



Networking

INFO/CSE 100, Spring 2006

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

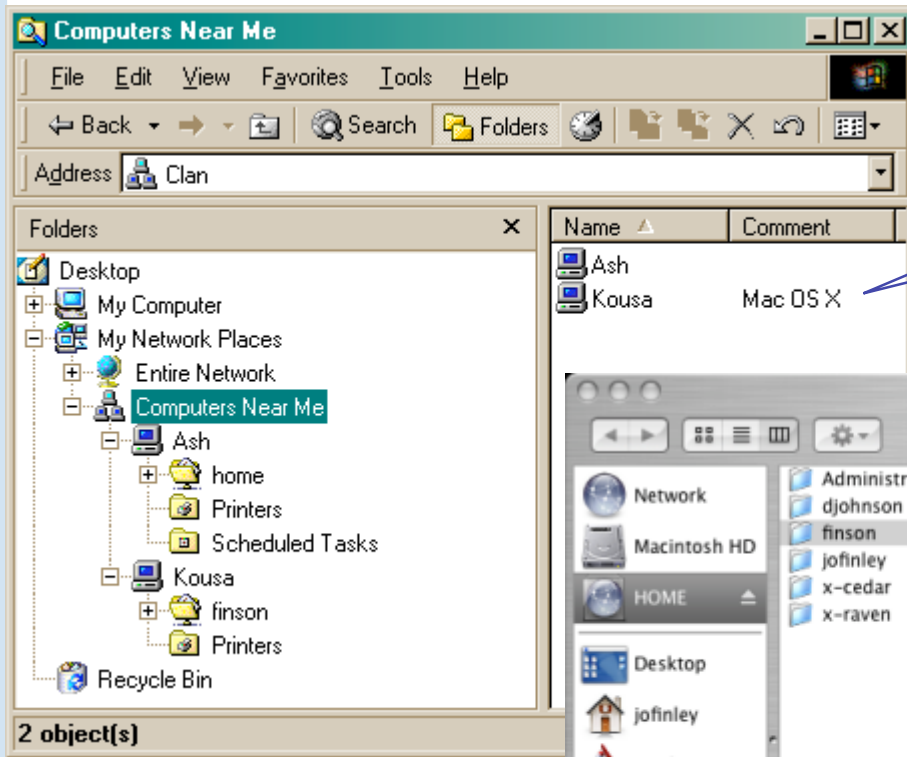
Networking Changes Life

- 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

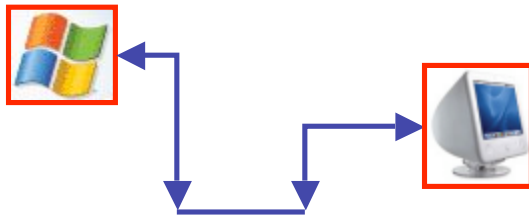
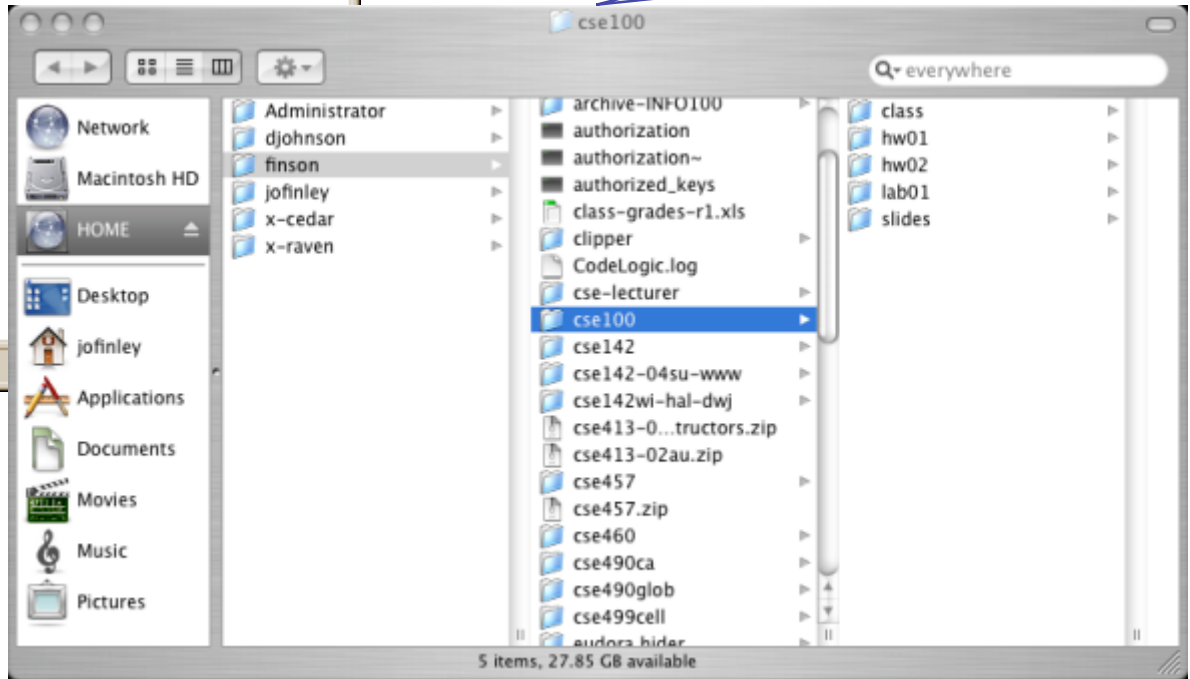
- Internet: all of the wires, fibers, switches, routers, etc... connecting named computers
 - Networks are structured differently based (mostly) on how far apart the computers are
