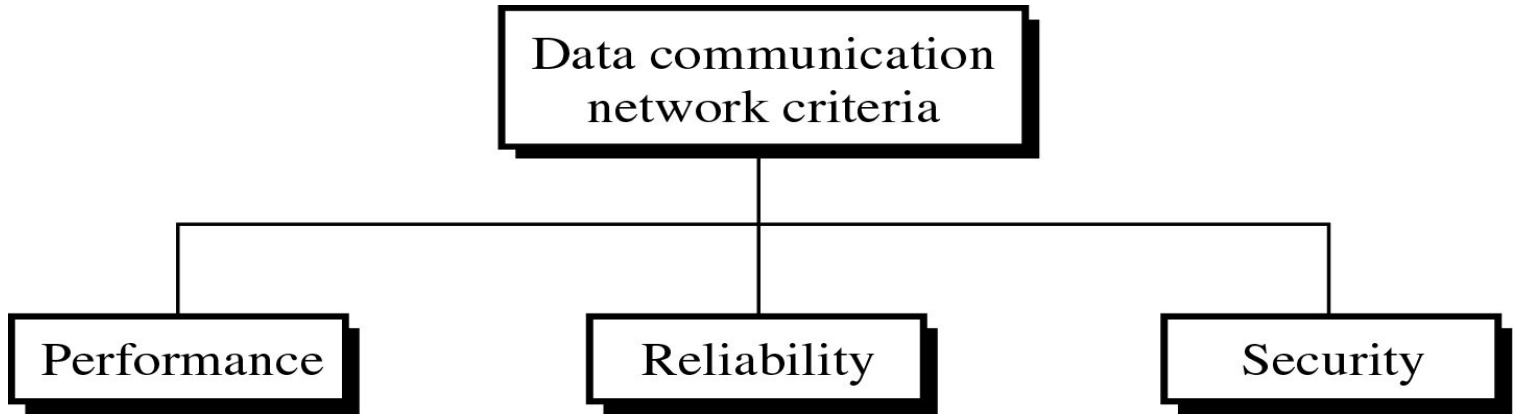
COMPUTER NETWORKS

An Introduction

Network

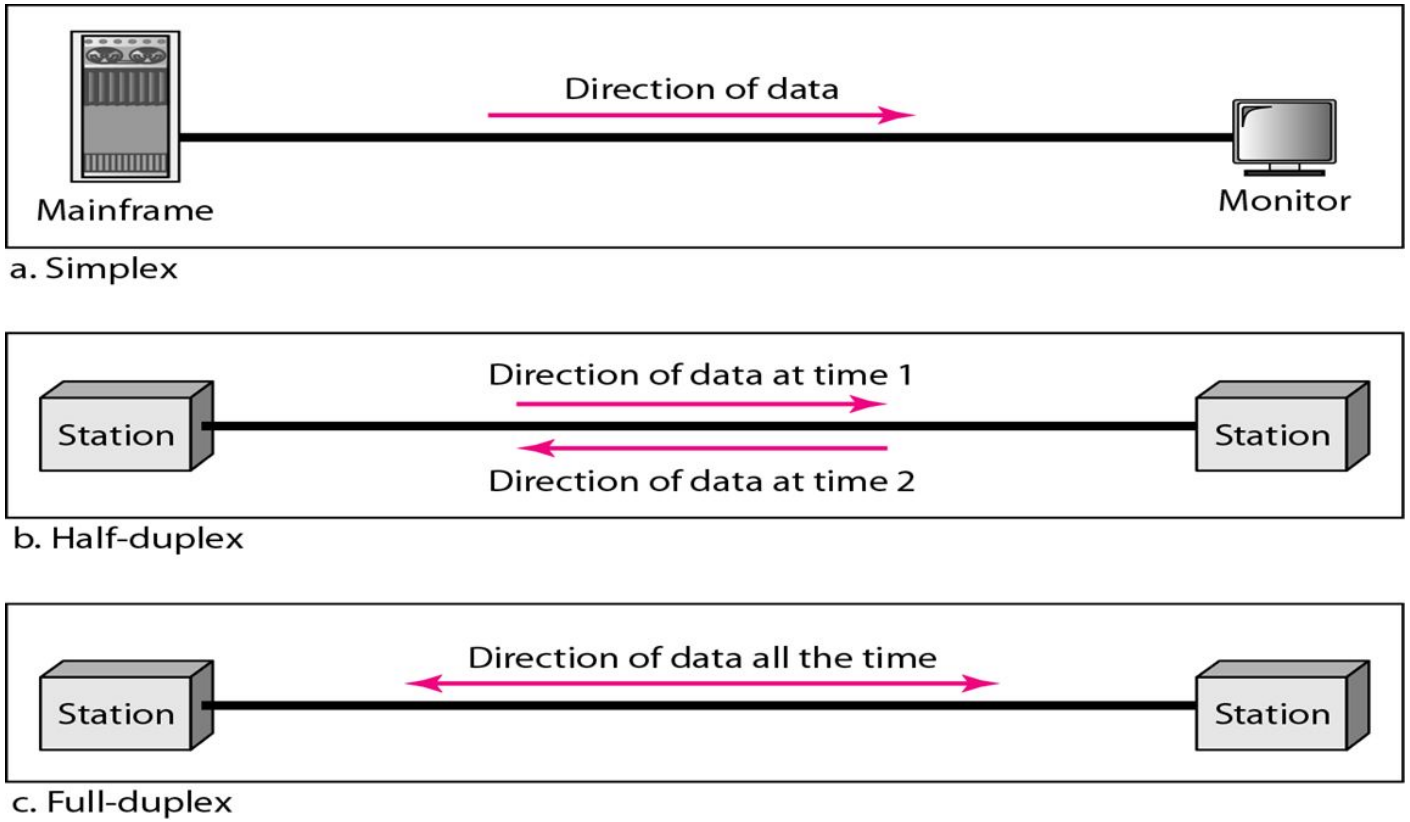
- **Network:** A set of devices (nodes) connected by communication links.
- **Node:** Computer, printer, or any device capable of sending and/or receiving data
- To be considered effective and efficient, a network must meet a number of criteria



Network Components

- Physical Media
- Interconnecting Devices
- Computers
- Networking Software
- Applications

