Computer Networks – Introduction

Outline:

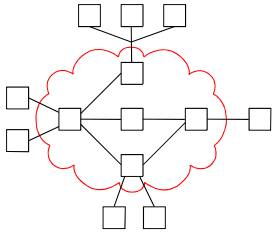
- General course information.
- Some basic concepts for computer networks.
- Network programming.

General Course Information

- Course Web page
  - http://www.cs.rochester.edu/~kshen/csc257-fall2009
- Course email address
  - cs257@cs.rochester.edu
- Textbooks
  - Kurose and Ross, "Computer Networking: A Top-Down Approach Featuring the Internet", 4th edition, 2007; 5th edition, 2009.
  - Peterson and Davie, "Computer Networks: A Systems Approach", 4th edition, 2007.
- Accounts in computer science labs

Basic Building Blocks for Computer Networks

- Network: two or most hosts connected by links/switches



- Host nodes:
  - PCs, servers, hand-held devices, sensors …
- Links:
  - Twisted pair, coaxial cable, phone line, optical fiber, wireless radio channels …

Addressing and Routing

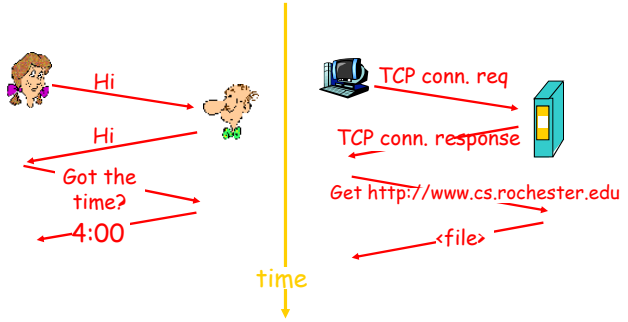
- Address: node identifier in a network.
  - often a unique byte string.
- Routing: finding a route (path) to the destination node based on its address.
- Types of traffic/addressing
  - unicast: to a single destination node;
  - broadcast: to all nodes on the network;
  - multicast: to some subset of nodes on the network;
  - anycast: to any one in a set of nodes.

Network Protocol

- A network protocol describes how communication entities (sender/receiver) should interact to accomplish a networking task.
  - format, order of messages sent and received between network entities
  - actions taken on message transmission, receipt
- Protocols define communication interface, not node-local implementations
  - allow two sides of a communication task to be independently implemented.

An Example

A human protocol and a computer network protocol:



Network Layers

- Separation of network functions/features allow independent design and implementation ⇒ thus distributing the complexity.
- Layering is a vertical separation of network functions/features.
  - Hiding the complexity: each layer interface hides complexity in this layer and layers below.
- Disadvantage of layering?
  - lack of full information sharing

Application programs
Host-to-host data transport
Host-to-host connectivity
Communications over link hardware

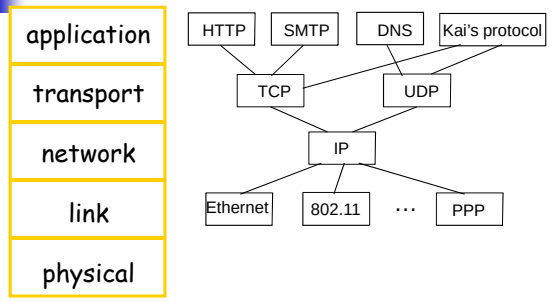
Internet Architecture

Bottom-up:

- physical: electromagnetic signals "on the wire"
- link: data transfer between neighboring network elements
  - encoding, framing, error correction, access control for shared links
- network: host-to-host connectivity
  - routing, addressing
- transport: host-to-host data transport
  - reliable data transport, congestion control, flow control
- application: anything you want to do on computer networks

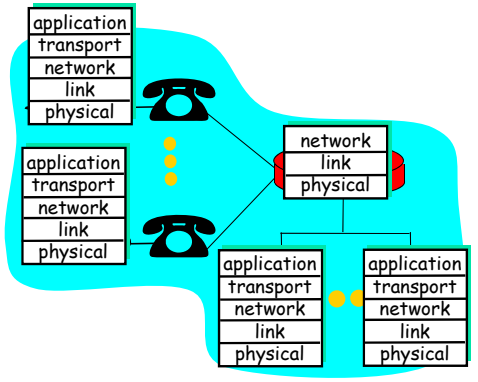
application
transport
network
link
physical

Protocols for the Internet Architecture



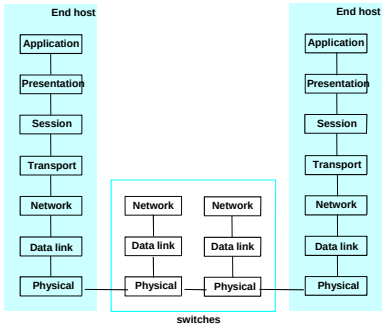
- Hourglass design.
- Understand layers, protocols, protocol implementations.