 - » Local area network (LAN)
 - A small area such as a room or building
 - » Wide area networks (WAN)
 - Large area, e.g.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

Local Area Network

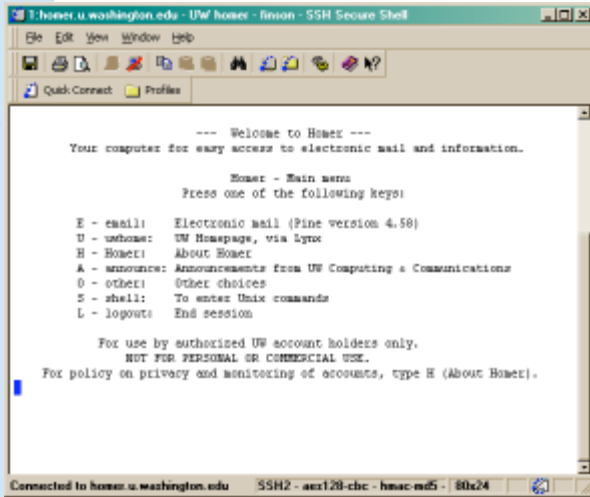


Mac disk and printers available on the nearby Windows PC

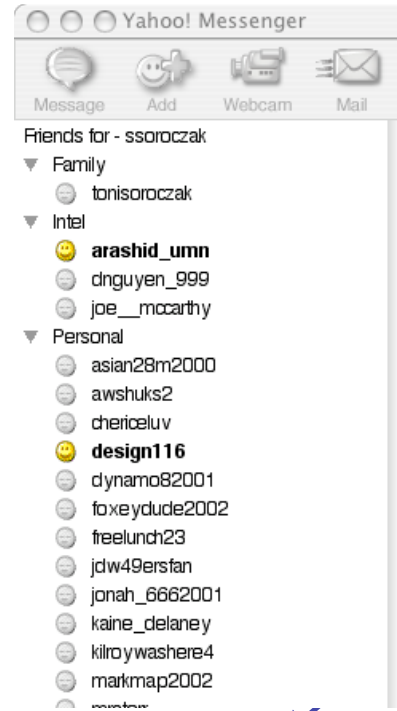
Windows disk and printers available on the nearby Mac



