1.1 The Global Village (1/2)

- Previously (i.e., 1960s) telecommunication networks were designed primarily for 64Kbps telephony
- Today, telecommunication networks also support E-Mail, video, chat, www, etc.
- Today’s network applications have non-uniform throughput, delay, security requirements (i.e., heterogeneous applications)

1.1 The Global Village (2/2)

- Modern networks, therefore, can not be application specific
- Challenge: Design and implementation of robust networks for diverse applications
- Require conventions for machines to exchange diverse forms of information
- “The sets of conventions and the rules that determine how digital information will be exchanged are normally referred to as communication protocols.” (p. 1, text)

1.2 Evolution of Telecommunication Networks (1/3)

- 1844: Samuel Morse sends first telegraph message from Washington DC to Baltimore, MD
- 1876: Alexander Graham Bell invents telephone
- 1889: Almond B. Strowger introduces electromechanical switching of calls
- 1932: Crossbar switched introduced in Sweden
- 1965: AT&T introduces the 1EES stored-program control switching system
- 1960s: Pulse code modulation for A-to-D conversion of voice (4KHz baseband signal converted to 64Kbps digital signal)
- 1960s: Digital transmission hierarchy (e.g., T1 carrier)
- 1965: First global civilian communications satellite is launched

1.2 Evolution of Telecommunication Networks (2/3)

- 1964: American Standard Code for Information Interchange (ASCII) approved
- 1969: Electronics Industries Association (EIA) recommended standard (RS) RS-232D is issued
- 1970: First low loss optical fiber
- 1971: An experimental packet-switching network, ARPANET, enters service
- 1974: Ethernet developed at Xerox
- 1976: X.25 packet switching protocol established as a world standard
- 1978: 7-layer open-systems-interconnection (OSI) model is approved
1.3 Evolution of Computing Technology (1/1)

- “…the cost of computing is halved approximately every 3 years.” (p. 8, text)
- Today, traffic related to computer applications (e.g., www, E-Mail) exceeds telephony traffic

1.4 What is a Communication Network? (1/1)

A communication network consists of nodes (i.e., switches and end user stations) interconnected by transmission links.

1.5 Switching Architectures (1/3)

- Circuit Switching
- Dedicated path, a connected sequence of links, is created for the duration of the communication session
- E.g., circuit switched telephony

1.5 Switching Architectures (2/3)

- Message Switching
- Entire message is sent from one node to the next in the path
- Message hops from one node to the next with possible queuing due to busy channels

1.5 Switching Architectures (3/3)

- Datagram Packet Switching
- Message is broken into several packets and forwarded hop-by-hop based on destination address in datagram header
- E.g., FTP over TCP/IP

1.6 Network Protocol Architecture (1/3)

- Layering of protocol functionality reduces the complexity of the end-to-end communication task
- Independence of protocols between different layers promotes transparency across different substrates (i.e., lower layers)
1.6 Network Protocol Architecture (2/3): OSI Model

<table>
<thead>
<tr>
<th>Layer</th>
<th>Application</th>
<th>Presentation</th>
<th>Session</th>
<th>Transport</th>
<th>Network</th>
<th>Data Link</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Host A</td>
<td>Switch</td>
</tr>
</tbody>
</table>

1.6 Network Protocol Architecture (3/3): Internet Model

- In the Internet model, layers 5-7 of the OSI model are compressed into a single layer (application)
- At the transport layer
  - TCP is standardized for reliable transport
  - UDP is standardized for unreliable transport
- IP is standardized at the network layer for addressing

1.7 Types of Communication Networks (1/1)

- Telephone network
- Wide-area data communication networks
- Local area networks
- Metropolitan area networks
- Integrated Digital Services Network (ISDN)
- Radio-based networks
- Satellite networks
- Mobile communication networks
  - Cellular phone
  - Personal communications network
  - Mobile ad hoc networks (MANETs)
- Cable television

1.8 Standards Activities (1/1)

- Many standards organizations exist
- One organization not mentioned in Chapter 1 is the Internet Engineering Task Force (IETF):
  - http://www.ietf.org/