Internet Layering on Hosts and Switches



OSI Model

- Session layer: tie up different transport streams belonging to the same application
- Presentation layer: defining uniform format for data representation



History/Dominance of the Internet

- Internet (TCP/IP) evolved from a Defense Department-supported project called ARPARNET.
- The Internet becomes dominant today because:
  - Simple core network layer (packet switching) with extensibility.
  - A good TCP/IP implementation was bundled with a popular UNIX operating system (Berkeley UNIX).

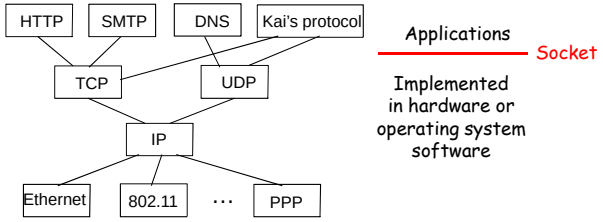
Course Outline

- Traditional materials about computer networks
  - Data links: Ethernet etc.
  - Network: IP addressing and routing.
  - Transport: TCP/UDP.
  - Application: HTTP, FTP, SMTP, and DNS.
- Advanced topics in computer networks
  - Multimedia networking (quality of service), computer security, wireless (mobile/mesh) networks, overlay networks.
- Case studies of network systems/technologies
  - HTTP load balancing.
  - Content distribution and network caching.
  - Peer-to-peer systems.

What we will learn?

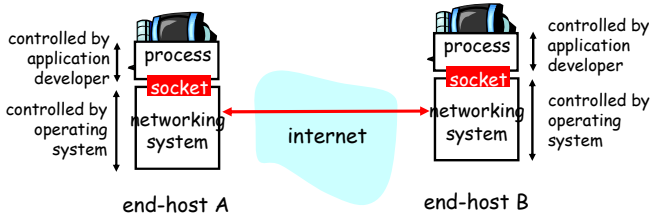
- Practices
  - How do things work in practice?
  - In the case of Internet, the Web, p2p overlay, etc.
- Principles
  - Why things work in ways they do?
  - Fundamental principles, design rationale (and sometimes a lack of it).

Socket Programming



Socket: the interface between application processes and underlying networking systems

Socket Programming (cont.)



Socket: an OS interface (a "door") into which application processes can communicate with remote application process.

TCP/UDP Sockets

Connection-oriented byte streams (TCP):

- Client/server need to establish connection before communications;
- Communications flow in streams of ordered bytes.

Connectionless datagram (UDP):

- No connection is needed before communications;
- Clear boundaries between groups of bytes (messages), but no ordering between messages.

Port Numbers

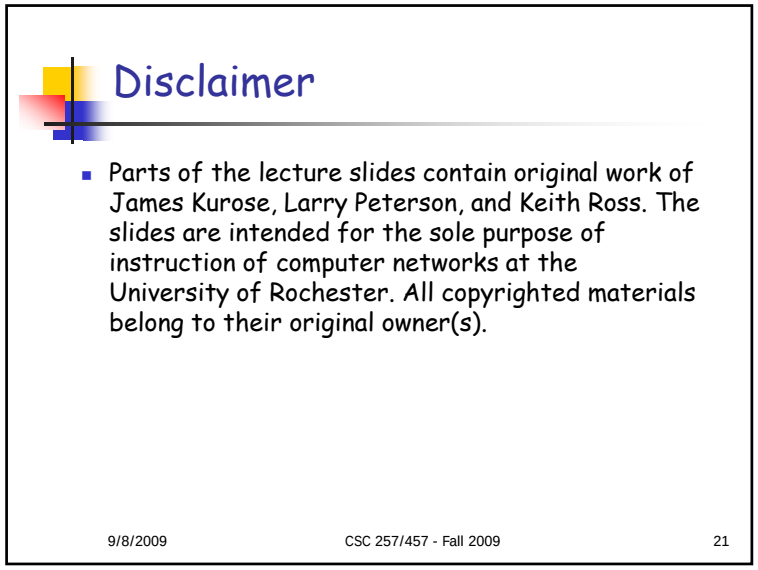
- Multiple sockets might exist in each host.
- A port number identifies each such socket in each host.
- Each port number is a 16-bit number, ranging from 0 to 65535.
- Port numbers ranging from 0 to 1023 are restricted for system-level services.

Learn Network Programming

- Reference books
  - Network programming in C: Stevens, "Unix Network Programming, Volume I", 2nd edition, 1998.
- Learn to use UNIX manual pages
- Find information on the web
- C versus Java

Assignment #0

- Part I: little warmup on socket programming, will not be graded
- Part II: network measurement
  - measuring transmission delays for varying TCP/UDP traffic
  - use high resolution timer
  - report stable results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