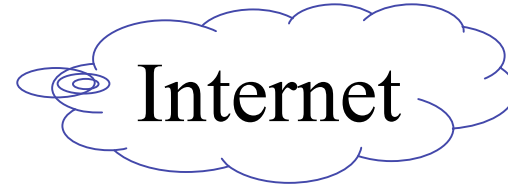
Wide Area Network



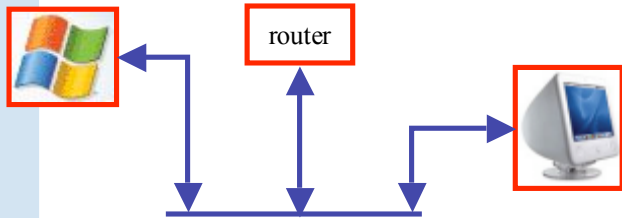
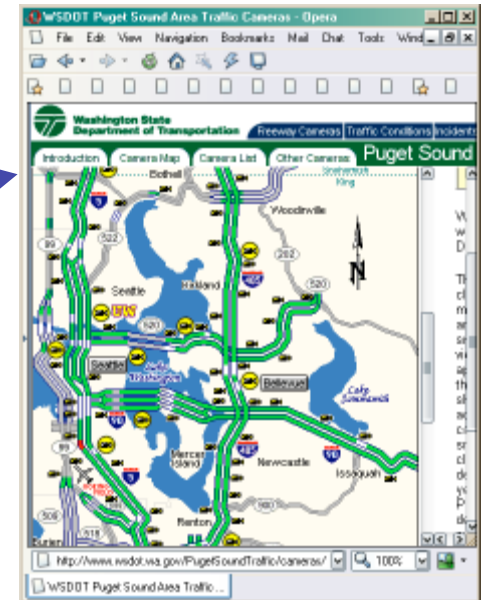
UW servers



