SWE 545
Distributed Systems Programming

Introduction

Course Outline

- Network layer
- Transport layer
- Network programming
- RPC Programming
- Client-Server Systems, Socket Programming
- Inter-Process Communication, Pipes
- I/O multiplexing
- Daemons and Inetd
- Application layer
- Network security

Course Materials

- **Textbook**: None
- **Reference books**:

Grading

- Midterm (20%)
- Final (50%)
- Projects (30%)
Introduction to Computer Networks

• Network: Collection of devices (computers, printers, etc.) that are able to communicate with each other.
• internet: Collection of more than one networks.
• Internet: You know …

Introduction (cont’d)

• Protocol: Set of rules that define what is communicated when and how.
• Protocols are defined by standards:
  – De facto
  – De jure
• Standard bodies, forums, and agencies:
  • ISO, ITU-T (formerly CCITT), ANSI, IEEE, EIA, Frame Relay Forum, ATM Forum, FCC.

Internet Hierarchy

OSI Model
**OSI Model (cont’d)**

- Layered architecture
- Peer processes
- Interfaces between layers (use of primitives)

(1) **Physical Layer**: Transmits bit streams over a physical medium. [representation of bits; synchronization; transmission mode (simplex, half-duplex, full-duplex); etc.]

(2) **Data Link Layer**: Provides link connectivity. [framing; physical addressing; flow, error, and access control]. MAC is a sublayer of data link layer.

(3) **Network Layer**: Provides network connectivity, i.e., delivery of packets from source to destination. Each packet is handled independently (no flow concept). [logical addressing; routing]

---

**OSI Model (cont’d)**

(4) **Transport Layer**: Provides connectivity between processes. [segmentation and reassembly; connection, flow, and error control]
   - Connectionless
   - Connection-oriented

---

**SAR in Transport Layer**
OSI Model (cont’d)

(5) Session Layer: Provides dialog control and synchronization.
(6) Presentation Layer: Provides syntax and semantics interoperability. [encoding translation; encryption; compression]
(7) Application Layer: Provides network virtual terminal, file transfer, mail, and directory services.
  • Actually, the last three layers are very thin or non-existent.

Data exchange in OSI Model

Hop-to-Hop Delivery

End-to-End Delivery
Connecting Multiple Networks

- Network
- Data link
- Physical

<table>
<thead>
<tr>
<th>Router (three-layer switch)</th>
<th>Bridge (two-layer switch)</th>
<th>Repeater (hub)</th>
</tr>
</thead>
</table>

| Network
| Data link
| Physical

Repeater

- Physical layer.
- Connects two segments of a LAN.
- Regenerates the signal in one segment and transmits to the other.

Hub

- Physical layer
- Multiport repeater
- Implements star topology.
- Hub relieves the length limitation.

Bridge

- Two layers.
- Has filtering capability.
- Most bridges today are transparent ⇒ They learn the physical (MAC) addresses of the stations connected directly.
Physical, data link, and network layers.
Provides LAN/LAN, LAN/WAN, WAN/WAN connectivity. (Repeaters, hubs, and bridges connect the segments of the same LAN.)

- For each interface, there is one physical (MAC) and one logical (IP) address.
- If the arriving packet at an interface is NOT destined to that interface, the router ignores the packet.
- The router changes both the source and destination physical addresses in the packet.

Switch
- Two-layer switch:
  - Unique interface for each terminal $\Rightarrow$ no competing traffic.
  - A better design for bridge.
- Three-layer switch:
  - Same as a router in functionality; just better in performance.
  - A better design for router.