The network is the computer.
                              - Sun Microsystems Motto

It's a mind-set, not a skill-set. Brilliance helps, but is not required.
> Instead, adopt these mantras: be stubborn, bossy, lazy, obsessive, cynical, **plodding**, and importunate. Why? So you can use IT as a tool to do cool stuff…

Computer Networks

- <u>History</u>
- <u>Technology</u>
- <u>Issues</u>

Computer networks present:

Opportunities

users can share files

you only need 1 printer for a group of people

you can communicate via email and ftp

computing loads could be balanced between machines

Difficulties

hackers can get shared files

when the 1 printer goes down, everyone is toast

you can send spam

Early Computer Networks

- Early machines were *stand-alone* machines.
- But people wanted to…
  - share data
  - share resources
- Growth
  - 1960s: some mainframes
  - 1980s: personal computers at home
  - 2000s: everything? mandatory?

We'll pretty much skip directly to the internet.

Computer networks present:

Opportunities

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when the 1 printer goes down, everyone is toast

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Security is a huge issue!

ARPANET

- 1969
- The DOD wanted a network that could handle computers that crashed regularly.

Packet switching is different from the explicit direct circuits used by the telephone system - if you are cut off there, you are cut off and need to re-establish a connection. In packet-switching, the packets just get re-routed. TCP/IP is one of the many packet switching protocols out there.

Note that this is very different from a centralized, switched telephone network. The DOD did not want a computer network in which communication lines could so easily be "disconnected".

Internet

- 1983
- ARPANET, CSNET & other networks combined to form the Internet.
- Network of independent, heterogeneous networks.
  - Within your network, use whatever protocol you want.
  - On the Internet, use TCP/IP

The internet is a network of networks, all using TCP/IP.

The instructor's station has the address: pcnh180-1.calvin.edu. This is completely unique in the world.

Vinton Cerf (1943-)
TCP/IP

- 1973
- Co-invented with Robert Kahn
- TCP/IP – a suite of protocols, including:
  - Transmission Control Protocol
  - Internet Protocol
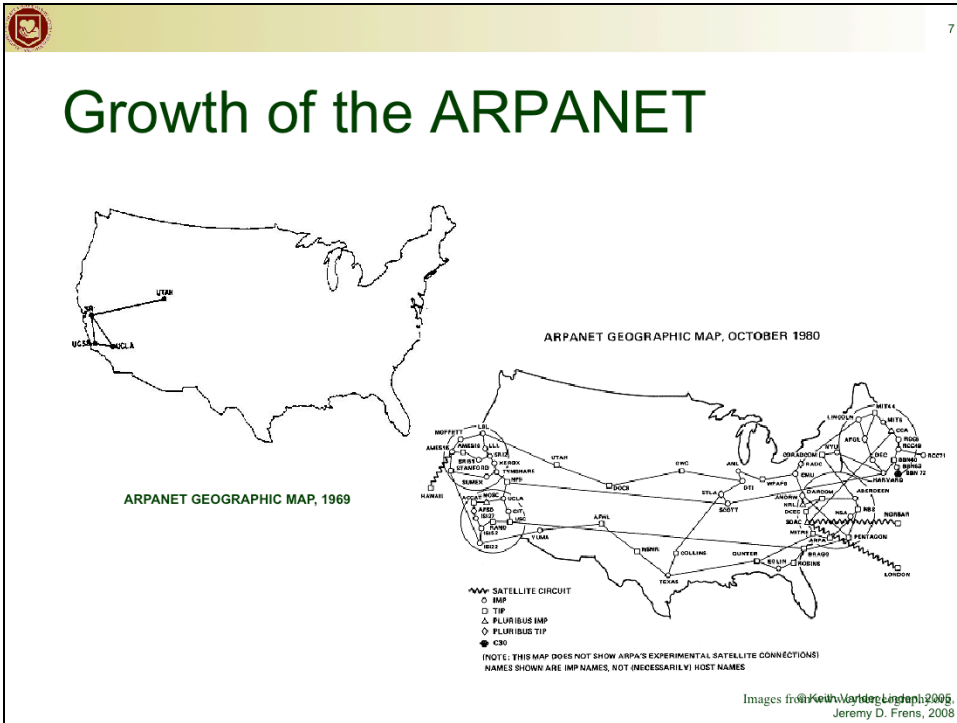- Together, they form the basis of the internet.

Transmission Control Protocol - rules for building and managing packets

Internet Protocol - rules for routing the packets

The basis of the internet for 2 reasons really:

packet switching

it was an **open-network architecture**, not a proprietary one.

Growth of the ARPANET

ARPANET GEOGRAPHIC MAP, OCTOBER 1980

ARPANET GEOGRAPHIC MAP, 1969

SATELLITE CIRCUIT
IMP
TIP
PLURIBUS IMP
PLURIBUS TIP
C30

(NOTE: THIS MAP DOES NOT SHOW ARPA'S EXPERIMENTAL SATELLITE CONNECTIONS)
NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES

Images from Keith Vander Linden 2005,
Jeremy D. Frens, 2008

No, I won't try to get a map of the whole internet today!