instant messenger



world wide web

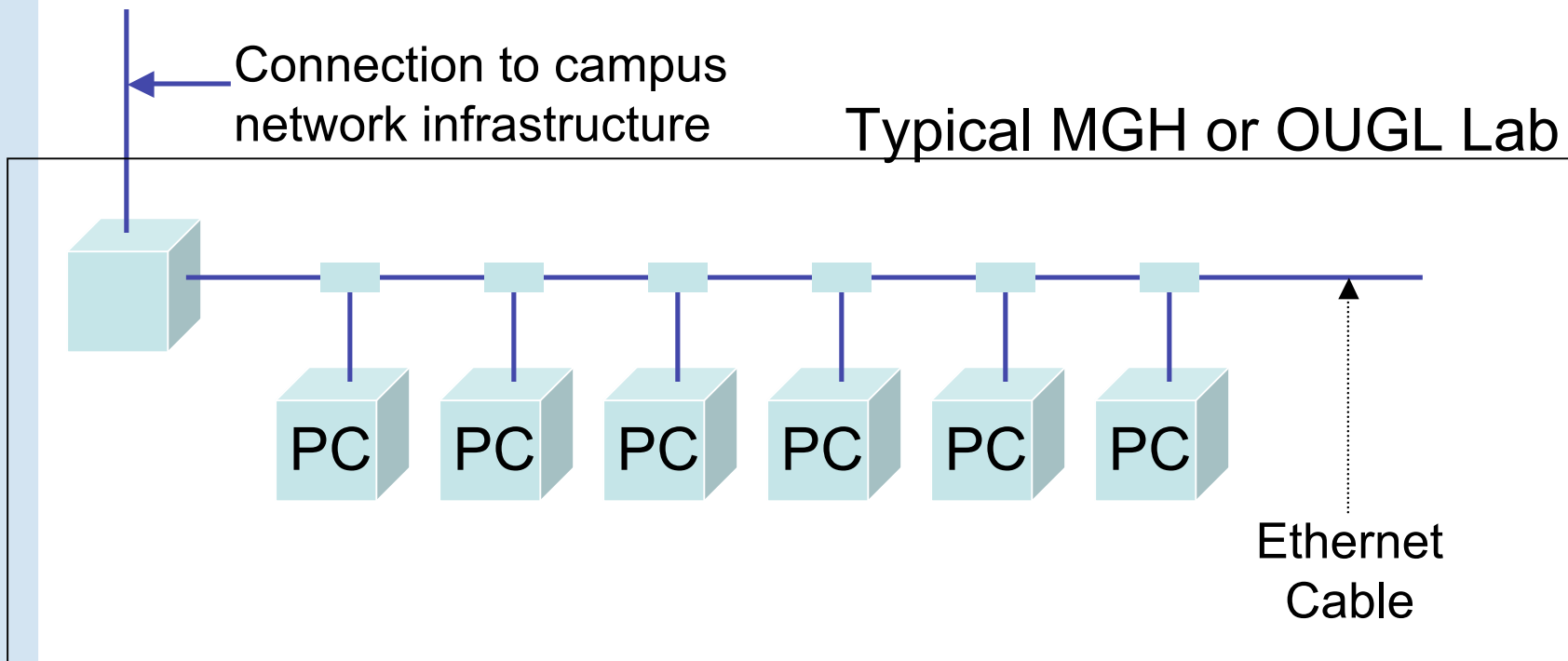


Protocol Rules!

- 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)

