Local Area Network (LAN)

- In 1980s, affordable computers become available
- Need for low-cost, high-speed networks
  - to interconnect local computers
  - to access locally shared resources (e.g., printers, storage, servers)

- Networks with limited distances (< 1 km) are called LANs
  - Short distance $\rightarrow$ high-speed communication with low error rate over cheap coaxial cable becomes possible
  - Messages are broadcasted to all machines in the LAN
    - Network Interface Card (NIC) of each machine has a globally unique address
    - A Medium Access Control (MAC) protocol becomes essential to coordinate access to the transmission medium
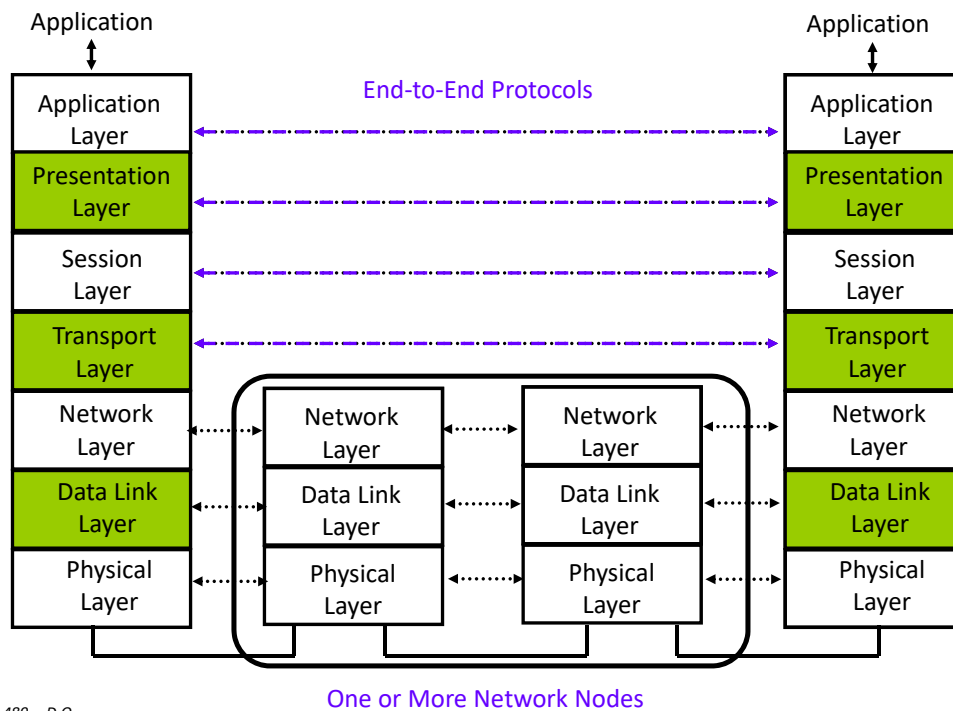
Various LAN Topologies
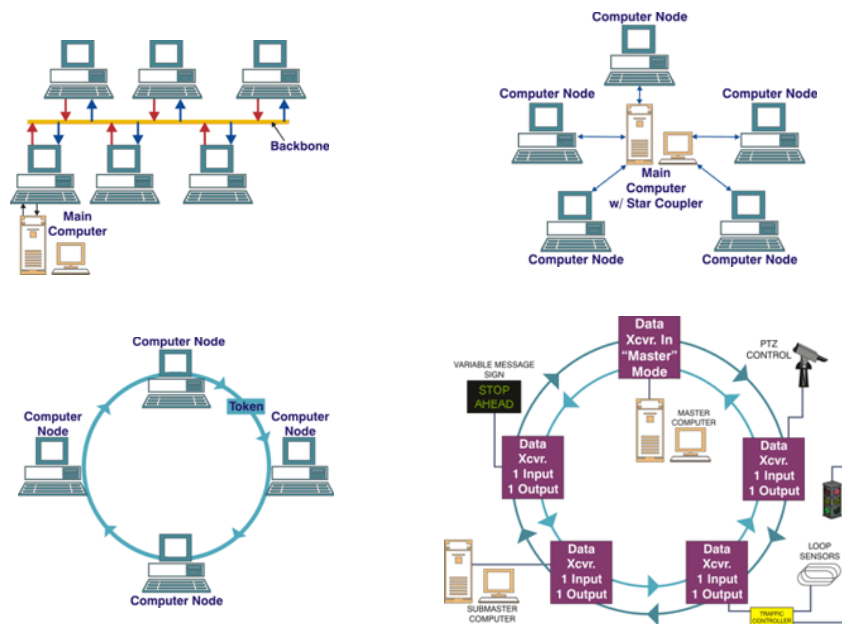
The OSI Reference Model

✛ OSI (Open System Interconnection) Model
- ➡ developed by ISO (International Organization of Standardization)
- ➡ describes a 7-layer abstract reference model for a network architecture
- ➡ provides a common framework for the development of standard protocols

7-Layer OSI Reference Model

Physical Layer (Layer 1)

