Protocols and Internetworking (CSE 573S)

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Request-reply Protocol Example (1)

- System
  - A transmitter process sends integer messages to a receiver process
  - Messages go over an error-free link
  - The transmitter always has another message to send after sending a message
  - The receiver has a single message buffer which takes a finite time to process
  - We want lossless (reliable) message delivery

Request-reply Protocol Example (2)

- Protocol Rules
  - Process States:
    - 1: Message was sent
    - 0: Message was received
  - A process in state 0 can send one message to the other process; it then enters state 1
  - A process in state 1 waits for one message from the other process and then enters state 0
  - Lower layer protocol insures no bit errors on physical medium

- Message Formats
  - Transmitter: Each msg is an arbitrary integer
  - Receiver: Each msg is a 1 (A msg was consumed)
Internets And The Internet

- An Internet: A network of heterogeneous networks
- THE (Global) Internet
  - An internet that uses IP
  - Organized into a multilevel hierarchy
- An Internet-Capable Host
  - Has a 32-bit IP address
    - e.g., 128.192.64.10, 0x80C0400A
  - Formats data into IP packets
- Goals of Internetworking
  - Universal connectivity
  - Uniform access (hide hardware/software heterogeneity)

Basic Internet Technology

- Packets
  - Packets carry information and are self-describing
  - A packet has 2 parts:
    - A header (metadata (information about the payload))
    - A payload (information content)
- Store-And-Forward Technology
  - The metadata allows a packet to be stored at a router for eventual delivery
    - The packet can be released when convenient
  - Direct analogy with the post office system
  - Less expensive to operate than the telephone network

Internet Protocol Layers

- Services at 1 level depend on lower layer services
- The layers form a protocol stack
Importance Of Layering

- Divide complex problem into smaller, more manageable pieces
- Hide implementation details
  - Protect clients from implementation optimizations
  - React to technical evolution
- Compose services from existing services
  - Reuse existing functionality
- Problems with layering
  - Poor Performance
  - How should your Web application react to network congestion?
  - Need to balance benefits of information hiding with higher performance

Internetworking Overview

Comparison Of TCP/IP And OSI
Internet Architecture

- FTP
- HTTP
- NV
- TFTP
- TCP
- UDP
- IP
- Net1
- ... Net8

Applications

The Internet Philosophy

- The End-To-End Argument
  » Functions that can be best handled by endsystems should not be duplicated in the network
  » Endsystems should handle delivering data reliably, NOT the network

- Decentralized Control
  » Endsystems should NOT depend on network for reliable/timely data

- Endsystem Control
  » Allows the network to be built with few assumptions (dumb network)
  » Easy to add new network types (e.g., satellite)
  » Leads to hour-glass design
    » Small number of features in the middle
    » Lots of applications and network interfaces

Key Internet Technologies

- TCP/IP (Matching Needs)
  » Protocol layering
  » Emergence outside of the military network

- Dynamic Routing (Evolution)
  » Route discovery
  » Route adjustments

- Packet Switching (Resilience to Failures)

- Ethernet
  » Complements packet switching (WAN) at the LAN level

Challenges

- IPv4 address space shortage (32 bits)
  » IPv6 (128 bits) deployment, backward compatibility

- Decentralized control (for scalability)
  » Accounting and billing
  » Security (scalable key distribution, complexity)
  » Reliable address discovery
  » Non-optimal routing

- Providing quality of service
  » Fair packet scheduling, buffer allocation
  » Signalling routers along a QoS path

- Is IP broken?