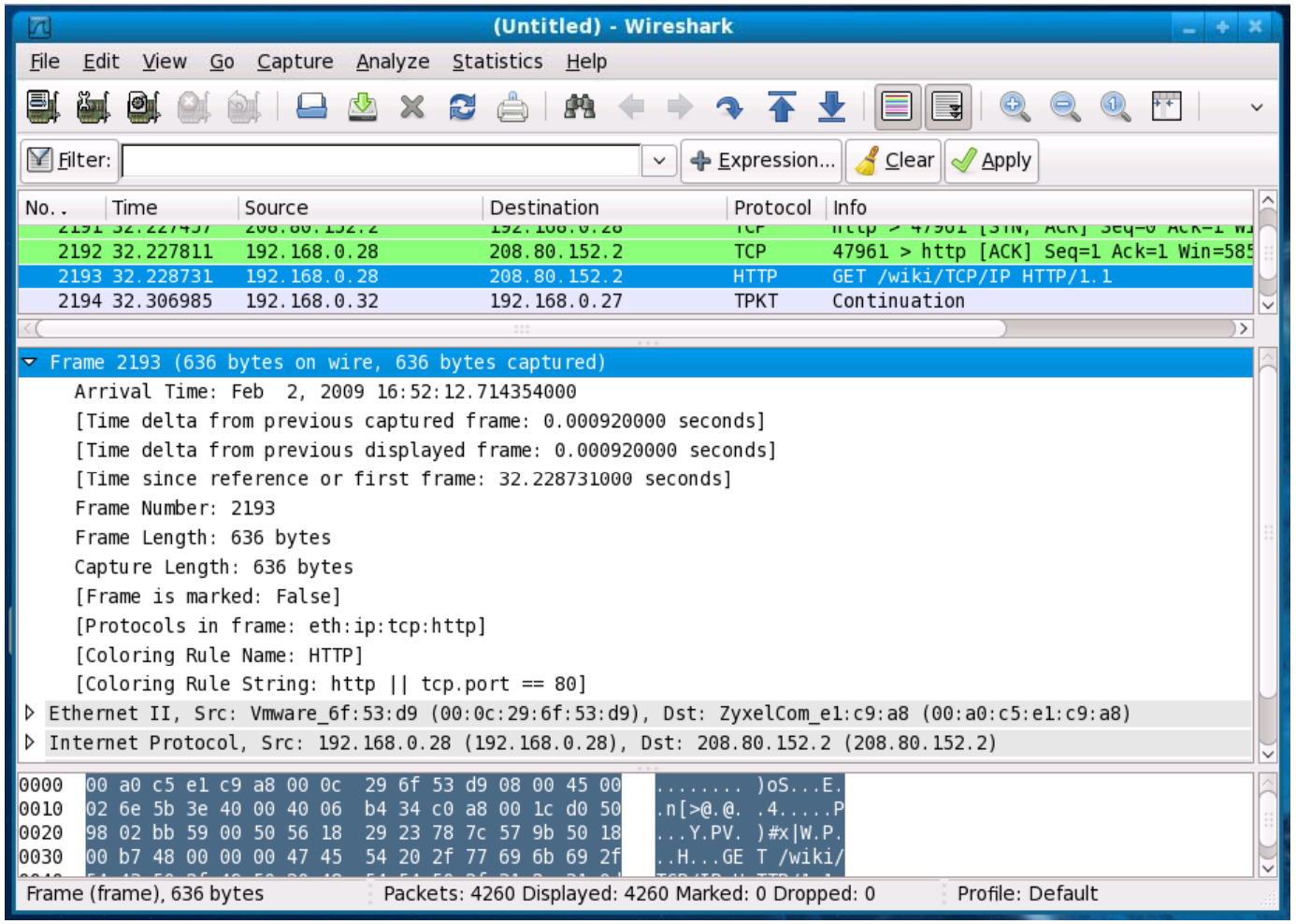
Note how Wireshark shows each layer for the selected HTTP GET packet

1-Physical
2-Link
3-Network
4-Transport
Application

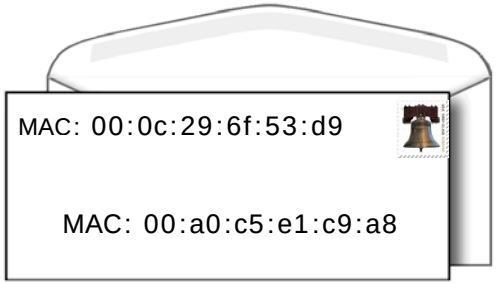


Deep dive into a single packet – Layer 1

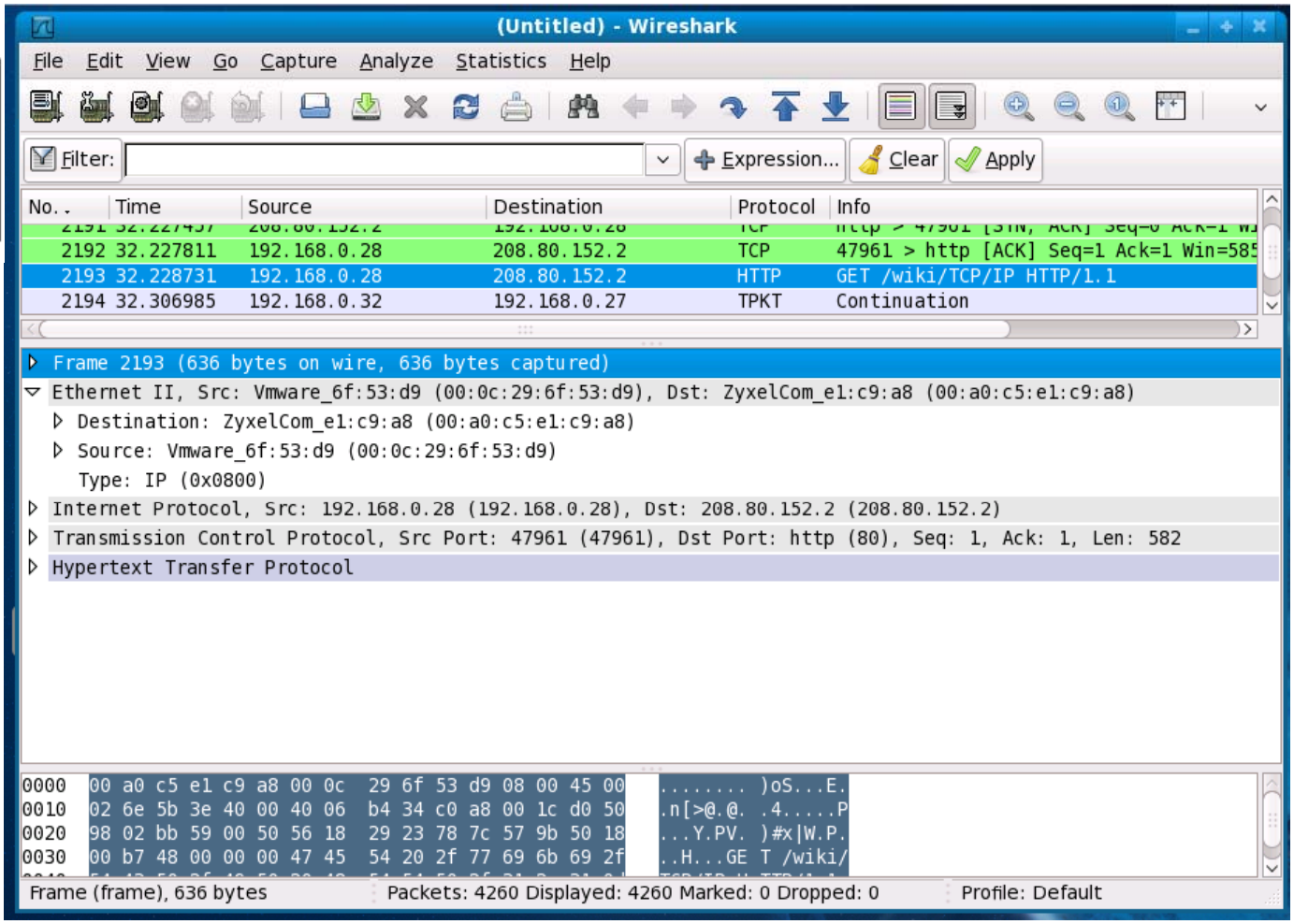
1-Physical layer expanded



Deep dive into a single packet – Layer 2

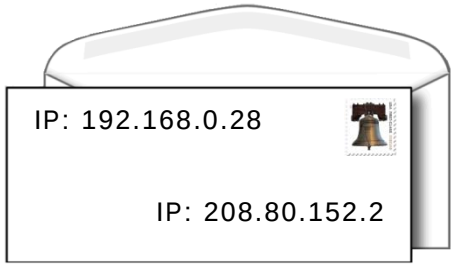


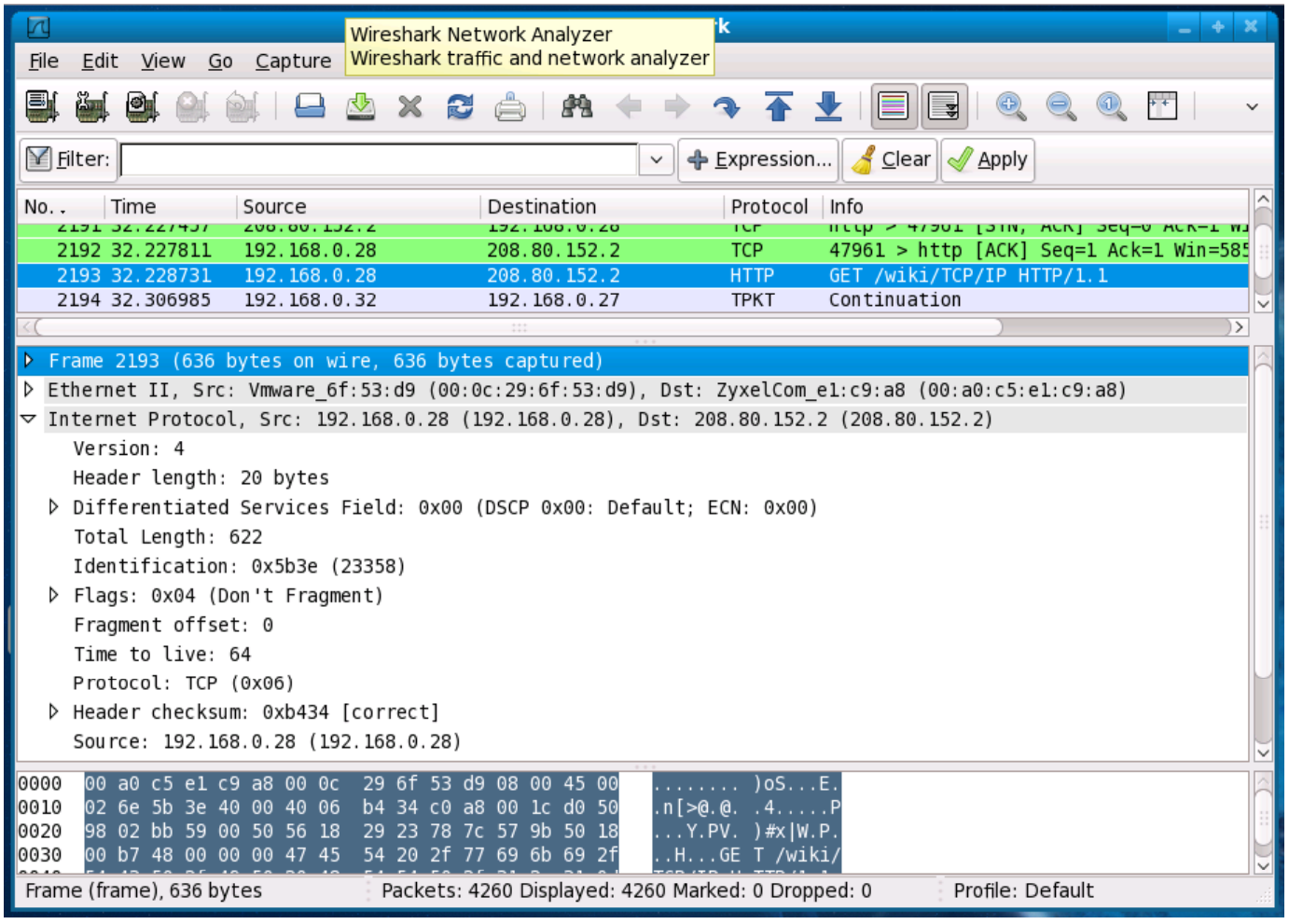
2-Link layer expanded



*Note the use of **MAC addresses** in this layer. The first half of the MAC address identifies the NIC vendor.*