Direction of Data Flow



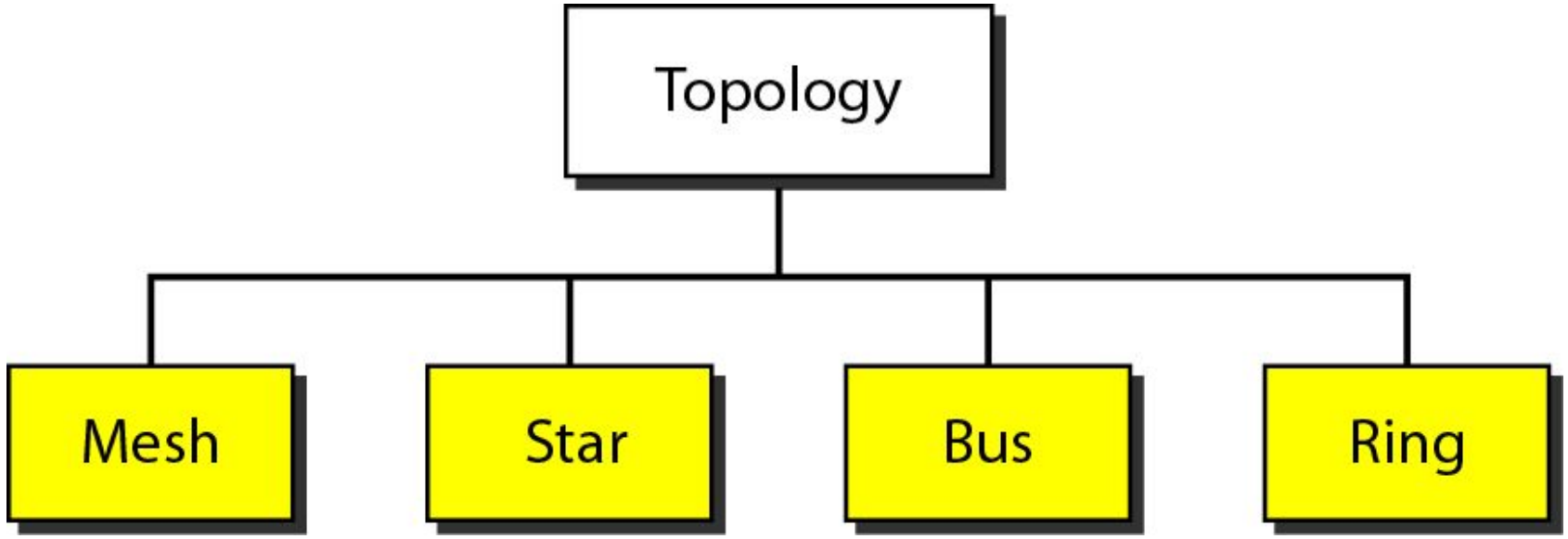
Data Flow

- **Simplex**
  - Unidirectional
  - As on a one-way street
- **Half-duplex**
  - Both transmit and receive possible, but not at the same time
  - Like a one-lane road with two-directional traffic
  - Walkie-talkie, CB radio
- **Full-duplex**
  - Transmit and receive simultaneously
  - Like a two-way street, telephone network
  - Channel capacity must be divided between two directions

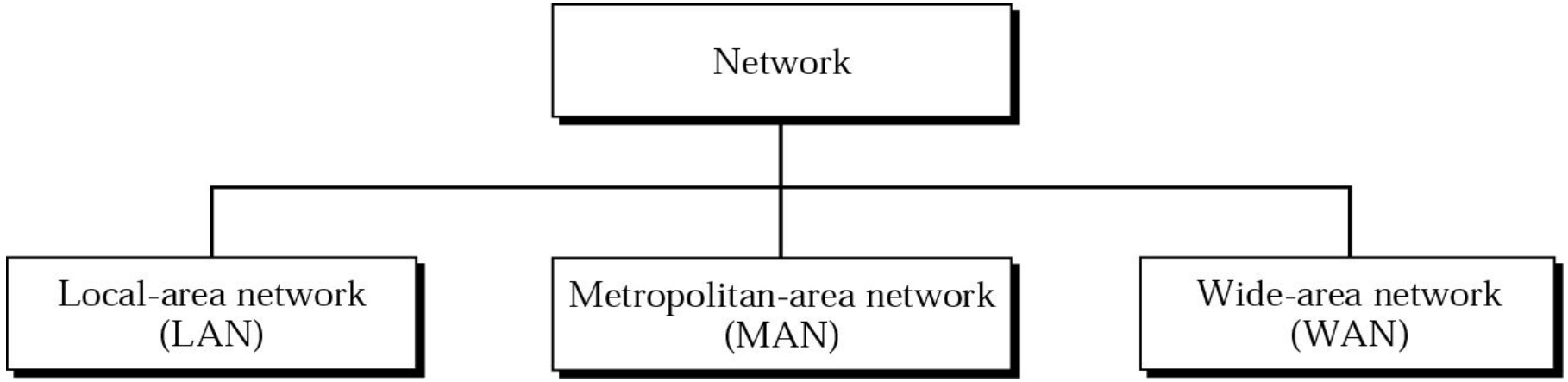
Type of Connection

- **Point-to-point**
  - Dedicated link between two devices
  - The entire capacity of the channel is reserved
  - Ex) Microwave link, TV remote control
- **Multipoint**
  - More than two devices share a single link
  - Capacity of the channel is either
    - *Spatially shared*: Devices can use the link simultaneously
    - *Timeshare*: Users take turns

