



# Networking

*More than just a social interaction*



# 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**



# 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**



# Protocol Rules!

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

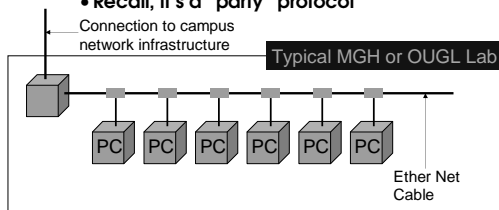
- \* Communication rules are a *protocol*
- \* Example protocols
  - **EtherNet** for physical connection in a LAN
  - **TCP/IP** -- transmission control protocol / internet protocol -- for Internet
  - **HTTP** -- hypertext transfer protocol -- for Web



# LAN in the Lab

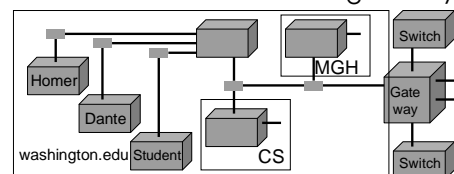
EtherNet is a popular LAN protocol

- **Recall, it's a "party" protocol**



# Campus & The World

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





## 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

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## 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.cse.washington.edu	University of Washington WASHINGTON	0	University of Washington WASHINGTON
1	128.95.1.100	...	University of Washington WASHINGTON	0	University of Washington WASHINGTON
2	140.142.150.1	uw02-OE0-1.cac.washington.edu	University of Washington UW-SEA	0	University of Washington UW-SEA
3	188.107.150.1	frisp1-wash-gs-0-0-0.pme-gigapop.net	UW Gateway	15	Vario, Inc. VRC-188-108
4	188.48.81.16	abilene-gw-gigapop.net	...	35	Exchange Point Blocks NET-EP-1
5	188.32.11.13v	abilene-188.abilene.usaid.edu	...	37	Exchange Point Blocks NET-EP-1
6	188.32.8.50	abilene-188.abilene.usaid.edu	...	40	Exchange Point Blocks NET-EP-1
7	188.32.11.111v	...	...	27	Exchange Point Blocks NET-EP-1
8	188.32.8.14	abilene-188.abilene.usaid.edu	...	40	Exchange Point Blocks NET-EP-1
9	188.32.11.111	abilene-188.abilene.usaid.edu	...	34	Exchange Point Blocks NET-EP-1
10	188.32.8.60	abilene-188.abilene.usaid.edu	...	201	Exchange Point Blocks NET-EP-1
11	188.32.8.76	abilene-188.abilene.usaid.edu	...	52	Exchange Point Blocks NET-EP-1
12	188.32.8.63	abilene-188.abilene.usaid.edu	...	72	Exchange Point Blocks NET-EP-1
13	188.32.8.46	abilene-188.abilene.usaid.edu	...	69	Exchange Point Blocks NET-EP-1
14	62.40.103.25	abilene-188.abilene.usaid.edu	...	165	IP allocation for GEANT network
15	62.40.99.62	abilene-188.abilene.usaid.edu	...	171	IP allocation for GEANT network
16	62.40.99.33	abilene-188.abilene.usaid.edu	...	163	IP allocation for GEANT network
17	62.40.103.10	abilene-188.abilene.usaid.edu	...	179	IP allocation for GEANT network
18	130.59.36.42	abilene-188.abilene.usaid.edu	...	167	SWITCH Teleinformatics Services SWITCH-LAN
19	130.59.36.1	abilene-188.abilene.usaid.edu	...	152	Swiss Federal Institute of Technology ETH-ETHZ
20	128.132.88.16	abilene-188.abilene.usaid.edu	...	198	Swiss Federal Institute of Technology ETH-ETHZ
21	128.132.88.145	abilene-188.abilene.usaid.edu	...	152	Swiss Federal Institute of Technology ETH-ETHZ

Roundtrip time to eth.ch, average = 192ms, min = 187ms, max = 204ms - 14-Nov-02 1:38:08 PM



## Check Internet Hops

Interested?

- \* Find software using Google: Search on "tracert" or "tracertool"
- \* 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

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## 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

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## 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

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## 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

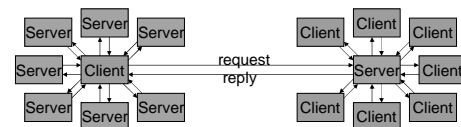
- Clearly, WWW ≠ Internet
- The "server" is the web site computer and the "client" is the surfer's browser
- Many Web server's domain names begin with www by tradition, but any name is OK
- Often multiple server names map to the same site: MoMA.org and www.MoMA.org

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## 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

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## 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

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