Deep dive into a single packet – Layer 3

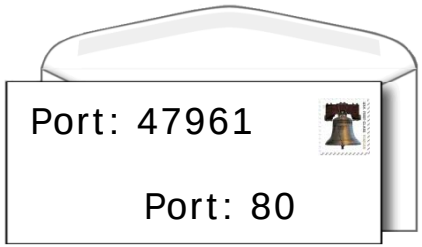




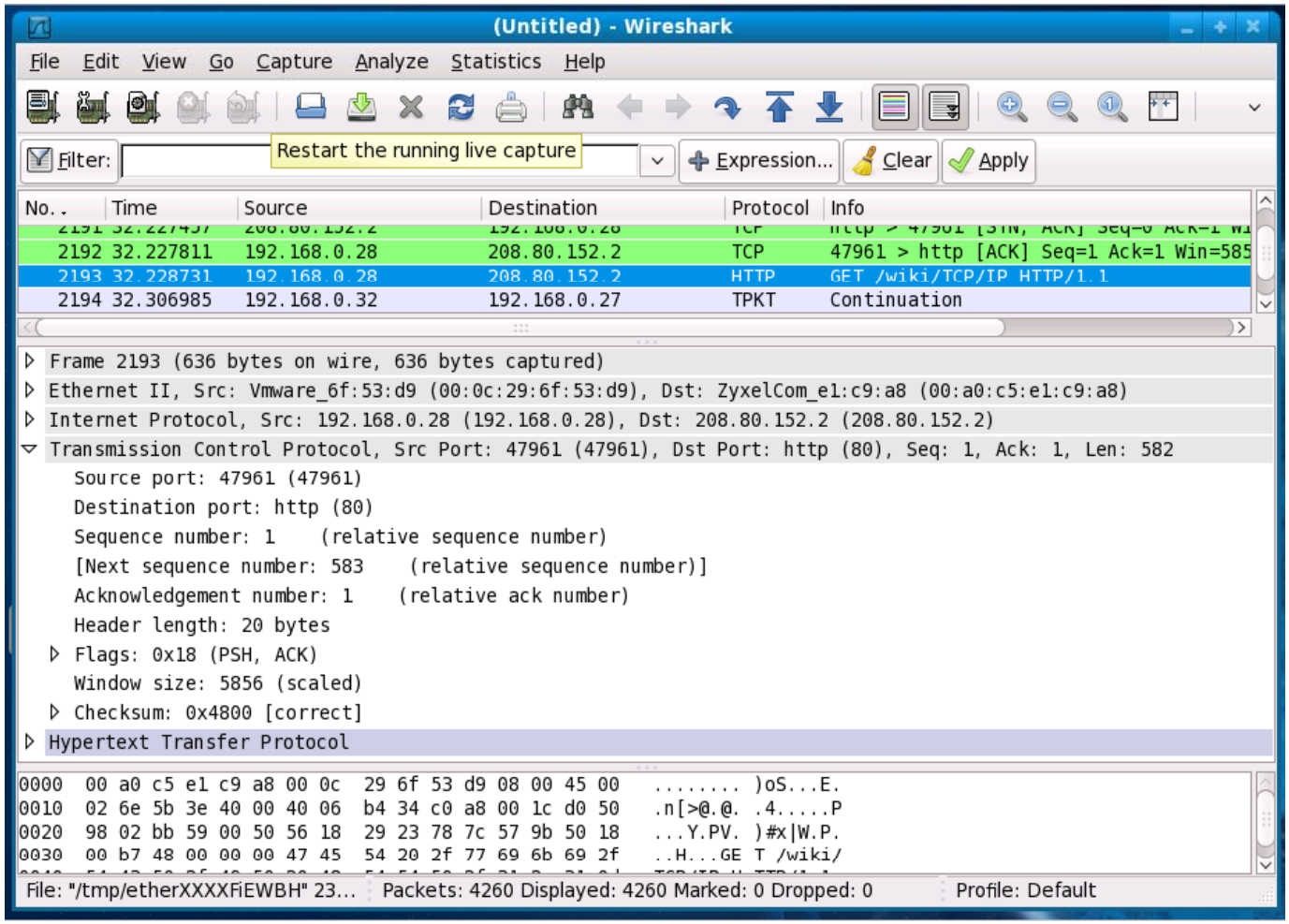
3-Network layer expanded

*Note the use of **IP addresses** in this layer.*

Deep dive into a single packet – Layer 4



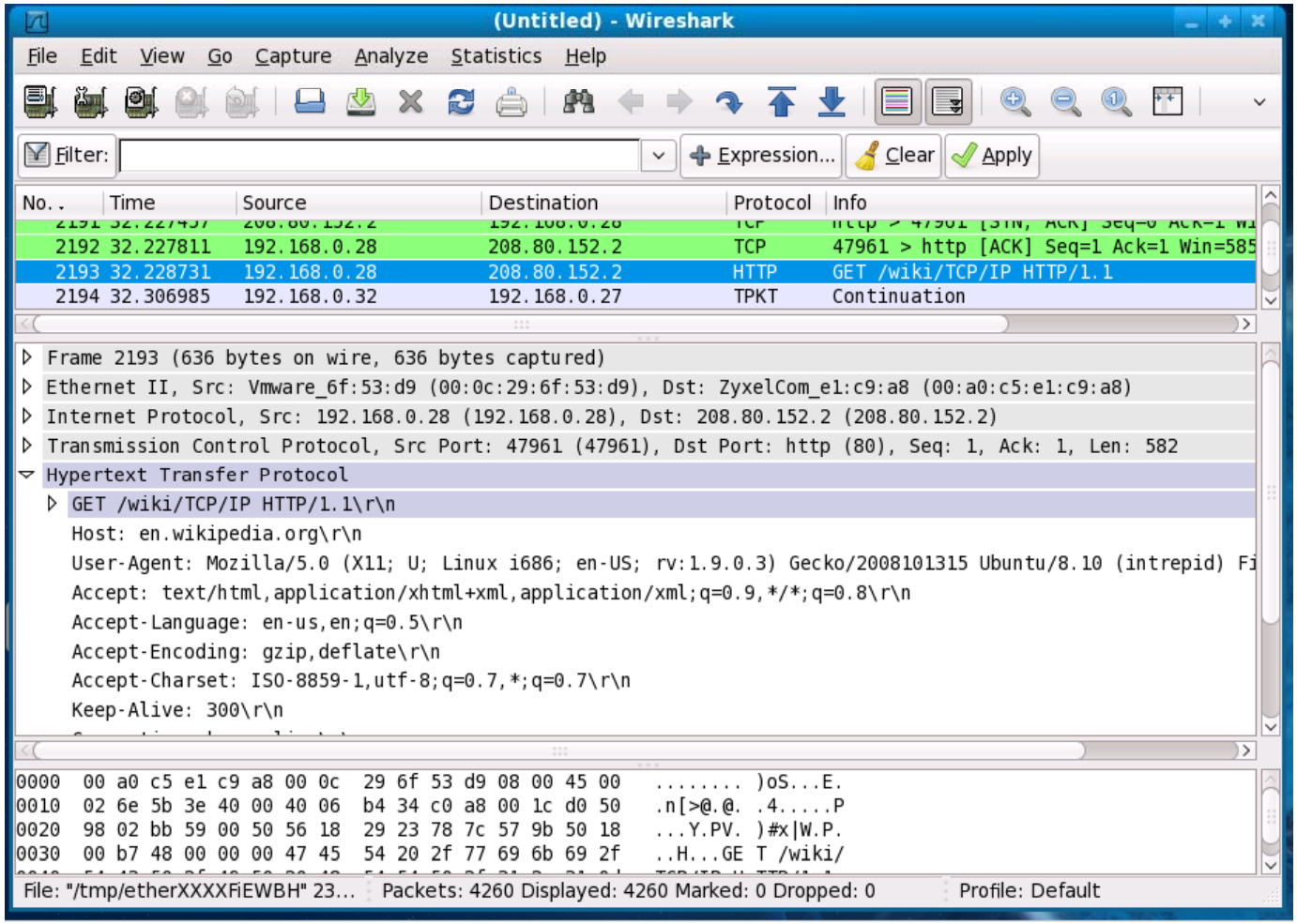
Transport layer expanded



*Note the use of **ports** in this layer. Port 80 is for web servers.*

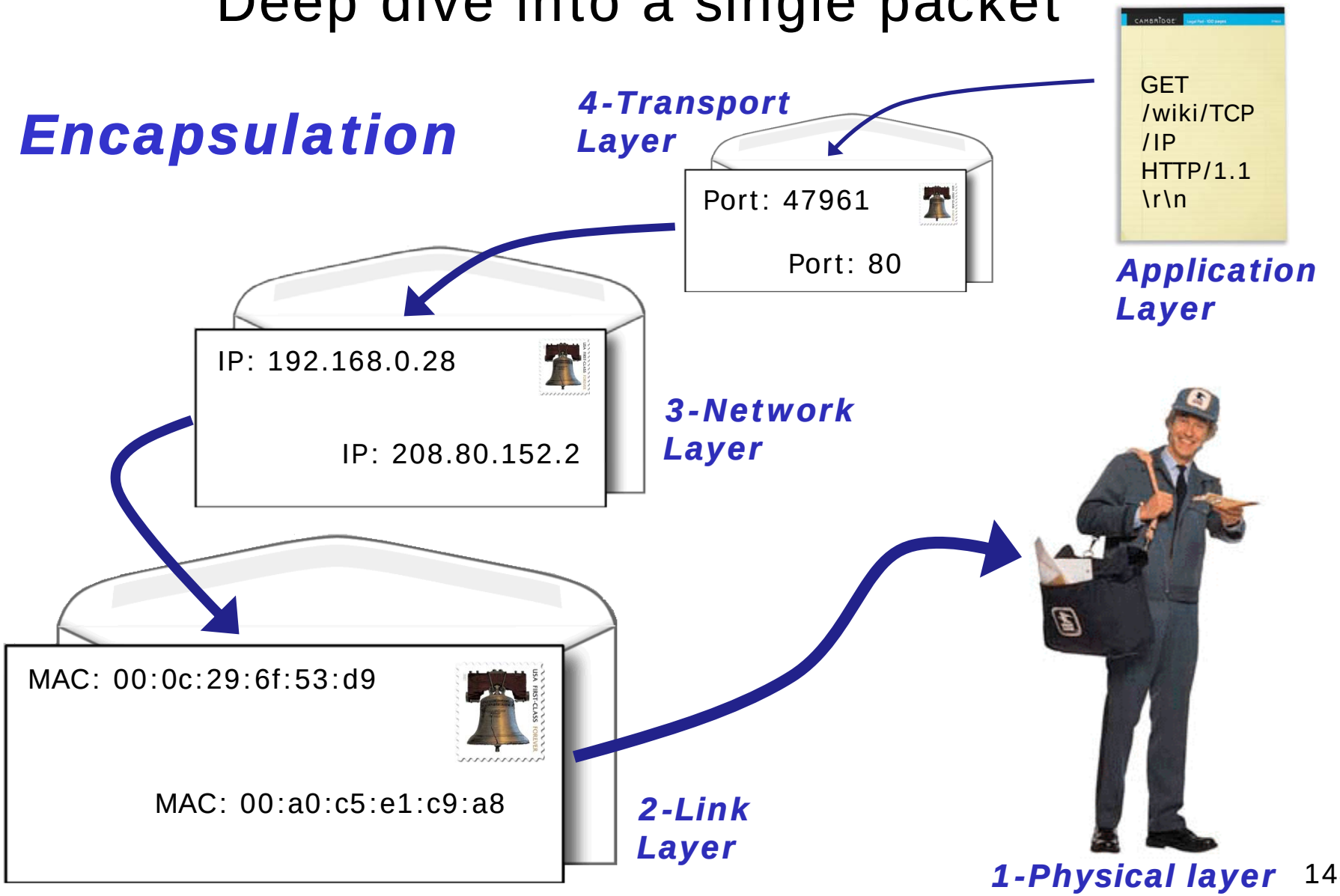
Deep dive into a single packet – Application layer

Application layer expanded



At last we get to the actual request being sent to the web server application

Deep dive into a single packet



Reconciling the TCP/IP Layers

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2 – Data link	Network Access	Link	Ethernet II	MAC	Ethernet Frame	Switch, NIC
1 - Physical		Physical	Frame	RJ-45 Jack	Bits	Hub, NIC, cables

- *For all this to work standards are essential.*
- *Each layer uses a protocol that follows a standard.*
- *Network equipment providers and software vendors build to standards so everyhing can interoperate.*

Standards

Standards

- How do we get all this stuff to work together?
- How can multiple vendors products interoperate?

Answer: Standards

- IEEE – lower layer focus, e.g. Ethernet
- IETF – higher layer focus, e.g. HTTP protocol
- "Defacto" – vendor with market share sets, e.g. MS Word Doc

Standards
IEEE

- Examples: 802.3 (Ethernet), 802.11 (WLAN)
- Search: **http://ieeexplore.ieee.org/xpl/standards.jsp**

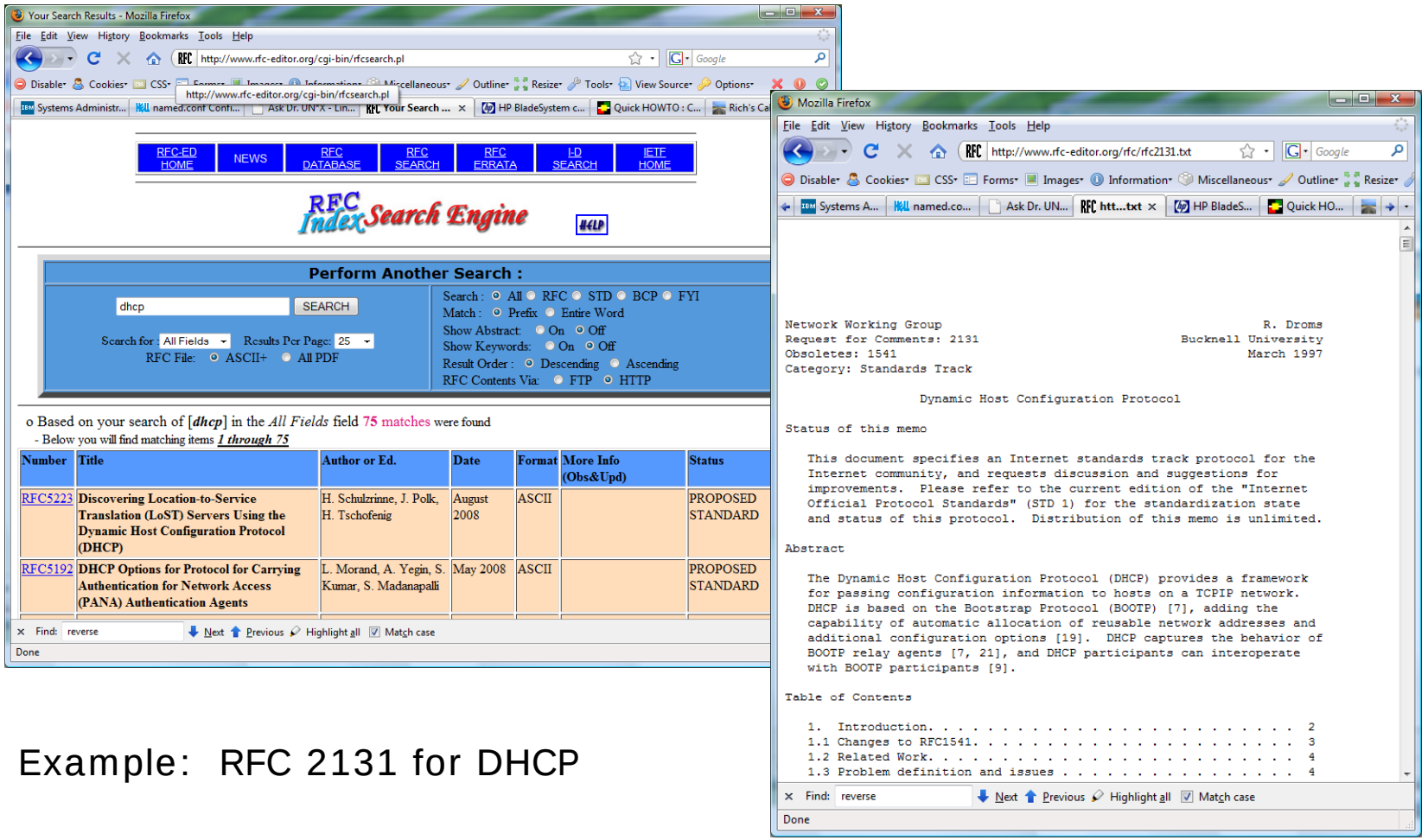
Example: the active Ethernet standard 802.3-2005

Standards
IETF (Internet Engineering Task Force)

- Published as RFCs (Request for Comments)
- Examples: TCP, IP, HTTP, FTP, DNS, DHCP, SSH
- Status
  - Informational (e.g. RFC 1983 "Glossary")
  - Experimental
  - Best Current Practice
  - Standards Track
    - Proposed Standard
    - Draft Standard
    - Internet Standard
  - Historic
- RFC Search Engine: **http://www.rfc-editor.org/rfcsearch.html**

Standards

IETF (Internet Engineering Task Force)



Example: RFC 2131 for DHCP

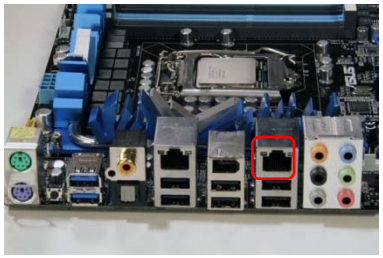
NIC Inventory

Connecting your Linux system to the Network

1. **Identify the NIC in your system (vendor and model)**
2. Locate a driver for your NIC
   - may be already available with your distro
   - may be available from NIC vendor
   - may be available from chipset vendor
   - may have get source and build (compile) it
3. Load the driver (**insmod** or **modprobe** command)
4. Bring up and configure the interface (ifconfig)

NIC (Network Interface Controller)

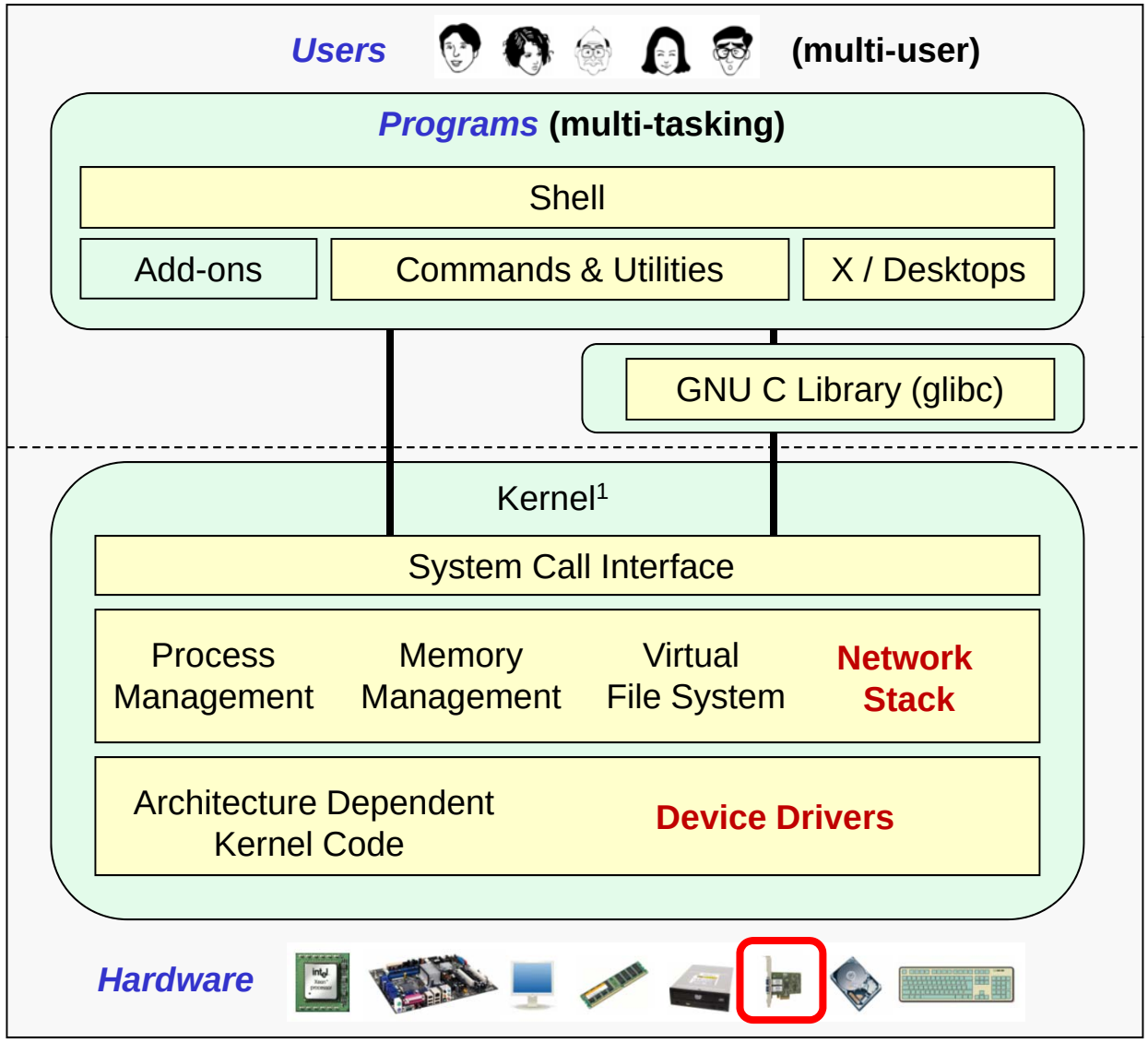
NIC card



NIC on the motherboard

- The NIC is used by a computer to send and receive packets on the network.
- Most PC NICs are now part of the motherboard rather than a card.
- A NIC operates at the level 2 (Link Layer) and can send and receive Ethernet frames using MAC addresses.
- Multiple NICs allow a computer to be on multiple networks or they can be teamed for higher performance.
- On the Red Hat family, kudzu is used to probe for new hardware at boot time. If you install a second NIC after installation you will get prompted to configure it.

