Networking

INFO/CSE 100, Spring 2005

Fluency in Information Technology

http://www.cs.washington.edu/100

Readings and References

- Reading
  - Fluency with Information Technology
    - » Chapter 3, Making the Connection

Networks…

- Computers are useful alone, but are even more useful when connected (networked)
  - Access more information and software than is stored locally
  - Help users to communication, exchange information .. Changing ideas about social interaction
  - Perform other services -- printing, audio, video
  - Immediate answers: for example, Google

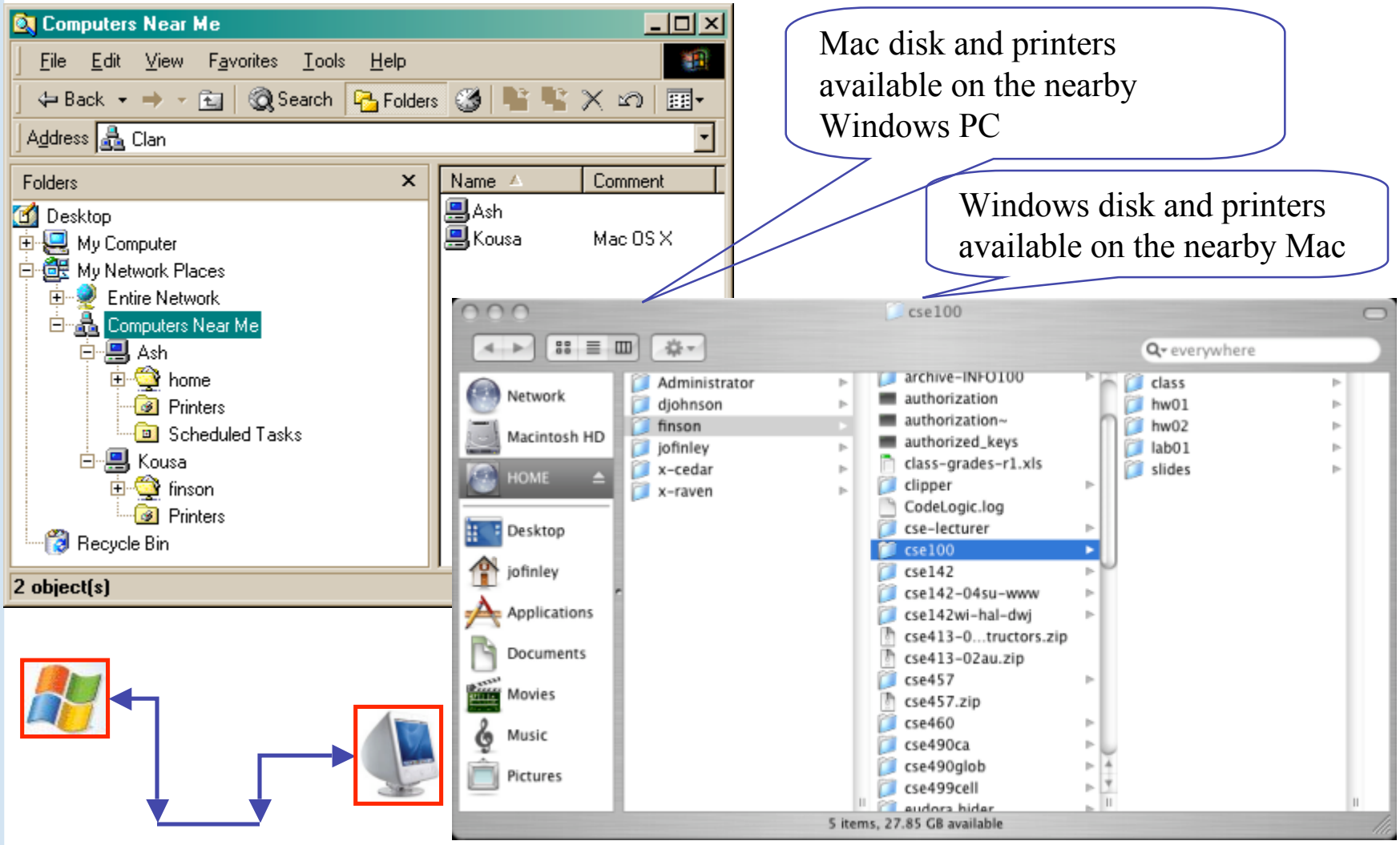
Networking Changes Life

- The Internet is making fundamental changes … the FIT text gives 5 ways
  - Nowhere is remote -- access to information is no longer bound to a place
  - Connection with others -- email is great! But what about spam?!?
  - Revised human relationships -- too much time spent online could be bad
  - English is becoming a universal language
  - Enhanced freedom of speech, assembly