Growth of the Internet

**Internet Users in the World
Growth 1995 - 2010**
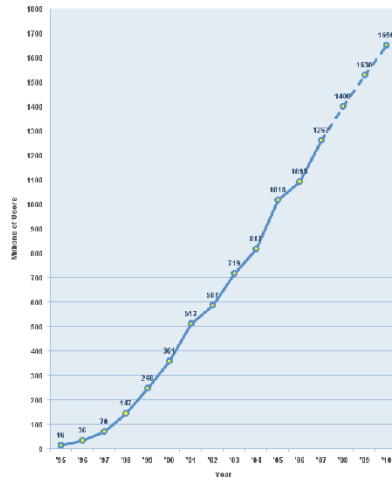
Source: www.internetworldstats.com - January, 2008
Copyright © 2008, Miniwatts Marketing Group

**Internet Penetration Rate in the Americas
December 2007**
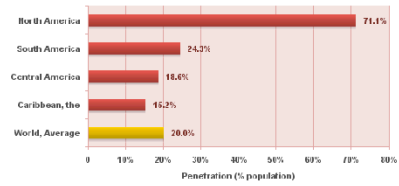
Source: Internet World Stats   www.internetworldstats.com
Copyright © 2008, Miniwatts Marketing Group

Distributed Network

- No one computer is in charge of the Internet.
  - *All* computers are in charge!
  - Some take on more responsibilities.
- Computers are connected to each other in multiple ways.
- Each computer routes data closer to its destination.
 - Routers: extra routing responsibilities.

Packet Switching

- Data is split up into small packets.
- Each packet is sent on its own to a nearby computer.
  - Not all packets take the same route!
- The packets are reassembled into the original data.
- If a packet goes missing, it's resent.

Network Architectures

- Networks can be characterized by how they manage their resources.
- Common network architectures:
  - Client-Server
  - Peer-to-Peer
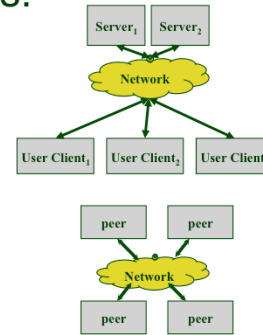
Common network architectures:

Client-server – Separates front-end interfaces (clients) from centralized service providers (servers) – This is by far the most common architecture today.

Peer-to-peer – used direct network connections between egalitarian client/servers (clervers!?)

Show them this commercial:

http://www-03.ibm.com/systems/tv/spacedout_flat.html

http://www-03.ibm.com/servers/uk/eserver/tv/campaigns/ takebackcontrol/?ca=2005q4_SystemLead_UK

Network Technologies

- Copper wire
    - coaxial or twisted pair (telephone wire, cat5/ ethernet cable)
- Fiber-optics
- Wireless technology
    - Radio Frequency (RF)
    - Infrared radiation
    - Microwave

Fiber is cheaper to fabricate, but slower to connect. Thus, copper is still common.

RF is nice, but there are limited radio frequencies to use

infrared is restricted to a single room, and is still slower than the others

microwave can't penetrate metal either, and are potentially dangerous to humans

Network Architecture
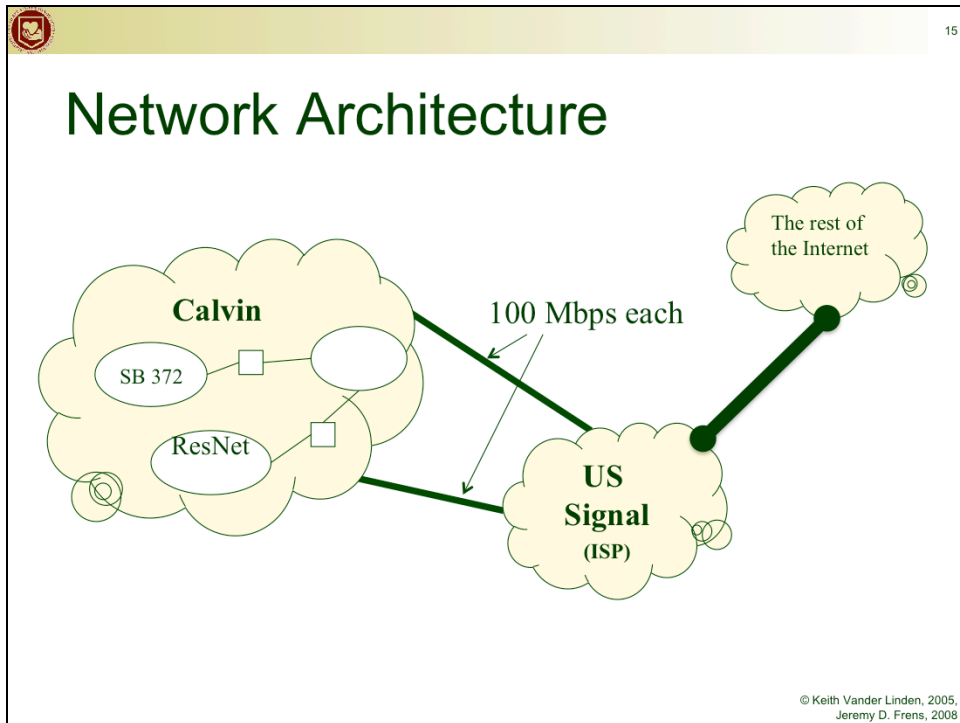
The internet is a network of heterogeneous networks, as can be seen in this myopic, SB372-centric view of the internet.