GNU/Linux Operating System Architecture

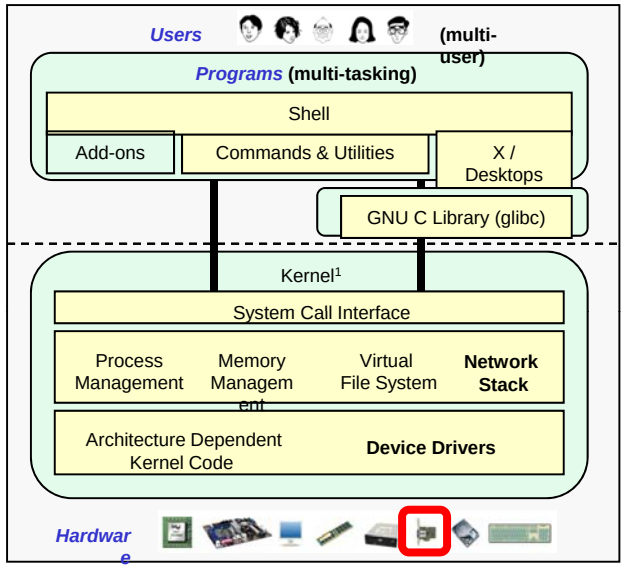


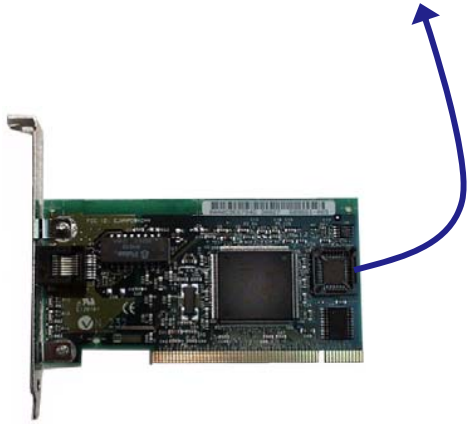
The network stack is implemented in the Linux kernel

NIC drivers are implemented as kernel modules than can be dynamically loaded and unloaded

[1]See "Anatomy of the Linux kernel" by M. Tim Jones at http://www-128.ibm.com/developerworks/linux/library/l-linux-kernel/

NIC Hardware Inventory





How to determine what NIC you have:

- Use **lspci** to show PCI hardware on the computer.
- Use **dmesg** and look for NIC related information
- Use the web to check the technical specifications for your computer or mother board (assumes you have not made any NIC changes)

NIC Hardware Inventory

Using **lspci** command to show NIC information

```
[root@celebrian ~]# lspci
00:00.0 Host bridge: Intel Corporation 440BX/ZX/DX - 82443BX/ZX/DX Host bridge (rev 01)
00:01.0 PCI bridge: Intel Corporation 440BX/ZX/DX - 82443BX/ZX/DX AGP bridge (rev 01)
00:07.0 ISA bridge: Intel Corporation 82371AB/EB/MB PIIX4 ISA (rev 08)
00:07.1 IDE interface: Intel Corporation 82371AB/EB/MB PIIX4 IDE (rev 01)
00:07.3 Bridge: Intel Corporation 82371AB/EB/MB PIIX4 ACPI (rev 08)
00:0f.0 VGA compatible controller: VMware Inc Abstract SVGA II Adapter
00:10.0 SCSI storage controller: LSI Logic / Symbios Logic 53c1030 PCI-X Fusion-MPT Dual
  Ultra320 SCSI (rev 01)
00:11.0 Ethernet controller: Advanced Micro Devices [AMD] 79c970 [PCnet32 LANCE] (rev 10)
00:12.0 Ethernet controller: Advanced Micro Devices [AMD] 79c970 [PCnet32 LANCE] (rev 10)
[root@celebrian ~]#
```

The Celebrian VM has two AMD 79C970 NICs installed

NIC Hardware Inventory

Using **dmesg** to show NIC related information

```
[root@celebrian ~]# dmesg
< snipped >
hdc: ATAPI 1X CD-ROM drive, 32kB Cache, UDMA(33)
Uniform CD-ROM driver Revision: 3.20
pcnet32.c:v1.32 18.Mar.2006 tsbogend@alpha.franken.de
ACPI: PCI Interrupt 0000:00:11.0[A] -> GSI 18 (level, low) -> IRQ 177
pcnet32: PCnet/PCI II 79C970A at 0x1400, 00 0c 29 e5 48 fe assigned IRQ 177.
eth0: registered as PCnet/PCI II 79C970A
ACPI: PCI Interrupt 0000:00:12.0[A] -> GSI 19 (level, low) -> IRQ 185
pcnet32: PCnet/PCI II 79C970A at 0x1480, 00 0c 29 e5 48 08 assigned IRQ 185.
eth1: registered as PCnet/PCI II 79C970A
pcnet32: 2 cards_found.
piix4_smbus 0000:00:07.3: Found 0000:00:07.3 device
piix4_smbus 0000:00:07.3: Host SMBus controller not enabled!
input: PC Speaker as /class/input/input2
sd 0:0:0:0: Attached scsi generic sg0 type 0
Floppy drive(s): fd0 is 1.44M
< snipped >
```

The pcnet32 driver is maintained by Thomas Bogendörfer

The Celebrian VM has two AMD 79C970 NICs installed

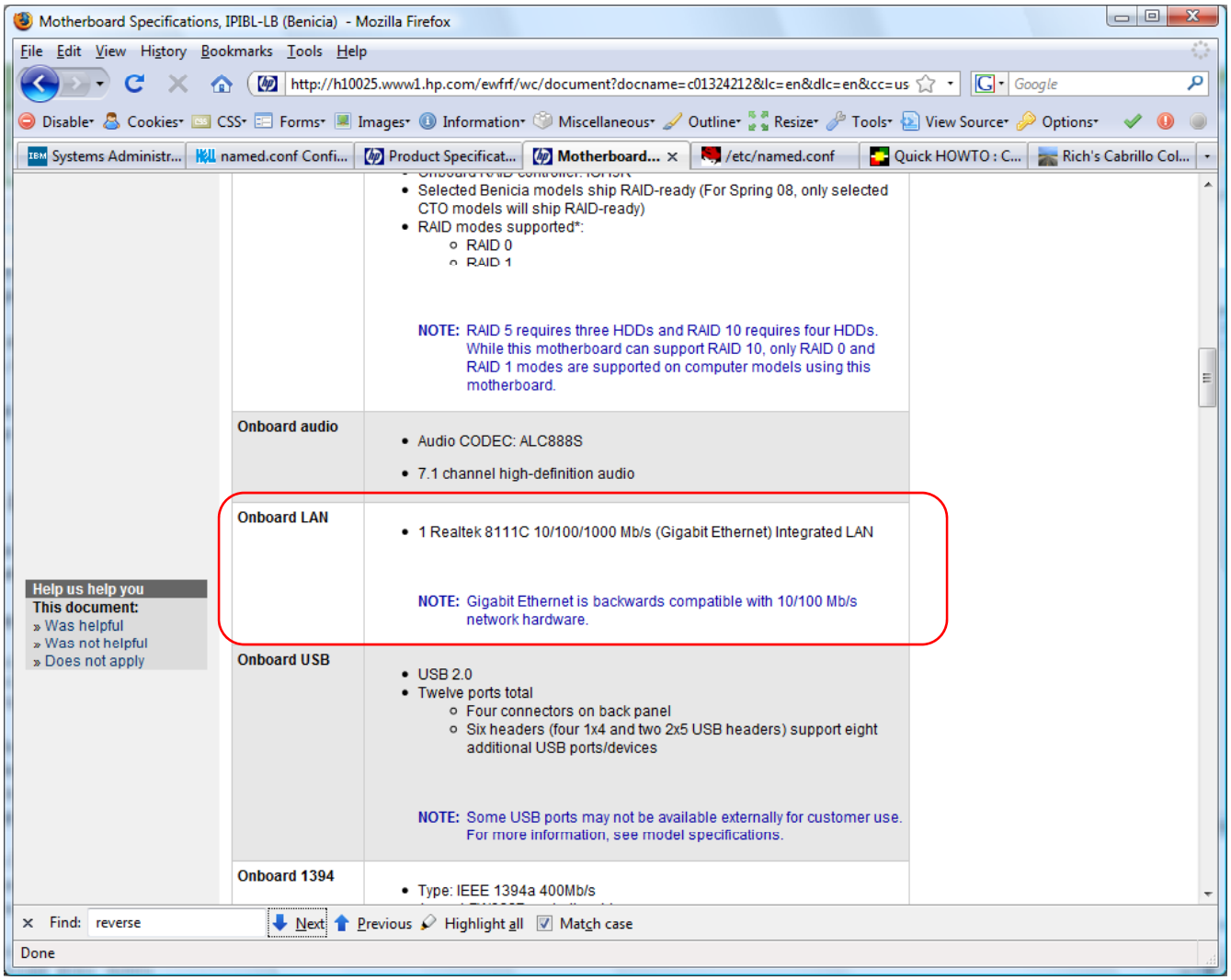
NIC Hardware Inventory

Use **dmesg** with **grep** to narrow down the output

```
[root@celebrian ~]# dmesg | grep eth0
eth0: registered as PCnet/PCI II 79C970A
eth0: link up
eth0: link up
eth0: no IPv6 routers present
[root@celebrian ~]# dmesg | grep net
audit: initializing netlink socket (disabled)
SELinux:  Registering netfilter hooks
Initializing IPsec netlink socket
pcnet32.c:v1.32 18.Mar.2006 tsbogend@alpha.franken.de
pcnet32: PCnet/PCI II 79C970A at 0x1400, 00 0c 29 12 50 1e assigned IRQ 177.
eth0: registered as PCnet/PCI II 79C970A
pcnet32: PCnet/PCI II 79C970A at 0x1480, 00 0c 29 12 50 28 assigned IRQ 185.
eth1: registered as PCnet/PCI II 79C970A
pcnet32: 2 cards_found.
VMware vmxnet virtual NIC driver release 1.0.8 build-126538
[root@celebrian ~]#
```

The dmesg command with no options will show all the kernel messages in the kernel ring buffer. A good way to see bootup status.

NIC Hardware Inventory



Using the web to find NIC information

Example: An HP Pavilion a6750t uses a ASUS: IPIBL-LB (Benicia) motherboard which has a Realtek 8111C 10/100/1000 Mb/s (Gigabit Ethernet) Integrated LAN

Class Activity

NIC Inventory

1. Run Frodo and Celebrian if they are not already up and login as cis192 then **su –** to root.
2. Use the **lspci** command and locate the NIC hardware.
3. Use the **dmesg | more** command browse through the kernel bootup messages.
4. Narrow down the output with **dmesg | grep pcnet** and **dmesg | grep eth**
5. Try again with **dmesg | grep -i pcnet** (the –i option makes the search case insensitive)
6. How many NICs does Frodo have? How many does Celebrian have?
7. What NIC vendor is used on both VMs?

NIC Drivers

Connecting your Linux system to the Network

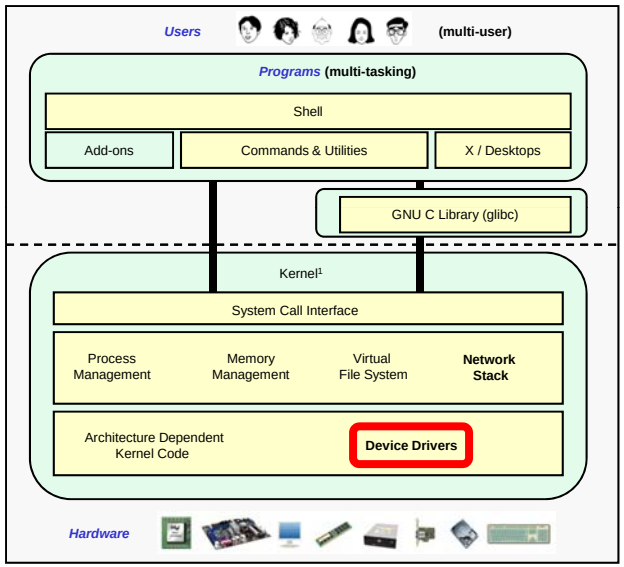
1. Identify the NIC in your system (vendor and model)

2. **Locate a driver for your NIC**
   - may be already available with your distro
   - may be available from NIC vendor
   - may be available from chipset vendor
   - may have get source and build (compile) it

3. Load the driver (**insmod** or **modprobe** command)

4. Bring up and configure the interface (ifconfig)

NIC Drivers



- The Linux kernel requires a specific driver to correctly use a specific vendors NIC hardware.
- Linux NIC drivers are implemented as **dynamic kernel modules**.
- Getting the right Linux NIC driver for your NIC can be **problematic**.
- ☺ Newer distributions are able to probe NIC hardware and automatically install the correct driver if they can recognize the NIC.
- ☹ An older distribution may not recognize a newer NIC and you will have to manually locate, sometimes compile and install the correct NIC driver.