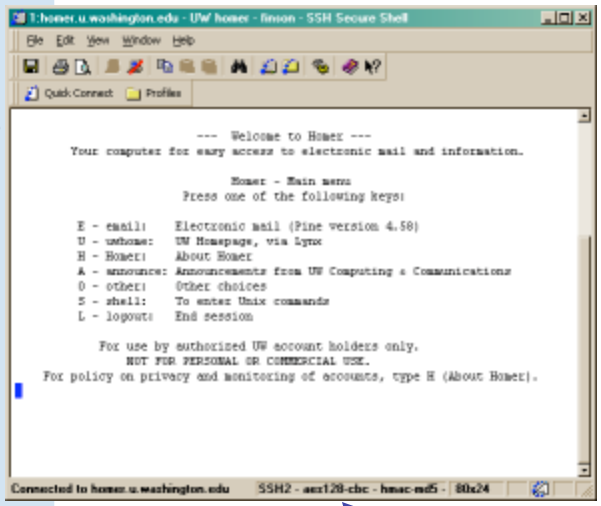
Network Structure

- Internet: all of the wires, fibers, switches, routers, etc… connecting named computers
  - Networks are structured differently based (mostly) on how far apart the computers are
    - » Local area network (LAN)
      - A small area such as a room or building
    - » Wide area networks (WAN)
      - Large area, e.g. distance is more than 1Km
    - » What do you think a PAN might be?!?