Physical Topology

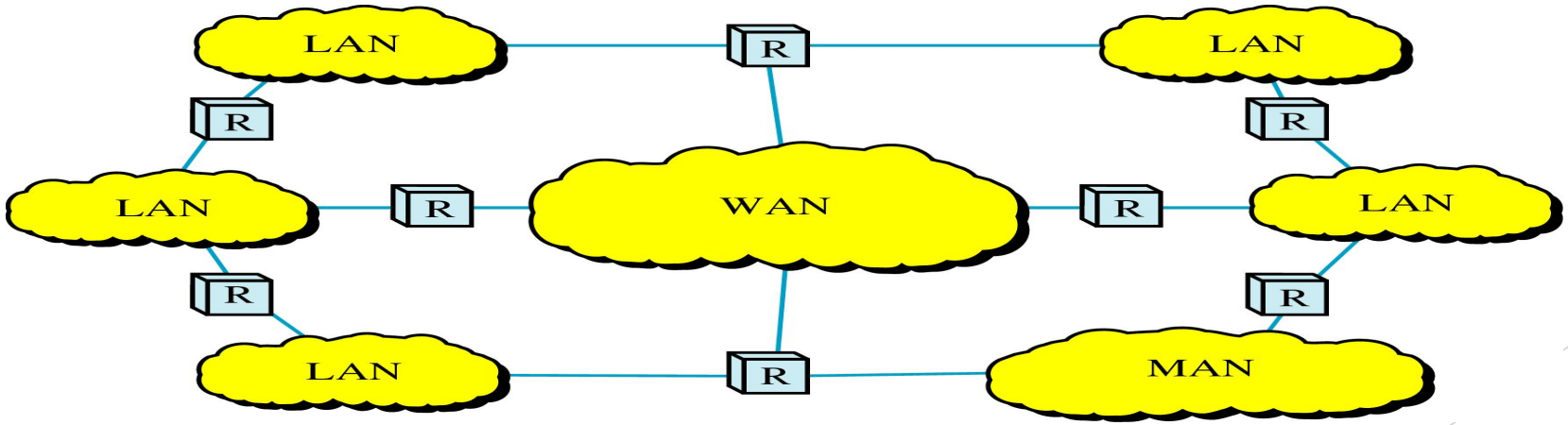


Categories of Networks



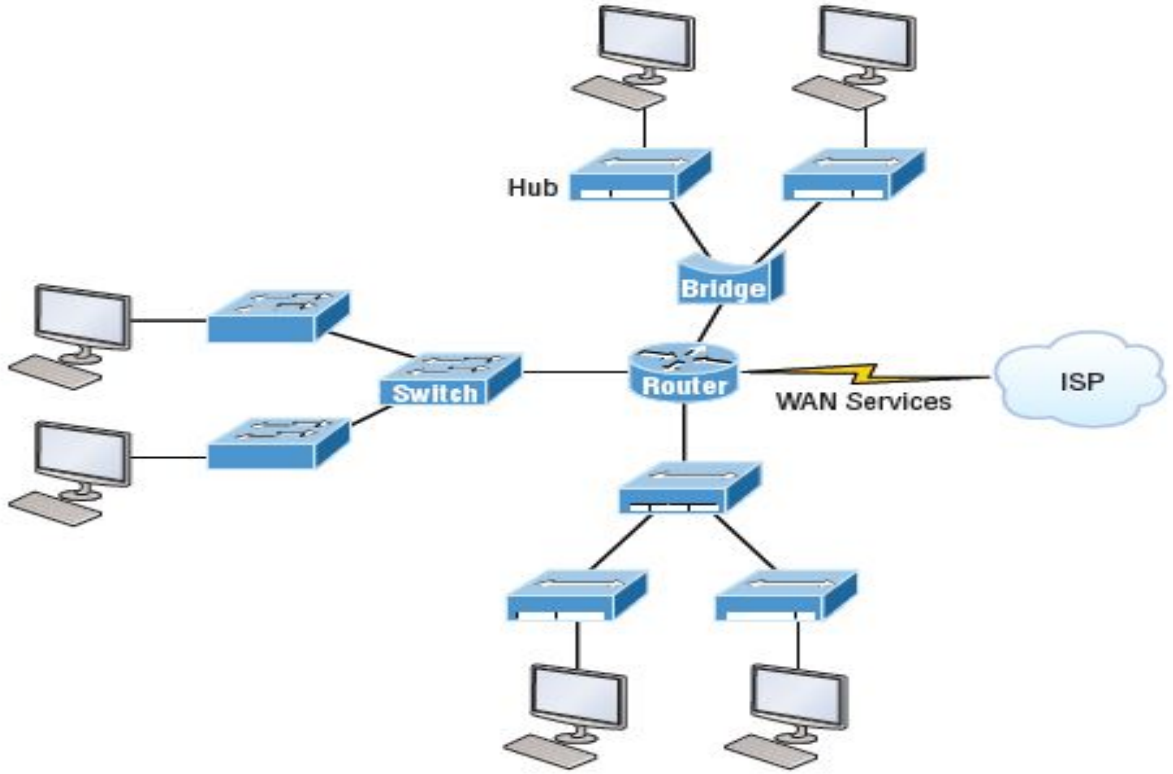
Internetwork

- **Internetwork** is a collection of a individual networks, connected by intermediate devices, that function as a single network.
- Internetwork (internet) : two or more networks are connected by internetworking devices
- Internetworking devices: router, gateway, etc.
- The Internet: a specific worldwide network



Internetworking devices

FIGURE 1.4 Internetworking devices



Protocols

- Protocol : rule
  - A set of rules that govern data communication
  - For communication to occur, entities must agree upon a protocol
- Key elements of a protocol
  - Syntax: structure or format of data
  - Semantics: meaning of each section in the structure
  - Timing: *when* and *how fast* data should be sent

Transmission Types

- Unicast
- Multicast
- Broadcast

Internet Standards

- IETF (Internet Engineering Task Force)
- Internet Draft
  - working document with no official status
  - with a 6-month lifetime
- RFC (Request for Comment)
