CPSC156a: The Internet

Co-Evolution of Technology and Society

Lecture 2: September 9, 2003

Internet Basics

Acknowledgments: S. Bradner and R. Wang

History

- Late 1960s and early 1970s: ARPANET
  - US Department of Defense
  - Connects small ARPA-sponsored data networks
  - Ground breaking testbed for network ideas and designs
- Early 1980s: Other wide-area data networks are established (*e.g.*, BITNET and Usenet).
- Late 1980s and early 1990s:
  - “ARPANET” fades out.
  - US Gov’t sponsors NSFNET, which connects large regional networks.
  - Commercial data networks become popular (*e.g.*, Prodigy, Compuserve, and AOL).
- Mid-1990s: Unified “Internet”

Internet Protocols Design Philosophy

- Ordered set of goals:
  1. multiplexed utilization of **existing networks**
  2. survivability in the face of failure
  3. support multiple types of communications service
  4. accommodate a variety of network types
  5. permit distributed management of resources
  6. cost effective
  7. low effort to attach a host
  8. account for resources
- Not all goals have been met

Packets!

- Basic decision: use packets not circuits (Kleinrock)
- Packet (*a.k.a.* datagram)

  - self contained
  - handled independently of preceding or following packets
  - contains destination and source **internetwork** address
  - may contain processing hints (*e.g.*, QoS tag)
  - **no delivery guarantees**
    - net may drop, duplicate, or deliver out of order
    - reliability (where needed) done at higher levels

Telephone Network

- Connection-based
- Admission control
- Intelligence is "in the network"
- Traffic carried by relatively few, "well-known" communications companies

Internet

- Packet-based
- Best effort
- Intelligence is "at the endpoints"
- Traffic carried by many routers, operated by a changing set of "unknown" parties

Technology Advances

	1981	1999	Factor
MIPS	1	1000	1,000
$/MIPS	$100K	$5	20,000
DRAM Capacity	128KB	256MB	2,000
Disk Capacity	10MB	50GB	5,000
Network B/W	9600b/s	155Mb/s	15,000
Address Bits	16	64	4
Users/Machine	10s	<=1	<0.1

- Expensive machines, cheap humans
- Cheap machines, expensive humans
- (Almost) free machines, really expensive humans, and communities

The Network *is* the Computer

- Relentless decentralization
  - "Smaller, cheaper, more numerous"

    mainframe → mini → PC → palms → ubiquitous/embedded
  - More computers → more data communication
- (Shifting) reasons computers talk to each other
  - Efficient sharing of machine resources
  - Sharing of data
  - Parallel computing
  - *Human* communication

The Network *is* the computer (continued)

- Networks are everywhere and they are converging.
  - SAN, LAN, MAN, WAN
  - All converging towards a similar technology
  - Sensor nets
- New chapter of every aspect of computer science
  - Re-examine virtually all the issues in the context of distributed systems or parallel systems
- This is only the beginning.

Discussion Point

- Ubiquitous computers and networks
- More data communication begets more human communication.
- “(Almost) free machines, really expensive humans”

Are humans on a collision course with networks?

Reading Assignment For This Week

- "Networks: How the Internet Works," Appendix C of The Digital Dilemma (NRC, 2000) http://books.nap.edu/html/digital_dilemma/appC.html

- "Rethinking the design of the Internet: The end-to-end arguments vs. the brave new world," Clark and Blumenthal, 2000 http://itel.mit.edu/itel/docs/jun00/TPRC-Clark-Blumenthal.pdf