Data Communications and Networking Overview

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These slides are available on-line at:
http://www.cse.wustl.edu/~jain/cse473-05/
Overview

- Data Comm vs Networking vs Distributed Systems
- Communications Tasks
- Types of Networks
- Protocol Layers
- ISO/OSI Reference Model
- TCP/IP Reference Model
Data Communication vs Networking

- Communication: Two Nodes. Mostly EE issues.

- Networking: Two or more nodes. More issues, e.g., routing
Distributed Systems vs Networks

Distributed Systems:
- Users are unaware of underlying structure.
  E.g., trn instead of `n\bone\0\trn`
- Mostly operating systems issues.
- Nodes are generally under one organization’s control.

Networks: Users specify the location of resources.
http:\www.cse.wustl.edu\~jain\`
- Nodes are autonomous.
Transmitter: encodes the information
Data Communications: Example

- Modem is used to transmit/receive digital information over analog phone system
Communications Tasks

- Transmission System Utilization (Multiplexing)
- Interfacing
- Signal generation (Coding)
- Synchronization between transmitter and receiver
- Exchange management (Connection Management)
- Error detection and correction
- Flow control
- Addressing
- Routing
- Recovery
- Message formatting
- Security
- Network Management
Types of Networks

- Point to point vs Broadcast
  - WAN
  - Bus LAN
  - Ring LAN

- Circuit switched vs packet switched
Types of Networks (Cont)

- Enterprise vs Telecom Networks
  Ethernet is the most common interface in Enterprise
  Frame relay and ATM are common in Telecom Networks

- Local Area Networks (LAN)  0-2 km, Single Ownership
  Metropolitan Area Networks (MAN) 2-50 km, 
  Wide Area Networks (WAN) 50+ km

- Telecom Networks:
  - Access: Between subscriber and the service provider
  - Metro: Covering a city
  - Core: Between cities
An Example Configuration
Problem: Philosophers in different countries speak different languages. The Telex system works only with English. **I believe there is a God!**
A Sample Protocol Architecture
## ISO/OSI Reference Model

<table>
<thead>
<tr>
<th>Layer</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Physical</td>
</tr>
<tr>
<td></td>
<td>How to transmit signal: Coding</td>
</tr>
<tr>
<td>2</td>
<td>Datalink</td>
</tr>
<tr>
<td></td>
<td>Two party communication: Ethernet</td>
</tr>
<tr>
<td>3</td>
<td>Transport</td>
</tr>
<tr>
<td></td>
<td>End-to-end communication: TCP</td>
</tr>
<tr>
<td></td>
<td>Routing, Addressing: IP</td>
</tr>
<tr>
<td></td>
<td>Establish/manage connection</td>
</tr>
<tr>
<td>4</td>
<td>Session</td>
</tr>
<tr>
<td></td>
<td>File transfer, Email, Remote Login</td>
</tr>
<tr>
<td>5</td>
<td>Presentation</td>
</tr>
<tr>
<td></td>
<td>ASCII Text, Sound</td>
</tr>
<tr>
<td>6</td>
<td>Application</td>
</tr>
</tbody>
</table>

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</tbody>
</table>
Service and Protocol Data Units

- Service Access Points (SAPs)
- Service Data Units (SDUs)
- Protocol Data Units (PDUs)
Service Data Unit (SDU)

Application
  ↓ PSDU
Presentation
  ↓ SSDU
Session
  ↓ TSDU
Transport
  ↓ NSDU
Network
  ↓ DSDU
Datalink
  ↓ PhSDU
Physical
Protocol Data Unit (PDU)
Use of a Relay

END SYSTEM

RELAY SYSTEM

END SYSTEM

1

Physical

7

Application-layer protocol

7

END SYSTEM

6

Presentation-layer protocol

6

END SYSTEM

5

Session-layer protocol

5

END SYSTEM

4

Transport-layer protocol

4

END SYSTEM

3

Network

3

END SYSTEM

2

Data Link

2

END SYSTEM

1

Physical

1

END SYSTEM

Physical media for OSI

Physical media for OSI
Service Primitives

- Indication = Interrupt

1. Request
2. Indication
3. Response
4. Confirm

Unconfirmed service: No confirmation or response
TCP/IP Reference Model

- TCP = Transport Control Protocol
- IP = Internet Protocol (Routing)

TCP/IP Ref Model  TCP/IP Protocols

<table>
<thead>
<tr>
<th>Application</th>
<th>FTP</th>
<th>Telnet</th>
<th>HTTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>TCP</td>
<td>UDP</td>
<td></td>
</tr>
<tr>
<td>Internetwork</td>
<td></td>
<td>IP</td>
<td></td>
</tr>
<tr>
<td>Host to Network</td>
<td>Ether</td>
<td>Point-to-Point</td>
<td>Packet Radio</td>
</tr>
<tr>
<td>Physical</td>
<td>Coax</td>
<td>Fiber</td>
<td>Wireless</td>
</tr>
</tbody>
</table>
## OSI vs TCP/IP

<table>
<thead>
<tr>
<th>OSI</th>
<th>TCP/IP</th>
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</thead>
<tbody>
<tr>
<td>Application</td>
<td>Application</td>
</tr>
<tr>
<td>Presentation</td>
<td></td>
</tr>
<tr>
<td>Session</td>
<td>Transport (host-to-host)</td>
</tr>
<tr>
<td>Transport</td>
<td>Internet</td>
</tr>
<tr>
<td>Network</td>
<td>Network Access</td>
</tr>
<tr>
<td>Data Link</td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td>Physical</td>
</tr>
</tbody>
</table>
OSI vs TCP Reference Models

- OSI introduced concept of services, interface, protocols. These were force-fitted to TCP later
  ⇒ It is not easy to replace protocols in TCP.
- In OSI, reference model was done before protocols. In TCP, protocols were done before the model
- OSI: Standardize first, build later
  TCP: Build first, standardize later
- OSI took too long to standardize.
  TCP/IP was already in wide use by the time.
- OSI became too complex.
- TCP/IP is not general. Ad hoc.
TCP/IP Concepts

- Network Attachment Point (NAP)
PDUs in TCP/IP Architecture

User data

Application byte stream

TCP segment

IP datagram

TCP header

IP header

Network-level packet

Sub-Network header

Sub-Network level packet

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Communication, Networks, and Distributed systems
ISO/OSI’s 7-layer reference model
TCP/IP has a 5-layer model
PDU, SDU, SAP
Request, Indication, Response, Confirmation
Reading Assignment

- Read Chapters 0, 1, and 2 of Stallings 7th Edition
  Appendix 2A can be skipped at this time
- 0.2 Internet and Web Resources
- 0.3 Standards
- Visit some of the web sites mentioned in 0.2 and 0.3
Homework

- Visit www.ietf.org and find the titles of RFC 1 and RFC 780
- Submit answers to Problems 2.2 and 2.7 of Stallings 7th Edition
  - Problem 2.2: Communications between France and China
  - Problem 2.7: Segmentation and Blocking