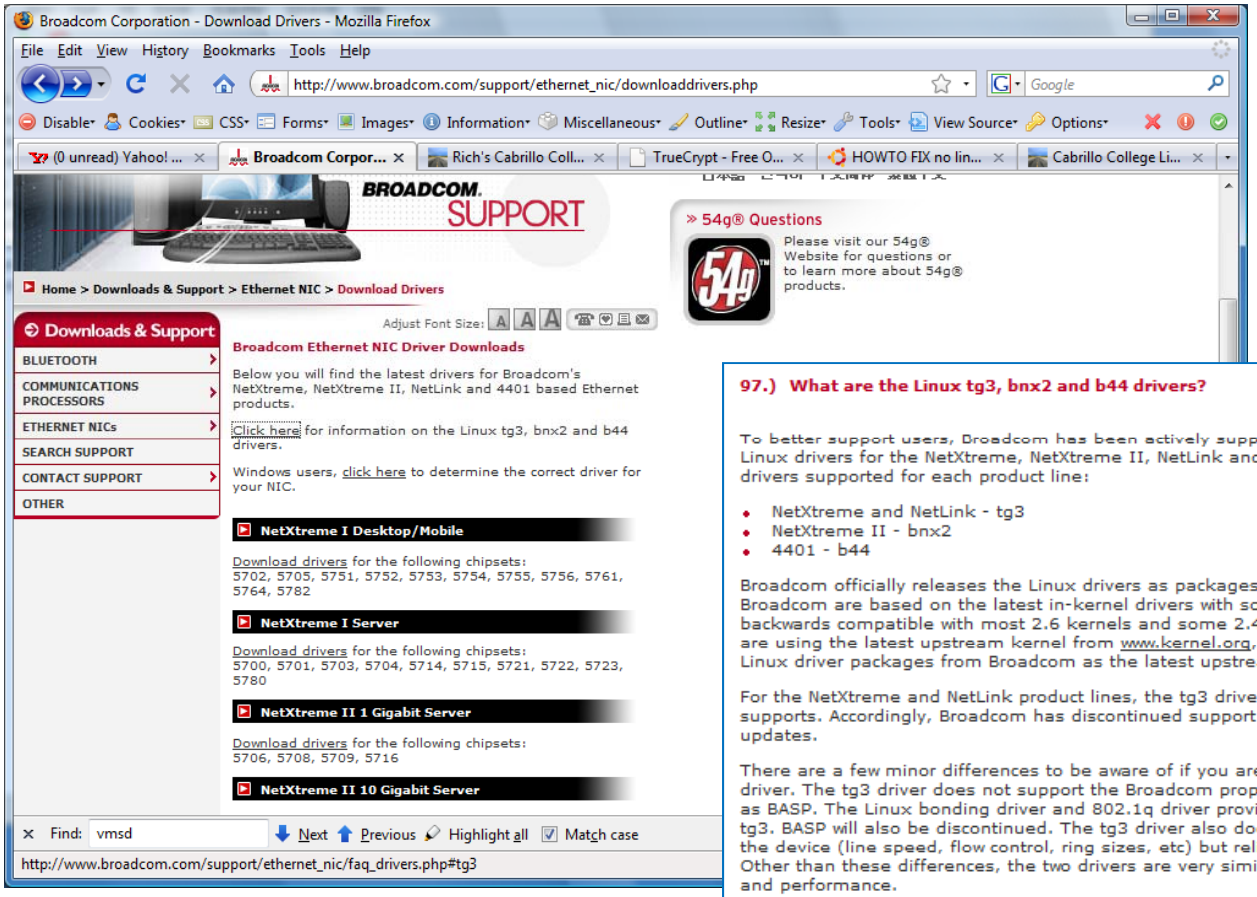
While there are hundreds of different NICs there are relatively few NIC chipsets many of which have Linux support

Locating NIC Drivers

- Newer distribution, older NICs – no problem, correct NIC driver is chosen automatically during installation. **/etc/modules.conf** (RH9) or **/etc/modprobe.conf** (CentOS 5) is updated with drivers to load at boot time.
- Check the computer or NIC vendors web site for NIC drivers. For example, HP supplies Linux drivers for many of its servers (but few of its desktops)
- Look in **/lib/modules/$(uname -r)/kernel/drivers/net** directory. This has all the NIC drivers that have been complied for your kernel. To choose the right one try **http://tldp.org/HOWTO/Ethernet-HOWTO.html**
- If the preceding methods have not worked you can always install an older NIC in your computer and use that until you find the correct driver for the newer NIC.
- Start googling, try **linux *nic-name* driver**. You may have to download source and compile a driver from the chipset vendor's site using their instructions.

NIC Drivers

Chipset vendor Downloads



97.) What are the Linux tg3, bnx2 and b44 drivers?

To better support users, Broadcom has been actively supporting, maintaining, and testing the in kernel Linux drivers for the NetXtreme, NetXtreme II, NetLink and 4401 product lines. The following is list of drivers supported for each product line:

- NetXtreme and NetLink - tg3
- NetXtreme II - bnx2
- 4401 - b44

Broadcom officially releases the Linux drivers as packages. The Linux driver packages released by Broadcom are based on the latest in-kernel drivers with some added compatibility code to make it backwards compatible with most 2.6 kernels and some 2.4 kernels (generally newer than 2.4.24). If you are using the latest upstream kernel from www.kernel.org, you generally do not need to download the Linux driver packages from Broadcom as the latest upstream kernel has the latest Linux driver patches.

For the NetXtreme and NetLink product lines, the tg3 driver is now the only Linux driver that Broadcom supports. Accordingly, Broadcom has discontinued support for the bcm5700 driver and no longer provides updates.

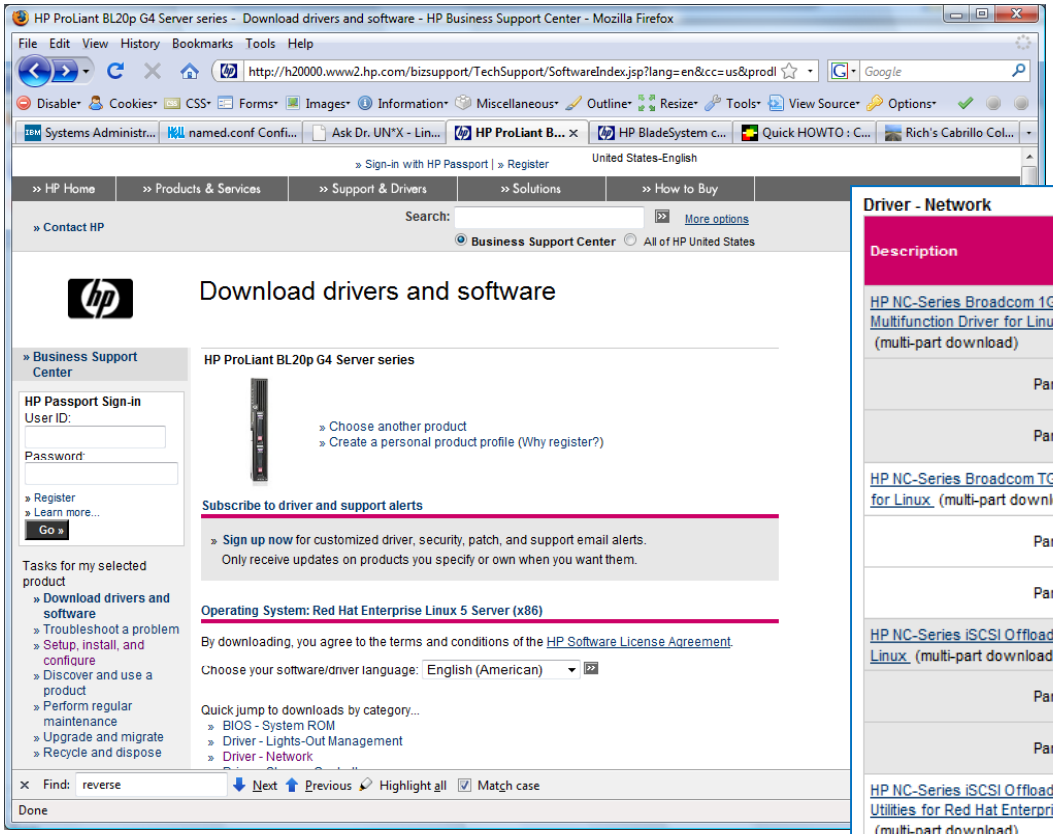
There are a few minor differences to be aware of if you are migrating from the bcm5700 driver to the tg3 driver. The tg3 driver does not support the Broadcom proprietary load balancing software module known as BASP. The Linux bonding driver and 802.1q driver provide similar functionalities and can be used with tg3. BASP will also be discontinued. The tg3 driver also does not support module parameters to configure the device (line speed, flow control, ring sizes, etc) but relies on standard Linux utilities such as ethtool. Other than these differences, the two drivers are very similar in terms of hardware support, robustness, and performance.

Back to Top

http://www.broadcom.com/support/ethernet_nic/downloaddrivers.php

NIC Drivers

Server vendor Downloads



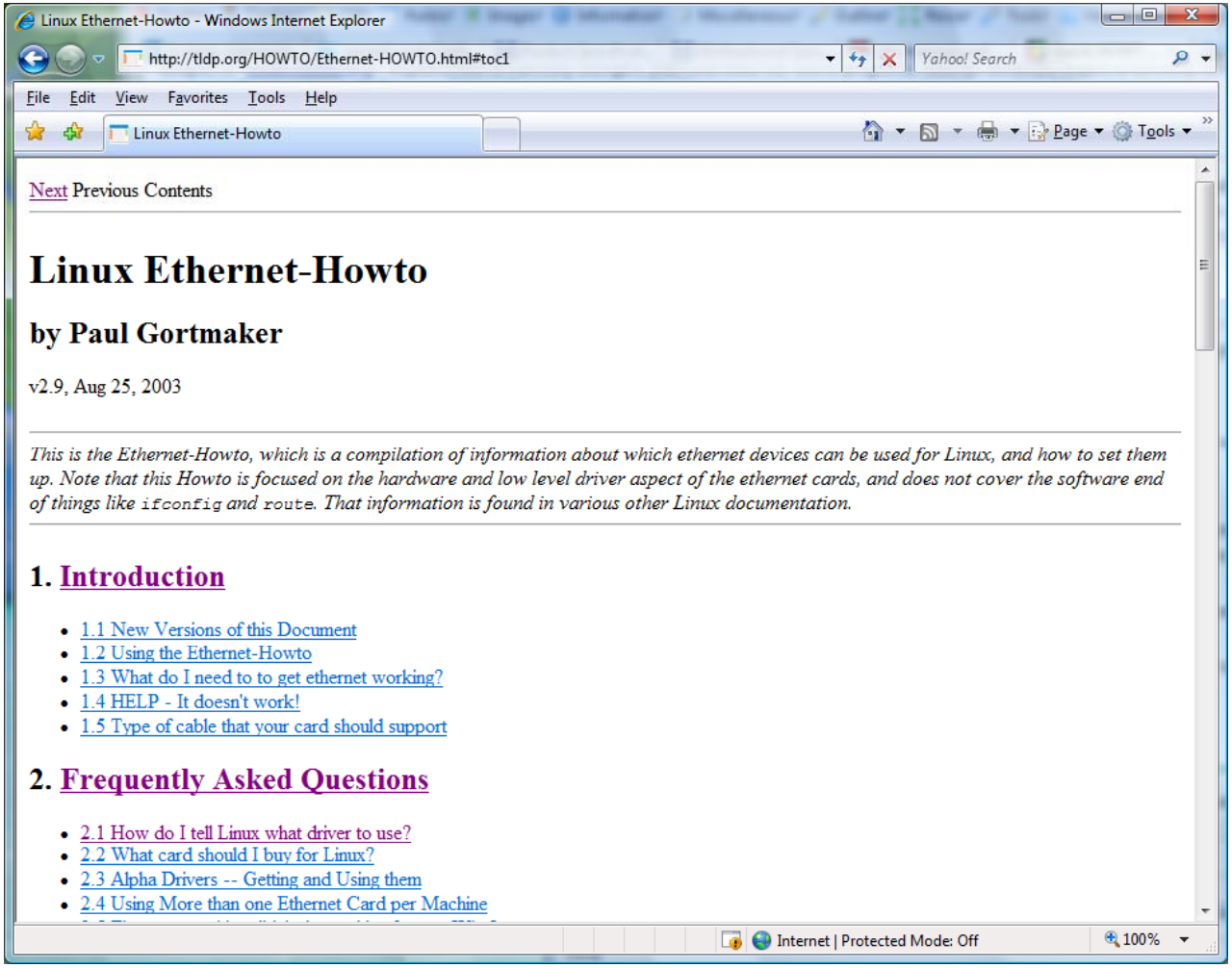
Driver - Network

Description	Current version	Size (MB)	Estimated download time	Previous version	
HP NC-Series Broadcom 1Gb Multifunction Driver for Linux (multi-part download)	1.8.1c-1 (B) 14 Nov 2008			1.8.1c-1 11 Nov 2008	
Part 1		0.31	56K: <1m 512K: <1m		Download »
Part 2		0.008	56K: <1m 512K: <1m		Download »
HP NC-Series Broadcom TG3 Driver for Linux (multi-part download)	3.92n-1 11 Nov 2008			3.92e-3 7 Aug 2008	
Part 1		0.14	56K: <1m 512K: <1m		Download »
Part 2		0.011	56K: <1m 512K: <1m		Download »
HP NC-Series iSCSI Offload Driver for Linux (multi-part download)	1.3.6-1 11 Nov 2008			1.2.14-1 8 Jul 2008	
Part 1		0.1	56K: <1m 512K: <1m		Download »
Part 2		0.011	56K: <1m 512K: <1m		Download »
HP NC-Series iSCSI Offload Initiator Utilities for Red Hat Enterprise Linux 5 (multi-part download)	6.2.0.868-0.7c 8 Jul 2008			6.2.0.742-0.6b 18 Dec 2007	
Part 1		0.26	56K: <1m 512K: <1m		Download »
Part 2		0.005	56K: <1m 512K: <1m		Download »
HP NC-Series open-iscsi Boot Package for Linux (multi-part download)	1.1.2-0 8 Jul 2008			1.1.0-6 18 Dec 2007	

http://www.hp.com/#Support

NIC Drivers

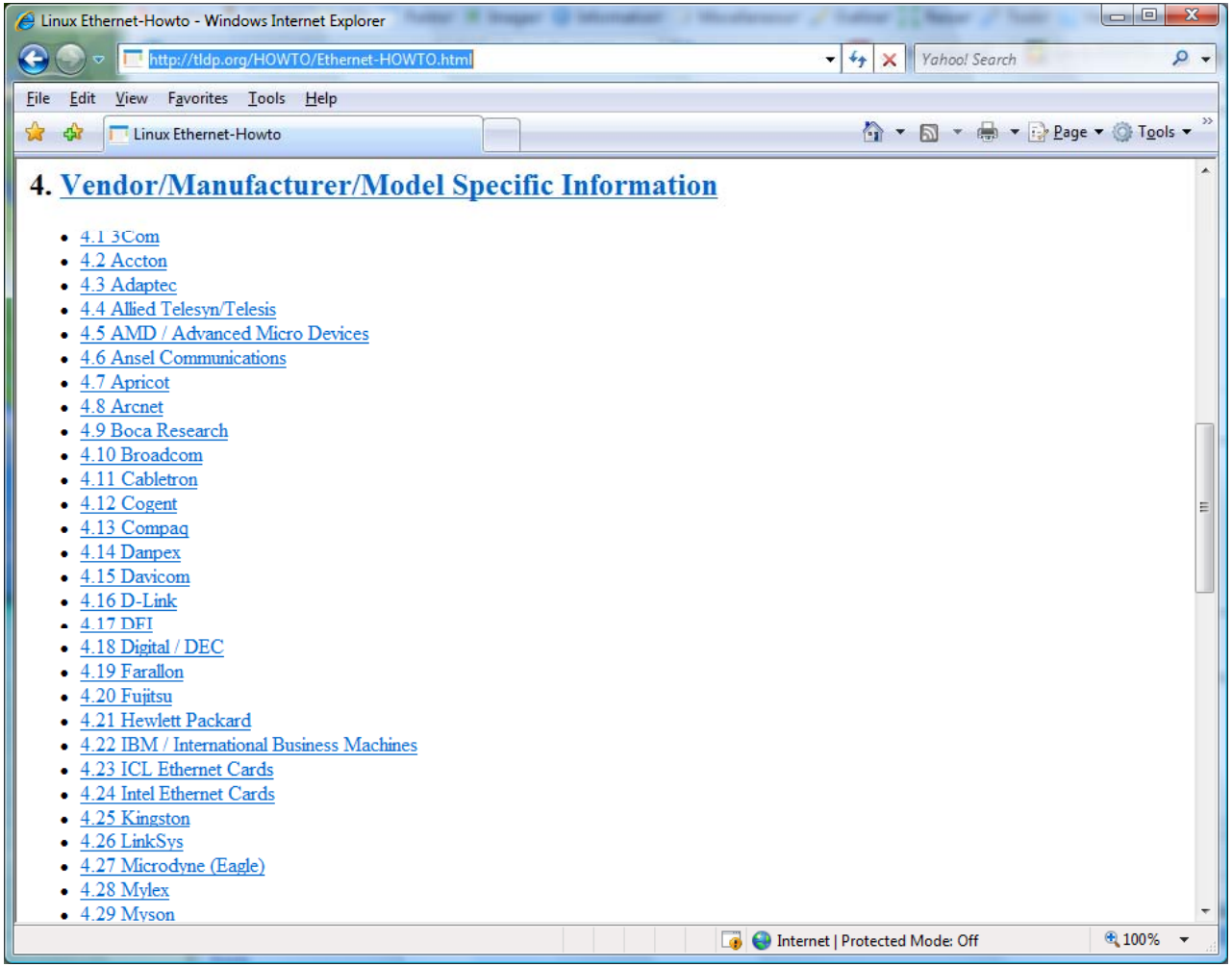
http://tldp.org/HOWTO/Ethernet-HOWTO.html