  - Edited, assigned a number, and made available to all interested parties

Open Systems

- Proprietary system: A system that uses technologies kept private by a particular commercial vendor

  One system couldn't communicate with another, leading to the need for

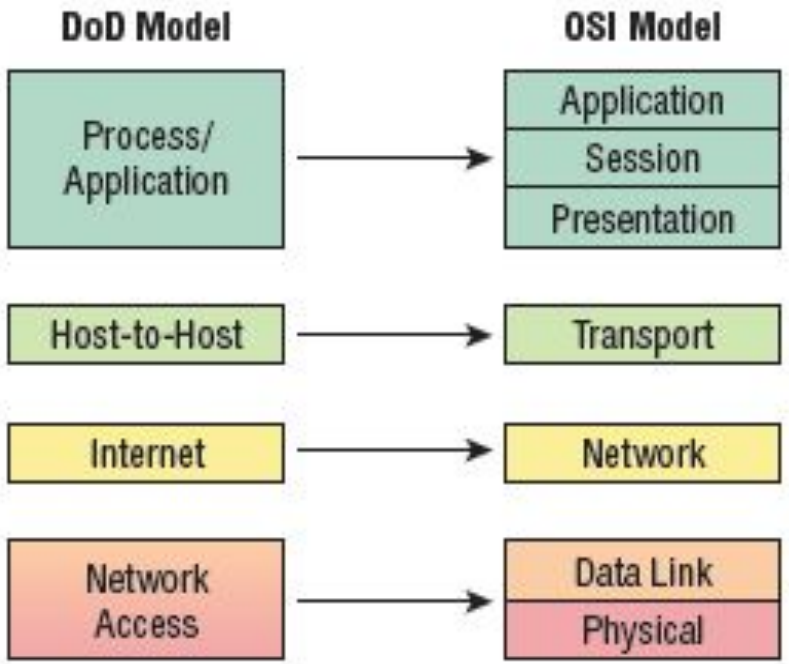
- Interoperability: The ability of software and hardware on multiple machines and from multiple commercial vendors to communicate

  Leading to

- Open systems: Systems based on a common model of network architecture and a suite of protocols used in its implementation

The DOD Model and OSI Model

FIGURE 3.1 The DoD and OSI models



OSI Model

- 7 Layers

1. **Physical Layer** - defines the relationship between a device and a physical medium. This includes layout of pins, voltages, cable specifications, and more
2. **Data Link Layer** - provides the functional and procedural means to transfer data between network entities and to detect and possibly correct errors
3. **Network Layer** – determine logical path for transferring data sequences from a source to a destination via one or more networks

