Networking

More than just a social interaction

1

Networks…

Computers are useful alone, but are better 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, Web,…

UW's networks move more than trillion bytes per day

2

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
- Revised human relationships -- too much time spent online could be bad
- English becoming a universal language
- Enhanced freedom of speech, assembly

Can you think of others?

3

Network Structure

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

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

4

Protocol Rules!

To communicate computers need to know how to set-up the info to be sent and interpret the info received

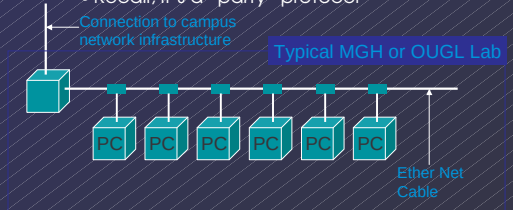
- Communication rules are a *protocol*
- Example protocols
  - EtherNet for physical connection in a LAN
  - TCP/IP -- transmission control protocol / internet protocol -- for Internet
  - HTTP -- hypertext transfer protocol -- for Web

5

LAN in the Lab

EtherNet is a popular LAN protocol

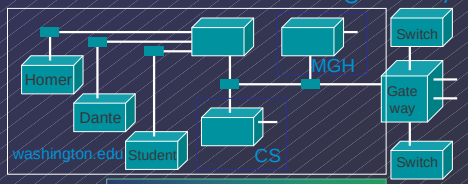
- Recall, it's a "party" protocol



6

Campus & The World

The campus subnetworks interconnect computers of the UW domain which connects to Internet via a gateway



All communication by TCP/IP

7

IP -- Like Using Postcards

Information is sent across the Internet using IP -- Cerf uses postcard analogy

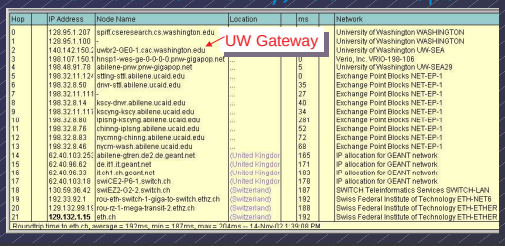
- Break message into fixed size units
- Form IP packets with destination address, sequence number and content | addr | # | data |
- Each makes its way separately to destination, possibly taking different routes
- Reassembled at destination forming msg

Taking separate routes lets packets by-pass congestion and out-of-service switches

8

A Trip to Switzerland

A packet sent from UW to ETH (Swiss Fed. Tech. 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	uwbr2-0E0-1.cac.washington.edu		University of Washington UW-SEA
3		198.107.150.1	hnsqrt-wes-ge-0-0-0-0.pnw-gigapop.net	0	Verio, Inc. VRIO-198-108
4		198.48.91.78	abilene-pnw.pnw-gigapop.net	5	University of Washington UW-SEA29
5		198.32.11.12	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		198.32.11.111	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		62.40.103.25	abilene-qtren.de2.de.geant.net	165	IP allocation for GEANT network
15		62.40.96.62	de.ffl.it.geant.net	171	IP allocation for GEANT network
16		62.40.96.33	it.ch1.ch.geant.net	193	IP allocation for GEANT network
17		62.40.103.18	swiCE2-PB-1.switch.ch	178	IP allocation for GEANT network
18		130.59.36.42	swiEZ3-G2-2.switch.ch	187	SWITCH Teleinformatics Services SWITCH-LAN
19		192.33.92.1	rou-eth-switch-1-giga-to-switch.ethz.ch	192	Swiss Federal Institute of Technology ETH-NETB
20		129.132.98.15	rou-rz-1-mega-transit-2.ethz.ch	188	Swiss Federal Institute of Technology ETH-ETHER
21		**129.132.1.15**	eth.ch	192	Swiss Federal Institute of Technology ETH-ETHER

Round-trip time to eth.ch, average = 197ms, min = 187ms, max = 704ms -- 14-Nov-07 1:39:08 PM

Check Internet Hops

Interested?

- Find software called Visual Routes (personal evaluation copies are free) at http://www.visualroute.com
- Download a copy of the software
- Install software and type in foreign URLs
  - Switzerland eth.ch
  - Australia www.usyd.edu.au
  - Japan kyoto-u.ac.jp
  - South Africa www.uct.ac.za

Use Google to find foreign computers

10

Naming Computers I

People name computers by a domain name -- a hierarchical scheme that groups like 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

Peers

Domains begin with a "dot" and get "larger" going right

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

A computer needs to know IP address of DNS server!

Domains

.edu .com .mil .gov .org .net domains are "top level domains" for the US

- Recently, new TLD names added
- Each country has a top level domain name: .ca (Canada), .es (Spain), .de (Germany), .au (Australia), .at (Austria), .us

The FIT book contains the complete list

13

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

14

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

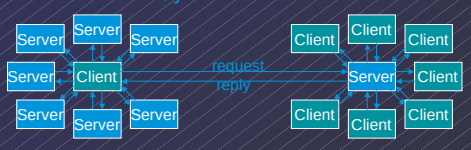
World Wide Web is the collection of servers (subset of Internet computers) & the information they give access to

- Clearly, WWW ≠ 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

16

Client/Server Interaction

For Web pages, the client requests a page, the server returns it: there's no connection, just two transmissions



Servers serve many clients; clients visit many servers

Dissecting a URL

Web addresses are URLs, *uniform resource locator*, an IP address+path

- URLs are often *redirected* to other places; e.g. http://www.cs.washington.edu/100/ goes to

http://www.cs.washington.edu/education/courses/100/04wi/index.htm

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

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

19