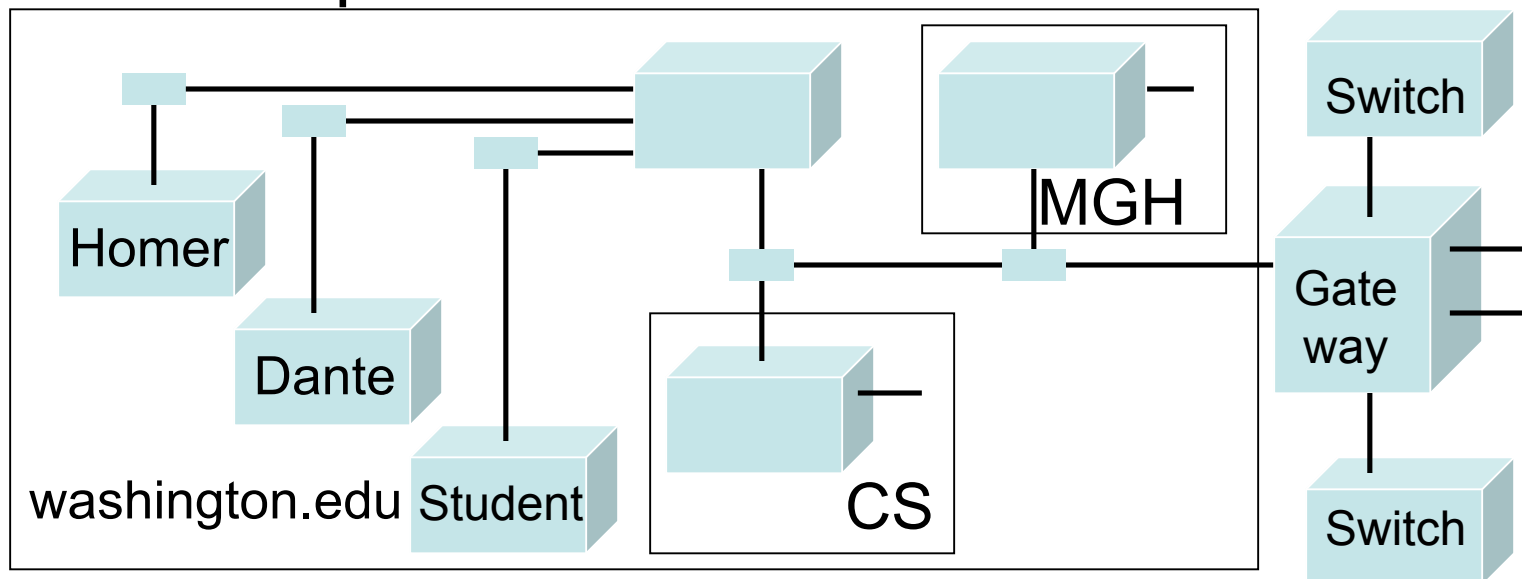
LAN in the Lab

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



Campus & The World

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

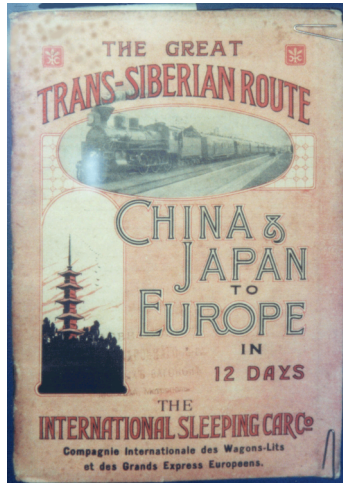


IP -- Like Using Postcards

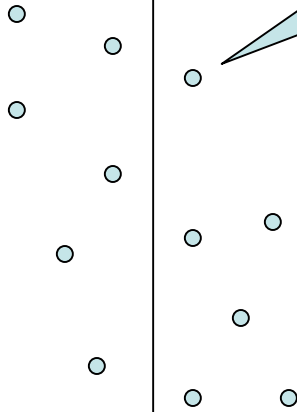
- Information is sent across the Internet using the Internet Protocol -- postcard analogy
 - Break message into fixed size units
 - Form IP Packets with destination address, sequence number, and content
 - Each makes it way separately to destination, possibly taking different routes
 - Reassembled at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



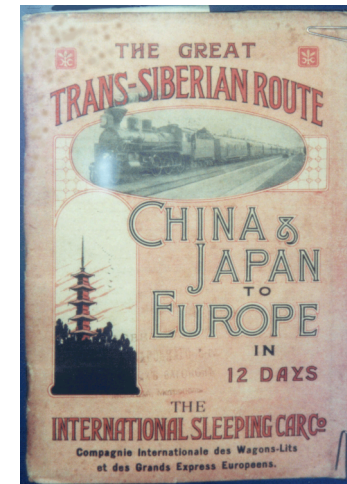
IP con'd



Source



DEST ADDRESS | SIZE | # | DATA



Destination

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 Kingdom)	165	IP allocation for GEANT network
15	62.40.96.62	de.it1.it.geant.net	(United Kingdom)	171	IP allocation for GEANT network
16	62.40.96.33	it.ch1.ch.geant.net	(United Kingdom)	183	IP allocation for GEANT network
17	62.40.103.18	swiCE2-P6-1.switch.ch	(United Kingdom)	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

