
Networking


INFO/CSE 100, Autumn 2004
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 much more useful when connected (networked)
 - » Access more information and software than is stored locally
 - » Help users to communicate, exchange information ... changing ideas about social interaction
 - » Perform other services -- printing, audio, video, ...
 - » Immediate answers:  Web Images Groups News Froogle more »
define: byte Search Advanced Search Preferences

UW's networks move more than a *trillion bytes per day*

Networking Changes Life

- The Internet is making fundamental changes ... The *FIT* text gives 5 ways
 - Nowhere is remote -- access to info is no longer bound to a place
 - Connecting with others -- email is great, but spam?
 - Revised human relationships -- too much time spent online could be bad
 - English becoming a universal language
 - Enhanced freedom of speech, assembly

Network Structure

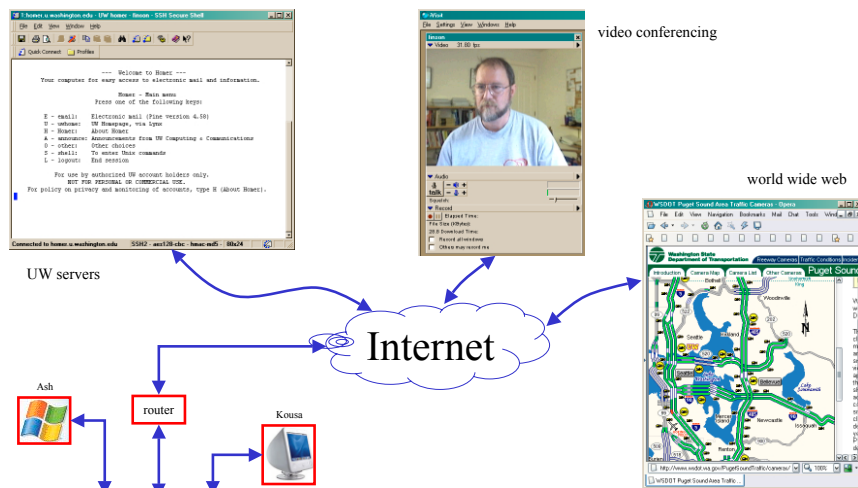
Internet: all of the wires, fibers, switches, routers etc. connecting named computers

- 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 1 Km
 - » What do you think a PAN might be?



Local Area Network

Wide Area Network

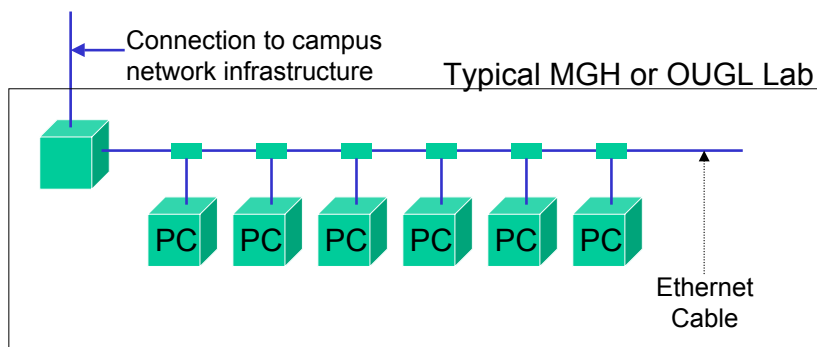


Protocol Rules!

- To communicate computers need to know how to set-up the info to be sent and 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 -- for Internet
 - HTTP -- hypertext transfer protocol -- for Web

LAN in the Lab

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



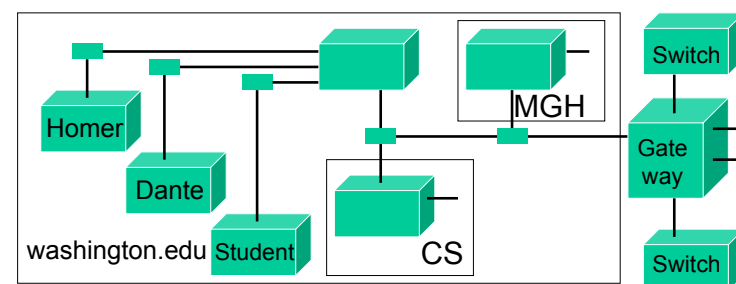
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Campus & The World

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



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IP -- Like Using Postcards

- Information is sent across the Internet using Internet Protocol -- postcard analogy
 - Break message into fixed size units
 - Form IP packets with destination address, sequence number and content
 - Each makes its 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

