Computer Networks: A Systems Approach, 5e

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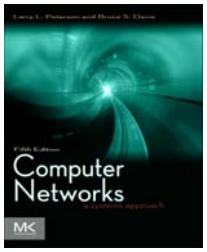


Chapter 1

Foundation

Problems

- How to build a scalable network that will support different applications?
- What is a computer network?
- How is a computer network different from other types of networks?
- What is a computer network architecture?

Chapter Outline

- Applications
- Requirements
- Network Architecture
- Implementing Network Software
- Performance

Chapter Goal

- Exploring the requirements that different applications and different communities place on the computer network
- Introducing the idea of network architecture
- Introducing some key elements in implementing Network Software
- Define key metrics that will be used to evaluate the performance of computer network

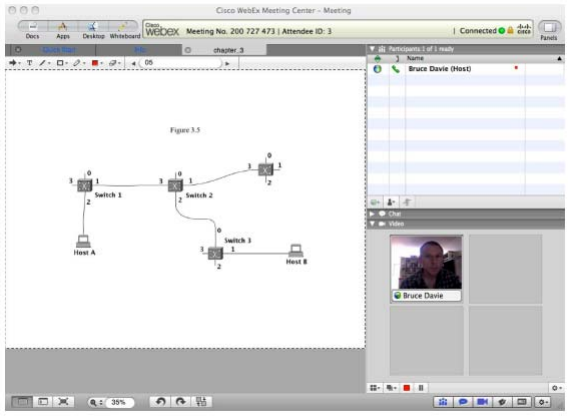
Chapter 1

Applications

- Most people know about the Internet (a computer network) through applications
  - World Wide Web
  - Email
  - Online Social Network
  - Streaming Audio Video
  - File Sharing
  - Instant Messaging
  - …

Chapter 1

Example of an application



A multimedia application including video-conferencing

Application Protocol

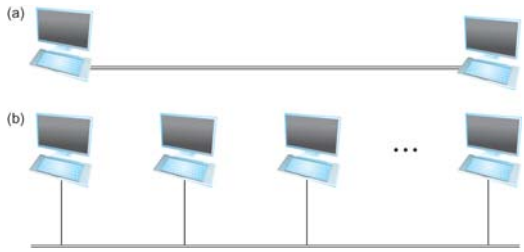
- URL
  - Uniform resource locater
  - http://www.cs.princeton.edu/~llp/index.html
- HTTP
  - Hyper Text Transfer Protocol
- TCP
  - Transmission Control Protocol
- 17 messages for one URL request
  - 6 to find the IP (Internet Protocol) address
  - 3 for connection establishment of TCP
  - 4 for HTTP request and acknowledgement
    - Request: I got your request and I will send the data
    - Reply: Here is the data you requested; I got the data
  - 4 messages for tearing down TCP connection

Requirements

- Application Programmer
  - List the services that his application needs: delay bounded delivery of data
- Network Designer
  - Design a cost-effective network with sharable resources
- Network Provider
  - List the characteristics of a system that is easy to manage

Connectivity

Chapter 1

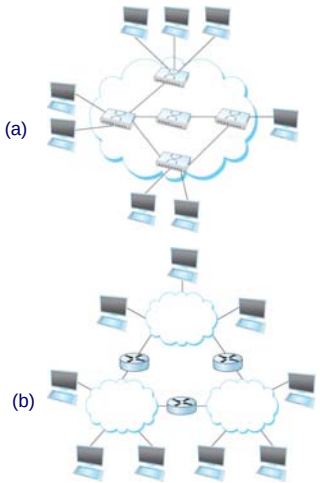


- Need to understand the following terminologies
  - Scale
  - Link
  - Nodes
  - Point-to-point
  - Multiple access
  - Switched Network
    - Circuit Switched
    - Packet Switched
  - Packet, message
  - Store-and-forward

Figure (a) Point-to-point
Figure (b) Multiple access

Connectivity

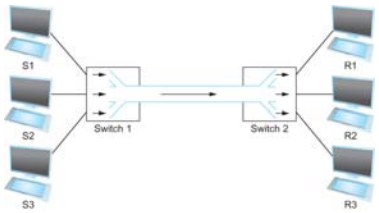
Chapter 1



- Terminologies (contd.)
  - Cloud
  - Hosts
  - Switches
  - internetwork
  - Router/gateway
  - Host-to-host connectivity
  - Address
  - Routing
  - Unicast/broadcast/multicast

(a) A switched network
(b) Interconnection of networks

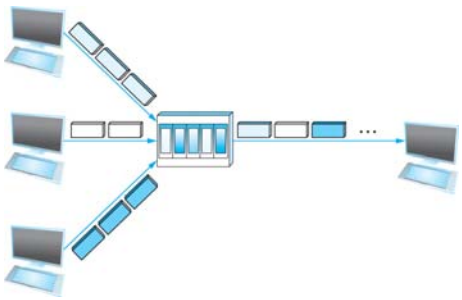
Cost-Effective Resource Sharing



Multiplexing multiple logical flows over a single physical link

- Resource: links and nodes
- How to share a link?
  - Multiplexing
  - De-multiplexing
  - Synchronous Time-division Multiplexing
    - Time slots/data transmitted in predetermined slots

Cost-Effective Resource Sharing

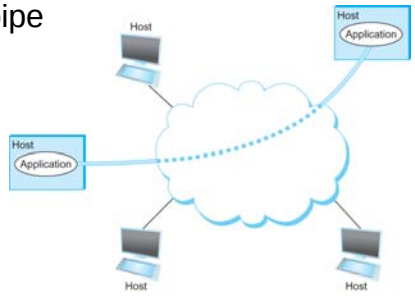


A switch multiplexing packets from multiple sources onto one shared link

- FDM: Frequency Division Multiplexing
- Statistical Multiplexing
  - Data is transmitted based on demand of each flow.
  - What is a flow?
  - Packets vs. Messages
  - FIFO, Round-Robin, Priorities (Quality-of-Service (QoS))
  - Congested?
- LAN, MAN, WAN
- SAN (System Area Networks

Support for Common Services

- Logical Channels
  - Application-to-Application communication path or a pipe



Process communicating over an abstract channel

Common Communication Patterns

- Client/Server
- Two types of communication channel
  - Request/Reply Channels
  - Message Stream Channels

Reliability

- Network should hide the errors
- Bits are lost
  - Bit errors (1 to a 0, and vice versa)
  - Burst errors – several consecutive errors
- Packets are lost (Congestion)
- Links and Node failures
- Messages are delayed
- Messages are delivered out-of-order
- Third parties eavesdrop