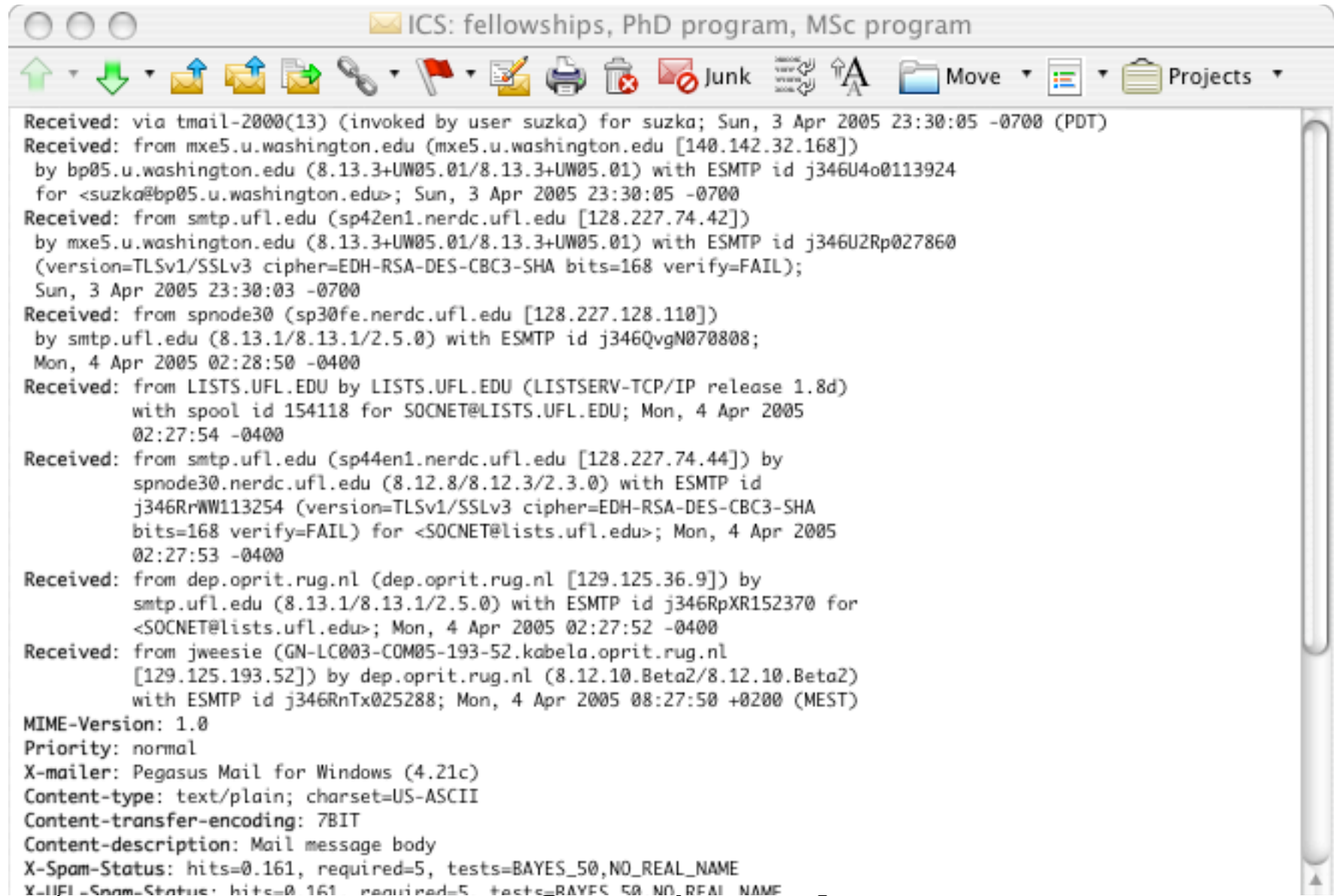
Tracing route to tube.tfl.gov.uk [217.28.130.10]
over a maximum of 30 hops:

  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    cnspl-ads-ge-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.bbri.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-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:\>_
```

Email Headers!