Local Area Network



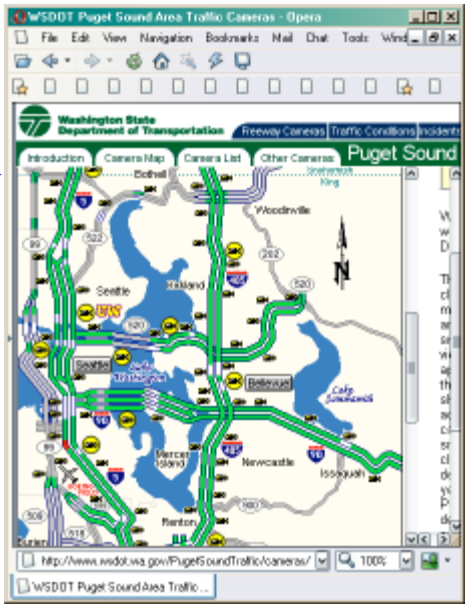
Wide Area Network



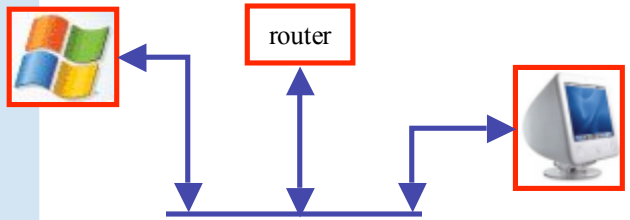
UW servers

video conferencing

world wide web



Internet

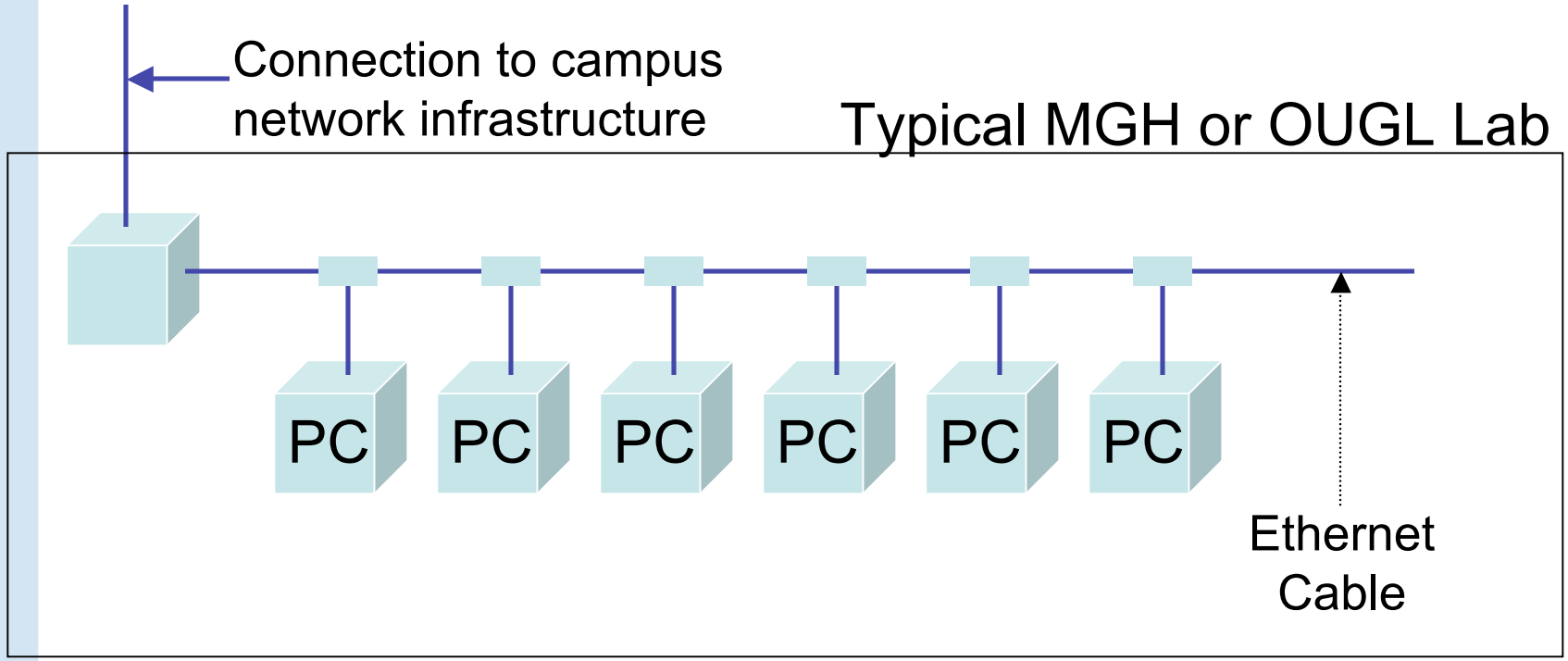


Protocol Rules!

- To communicate, computers need to know how to set-up the info to be sent and to interpret the info received
  - Communication rules are a *protocol*
  - Example protocols:
    - » Ethernet for physical connection in a LAN
    - » TCP/IP -- transmission control protocol/internet protocol
    - » HTTP -- hypertext transfer protocol (for the WWW)
    - » FTP -- file transfer protocol (for transferring files)