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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	hnspl-wes-ge-0-0-0-0.pnw-gigapop.net		0	Verio, Inc. VRIO-198-106
4	198.48.91.78	abilene-prnw.pnw-gigapop.net		5	University of Washington UW-SEA29
5	198.32.11.124	stllng-stll.abilene.ucaid.edu		0	Exchange Point Blocks NET-EP-1
6	198.32.8.50	dmw-stll.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-dmwr.abilene.ucaid.edu		40	Exchange Point Blocks NET-EP-1
9	198.32.11.117	kscyng-kscyng.abilene.ucaid.edu		34	Exchange Point Blocks NET-EP-1
10	198.32.8.80	lplisng-kscyng.abilene.ucaid.edu		281	Exchange Point Blocks NET-EP-1
11	198.32.8.76	chinnng-lplisng.abilene.ucaid.edu		52	Exchange Point Blocks NET-EP-1
12	198.32.8.83	mycmng-chinnng.abilene.ucaid.edu		72	Exchange Point Blocks NET-EP-1
13	198.32.8.46	mycm-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	129.132.99.11	rou-rz-1-mega-transit-2.ethz.ch	(Switzerland)	188	Swiss Federal Institute of Technology ETH-ETHER
21	129.132.1.15	ethz.ch	(Switzerland)	192	Swiss Federal Institute of Technology ETH-ETHER

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

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Check Internet Hops

- there are numerous Trace Route utilities
 - » Windows: tracert, OSX: Network Utilities, ...

```
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:
  0  <1 ms  <1 ms  <1 ms  eureka-GE1-6.cac.washington.edu [128.208.5.100]
  1  <1 ms  <1 ms  <1 ms  iron-GE1-8.cac.washington.edu [140.142.153.68]
  2  <1 ms  <1 ms  <1 ms  dante%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:
  0  <1 ms  <1 ms  <1 ms  eureka-GE1-6.cac.washington.edu [128.208.5.100]
  1  <1 ms  <1 ms  <1 ms  usbr1-ge2-2.cac.washington.edu [140.142.155.231]
  2  <1 ms  <1 ms  <1 ms  cnsp1-ads-gw-0-0-0.gow.gigamon.net [198.107.150.41]
  3  <1 ms  <1 ms  <1 ms  unknown.Level3.net [209.247.84.37]
  4  <1 ms  <1 ms  <1 ms  se-7-0-0.sp2.Seattle1.Level3.net [64.159.1.165]
  5  <1 ms  <1 ms  <1 ms  se-8-1-0.bbr1.NewYork1.Level3.net [64.159.1.41]
  6  68 ms  69 ms  69 ms  4.68.128.185
  7  134 ms  134 ms  134 ms  ge-3-0-0-gar2.London1.Level3.net [4.68.128.126]
  8  134 ms  134 ms  134 ms  se-6-0-0.mtr1.Londency009.London1.Level3.net [212.113.3.30]
  9  134 ms  134 ms  134 ms  213.232.65.153
  10  134 ms  134 ms  134 ms  217.28.128.10
  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:\>
```

Naming Computers I

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

.edu
.washington.edu
dante.washington.edu
.ischool.washington.edu
.cs.washington.edu
june.cs.washington.edu

All educational computers
All computers at UW
A UW computer
iSchool computers
CSE computers
A CSE computer

Naming Computers II

- 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 addresses would be brutal for humans, so we use domains
- » Computers find the IP address for a domain name from the Domain Name System
 - an IP address-book computer

Domains

- .edu .com .mil .gov .org .net domains are “top level domains” in the USA
 - » Recently, new TLD names added
 - .biz, .info, .name, .pro, .aero, .coop, and .museum
- Each country has a top level domain name: .ca (Canada), .es (Spain), .de (Germany), .au (Australia), .at (Austria), .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
- The 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/server protocol: servers provide services, clients use them
 - Sample servers: email server, web server, ...
 - UW servers: dante, courses, www, student, ...
 - Frequently, a “server” is actually many computers acting as one, e.g. dante is a group of more than 50 servers

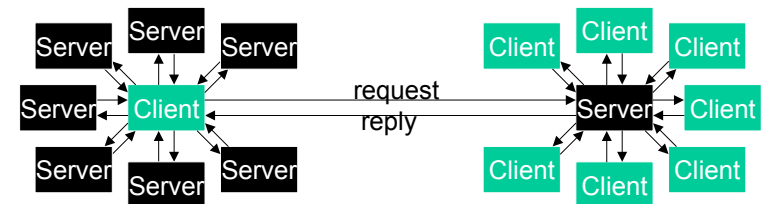
Protocol: Client packages a request, and sends it to a server; Server does the service and sends a reply

World Wide Web

- World Wide Web is a collection of servers (subset of Internet computers) & the information they give access to using http protocol
 - WWW is not the same as the Internet
 - The “server” is the web site computer and the “client” is the surfer’s browser
 - Many Web server’s domain names begin with www by tradition, but any name is OK
 - Often multiple server names 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 URLs (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/100/04wi/index.html>

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

Summary

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