```

Received: via tmail-2000(13) (invoked by user suzka) for suzka; Sun, 3 Apr 2005 23:30:05 -0700 (PDT)
Received: from mxe5.u.washington.edu (mxe5.u.washington.edu [140.142.32.168])
  by bp05.u.washington.edu (8.13.3+UW05.01/8.13.3+UW05.01) with ESMTMP id j346U4o0113924
  for <suzka@bp05.u.washington.edu>; Sun, 3 Apr 2005 23:30:05 -0700
Received: from smtp.ufl.edu (sp42en1.nerdc.ufl.edu [128.227.74.42])
  by mxe5.u.washington.edu (8.13.3+UW05.01/8.13.3+UW05.01) with ESMTMP id j346U2Rp027860
  (version=TLSv1/SSLv3 cipher=EDH-RSA-DES-CBC3-SHA bits=168 verify=FAIL);
  Sun, 3 Apr 2005 23:30:03 -0700
Received: from spnode30 (sp30fe.nerdc.ufl.edu [128.227.128.110])
  by smtp.ufl.edu (8.13.1/8.13.1/2.5.0) with ESMTMP id j346QvgN070808;
  Mon, 4 Apr 2005 02:28:50 -0400
Received: from LISTS.UFL.EDU by LISTS.UFL.EDU (LISTSERV-TCP/IP release 1.8d)
  with spool id 154118 for SOcNET@LISTS.UFL.EDU; Mon, 4 Apr 2005
  02:27:54 -0400
Received: from smtp.ufl.edu (sp44en1.nerdc.ufl.edu [128.227.74.44]) by
  spnode30.nerdc.ufl.edu (8.12.8/8.12.3/2.3.0) with ESMTMP id
  j346RrWW113254 (version=TLSv1/SSLv3 cipher=EDH-RSA-DES-CBC3-SHA
  bits=168 verify=FAIL) for <SOcNET@lists.ufl.edu>; Mon, 4 Apr 2005
  02:27:53 -0400
Received: from dep.oprit.rug.nl (dep.oprit.rug.nl [129.125.36.9]) by
  smtp.ufl.edu (8.13.1/8.13.1/2.5.0) with ESMTMP id j346RpXR152370 for
  <SOcNET@lists.ufl.edu>; Mon, 4 Apr 2005 02:27:52 -0400
Received: from jweesie (GN-LC003-COM05-193-52.kabela.oprit.rug.nl
  [129.125.193.52]) by dep.oprit.rug.nl (8.12.10.Beta2/8.12.10.Beta2)
  with ESMTMP id j346RnTx025288; Mon, 4 Apr 2005 08:27:50 +0200 (MEST)
MIME-Version: 1.0
Priority: normal
X-mailer: Pegasus Mail for Windows (4.21c)
Content-type: text/plain; charset=US-ASCII
Content-transfer-encoding: 7BIT
Content-description: Mail message body
X-Spam-Status: hits=0.161, required=5, tests=BAYES_50,NO_REAL_NAME
X-UIFI-Spam-Status: hits=0.161, required=5, tests=BAYES_50,NO_REAL_NAME
  
```



Naming Computers

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

.edu

.washington.edu

dante.u. washington.edu

.ischool.washington.edu

.cs.washington.edu

aloha.ischool.washington.edu

All educational computers

All computers at UW

A UW computer

iSchool computers

CSE computers

an iSchool 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



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

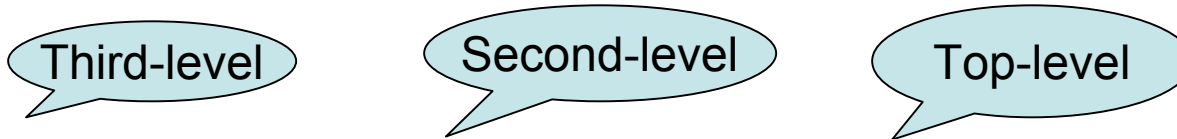


Logical vs. Physical

- 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

Anatomy of it All

- Domain name:



dante . u . washington . edu

- IP address:

140.142.14.73

Client/Server Structure

- The Internet computers rely on the client/protocol: servers provide services, clients use them
 - Example servers: email server, web server, ftp server
 - UW servers: dante, students, www