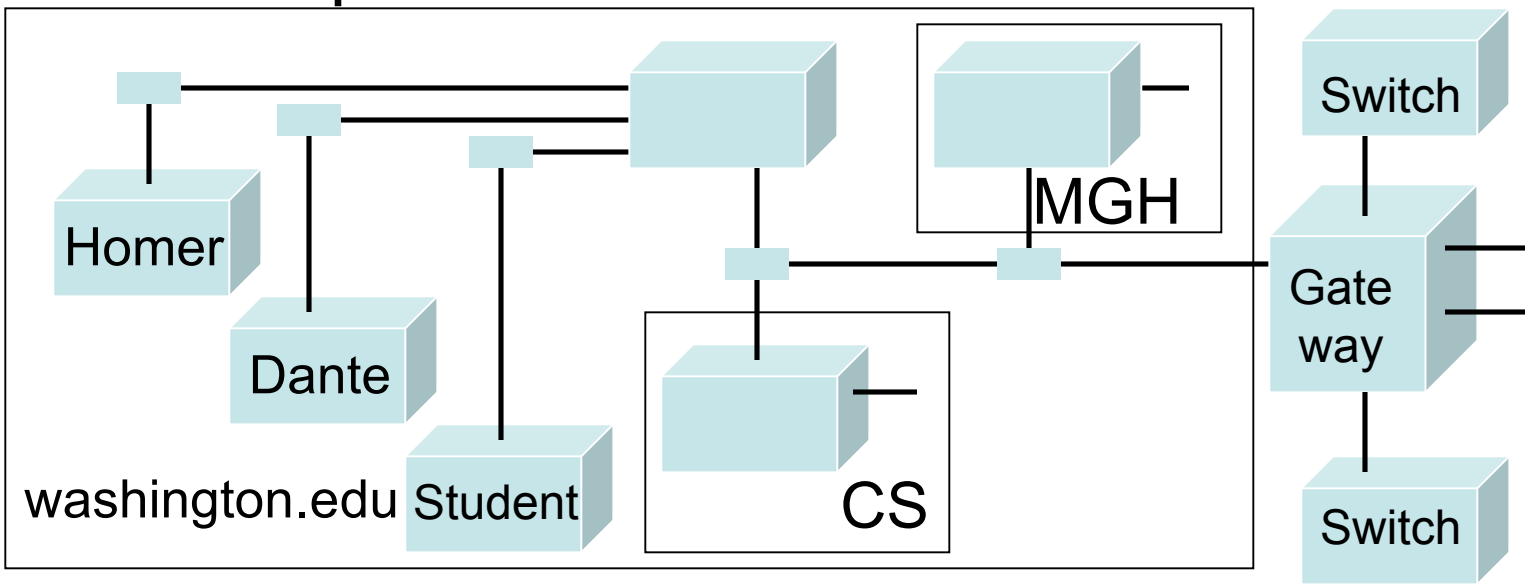
LAN in the Lab

- Ethernet is a popular LAN protocol
  - Recall that it's a "party line" protocol



Campus & The World

- The campus subnetworks interconnect computers of the UW domain which connects to the Internet via a gateway
  - The protocol used is TCP/IP



IP -- Like Using Postcards

- Information is sent across the Internet using the Internet Protocol -- postcard analogy
  - Break message into fixed size units
  - Form IP Packets with destination address, sequence number, and content
  - Each makes it way separately to destination, possibly taking different routes
  - Reassembled at destination forming message
    - » Taking separate routes lets packets by-pass conjestion and out-of-service switches

A Trip to Switzerland

- A packet sent from UW to ETH (Swiss Federal Technical University took 21 hops

Hop	IP Address	Node Name	Location	ms	Network
0	128.95.1.207	spiff.cseresearch.cs.washington.edu			University of Washington WASHINGTON
1	128.95.1.100	-			University of Washington WASHINGTON
2	140.142.150.2	uwbr2-GE0-1.cac.washington.edu			University of Washington UW-SEA
3	198.107.150.1	hnsp1-wes-ge-0-0-0-0.pnw-gigapop.net	...	0	Verio, Inc. VRIO-198-106
4	198.48.91.78	abilene-pnw.pnw-gigapop.net	...	5	University of Washington UW-SEA29
5	198.32.11.124	sttlng-sttl.abilene.ucaid.edu	...	0	Exchange Point Blocks NET-EP-1
6	198.32.8.50	dnvr-sttl.abilene.ucaid.edu	...	35	Exchange Point Blocks NET-EP-1
7	198.32.11.111	-	...	27	Exchange Point Blocks NET-EP-1
8	198.32.8.14	kscy-dnvr.abilene.ucaid.edu	...	40	Exchange Point Blocks NET-EP-1
9	198.32.11.117	kscyng-kscy.abilene.ucaid.edu	...	34	Exchange Point Blocks NET-EP-1
10	198.32.8.80	iplsng-kscyng.abilene.ucaid.edu	...	281	Exchange Point Blocks NET-EP-1
11	198.32.8.76	chinng-iplsng.abilene.ucaid.edu	...	52	Exchange Point Blocks NET-EP-1
12	198.32.8.83	nycmng-chinng.abilene.ucaid.edu	...	72	Exchange Point Blocks NET-EP-1
13	198.32.8.46	nycm-wash.abilene.ucaid.edu	...	68	Exchange Point Blocks NET-EP-1
14	62.40.103.253	abilene-gtren.de2.de.geant.net	(United Kingdor	165	IP allocation for GEANT network
15	62.40.96.62	de.it1.it.geant.net	(United Kingdor	171	IP allocation for GEANT network
16	62.40.96.33	it.ch1.ch.geant.net	(United Kingdor	183	IP allocation for GEANT network
17	62.40.103.18	swiCE2-P6-1.switch.ch	(United Kingdor	178	IP allocation for GEANT network
18	130.59.36.42	swiEZ2-G2-2.switch.ch	(Switzerland)	187	SWITCH Teleinformatics Services SWITCH-LAN
19	192.33.92.1	rou-eth-switch-1-giga-to-switch.ethz.ch	(Switzerland)	192	Swiss Federal Institute of Technology ETH-NET6
20	129.132.99.19	rou-rz-1-mega-transit-2.ethz.ch	(Switzerland)	188	Swiss Federal Institute of Technology ETH-ETHER
21	**129.132.1.15**	eth.ch	(Switzerland)	192	Swiss Federal Institute of Technology ETH-ETHER