The TLDP web site has an Ethernet Howto that is extremely valuable when trying to find the correct NIC drivers

NIC Drivers

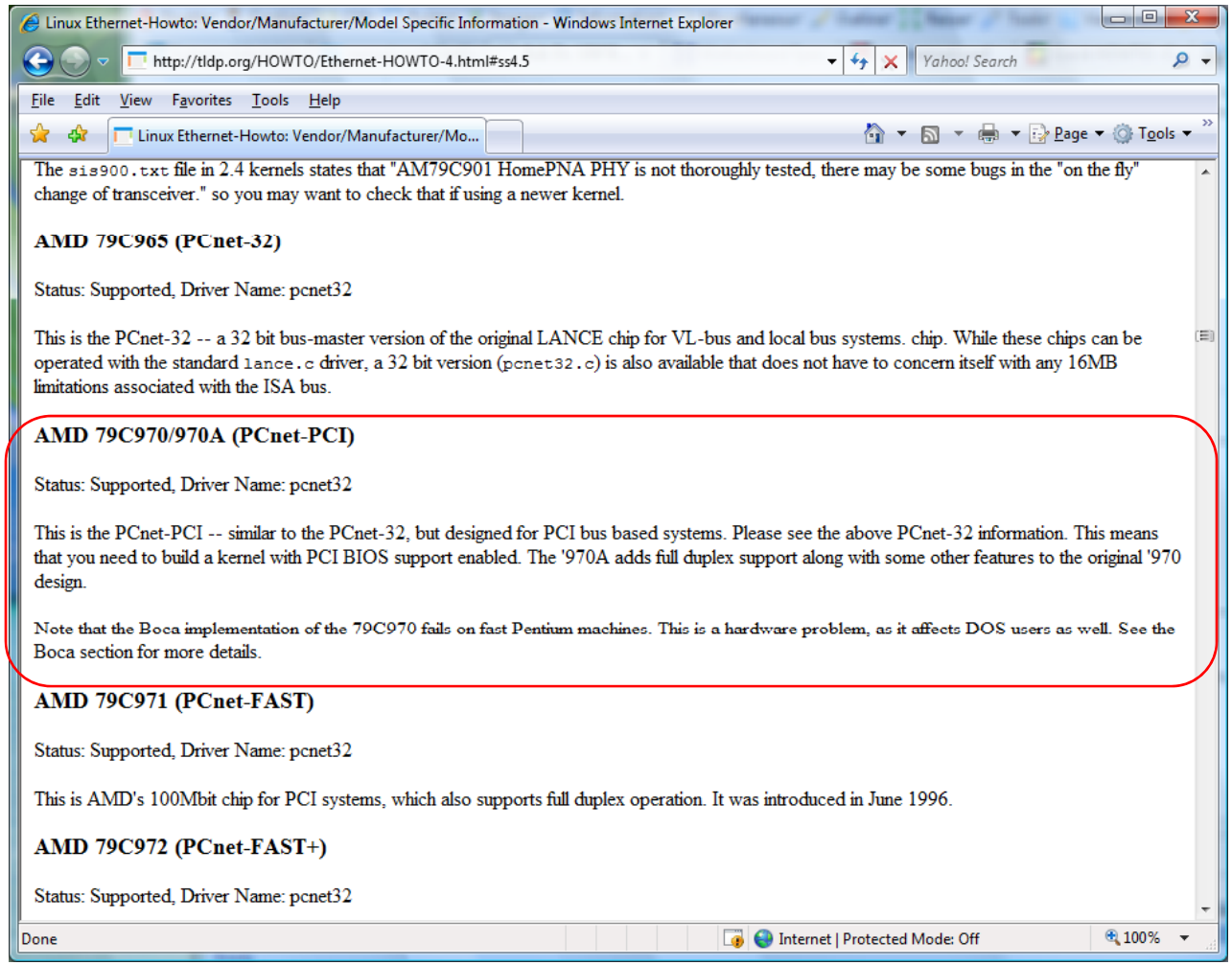
http://tldp.org/HOWTO/Ethernet-HOWTO.html



See section 4 for specific NICs

NIC Drivers

http://tldp.org/HOWTO/Ethernet-HOWTO.html



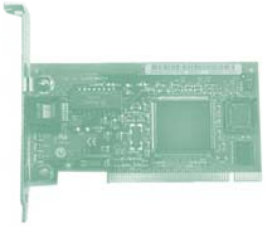
*The AMD 79C970 on the Celebrian VM uses the **pcnet32** driver*

NIC Drivers

*NIC drivers are **kernel modules** and are kept is a specific directory so the kernel knows where to find them. Note, they were .o files in older distros.*

```
[root@celebrian ~]# uname -r
2.6.18-92.1.22.el5
[root@celebrian ~]# ls /lib/modules/$(uname -r)/kernel/drivers/net
3c59x.ko      dummy.ko       natsemi.ko      ppp_synctty.ko  sunhme.ko
8139cp.ko     e1000          ne2k-pci.ko     qla3xxx.ko      tg3.ko
8139too.ko    e1000e         netconsole.ko   r8169.ko        tlan.ko
8390.ko       e100.ko        netxen          s2io.ko         tokenring
acenic.ko     epic100.ko     ns83820.ko      sis190.ko       tulip
amd8111e.ko   fealnx.ko      pcmcia          sis900.ko       tun.ko
b44.ko        forcedeth.ko   pcnet32.ko      skge.ko         typhoon.ko
bnx2.ko       ifb.ko         phy             sky2.ko         via-rhine.ko
bnx2x.ko      igb            ppp_async.ko    slhc.ko         via-velocity.ko
bonding       ixgb           ppp_deflate.ko  slip.ko         wireless
cassini.ko    ixgbe          ppp_generic.ko  starfire.ko
chelsio       mii.ko         ppp_mppe.ko     sundance.ko
cxgb3         mlx4           pppoe.ko        sungem.ko
dl2k.ko       myri10ge       pppox.ko        sungem_phy.ko
[root@celebrian ~]#

[root@celebrian ~]# file /lib/modules/$(uname -r)/kernel/drivers/net/e100.ko
/lib/modules/2.6.18-92.1.22.el5/kernel/drivers/net/e100.ko: ELF 32-bit LSB relocatable,
  Intel 80386, version 1 (SYSV), not stripped
[root@celebrian ~]#
```

VMware Server Virtual Machines
The Virtual NICs



Note: All the VMs have the same AMD 79c970 NICs which use the pcnet32 driver

Treebeard eth0 eth1 **Arwen** eth0 eth1 **Elrond** eth0 eth1 **Celebrian** eth0 eth1 **Legolas** eth0 eth1

Servers

Frodo eth0 **Sauron** eth0 **Fang** eth0

Clients

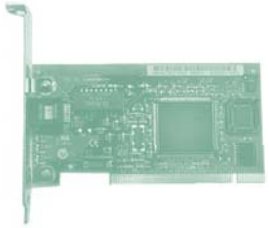
Nosmo eth0 **Sniffer** eth0 eth1 eth2 eth3

Special

Real NICs can be more challenging

System Pod

Press middle button to boot Linux



There are a variety on NICs on the older systems in the System pods

NIC	Linux Driver
Intel PRO 100 NIC	e100
D-Link NICs with RealTek 8129/8139 chipsets	8139too
3Com 3c905x NICs	3c59x
Lite-on Communications LNE 100TX cards with DEC chipsets	tulip
AMD 79c970 NIC (used in VMware VMs)	pcnet32

NIC Drivers

Some drivers that have been used with the PC's in the CIS Lab

```
[root@celebrian ~]# ls /lib/modules/$(uname -r)/kernel/drivers/net
3c59x.ko        dummy.ko        natsemi.ko      ppp_synctty.ko  sunhme.ko
8139cp.ko       e1000           ne2k-pci.ko     qla3xxx.ko      tg3.ko
8139too.ko      e1000e          netconsole.ko   r8169.ko        tlan.ko
8390.ko         e100.ko         netxen          s2io.ko         tokenring
acenic.ko       epic100.ko      ns83820.ko      sis190.ko       tulip
amd8111e.ko     fealnx.ko       pcmcia          sis900.ko       tun.ko
b44.ko          forcedeth.ko    pcnet32.ko      skge.ko         typhoon.ko
bnx2.ko         ifb.ko          phy             sky2.ko         via-rhine.ko
bnx2x.ko        igb             ppp_async.ko    slhc.ko         via-velocity.ko
bonding         ixgb            ppp_deflate.ko  slip.ko         wireless
cassini.ko      ixgbe           ppp_generic.ko  starfire.ko
chelsio         mii.ko          ppp_mppe.ko     sundance.ko
cxgb3           mlx4            pppoe.ko        sungem.ko
dl2k.ko         myri10ge        pppox.ko        sungem_phy.ko
[root@celebrian ~]#
```

NIC	Linux Driver
Intel PRO 100 NIC	e100
D-Link NICs with RealTek 8129/8139 chipsets	8139too
3Com 3c905x NICs	3c59x
Lite-on Communications LNE 100TX cards with DEC chipsets	tulip
AMD 79c970 NIC (used in VMware VMs)	pcnet32

Managing
(showing, installing, removing)
Drivers

Connecting your Linux system to the Network

1. Identify the NIC in your system (vendor and model)

2. Locate a driver for your NIC
   - may be already available with your distro
   - may be available from NIC vendor
   - may be available from chipset vendor
   - may have get source and build (compile) it

3. Load the driver (insmod or modprobe command)

4. Bring up and configure the interface (ifconfig)

Commands for handling NIC drivers (kernel modules)

- To show available NIC drivers:
  ls /lib/modules/$(uname -r)/kernel/drivers/net

- To show loaded kernel modules including NIC drivers
  lsmod
  example: **lsmod | grep pcnet32** (show NIC drivers used on VMs)

- To remove (unload) a NIC driver
  rmmod *driver*
  example: **rmmod pcnet32** (removes pcnet32 VM NIC driver)

  Do not specify the path or suffix (.ko) for drivers

- To insert (load) a NIC driver
  insmod *driver*
  modprobe *driver*
  example: **modprobe pcnet32** (installs pcnet32 VM NIC driver)

  modprobe is more intelligent and recommended over insmod

Commands for handling NIC drivers (kernel modules)

To show available NIC drivers:

ls /lib/modules/$(uname -r)/kernel/drivers/net

```
Bluetooth: L2CAP ver 2.8
Bluetooth: L2CAP socket layer initialized
Bluetooth: RFCOMM socket layer initialized
Bluetooth: RFCOMM TTY layer initialized
Bluetooth: RFCOMM ver 1.8
Bluetooth: HIDP (Human Interface Emulation) ver 1.1
SELinux: initialized (dev autofs, type autofs), uses genfs_contexts
SELinux: initialized (dev autofs, type autofs), uses genfs_contexts
SELinux: initialized (dev autofs, type autofs), uses genfs_contexts
[root@elrond ~]# ls /lib/modules/2.6.18-92.el5/kernel/drivers/net/
3c59x.ko      dummy.ko       natsemi.ko      ppp_synctty.ko  sunhme.ko
8139cp.ko     e1000          ne2k-pci.ko     qla3xxx.ko      tg3.ko
8139too.ko    e1000e         netconsole.ko   r8169.ko        tlan.ko
8390.ko       e100.ko        netxen          s2io.ko         tokenring
acenic.ko     epic100.ko     ns83820.ko      sis190.ko       tulip
amd8111e.ko   fealnx.ko      pcmcia          sis900.ko       tun.ko
b44.ko        forcedeth.ko   pcnet32.ko      skge.ko         typhoon.ko
bnx2.ko       ifb.ko         phy             sky2.ko         via-rhine.ko
bnx2x.ko      igb            ppp_async.ko    slhc.ko         via-velocity.ko
bonding       ixgb           ppp_deflate.ko  slip.ko         wireless
cassini.ko    ixgbe          ppp_generic.ko  starfire.ko
chelsio       mii.ko         ppp_mppe.ko     sundance.ko
cxgb3         mlx4           pppoe.ko        sungem.ko
dl2k.ko       myri10ge       pppox.ko        sungem_phy.ko
[root@elrond ~]#
```

Use tab completes!

We are using the pcnet32 driver for the VM NICs

Commands for handling NIC drivers (kernel modules)

To show loaded kernel modules including NIC drivers

lsmod

example: **lsmod | grep pcnet32** (show NIC drivers used on VMs)

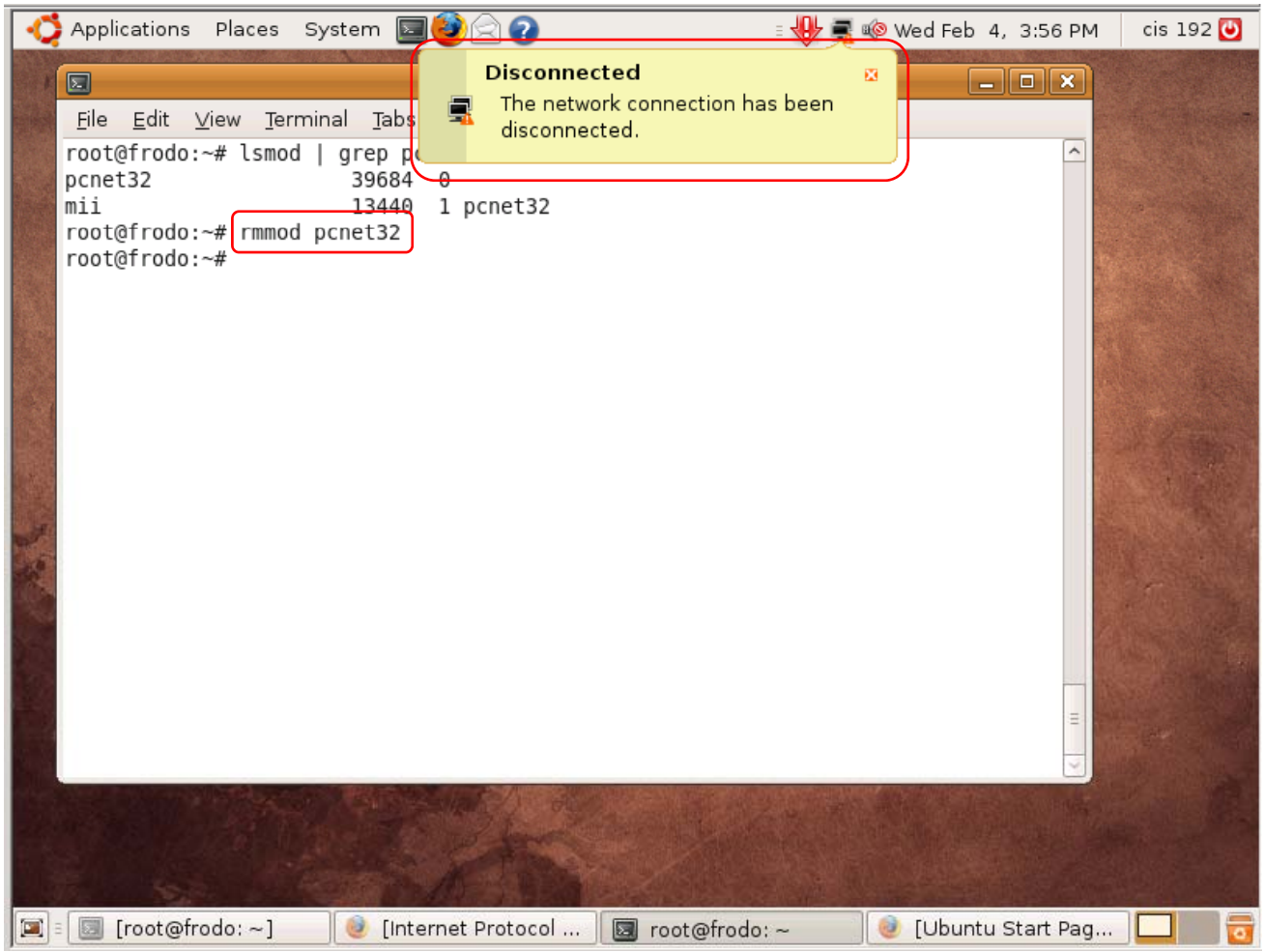
```
[root@elrond ~]# lsmod | head
Module                  Size  Used by
autofs4                24517  2
hidp                   23105  2
rfcomm                 42457  0
l2cap                  29505  10 hidp,rfcomm
bluetooth              53797  5 hidp,rfcomm,l2cap
vmxnet                 15488  0
vmhgfs                 44176  0
sunrpc                144893  1
ip_conntrack_netbios_ns     6977  0
[root@elrond ~]# lsmod | grep pcnet32
pcnet32                35269  0
mii                     9409  1 pcnet32
[root@elrond ~]# _
```

