DATA COMMUNICATIONS AND COMPUTER NETWORKS

Network basics

Unit objectives

- Describe the basic components of a network
- Identify characteristics of network technologies
- Analyze the OSI model

DATA COMMUNICATIONS AND COMPUTER NETWORKS

- Topic A: Network concepts
- Topic B: Network architectures
- Topic C: The OSI model

DATA COMMUNICATIONS AND COMPUTER NETWORKS

- Some of the common terminologies that are used in computer networking are:
  - Networks
  - Server
  - Client
  - Peers
  - Host computers
  - Terminals
  - Networking Standards
  - Standards organizations

DATA COMMUNICATIONS AND COMPUTER NETWORKS

- A ***computer network*** is a group of computers that are connected together to communicate and share resources such as files, printers, and email.

DATA COMMUNICATIONS AND COMPUTER NETWORKS

- A ***server*** is a network computer that shares resources with and responds to requests form other network computers, including other servers.

DATA COMMUNICATIONS AND COMPUTER NETWORKS

- A ***client*** is a network computer that utilizes the resources of other network computers including other clients.

❑ A ***peer*** is a self-sufficient computer that acts as both a server and a client to other similar computers on the network.

DATA COMMUNICATIONS AND COMPUTER NETWORKS

❑ A ***host computer*** is a powerful, centralized computer system, such as a mainframe computer, that performs data storage and processing tasks on behalf of clients and other network devices.

DATA COMMUNICATIONS AND COMPUTER NETWORKS

❑ A ***terminal*** is a specialized network device on a host-based network that transmits the data entered by the user to host for processing and displays the results.

DATA COMMUNICATIONS AND COMPUTER NETWORKS

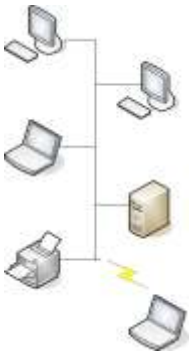
❑ The building blocks that are used to construct network are:

- Nodes
- The Network backbone
- Segments
- Subnets

DATA COMMUNICATIONS AND COMPUTER NETWORKS

Local area networks

- Located within a confined area
- Connected by wires or radio waves
- Node – any network device
- Host – always a computer
- Can be connected to the Internet
- Requires host OS



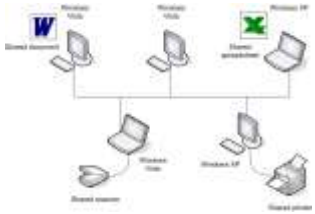
DATA COMMUNICATIONS AND COMPUTER NETWORKS

Basic network types

- Peer-to-peer
  - Simple file and resource sharing
  - Home or small office
  - Less than a dozen hosts
  - