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!

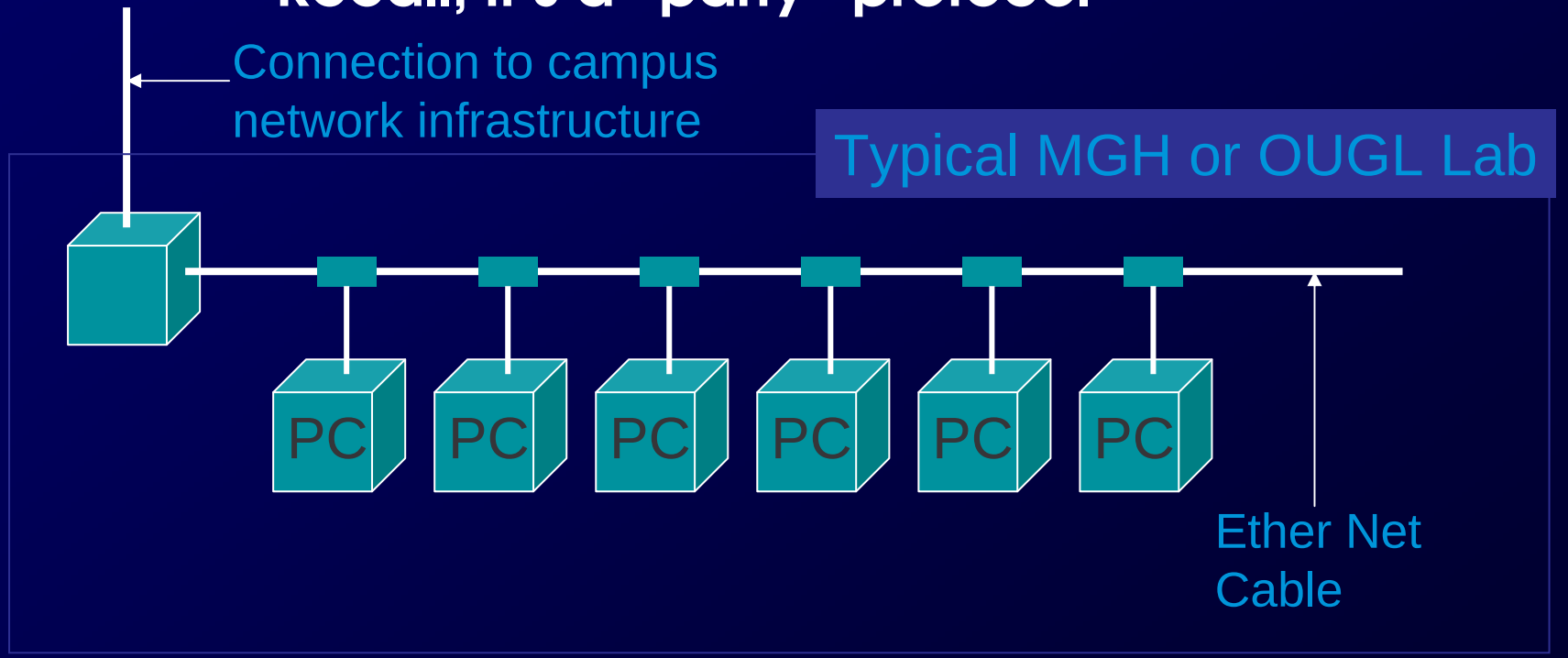
To communicate computers need to know how to set-up the info to be sent and interpret the info received