This shows that the pcnet32 NIC driver is loaded and it uses the MII (Media Independent Interface) module

Commands for handling NIC drivers (kernel modules)

To remove (unload) a NIC driver

rmmod *driver*



When you remove the NIC driver you will lose the network connection

Note: The pcnet32 driver is used for the NICs on the VMs

Class Activity - Managing NIC Drivers

1. Power on Frodo and Celebrian if they are not already up.
2. Login as cis192 then **su –** to root. Use a graphical terminal on Frodo.
3. Do a short listing of the NIC drivers on Frodo and Celebrian with:
   ls /lib/modules/$(uname -r)/kernel/drivers/net
   Note: you can also type 2 then Tab key instead of $(uname –r)
4. Pipe the output of the ls command above into **wc –l** and determine which distro includes the most NIC drivers on their standard installation.
5. On Frodo, locate the pcnet32 driver **pcnet32.ko**
6. On Frodo, check that the driver is loaded with **lsmod | grep pcnet32** then check the interface status with **ifconfig**
7. On Frodo, unload the NIC driver with **rmmod pcnet32**
8. On Frodo, check that the driver is unloaded with **lsmod | grep pcnet32** then check the interface status with **ifconfig eth0**
9. On Frodo, use **modprobe pcnet32** to reload the NIC driver again.
10. On Frodo, check that the driver is loaded again with **lsmod | grep pcnet32** then check the interface status with **ifconfig**
11. If you no longer have a IPv4 address use **dhclient**

Configuring Static IP addresses (temporary)

Connecting your Linux system to the Network

1. Identify the NIC in your system (vendor and model)

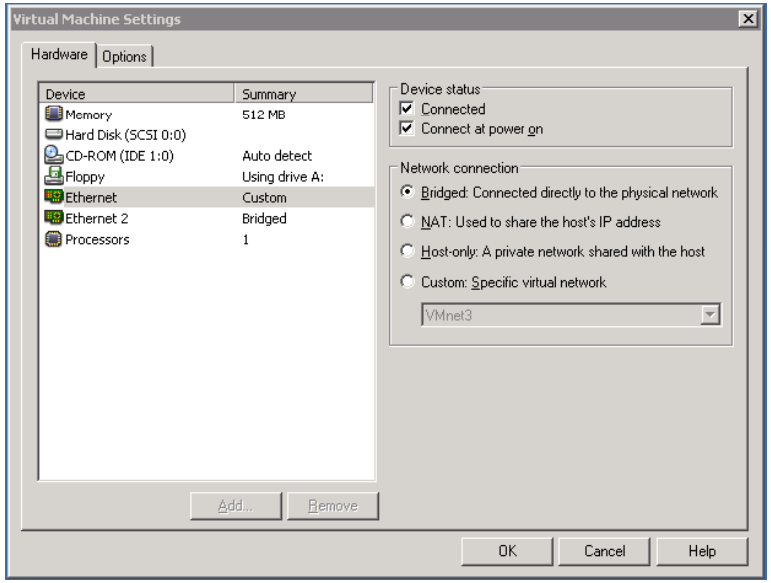
2. Locate a driver for your NIC
   - may be already available with your distro
   - may be available from NIC vendor
   - may be available from chipset vendor
   - may have get source and build (compile) it

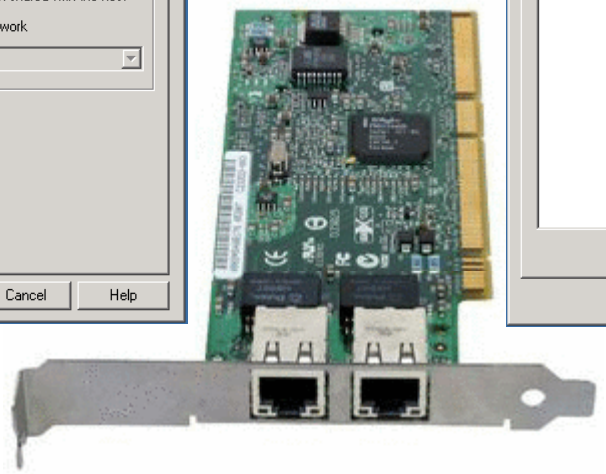
3. Load the driver (insmod or modprobe command)

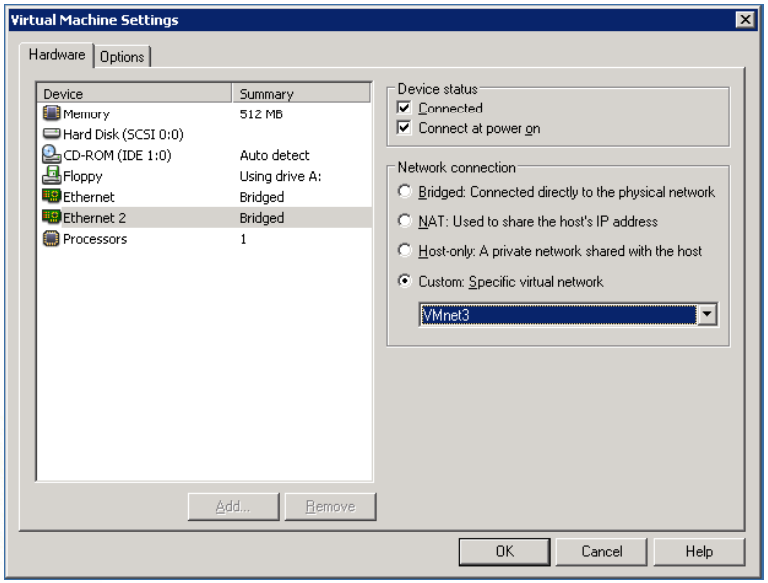
4. Bring up and configure the interface (ifconfig)

Configuring a static IP address with ifconfig

Having two Ethernet adapters in your VM is the same as having two real adapters in a real physical computer







Ethernet = eth0

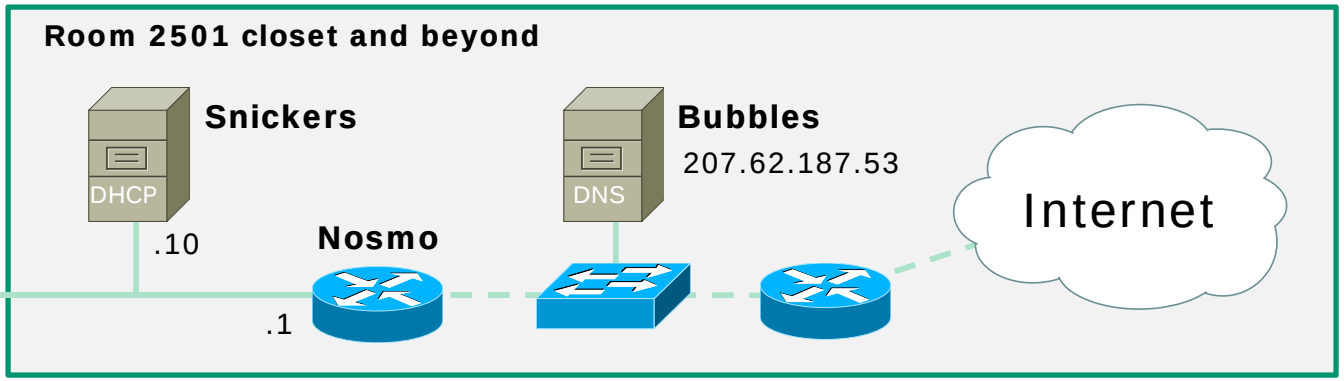
Ethernet2 = eth1

Linux will refer to the first adapter as eth0 and the second as eth1

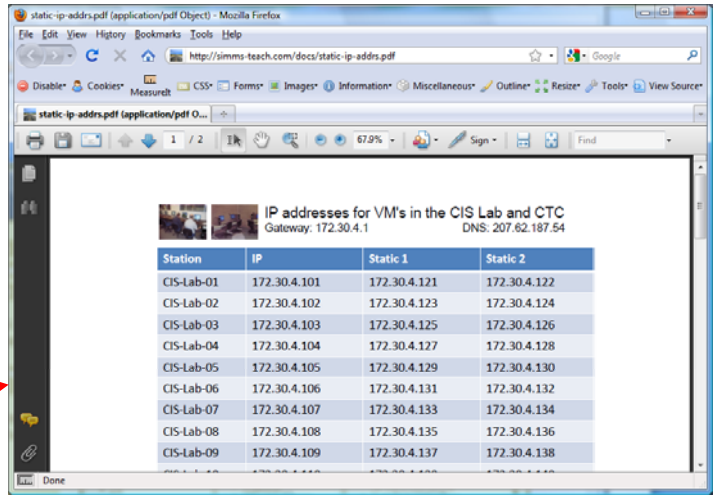
Configuring a static IP address with ifconfig

Classroom Room 2501

172.30.1.0 /24



To avoid duplicate IP address conflicts only use the static IP addresses assigned to your specific VMware station



StationXX
(VMware host PC)

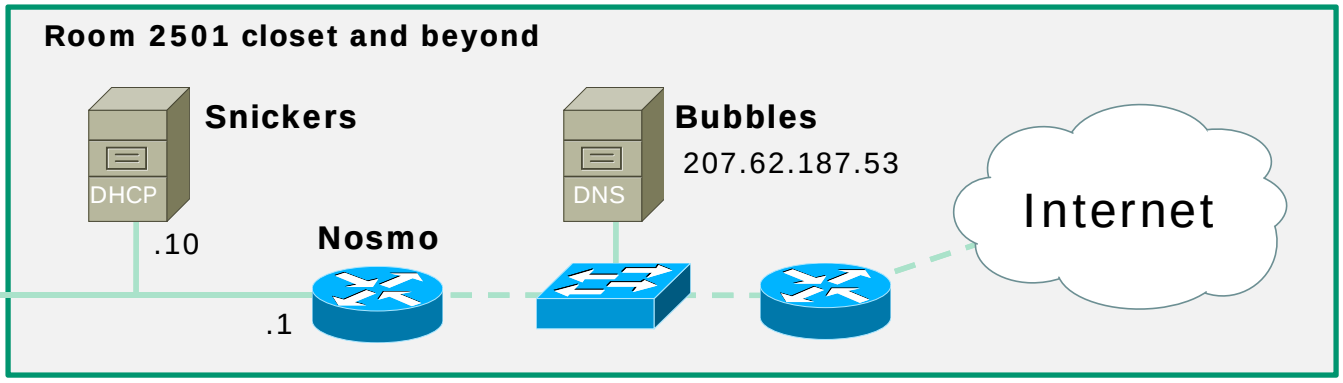
Elrond

eth0
.1xx

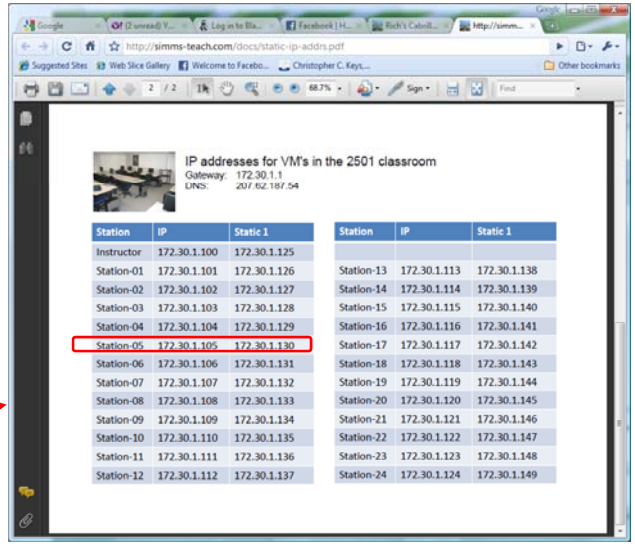
Configuring a static IP address with ifconfig

Classroom Room 2501

172.30.1.0 /24



For example, Station05 in the classroom is assigned 172.30.1.105 and 172.30.1.130 is available for use on one of the VMs.



Station05
(VMware host PC)

.105

eth0

.130

Elrond

CentOS 5

Configuring a static IP address with ifconfig

- To show all interfaces (and to show your IP address):
  ifconfig

- To show the eth0 interface:
  ifconfig eth0

- To set ip address and subnet mask:
  ifconfig ethx xxx.xxx.xxx.xxx **netmask** xxx.xxx.xxx.xxx
  or **ifconfig eth**x xxx.xxx.xxx.xxx**/**nn *(where nn=prefix)*

- To shut down an interface:
  ifconfig ethx **down**

- To bring up an interface:
  ifconfig ethx **up**

*Note: Configuring an IP address with **ifconfig** is temporary. It will last until the system is rebooted or the network service is restarted.*

Configuring a static IP address with ifconfig

The **ifconfig** command, with no arguments, will list all “up” interfaces

```
[root@elrond ~]# ifconfig
lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:8 errors:0 dropped:0 overruns:0 frame:0
          TX packets:8 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0
          RX bytes:560 (560.0 b)  TX bytes:560 (560.0 b)

[root@elrond ~]# _
```

Network settings have been disabled on the CentOS VMs so you can practice setting them up. When you first power them on only the loopback “lo” interface is active.