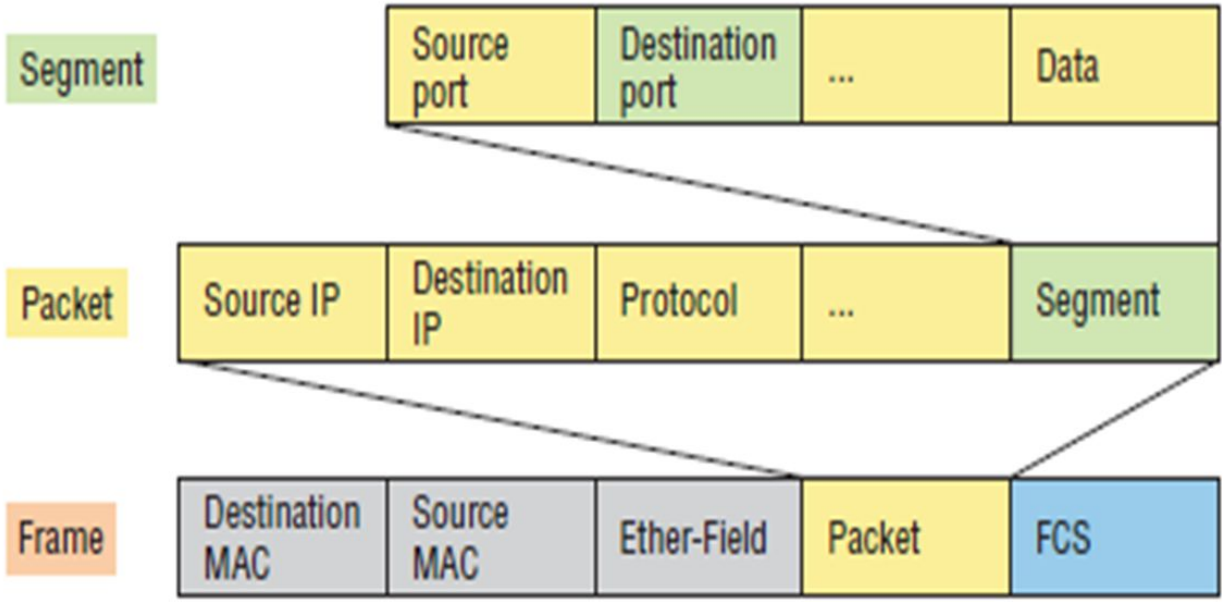
4. **Transport Layer -** The Transport Layer controls the reliability of a given link through flow control, segmentation/desegmentation, and error control
5. **Session Layer -** controls the connections between computers. It establishes, manages and terminates the connections between the local and remote application
6. **Presentation Layer -** provides independence from differences in data representation (e.g., encryption) by translating from application to network format, and vice versa
7. **Application Layer** - interacts with software applications that implement a communicating component

- Protocol Suite

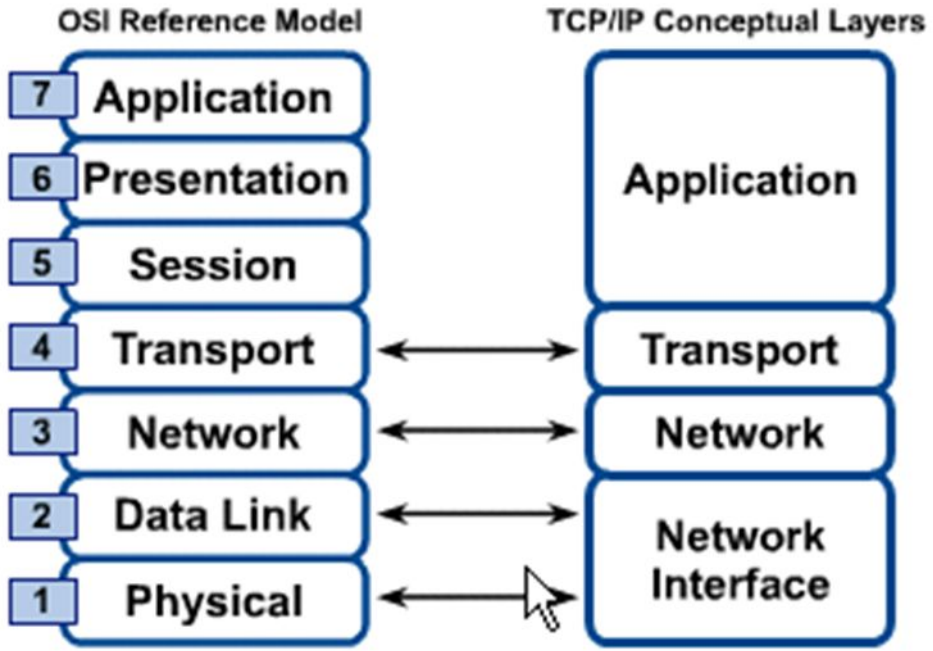
  TCP,UDP
- Windowing
- Flow Control
- Data Encapsulation