Talk through all of this, including a discussion of:

> LANS (circles at Calvin)

> routers link one (potentially incompatible) network to another (little box between calvin and michnet)

> backbones

> modems (little circles) /ISPs vs. direct internet connections (MichNet/Merit)

> reiterate the "last mile" problem here

MichNet architecture is at: http://www.merit.edu/mn/resources/network/backbone.pdf
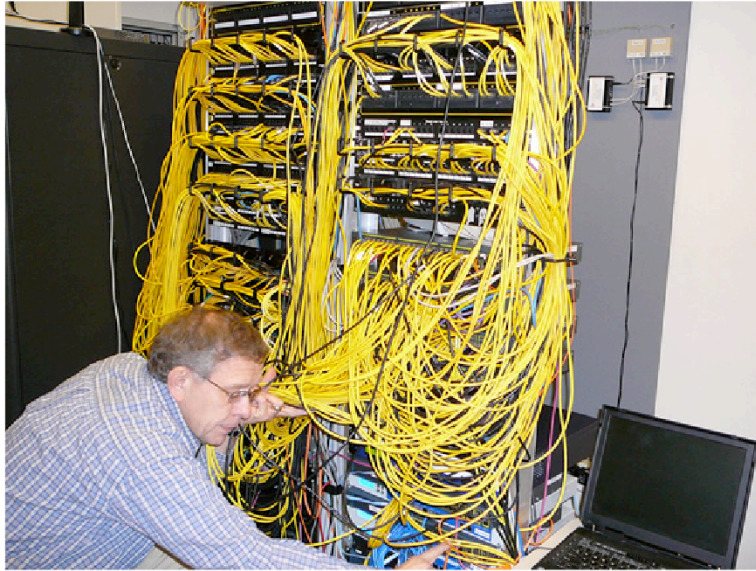
Find an architecture diagram for CIT as well.

Calvin's Network

- Dual 100 Mbps fiber connections to/from US Signal

- 400 switches

- Distribution closets in all buildings – with big one in Bolt-Heyns-Timmer

- All data through a "packet shaper", "intrusion prevention device", and "external firewall".

Calvin's Network

Vander Linden, 2005,
Jeremy D. Frens, 2008

Internet Services

- The Internet supports a variety of information services.
- These services *use* the Internet.
- Examples:
  - World Wide Web (http)
  - Email
  - Telnet/SSH
  - FTP/SFTP

The internet now supports a vast array of programs/systems, called services.

The Web is an Internet service that supports the sharing of hypermedia. **Internet != WWW**

Email is a service for exchanging mail messages.

don't push on the other two (i.e., on telnet/ssh and ftp/sftp).

Inclusiveness of the Web

- How "world-wide" is the web?

- How could we make it more international?

- How inclusive or *intrusive* should it be?

Given the English-centric nature of the web, one might more accurately call it the *Western*-**wide web.**

Digital divide – the WWW is hard to access in:

> the developing world
>
> the non-western world
>
> underpriviledged social classes
>
> the disabled community

What could we do to help bridge this divide?

> Unicode
>
> internationalized domain name resolution
>
> better translation tools
>
> better international/disabled design and testing

Malware

- malicious software: "software to infiltrate a computer system without the owner's informed consent" [wikipedia]
  - definition based on the user's *intent* or *motive*
  - Note: God judges us based on our *motives*.
- includes computer viruses, worms, trojan horses, rootkits, spyware, dishonest adware, crimeware, etc.

© Keith Vander Linden, 2005,
Jeremy D. Frens, 2008

What kinds of data:

    internet usage patterns

    credit cards (even with encryption)

    informational databases

    proprietary systems or information

    passwords

how can they be compromised:

    copying

    hacking into protected sites

    sniffed in various ways

        packet-sniffers

        carnivore

        companies monitoring stuff

    cookies

    identity theft

Privacy is somewhat of a fallacy on the internet.

What to do:

    privacy legislation

    proper security

    ethical behavior.

Malware (cont)

- virus: attached to an existing program, does damage to files, and copies itself.
- worm: unattached, damages the network, and copies itself.
- trojan horse: opens up a "backdoor" to the system for future unauthorized access; non-replicating.
- spyware: collects info about users.
- crimeware: for identity theft.

Privacy and the Internet

- The internet never sleeps, it never forgets and it doesn't always tell the truth.
  - phishing schemes
- The internet makes information more vulnerable to improper use.
- What can be done about this?
- "…be shrewd as snakes and as innocent as doves." - Matthew 10:16

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