The Internet and its Architecture

CS 360 Internet Programming

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A Network of Networks

- roughly hierarchical
  - Tier-1 ISPs provide national, international coverage
  - Tier-2 ISPs provide regional coverage
  - Tier-3 and lower levels provide local coverage

- any tier may sell to business and residential customers

- any ISP may have a link to any other ISP (not strictly hierarchical)
Many Different Internet Service Providers

- Each network is independent
- Interoperability requires using Internet standards: IP, TCP
  - the Internet is global and must run these standards
  - your private intranet can do whatever you want it to do
Standardization

- standards are essential to interoperability on the Internet
- Internet Engineering Task Force [www.ietf.org](http://www.ietf.org)
  - standardizes Internet protocols: IP, TCP, HTTP, etc
  - open to all to participate, free of charge
  - relies on working code and rough consensus
- W3C [www.w3c.org](http://www.w3c.org)
  - standardizes web protocols and formats
  - industry-oriented consortium
  - requires approved and paid membership ($6,350 - $63,500 per year)
  - many standards do not require Internet-wide deployment
The Internet Hourglass

Application Layer
- DNS
- DHCP
- HTTP
- SMTP
- FTP
- BitTorrent

Transport Layer
- UDP
- TCP

Network Layer
- IP

Link Layer
- Ethernet
- 802.11
- SONET
- ATM
The Internet at each Hop

Web Client

HTTP
TCP
IP
Ethernet

Web Server

HTTP
TCP
IP
Ethernet

Router

HTTP message
TCP segment
IP Packet
Ethernet Frame

Switch

SONET
Ethernet
IP
Application Layer

- the focus of this class
  - client-server
  - peer-to-peer
  - web applications

- important topics
  - design
  - concurrency
  - performance evaluation
  - security

- use socket API to access transport protocols
Transport Layer

- **TCP**
  - provides a connection between two processes
  - reliable, ordered byte stream
    - **reliable**: retransmits any segments that are lost
    - **ordered**: buffers and re-orders segments before delivery to application
    - **byte stream**: transfers bytes, not messages
  - provides **flow control**: avoid overflowing the receiver’s buffer
  - provides **congestion control**: control rate based on feedback from the network

- **UDP**
  - connectionless and unreliable: lost packets are not re-sent
  - no flow control
  - no congestion control
  - designed for simple query-response applications, e.g. DNS or DHCP
Network Layer

- **IP**
  - common protocol needed to interoperate with other computers on the Internet
  - data from transport layer is divided into packets (about 1 KB) and sent individually
  - provides *best-effort* service
    - each router usually uses a FIFO queue at each link
    - packets may be delayed (large queue), dropped (queue overflow), or re-ordered (different paths)

- **routing protocols**
  - decide which path to use when sending packets from one computer to another
Link Layer

- provides ability to send packets from one computer to the next, using a link that directly connects them
- may be wired or wireless
- key features
  - bandwidth - number of bits that can be transmitted per second, measured in bps, Kbps, Mbps or Gbps
  - latency - the time it takes to propagate a bit down a link
  - shared vs dedicated resources