- Transfers bits across a communication link
  - Twisted-pair cable, coaxial cable, optical fiber
  - Radio, infrared, …

- Definition and specification of the physical aspects of a communication link
  - Mechanical: cable, plugs, pins...
  - Electrical/optical: modulation, signal strength, voltage levels, …
 - Functional/procedural: how to activate, maintain, and deactivate physical links, …

Data Link Layer (Layer 2)

- Transfers frames across direct connections
- Framing: groups bits into frames
- Detection of bit errors; retransmission of frames
- Flow Control
- Medium Access Control for LANs (Local Area Networks)

Data Link Layer	frames	Data Link Layer
Physical Layer	bits	Physical Layer
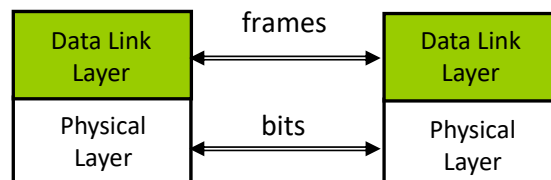
Network Layer (Layer 3)

✚ Transfers packets across multiple links and/or multiple networks

✚ Addressing must scale to large networks

✚ Nodes jointly execute routing algorithm to determine paths across the network

✚ Best-effort connectionless service (no guarantee)

R = Router
H = Host
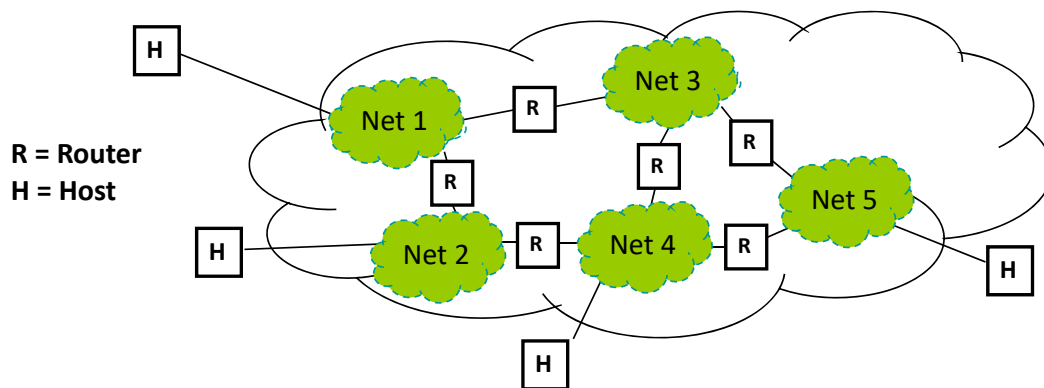
Transport Layer (Layer 4)

✚ Transfers segments from process in one machine to process in another machine (end-to-end transfer)

✚ Reliable stream transfer or quick-and-simple single-block transfer

✚ Port numbers enable multiplexing

✚ Connection setup, maintenance, and release

✚ Congestion control, flow control

Communication Network
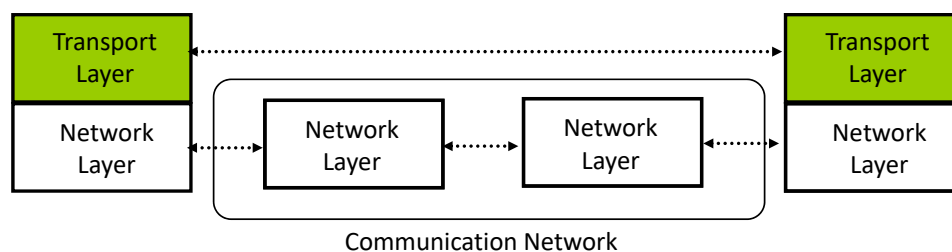
Upper Layers (Layers 5, 6, 7)

- Application Layer: provides services that are frequently required by applications --- DNS, web access, file transfer, email, …