* 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

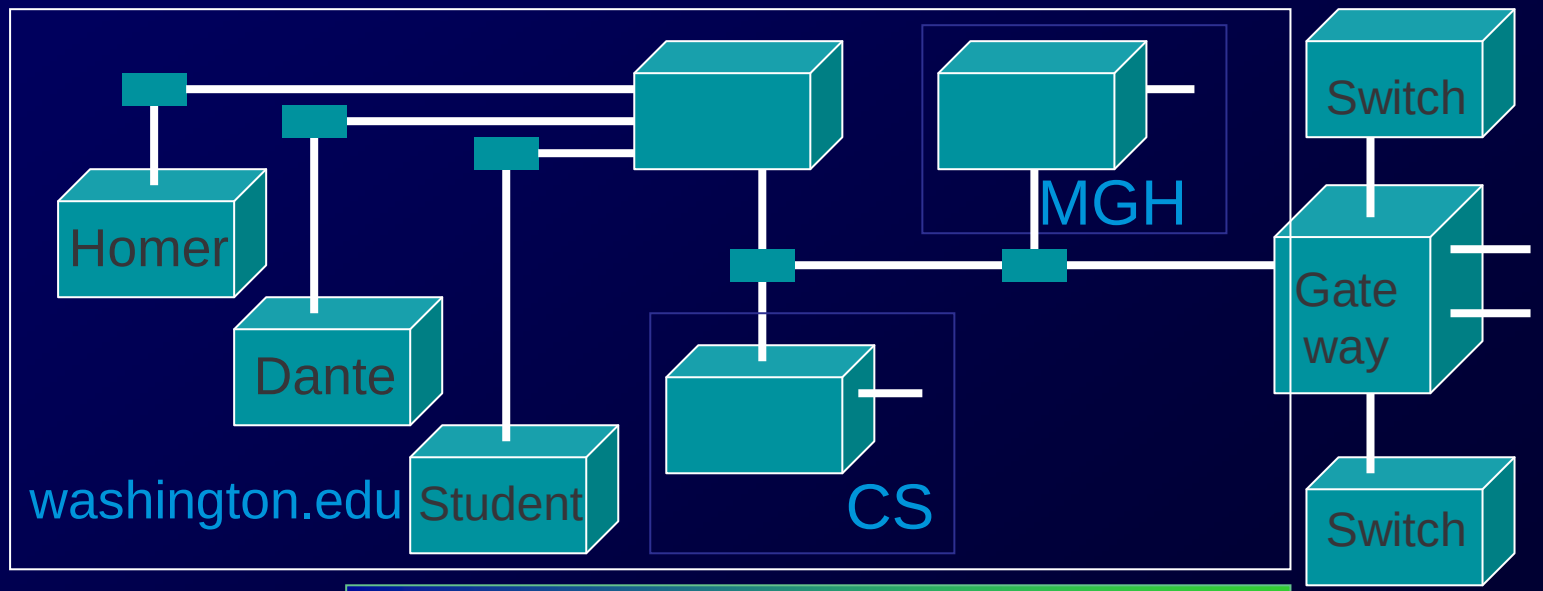
EtherNet is a popular LAN protocol

- **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



All communication by TCP/IP

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

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-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

Interested?

- Find software using Google: Search on "traceroutes"
- 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

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

Peers

.ischool.washington.edu iSchool computers

.cs.washington.edu CSE computers

june.cs.washington.edu A CSE computer

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

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

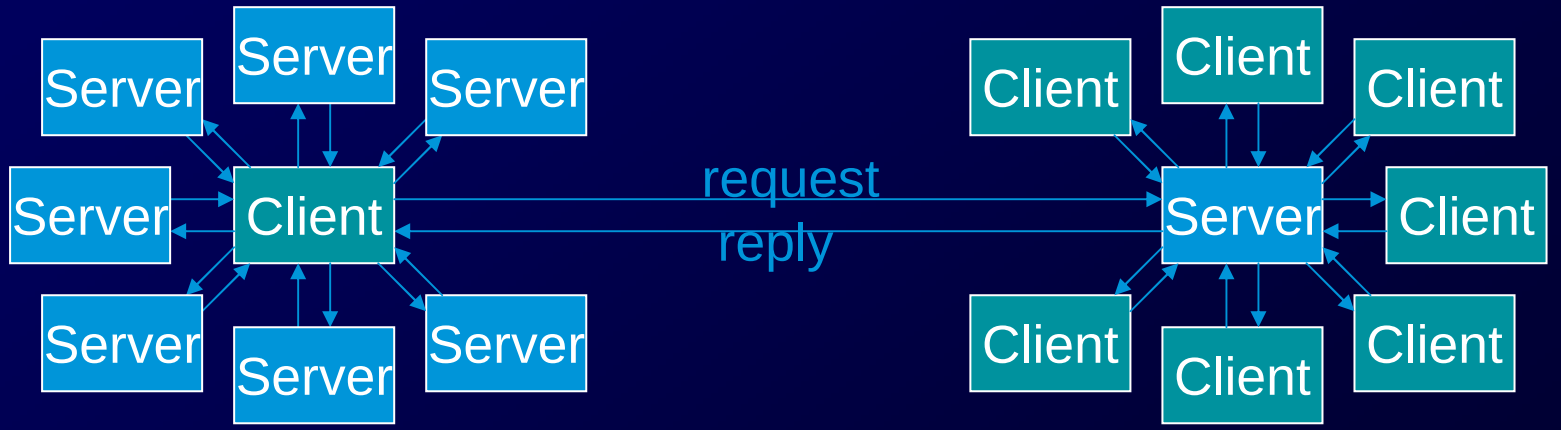
World Wide Web

World Wide Web is 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

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**