EECS 122
Communications Networks

Kevin Fall

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Course Information

- Instructor: Kevin Fall (kfall@cs)
- Office Hours: Thursdays 10-11am in 741 Soda Hall
- Home Page:
  - http://www-inst.eecs.berkeley.edu/~ee122
- Tas: Hoi-Sheung "Wilson" So, Lin Hei
- Final Exam: May 21, 12:30-3:30 [19]

TA Information

- Wilson So
  - Office Hours: Th 2.15-3.15, 179M Cory
  - E-mail: so@cs.berkeley.edu
- Lin He
  - Office Hours: Fri 2-3, 179M Cory
  - E-mail: linhai@eecs.berkeley.edu

Description

Design and implementation of computer networks and inter-networks

Fundamental design principles

Common underlying technologies

Implementation and programming

Grading

- Final Exam (35%), Mid-term (20%)
- Problem Sets (10%)
- Project (35%)
- TA input and class participation will be used to assess borderline cases
- (Details will appear on web page -- check frequently!)

Books

- Required Textbook:

  L. Peterson & B. Davie,

  Computer Networks: A Systems Approach

- Other Useful Networking Texts:
  - A. Tanenbaum, *Computer Networks*
  - R. Stevens, *TCP/IP Illustrated (vol 1)*
  - S. Keshav, *An Engineering Approach to Computer Networking*

Problem Set #1

- P & D, Chapter 1, Problems:
  - *6, 7, 8, 9, 12, 16*
- Due Jan 28th end of class

Programming

- This course will involve programming. Projects may be implemented in either C or C++, on either Windows or UNIX
- Your work can be done on your "named" account. If you lack one, you may log in as "newacct" on one of the clients listed below:

http://www-inst.eecs.berkeley.edu/clients

Books on Programming

- S. Maguire, *Writing Solid Code*
- S. Lippman, *C++ Primer*
- R. Stevens, *UNIX Network Programming, Volume 1, 2nd ed*

Course Themes

- Supporting reliability and applications
- From bits to unreliable global messages
- Distributed applications
- Security, mobility, QoS and pricing

Course Outline

- Introduction and Motivation [1]
- Architecture, naming, addressing [2]
- Bits, LANs, unreliable transport [3]
- Switching, routing, multicast [3]
- Reliable transport [3]
- Distributed applications [2]
- Special topics [1]

Introduction

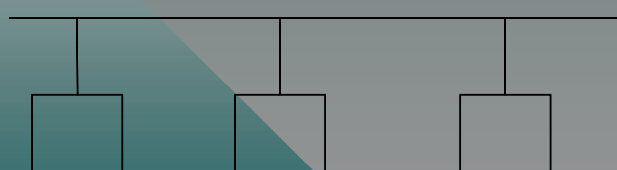
- What’s a network?
- Principles of network design
- What happens when you click on a Web link?

What's a network?

- **Link**: carry bits from one place to another (or maybe to many other places)
- **Switch/gateway/router**: move bits between links, forming internetwork
- **Host**: communication endpoint (workstation, PDA, cell phone, toaster, tank)

An example link (a LAN):

- Ethernet is a *broadcast-capable, multi-access* LAN



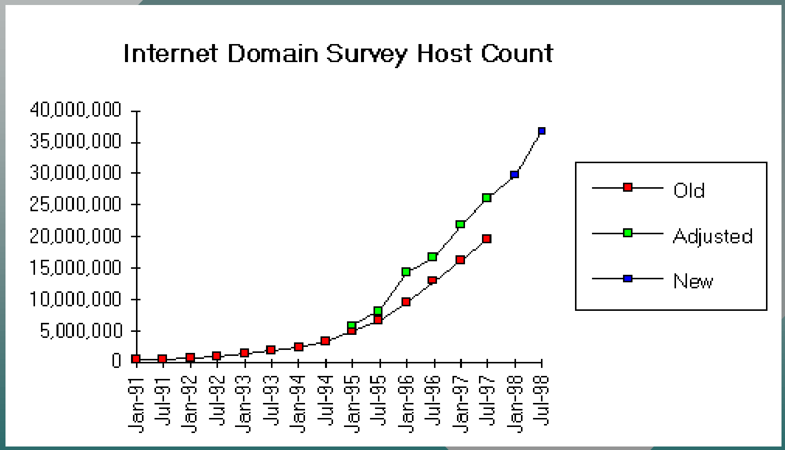
An Internetwork

- Provides message delivery between multiple networks:

The Internet

- A global network of networks all using a common protocol (IP, the Internet Protocol)
- Focus of this class
- A challenge to understand:
  - large scale (10’s of millions of users, 10’s of thousands of networks)
  - heterogeneity, irregular topology, decentralized management

Scale of the Internet



- Data from www.nw.com

Other Networks

- The Telephone Network
- Processor interconnect networks
- ATM Networks
- Cable-TV Networks

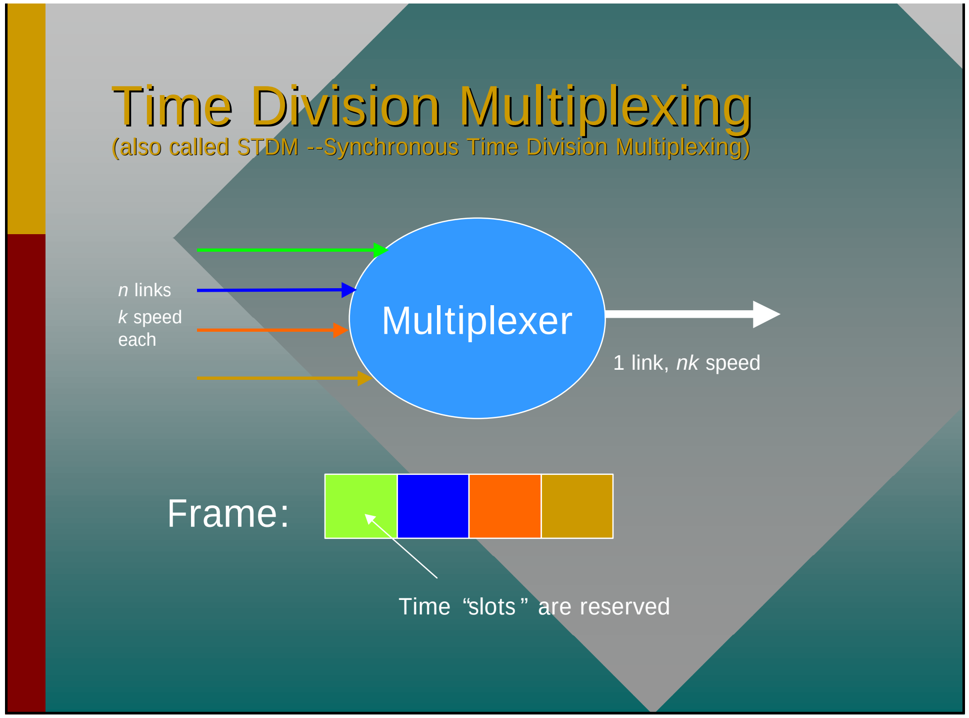
Resource Sharing

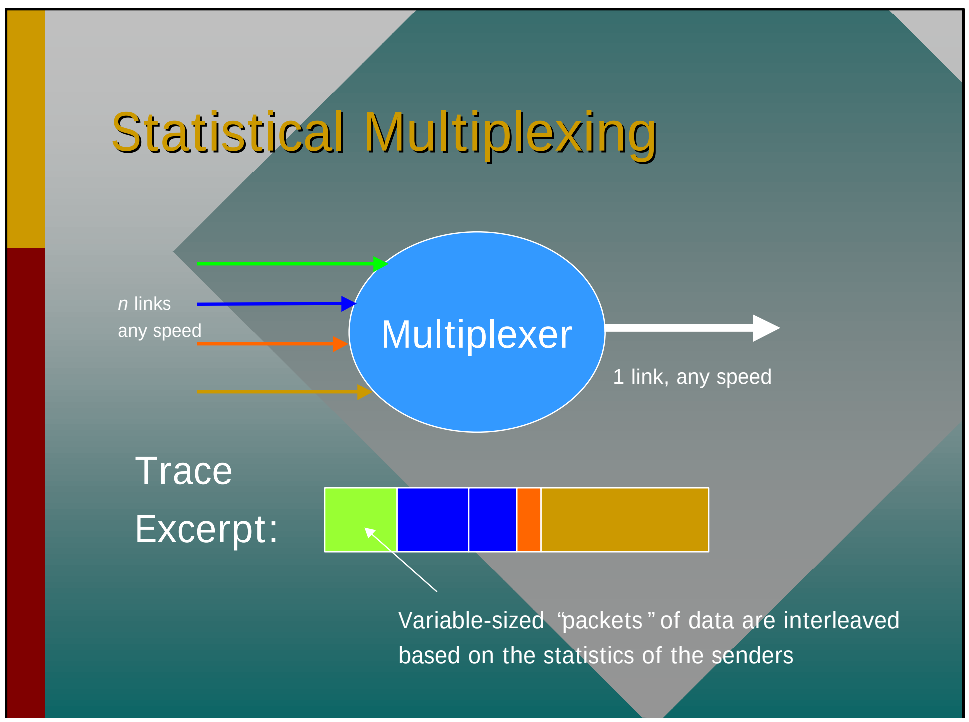
- Networks are *shared resources*
- Sharing via *multiplexing*
- Fundamental Question:

how to achieve <u>controlled sharing</u>

Multiplexing

- Methods for sharing a communication channel
- Tradeoff between utilization and predictability
- Common Approaches:
  - TDM (time-division multiplexing)
  - Statistical Multiplexing


Time Division Multiplexing
(also called STDM --Synchronous Time Division Multiplexing)
n links
k speed
each
Multiplexer
1 link, nk speed
Frame:
Time “slots” are reserved


Statistical Multiplexing
n links
any speed
Multiplexer
1 link, any speed
Trace
Excerpt:
Variable-sized “packets” of data are interleaved
based on the statistics of the senders

Analysis of STDM/FDM

- TDM, FDM (frequency division multiplexing), and WDM (wavelength) may under-utilize channel with idle senders