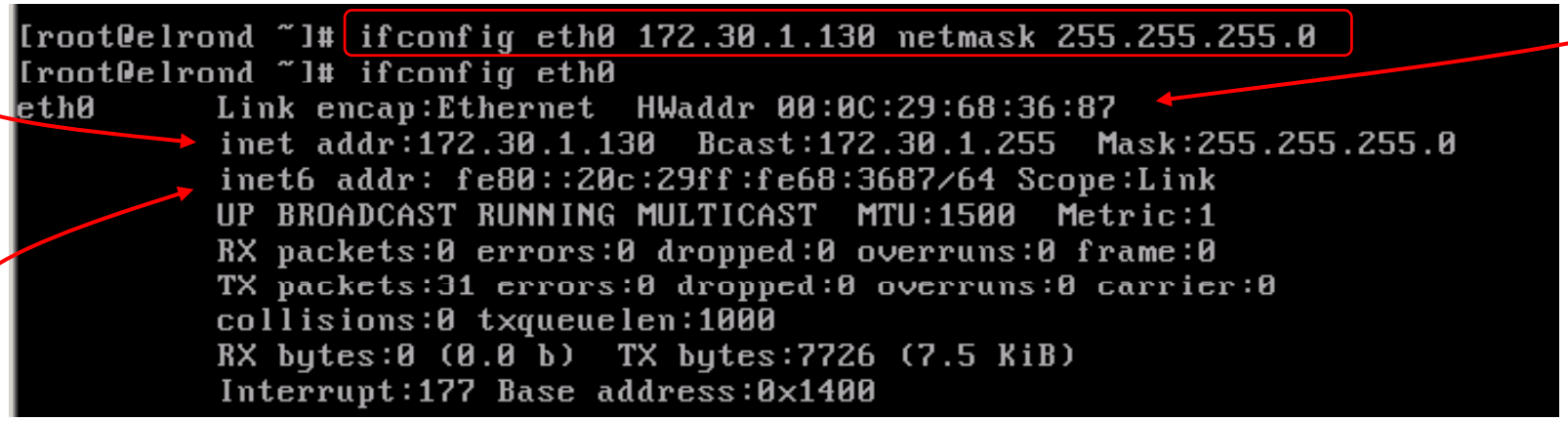
Configuring a static IP address with ifconfig

To set ip address and subnet mask on Station 05 in the classroom:

ifconfig eth0 172.30.4.130 netmask 255.255.255.0

MAC address

IPv4 address

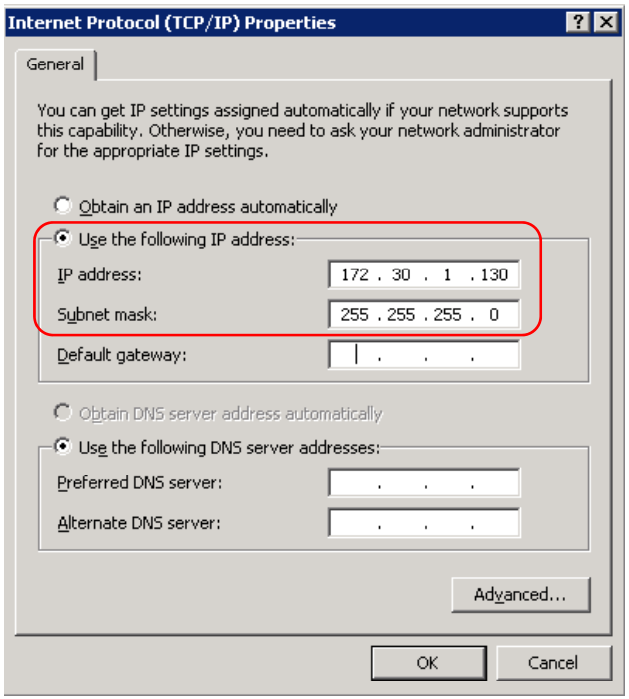


IPv6 address

Remember that 172.30.1.130 is only to be used on Station 5.

If every student configures their VM with the same static IP address there will be duplicate IP issues with the classroom network.

Configuring static IP and mask on other planets



Lan Area Connection on Windows XP

One standard …. many implementations!

fa 0/0 on Cisco 2811 router

```
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#int fa0/0
Router(config-if)#ip add 172.30.1.130 255.255.255.0
Router(config-if)#
```

Caveat: Root's environment has /sbin in path

To show all interfaces (and to show your IP address):
ifconfig

As root, your path includes /sbin

```
[root@benji ~]# ifconfig
eth0      Link encap:Ethernet  HWaddr 00:0C:29:E6:2C:03
          inet addr:192.168.0.34  Bcast:192.168.0.255  Mask:255.255.255.0
          inet6 addr: fe80::20c:29ff:fee6:2c03/64 Scope:Link
<snipped>
```

As non-root user your path does not include /sbin

```
[cis192@benji ~]$ ifconfig
-bash: ifconfig: command not found


[cis192@benji ~]$ /sbin/ifconfig
eth0      Link encap:Ethernet  HWaddr 00:0C:29:E6:2C:03
          inet addr:192.168.0.34  Bcast:192.168.0.255  Mask:255.255.255.0
          inet6 addr: fe80::20c:29ff:fee6:2c03/64 Scope:Link
<snipped>
```

Configuring Gateway DNS

Configuring the gateway and DNS

- To show the routing table (including gateway)
  route -n

- To set the gateway
  route add default gw xxx.xxx.xxx.xxx

- To delete the gateway
  route del default gw xxx.xxx.xxx.xxx

- To set the DNS server
  edit **/etc/resolv.conf** and add:
  nameserver xxx.xxx.xxx.xxx

Configuring the gateway and DNS

To set the default gateway

route add default gw xxx.xxx.xxx.xxx

```
[root@elrond ~]# route add default gw 172.30.1.1
[root@elrond ~]# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
172.30.1.0      0.0.0.0         255.255.255.0   U     0      0        0 eth0
0.0.0.0         172.30.1.1      0.0.0.0         UG    0      0        0 eth0
[root@elrond ~]#
```

*After setting a new route it's a good idea to verify it using **route –n***

The routing table above has two entries:

- *Packets destined for 172.30.1.0/24 are sent out the eth0 interface to the connected subnet*
- *All other packets are sent to the default gateway at 172.30.1.1*

Configuring the gateway and DNS

To delete the default gateway

route delete default gw xxx.xxx.xxx.xxx

```
[root@elrond ~]# route del default gw 172.30.1.1
[root@elrond ~]# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
172.30.1.0      0.0.0.0         255.255.255.0   U     0      0        0 eth0
[root@elrond ~]# _
```

*After changing a route it's a good idea to verify it using **route -n***

Configuring the gateway and DNS

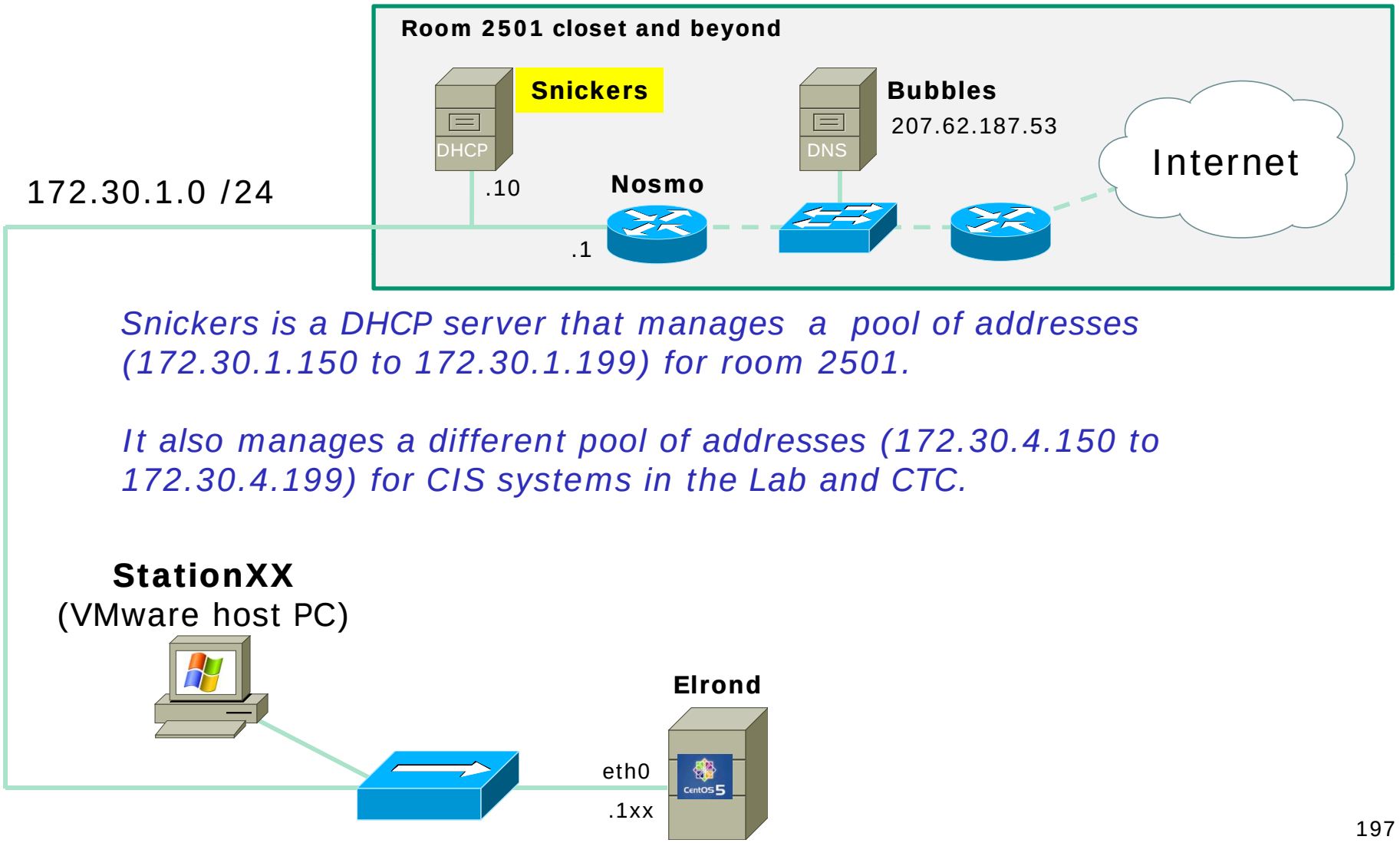
To set the DNS server edit **/etc/resolv.conf** and add:

nameserver xxx.xxx.xxx.xxx

```
[root@elrond ~]# cat /etc/resolv.conf
cat: /etc/resolv.conf: No such file or directory
[root@elrond ~]# echo nameserver 207.62.187.53 > /etc/resolv.conf
[root@elrond ~]# cat /etc/resolv.conf
nameserver 207.62.187.53
[root@elrond ~]# _
```

Configuring dynamic IP address (dhcp)

Configuring dynamic IP addresses



Snickers is a DHCP server that manages a pool of addresses (172.30.1.150 to 172.30.1.199) for room 2501.

It also manages a different pool of addresses (172.30.4.150 to 172.30.4.199) for CIS systems in the Lab and CTC.

Configuring dynamic IP addresses

- To request a dynamic IP address for eth0:
  dhclient eth0

- To release a dynamic IP address:
  dhclient –r eth0

Note: Specifying eth0 is not necessary for systems with a single NIC. However, all the CentOS systems used for this course have 2 NICs making it necessary to designate the specific interface

Configuring dynamic IP addresses

To get a dynamic IP address from a DHCP server:

dhclient eth0

```
[root@elrond ~]# dhclient eth0
Internet Systems Consortium DHCP Client V3.0.5-RedHat
Copyright 2004-2006 Internet Systems Consortium.
All rights reserved.
For info, please visit http://www.isc.org/sw/dhcp/

Listening on LPF/eth0/00:0c:29:68:36:87
Sending on   LPF/eth0/00:0c:29:68:36:87
Sending on   Socket/fallback
DHCPDISCOVER on eth0 to 255.255.255.255 port 67 interval 4
DHCPOFFER from 172.30.1.1
DHCPREQUEST on eth0 to 255.255.255.255 port 67
DHCPACK from 172.30.1.1
bound to 172.30.1.199 -- renewal in 10348 seconds.
[root@elrond ~]# _
```

I made this screen shot at home rather than at school … how can could you determine this by looking at the output above?

Configuring dynamic IP addresses

To release a dynamic IP address back to the DHCP server:

dhclient –r eth0

```
[root@elrond ~]# dhclient -r eth0
Internet Systems Consortium DHCP Client V3.0.5-RedHat
Copyright 2004-2006 Internet Systems Consortium.
All rights reserved.
For info, please visit http://www.isc.org/sw/dhcp/

Listening on LPF/eth0/00:0c:29:68:36:87
Sending on   LPF/eth0/00:0c:29:68:36:87
Sending on   Socket/fallback
DHCPRELEASE on eth0 to 172.30.1.1 port 67
[root@elrond ~]#
```

We will learn more about DHCP and how to set up a DHCP server later in the course.

Testing

Testing Interface Settings

- Check IP address by pinging router or neighbor
  ping xxx.xxx.xxx.xxx

At school, the nosmo router is at:
- *172.30.1.1 in the classroom*
- *172.30.4.1 in the lab*

- Check DNS by pinging hostname
  ping google.com

Use Ctrl-C to stop pinging which will go on forever if you don't.

Commands for testing interfaces

Check settings by pinging the classroom router

ping 172.30.1.1

```
[root@elrond ~]# ping 172.30.1.1
PING 172.30.1.1 (172.30.1.1) 56(84) bytes of data.
64 bytes from 172.30.1.1: icmp_seq=1 ttl=64 time=5.81 ms
64 bytes from 172.30.1.1: icmp_seq=2 ttl=64 time=1.20 ms
64 bytes from 172.30.1.1: icmp_seq=3 ttl=64 time=1.31 ms
64 bytes from 172.30.1.1: icmp_seq=4 ttl=64 time=0.956 ms

--- 172.30.1.1 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3003ms
rtt min/avg/max/mdev = 0.956/2.322/5.813/2.019 ms
[root@elrond ~]#
```

Use Ctrl-C to stop pinging which will go on forever if you don't.

Commands for testing interfaces

Check settings by pinging the classroom router

ping 172.30.1.1

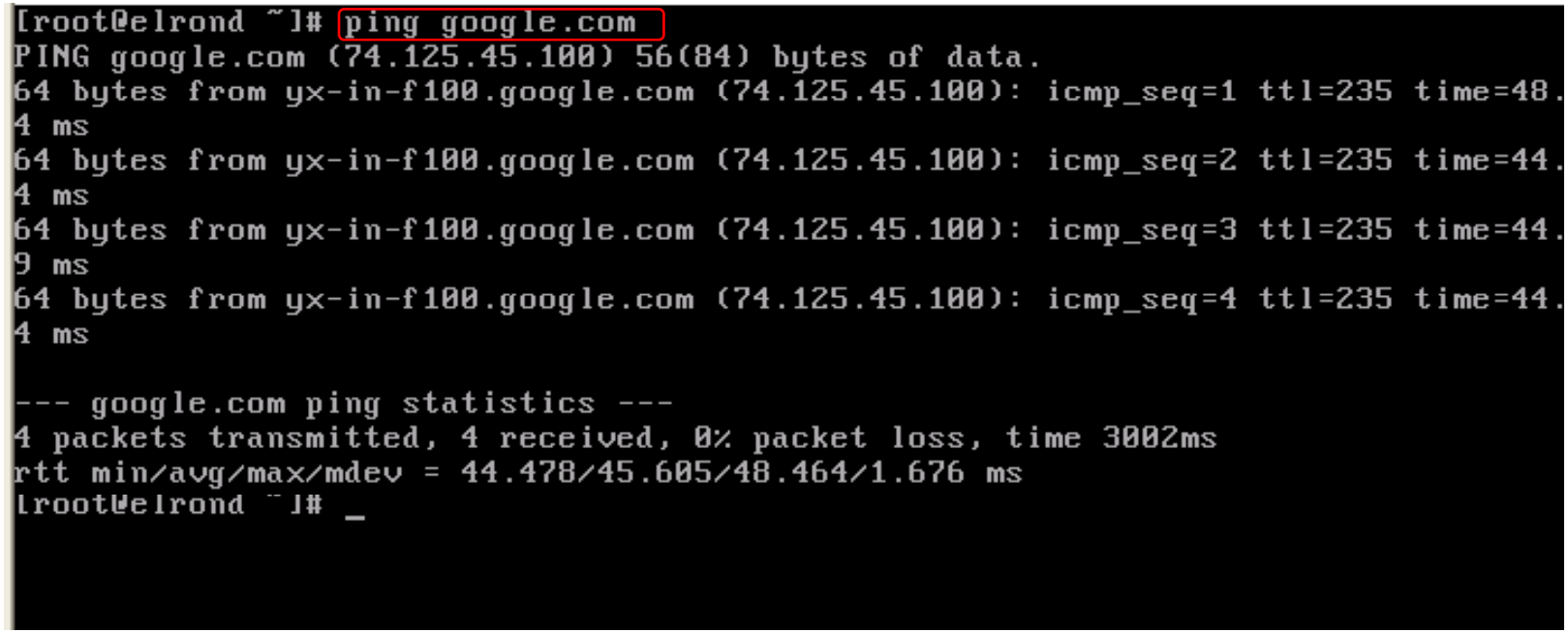
```
[root@elrond ~]# ping 172.30.1.1
connect: Network is unreachable
```

The interface has not been configured with an IP address or a default route has not been set.

Commands for testing interfaces

Check DNS settings by pinging hostname

ping google.com



Use Ctrl-C to stop pinging which will go on forever if you don't.