Roundtrip time to eth.ch, average = 192ms, min = 187ms, max = 204ms -- 14-Nov-02 1:39:08 PM

UW Gateway

Check Internet Hops

- There are numerous Trace Route utilities
  - Windows: tracert, OSX: Network Utility

```
Command Prompt
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

Z:\>tracert dante.u.washington.edu

Tracing route to dante.u.washington.edu [140.142.14.69]
over a maximum of 30 hops:

  1    <1 ms    <1 ms    <1 ms  eureka-GE1-6.cac.washington.edu [128.208.5.100]
  2    <1 ms    <1 ms    <1 ms  iron-GE-1-8.cac.washington.edu [140.142.153.68]
  3    <1 ms    <1 ms    <1 ms  dante76.u.washington.edu [140.142.14.69]

Trace complete.

Z:\>tracert tube.tfl.gov.uk

Tracing route to tube.tfl.gov.uk [217.28.130.10]
over a maximum of 30 hops:

  1    <1 ms    <1 ms    <1 ms  eureka-GE1-6.cac.washington.edu [128.208.5.100]
  2    <1 ms    <1 ms    <1 ms  uwbr1-ge2-2.cac.washington.edu [140.142.155.23]
  3    <1 ms    <1 ms    <1 ms  cnsp1-ads-ge-0-0-0-0.pnw-gigapop.net [198.107.150.4]
  4     1 ms     1 ms     1 ms  unknown.Level3.net [209.247.84.37]
  5     1 ms     1 ms     1 ms  so-7-0-0.mp2.Seattle1.Level3.net [64.159.1.165]
  6    68 ms    69 ms    69 ms  so-0-1-0.bbr1.NewYork1.Level3.net [64.159.1.41]
  7   134 ms   134 ms   134 ms  4.68.128.105
  8   134 ms   134 ms   134 ms  ge-3-0-0-0.gar2.London1.Level3.net [4.68.128.126]
  9   134 ms   134 ms   134 ms  so-6-0.metro1-londencyh00.London1.Level3.net [212.113.3.30]
 10   134 ms   134 ms   134 ms  213.232.65.153
 11   135 ms   135 ms   135 ms  217.28.128.10
 12   135 ms   146 ms   135 ms  217.28.130.10

Trace complete.

Z:\>_
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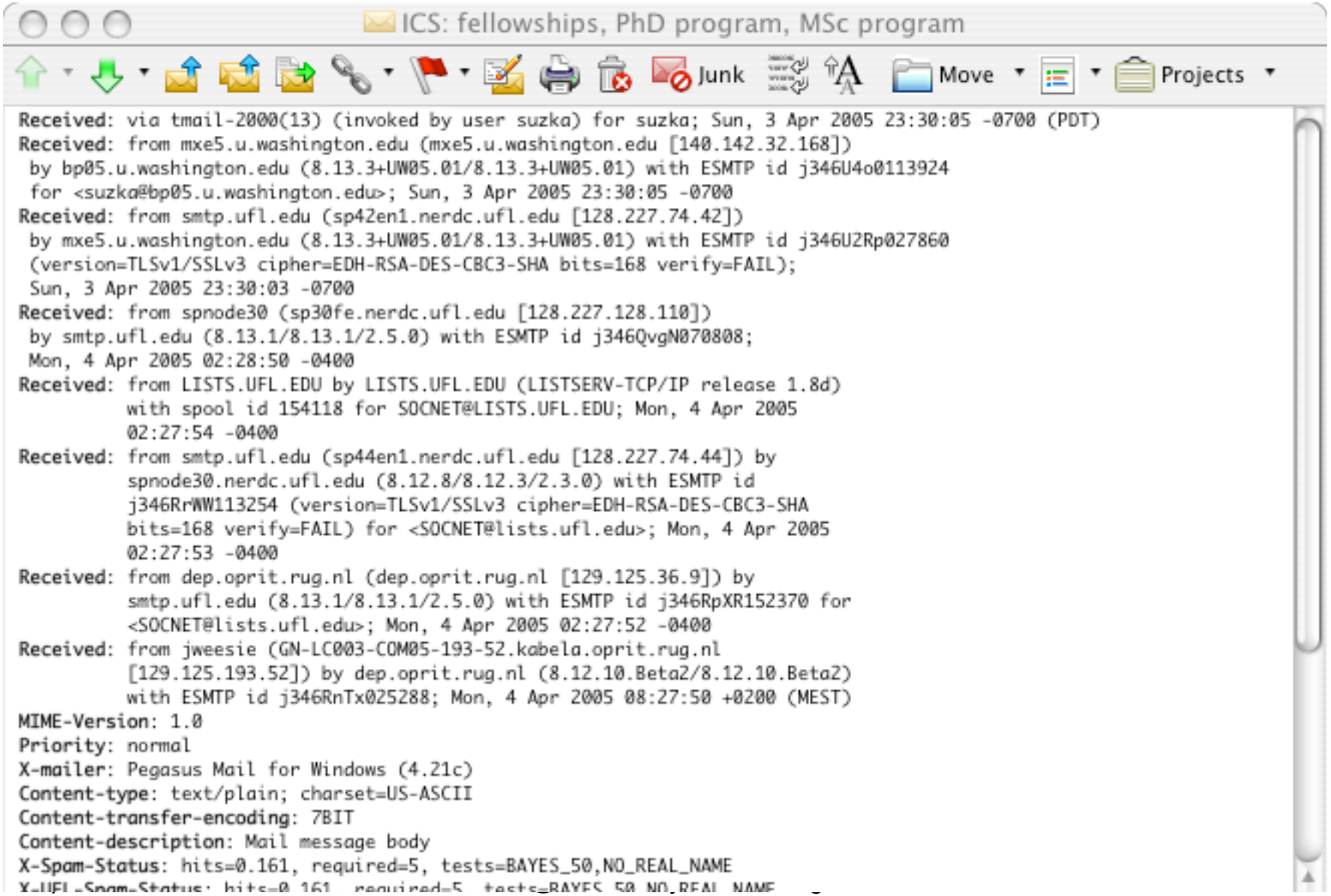
The Information School of the University of Washington