- applicable only to fixed numbers of flows
- requires precise timer (or oscillator and guard bands for FDM)
- resources are guaranteed

Analysis of Statistical Mux'ing

- traffic is sent *on demand,* so channel is fully utilized if there is traffic to send
- any number of flows
- need to control sharing:
  - packets are limited in size
  - prevents domination of single sender
- resources are not guaranteed

Protocols

- Agreement dictating the form and function of data exchanged between two (or more) parties to effect a communication
- Two parts: *syntax* and *semantics*
  - syntax: where bits go
  - semantics: what they mean and what to do with them

Protocol Example

- Internet Protocol (IP)
  - if you can generate and understand IP, you can be on the Internet
  - media, OS, data rate independent
- TCP and HTTP
  - if you can do these, you are on the web

Protocol Standards

- New functions require new protocols
- Thus there are many (e.g. IP, TCP, UDP, HTTP, RIP, OSPF, IS-IS, SMTP, SNMP, Telnet, FTP, DNS, NNTP, NTP, BGP, PIM, DVMRP, ARP, NFS, ICMP, IGMP)
- Specifications do not change frequently
- Organizations: IETF, IEEE, ITU

The IETF

- specifies Internet-related protocols
- produces "RFCs" (www.rfc-editor.org)
- Quotation from IETF T-shirt:

We reject kings, presidents and voting.
We believe in rough consensus and running code.

--- David Clark