Commands for testing interfaces

Check DNS settings by pinging hostname

ping google.com

```
[root@elrond ~]# ping google.com
ping: unknown host google.com
```

The DNS name server has not been configured

IP addresses for VM's in the classroom

http://simms-teach.com/docs/static-ip-addrs.pdf

Station	IP	Static 1
Instructor	172.30.1.100	172.30.1.125
Station-01	172.30.1.101	172.30.1.126
Station-02	172.30.1.102	172.30.1.127
Station-03	172.30.1.103	172.30.1.128
Station-04	172.30.1.104	172.30.1.129
Station-05	172.30.1.105	172.30.1.130
Station-06	172.30.1.106	172.30.1.131
Station-07	172.30.1.107	172.30.1.132
Station-08	172.30.1.108	172.30.1.133
Station-09	172.30.1.109	172.30.1.134
Station-10	172.30.1.110	172.30.1.135
Station-11	172.30.1.111	172.30.1.136
Station-12	172.30.1.112	172.30.1.137

Station	IP	Static 1
Station-13	172.30.1.113	172.30.1.138
Station-14	172.30.1.114	172.30.1.139
Station-15	172.30.1.115	172.30.1.140
Station-16	172.30.1.116	172.30.1.141
Station-17	172.30.1.117	172.30.1.142
Station-18	172.30.1.118	172.30.1.143
Station-19	172.30.1.119	172.30.1.144
Station-20	172.30.1.120	172.30.1.145
Station-21	172.30.1.121	172.30.1.146
Station-22	172.30.1.122	172.30.1.147
Station-23	172.30.1.123	172.30.1.148
Station-24	172.30.1.124	172.30.1.149

*Note **your** static IP address for **your** station to use in the next Class Activity*

Class Activity

Configuring Interface, default gateway and DNS

1. Power on **Celebrian** if it is not already on.
2. Configure eth0 with ***your*** static IP address (based on **your** station number) and subnet mask
   ifconfig eth0 172.30.1.xxx netmask 255.255.255.0
3. Check it with **ifconfig eth0**
4. Configure your default gateway with:
   route add default gw 172.30.1.1
5. Set up your DNS with:
   echo nameserver 207.62.187.53 > /etc/resolv.conf
6. Test by pinging the router 172.30.1.1, google.com and your Windows station.
7. Bring the interface down with **ifconfig eth0 down** and see if you can still ping anything.
8. Use **dhclient eth0** and get a dynamic address. Can you ping your neighbor, Google and the router? Is your IP address the same your neighbor?

ipv6

Using IPv6 addresses in Linux

- IPv6 is a layer 3 protocol designed to replace IPv4
- The CentOS VMs for this course have the IPv6 module loaded into the kernel (**use lsmod | grep ipv6** to see it)
- IPv6 uses 128 bits to form an IP address as opposed to 32 bits in IPv4
- We will learn more about IPv4 and IPv6 later in the course.
- IPv4 IP address and mask do not need to be configured in order to use IPv6
- The loopback address for IPv6 is **::1**, for IPv4 it is **127.0.0.1**
- To ping yourself use **ping6 ::1**

Using IPv6 addresses in Linux – ping6

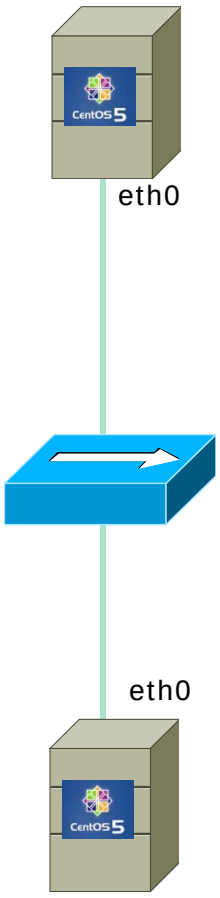

```
root@elrond ~]# ping6 ::1
ING ::1(::1) 56 data bytes
4 bytes from ::1: icmp_seq=0 ttl=64 time=0.330 ms
4 bytes from ::1: icmp_seq=1 ttl=64 time=0.265 ms

-- ::1 ping statistics ---
 packets transmitted, 2 received, 0% packet loss, time 1001ms
tt min/avg/max/mdev = 0.265/0.297/0.330/0.036 ms, pipe 2
root@elrond ~]# ping 127.0.0.1
ING 127.0.0.1 (127.0.0.1) 56(84) bytes of data.
4 bytes from 127.0.0.1: icmp_seq=1 ttl=64 time=0.980 ms
4 bytes from 127.0.0.1: icmp_seq=2 ttl=64 time=0.095 ms

-- 127.0.0.1 ping statistics ---
 packets transmitted, 2 received, 0% packet loss, time 1000ms
tt min/avg/max/mdev = 0.095/0.537/0.980/0.443 ms
root@elrond ~]#
```

The first ping uses an IPv6 loopback address.

The second ping uses the traditional IPv4 loopback address.

Loopback address are used to make network connections to local services. Packets stay local and are not sent out the NIC to the network.

Using IPv6 addresses in Linux – ping6



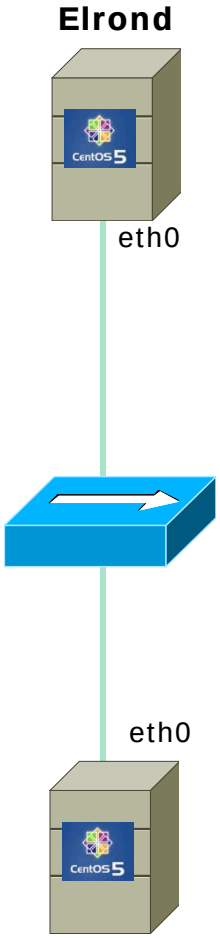

```
[root@elrond ~]# ping6 -I eth0 fe80::20c:29ff:fe4b:f5ce
PING fe80::20c:29ff:fe4b:f5ce(fe80::20c:29ff:fe4b:f5ce) from fe80::20c:29ff:fe68
:3687 eth0: 56 data bytes
64 bytes from fe80::20c:29ff:fe4b:f5ce: icmp_seq=0 ttl=64 time=2.30 ms
64 bytes from fe80::20c:29ff:fe4b:f5ce: icmp_seq=1 ttl=64 time=2.14 ms

--- fe80::20c:29ff:fe4b:f5ce ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1000ms
rtt min/avg/max/mdev = 2.141/2.223/2.306/0.095 ms, pipe 2
[root@elrond ~]# _
```

Note: the interface must be specified on the ping6 command

```
eth0      Link encap:Ethernet  HWaddr 00:0C:29:4B:F5:CE
          inet6 addr: fe80::20c:29ff:fe4b:f5ce/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:713 errors:0 dropped:0 overruns:0 frame:0
          TX packets:605 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:557922 (544.8 KiB)  TX bytes:61674 (60.2 KiB)
          Interrupt:177 Base address:0x1400

[root@arwen ~]# _
```

*Use the **ifconfig** command to see what the ipV6 address is*

Using IPv6 addresses in Linux - ssh




```
[root@elrond ~]# ssh fe80::20c:29ff:fe4b:f5ce%eth0
root@fe80::20c:29ff:fe4b:f5ce%eth0's password:
Last login: Mon Jan 25 23:30:16 2010 from fe80::20c:29ff:fe68:3687%eth0
[root@arwen ~]# _
```

Note: the interface must be specified on the ssh command

```
eth0      Link encap:Ethernet  HWaddr 00:0C:29:4B:F5:CE
          inet6 addr: fe80::20c:29ff:fe4b:f5ce/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:713 errors:0 dropped:0 overruns:0 frame:0
          TX packets:605 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:557922 (544.8 KiB)  TX bytes:61674 (60.2 KiB)
          Interrupt:177 Base address:0x1400

[root@arwen ~]# _
```

*Use the **ifconfig** command to see what the ipV6 address is*

Class Activity

IPv6

1. Power on **Frodo** and **Celebrian** if they are not on already using two different VMware consoles.

2. Their eth0 NICs should both be connected as **bridged**.

3. On Frodo, ping yourself using the loopback address with **ping6 ::1**

4. On Frodo, discover your IPv6 address using **ifconfig**

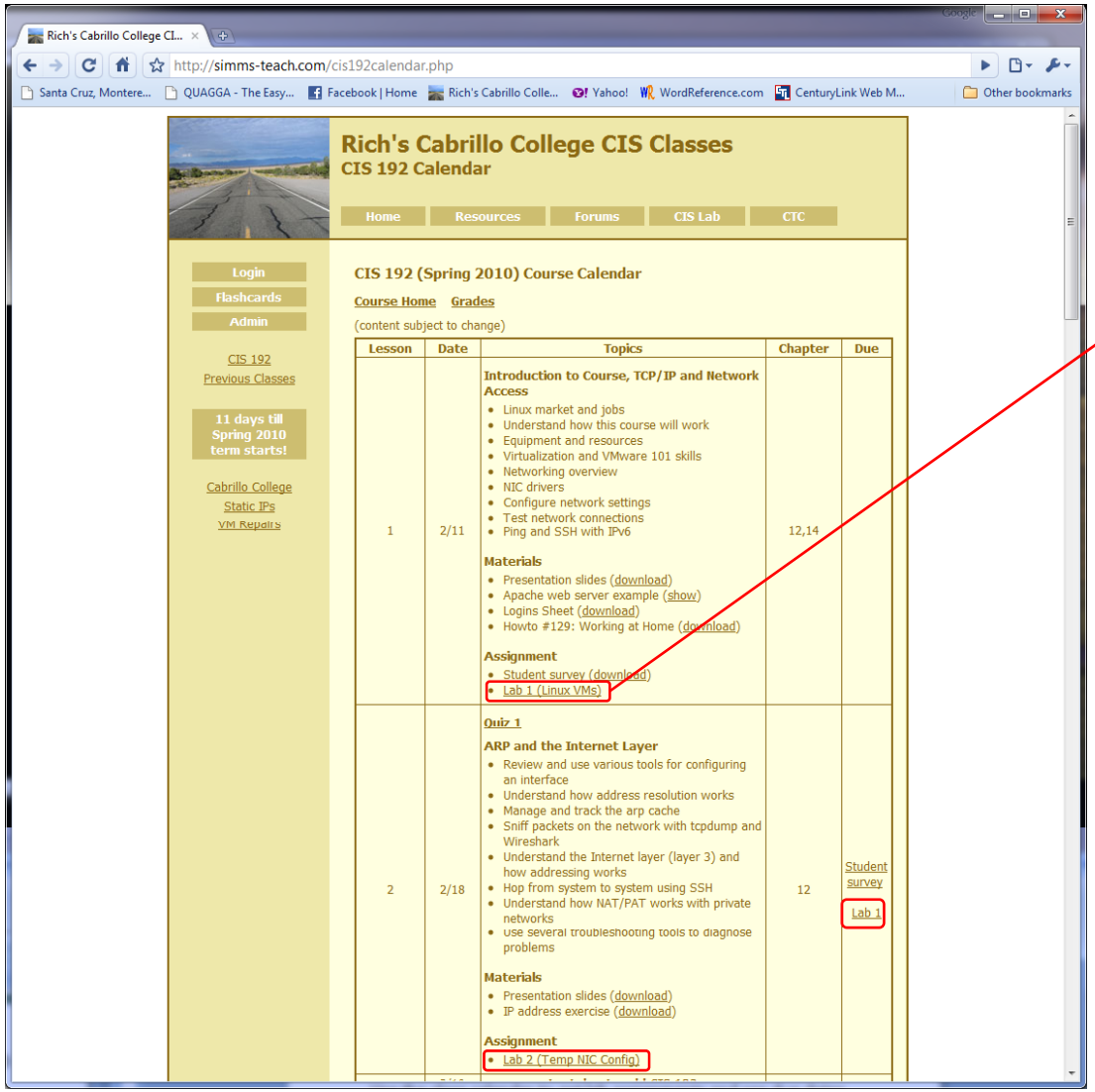
5. Position the smaller Celebrian console on top of the Frodo console so you can see Frodo's IPv6 address.

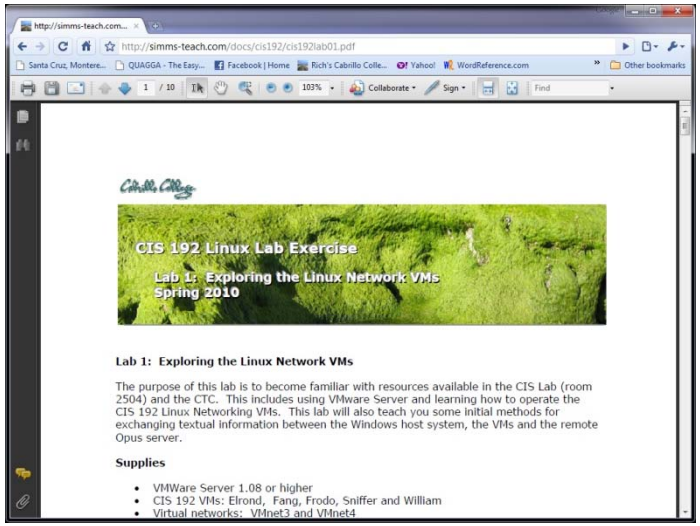
6. On Celebrian use **ping6 –I eth0** <*insert Frodo's IPv6 address*> to ping Frodo using IPv6.

7. On Celebrian use **ssh cis192@**<*insert Frodo's IPv6 address*>**%eth0** and login to Frodo.

Lab Assignment

Use the class calendar to get assignments and see due dates





How to submit your work for grading

- For each lab you will create a text file that gets turned in
- The **scp** (**pscp** on Windows) is used to copy your text file to a special turnin directory on Opus.
- It's a good idea to verify your **scp** copy worked!
- Labs must get turned in by midnight (Opus time) on the due date to get credit.
- Submit as many times as you wish up till the deadline.
- No points for late work. Its better to make a partial submittal before the deadline for partial credit.

How to submit your work for grading

Examples:

- Submit from Windows command line (Lab 1):

```
C:\>pscp lab1.txt cis192@opus.cabrillo.edu:lab1.simmsben
cis192@opus.cabrillo.edu's password:
C:\>
```

Replace simmsben with your Opus logname. For the first lab can just use your last name since you won't have a logname yet.

- Submit from Linux system (all other labs):

```
[root@arwen ~]$ scp lab2 cis192@opus.cabrillo.edu:lab2.simmsben
cis192@opus.cabrillo.edu's password:
lab1                                  100%    5     0.0KB/s   00:00
[root@arwen ~]$
```

- Check your submittal from Opus:

```
[simmsben@opus ~]$ ls /home/turnin/cis192
lab1.simmsben  lab2.simmsben
[simmsben@opus ~]$
```

Some essentials for doing labs

The "I've tried everything and it still won't work" problem

- Use the forum to ask questions and to clarify things
- Review Lesson Powerpoints which usually have examples aimed at doing the lab assignments.
- Make a network diagram with all interfaces labeled. Confirm your configuration matches the diagram.
- Go back and methodically verify each step was completed. For example, if you modified /etc/hosts then cat it out and review your changes. If you set the default gateway, use route –n command to verify. If you configured an IP address, use **ifconfig** to verify.
- If your VM is completely "hosed": Use **Revert to snapshot** to restore to a pristine version.

Some essentials for doing labs

Some Tips

- Start early, doing labs at the last minute adds unnecessary time pressure.
- Its best if you fully understand each step as you do it. Use Google or refer back to Lesson slides to understand what you are doing.
- Keep a growing cheat sheet of commands and examples.
- Partner with another student – "two heads are better than one" (at least most of the time!)
- Use the forum to share specific tips you learned while doing a lab.

Some essentials for doing labs

- Becoming root:
  - sudo *command*
  - su –

The – is very important as this gets you root's environment

- To get command documentation:
  - man command
  - google.com (linux xxxxxx command)

- To try again for a DHCP address: dhclient

Sometimes the systems in the lab time out before the IP address arrives from Snickers. Issue this command as root.

- Use Google to research an error message
  - Google *network is unreachable*

You will need to be the root user to do most labs. Be careful as root can do anything !!

Wrap

New commands:

- dmesg
- ifconfig
- insmod
- lsmod
- lspci
- modprobe
- ping
- ping6
- rmmod
- route
- scp
- ssh
- su

New Files and Directories:

- /etc/resolv.conf
- /lib/modules/2.6.18-164.e15/kernel/drivers.net

VMware:

- Revert to snapshot
- vmware-toolbox &

Next Class

Assignment: Check Calendar Page on web site to see what is due next week.

Quiz questions for next class:

- What command would you use to remove (unload) the pcnet32 NIC driver?
- What command would you use to add 172.30.4.1 as the default gateway.
- At what OSI layer are IP addresses used?

Backup

Frodo and Celebrian VMs running on Windows VMware station