Chapter 1: Introduction

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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 \
bone\0\trn
  - Mostly operating systems issues.
  - Nodes are generally under one organization’s control.

- Networks: Users specify the location of resources.
  http:\www.cis.ohio-state.edu\~jain
  - Nodes are autonomous.

Types of Networks

- Point to point vs Broadcast

- Circuit switched vs packet switched

- Local Area Networks (LAN) 0-2 km, Metropolitan Area Networks (MAN) 2-50 km, Wide Area Networks (WAN) 50+ km
**Protocol Layers**

- Problem: Philosophers in different countries speak different languages. The Telex system works only with English.

  ![Image](image_url)

  I believe there is a God!

**Design Issues for Layers**

- Duplexity:
  - Simplex: Transmit or receive
  - Full Duplex: Transmit and receive simultaneously
  - Half-Duplex: Transmit and receive alternately

- Error Control: Error detection and retransmission
- Flow Control: Fast sender
### ISO/OSI Reference Model

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

- Protocols of each layer have to perform a set of functions
- All alternatives for a row have the same interfaces
- Choice of protocols at each layer is independent of those of at other layers. E.g., TCP works over IP or IPX (Novell’s IP)
- UDP = User Data Protocol
- Need one component of each layer ⇒ Null components
- Nth layer control info is passed as N-1th layer data.
**Interfaces and Services**

- IDU = Interface Data Unit = ICI + SDU
- ICI = Interface Control Information
- SDU = Service Data Unit
- PDU = Protocol Data Unit = Fragments of SDU + Header or Several SDUs + Header (blocking)

**Protocol Data Unit (PDU)**

- Application
- Presentation
- Session
- Transport
- Network
- Datalink
- Physical

<table>
<thead>
<tr>
<th>Application</th>
<th>APDU, Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation</td>
<td>PPDU</td>
</tr>
<tr>
<td>Session</td>
<td>SPDU</td>
</tr>
<tr>
<td>Transport</td>
<td>TPDU</td>
</tr>
<tr>
<td>Network</td>
<td>NPDU, Packet</td>
</tr>
<tr>
<td>Datalink</td>
<td>DPDU</td>
</tr>
<tr>
<td>Physical</td>
<td>PhPDU, Frame</td>
</tr>
</tbody>
</table>

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IB-9

IB-10
**Service Data Unit (SDU)**

- Application
  - PSDU
- Presentation
  - SSDU
- Session
  - TSDU
- Transport
  - NSDU
- Network
  - DSDU
- Datalink
  - PhSDU
- Physical

**Connection-Oriented vs Connectionless**

- Connection-Oriented: Telephone System
  - Path setup before data is sent
  - Data need not have address. Circuit number is sufficient.
  - Virtual circuits: Multiple circuits on one wire.
- Connectionless: Postal System. Also known as datagram.
  - Complete address on each packet
  - The address decides the next hop at each routing point
### Types of Services

- **Connection-oriented**
  - Reliable
  - Message

- **Datagram**
  - Unreliable
  - Byte Stream

- **Request-reply**
  - Acknowledged

- **Byte streams**: user message boundaries are not preserved
- **Request-reply**: The reply serves as an acknowledgement also

### Service Primitives

- **Indication** = Interrupt

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

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

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

<table>
<thead>
<tr>
<th>Application</th>
<th>FTP</th>
<th>Telnet</th>
<th>HTTP</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td></td>
<td></td>
<td></td>
<td>Presentation</td>
</tr>
<tr>
<td>Internetwork</td>
<td></td>
<td></td>
<td></td>
<td>Session</td>
</tr>
<tr>
<td>Host to Network</td>
<td></td>
<td></td>
<td></td>
<td>Transport</td>
</tr>
<tr>
<td></td>
<td>IP</td>
<td></td>
<td></td>
<td>Network</td>
</tr>
<tr>
<td></td>
<td>Ethernet</td>
<td>Packet Radio</td>
<td>Point-to-Point</td>
<td></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 become too complex.
- TCP/IP is not general. Ad hoc.
Summary

- Networking is growing exponentially
- Communication, Networks, and Distributed systems
- ISO/OSI’s 7-layer reference model
- TCP/IP has a 4-layer model
- PDU, SAP, Request, Indication

Reading Assignment

- Read Chapter 1 of Tanenbaum, particularly, Sections 1.2-1.4
- Homework: Problems 9, 17