 - Frequently, a “server” is actually many computers acting as one, e.g. dante is a group of more than 50 servers
- Protocol governs the communication
 - 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 web servers on the Internet
- Subset of Internet computers
 - WWW is not the same as the Internet!
- They give access to information using the HTTP protocol
 - 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

History of the WWW

- Web beginnings
 - 1989: Tim Berners-Lee
 - » URLs, http, first browser (HTTP 1.0)
 - 1993: NCSA Mosaic
 - » HTTP 1.1 supported images
 - » Then Netscape, then Mozilla
 - 1994: World Wide Web Consortium
 - » <http://w3.org/>
 - » Standards organization for Web protocols and formats
 - 1994-5: Web crawlers and search engines
 - » WebCrawler, Lycos, AltaVista, Yahoo

World Wide Web

- URL -- uniform resource locator
 - » Web page addresses
- HTTP -- hypertext transfer protocol
 - » Client-server communication rules
- HTML -- hypertext markup language
 - » A special format for making the pages universally readable by all clients



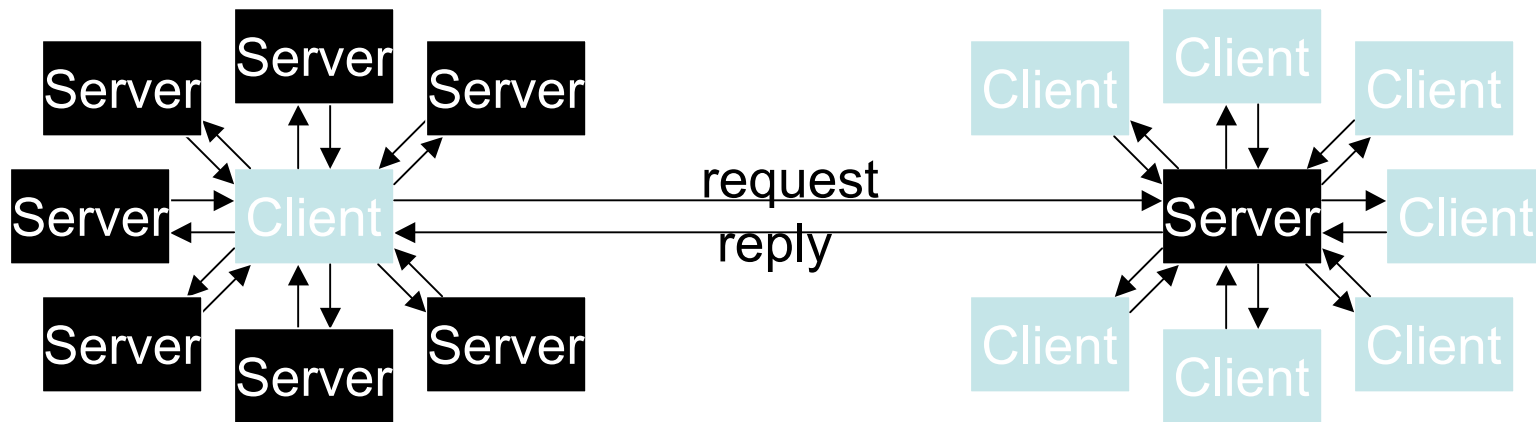
Dissecting a URL

- 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/cse100/CurrentQtr/	<i>dirs(folders)</i>
file	= calendar100	
file extension	= .html	<i>hypertext markup language</i>

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





Simple HTTP Request

method request protocol

GET /pub/WWW/TheProject.html HTTP/1.1

Host: www.w3.org

host

A diagram showing an HTTP request. The text 'GET /pub/WWW/TheProject.html HTTP/1.1' is on the top line, and 'Host: www.w3.org' is on the bottom line. Red arrows point from labels to parts of the request: 'method' points to 'GET', 'request' points to '/pub/WWW/TheProject.html', 'protocol' points to 'HTTP/1.1', and 'host' points to 'www.w3.org'.



A Typical Browser Request

GET /pub/WWW/TheProject.html HTTP/1.1

**Accept: image/gif, image/x-xbitmap, image/jpeg,
image/pjpeg, application/vnd.ms-powerpoint,
application/vnd.ms-excel, application/msword,
application/x-shockwave-flash, */***

Accept-Language: en-us

Accept-Encoding: gzip, deflate

**User-Agent: Mozilla/4.0 (compatible; MSIE 6.0; Windows
NT 5.0; APC)**

Host: www.w3.org

Connection: Keep-Alive



Server Response

HTTP/1.1 200 OK

Date: Monday, 23 May 2005 22:38:34 GMT

Server: Apache/1.3.27 (Unix) (Red-Hat/Linux)

Last-Modified: Wed, 08 Jan 2003 23:11:55 GMT

Etag: "3f80f-1b6-3e1cv03b"

Accept-Ranges: bytes

Content-Length: 438

Connection: close

Content-Type: text/html

<html>

<head><title>A Sample Page</title></head>

<body>

...

Summary

- Networking is changing the world
 - Internet: named computers using TCP/IP
 - WWW: servers providing access to information via the HTTP protocol
 - 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