- Presentation Layer: machine-independent representation of data, …

- Session Layer: dialog management, recovery from errors, …

Been incorporated into
Application Layer

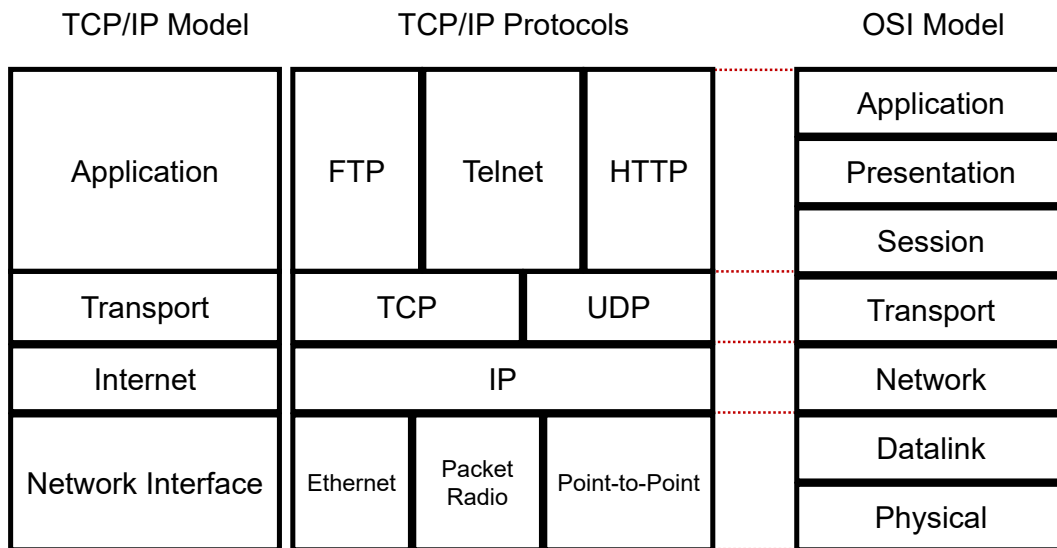Application

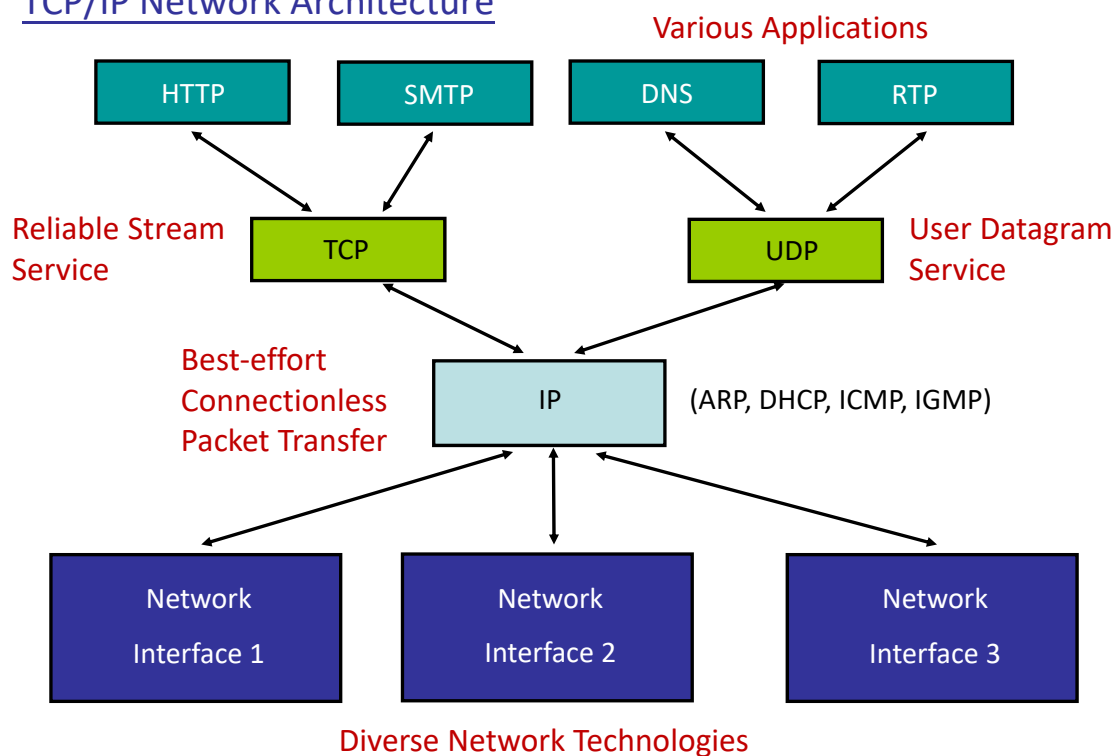| Application Layer |
| Transport Layer |
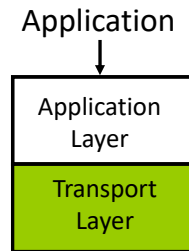
Headers & Trailers

- Each protocol uses a header that carries control information such as addresses, sequence numbers, flag bits, length indicators, etc.
- CRC check bits are appended at Data Link Layer for error detection

TCP/IP Network Architecture

TCP/IP Model	TCP/IP Protocols				OSI Model
	FTP	Telnet	HTTP		Application
Application					Presentation
					Session
Transport	TCP		UDP		Transport
Internet	IP				Network
Network Interface	Ethernet	Packet Radio	Point-to-Point		Datalink
					Physical

TCP/IP Network Architecture

Various Applications

HTTP   SMTP   DNS   RTP

Reliable Stream Service   TCP   UDP   **User Datagram Service**

Best-effort Connectionless Packet Transfer   IP   (ARP, DHCP, ICMP, IGMP)

Network Interface 1   Network Interface 2   Network Interface 3

Diverse Network Technologies

Features of the Internet

- It is a digital transmission system
  - Information is converted to symbols (zeros and ones)
  - Transmission system is designed to convey symbols

- It is a packet-switching network
  - Transfer mode: packet switching

- It is a global network of networks
  - WAN (Wide Area Network)
  - LAN (Local Area Network)

- It has a layered network architecture
  - OSI reference model
  - TCP/IP architecture