Email Headers!



Naming Computers

- Computers connected to the Internet are part of a network domain
  - A hierarchical scheme that groups computers

.edu	All educational computers
.washington.edu	All computers at UW
dante.washington.edu	A UW computer
.ischool.washington.edu	iSchool computers
.cs.washington.edu	CSE computers
june.cs.washington.edu	A CSE computer

Naming Computers con'd

- Computers are named by IP address, four numbers in the range 0-255
  - cse.washington.edu: 128.95.1.4
  - ischool.washington.edu: 128.208.100.150
    - » Remembering IP address would be brutal for humans, so we use domain names
    - » Computers find the IP address for a domain name from the Domain Name System (DNS)
      - An IP address-book for the computer

Domains

- .edu, .com, .mil, .gov., .org, .net domains are the “top level domains” in the USA
  - Recently added TLD names include:
    - » .biz, .info, .name, .pro, .aero, .coop, .museum, .tv
- Each country has a TLD name: .ca (Canada), .es (Spain), .de (Germany), .au (Australia), .uk (England), .us (USA)
- The FIT book contains the complete list of country domains

Logical vs. Physical

- There are 2 ways to view the Internet
  - Humans see a hierarchy of domains relating computers
    - » Logical network
  - Computers see groups of four-number IP addresses
    - » Physical network
  - Both are ideal for the “users” needs
- Domain Name System (DNS) relates the logical network to the physical network by translating domains to IP addresses

Client/Server Structure

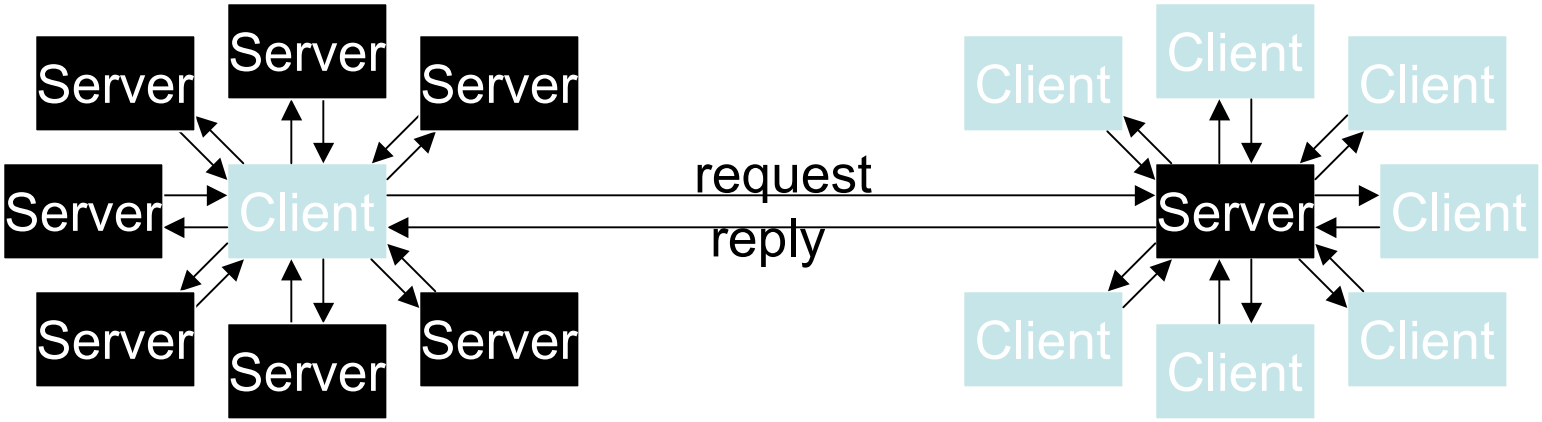
- The Internet computers rely on the client/protocol: services provide services, clients use them
  - Samples servers: email server, web server, ftp server
  - UW servers: dante, courses, www