Data Encapsulation

FIGURE 2.22 PDU and layer addressing



OSI & TCP/IP Models



Network Core

- Packet Switching
- Circuit Switching

Delay & Loss

- Processing delay
- Queuing delay
- Transmission delay
- Propagation delay

$$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$$

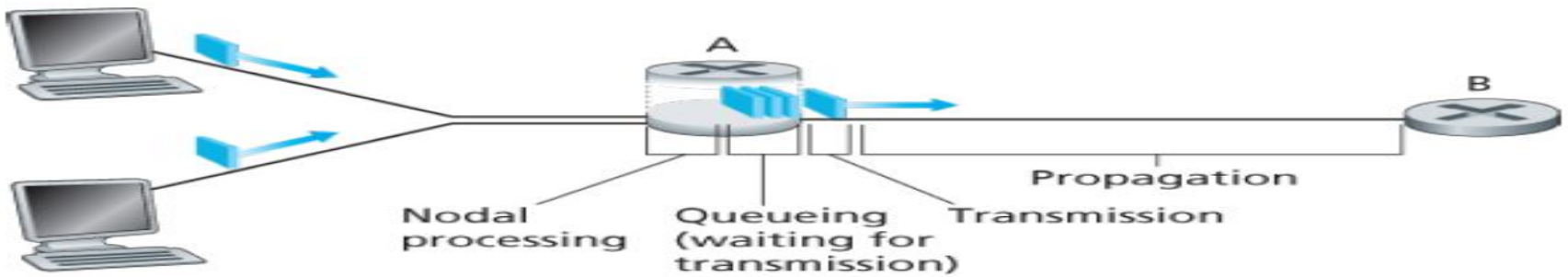


Figure 1.16 The nodal delay at router A

Delay & Loss

- Packet loss
- End-to-End Delay

$$d_{end-end} = N(d_{proc} + d_{trans} + d_{prop})$$

Physical Media

- Twisted pair copper wire
- Coaxial Cable
- Fiber Optics
- Terrestrial Radio Channels
- Satellite Radio Channels

Internet

- It is a worldwide system of computer networks - a network of networks in which users at any one computer can, if they have permission, get information from any other computer (and sometimes talk directly to users at other computers).
  - Global system of interconnected computer networks that use the standard Internet Protocol Suite (TCP/IP) to serve billions of users worldwide.
  - It consists of millions of private and public, academic, business, and government networks of local to global scope that are linked by a broad array of electronic and optical networking technologies.

Internet

- Internet carries vast information resources and services,
  - most notably the inter-linked hypertext documents of the World Wide Web (WWW)
  - and the infrastructure to support electronic mail
- Inter net services, you can get,
  - VoIP and IPTV,
  - Newspaper publishing Web sites,
  - blogging, Internet forums, and SNS,
  - file sharing, e-commerce,
  - research, download books or software,
  - E-mail, Video Conferencing,
  - Chat Groups, Instant Messengers
  - Internet Radio
  - and many more

Intranet & Extranet

- ***Intranet:*** An intranet is a private network that is contained within an enterprise.
  - It may consist of many interlinked local area networks and also use leased lines in the wide area network.
  - An intranet uses TCP/IP, HTTP, and other Internet protocols and in general looks like a private version of the Internet.
  - With tunneling, companies can send private messages through the public network, using the public network with special encryption/decryption and other security safeguards to connect one part of their intranet to another.
- **Extranet** - internetwork that is limited in scope to a single organization and also has limited connections to the networks of one or more other trusted organizations