  - Frequently, a “server” is actually many computers acting as one, e.g. dante is a group of more than 50 servers
- Protocol: client packages a request and sends it to a server; Server does the service and sends a reply

World Wide Web

- World Wide Web (WWW) is a collection of servers (subset of Internet computers) and the info they give access to using the HTTP protocol
  - WWW is not the same as the Internet
  - The “server” is a web site computer and the “client” is a web browser (like Internet Explorer)
  - Many Web server’s domain names begin with www by tradition, but any name is OK
  - Often multiple servers map to the same site: moma.org and www.moma.org

Client/Server Interaction

- For Web pages, the client requests a page the server returns it: there's no permanent connection, just a short conversation
  - Details of the conversation are specified by HTTP



Dissecting a URL

- Web addresses are URL (uniform resource locator)
  - A server address and a path to a particular file
  - URLs are often redirected to other places
    - » http://www.cs.washington.edu/100
    - » http://www.cs.washington.edu/education/courses/cse100/CurrentQtr/calendar100.html

protocol	= http://	
Web server	= www	
domain	= .cs.washington.edu	
path	= /education/courses/100/04au/	*directories (folders)*
file	= index	
file extension	= .html	*hypertext markup language*

Summary

- Networking is changing the world
  - Internet: named computers using TCP/IP
  - WWW: servers providing access to information
  - Principles
    - » Local network of domain names
    - » Physical network of IP address
    - » Protocols rule: LAN, TCP/IP, HTTP
    - » Domain Name System connects the two
    - » Client/Server, fleeting relationship on WWW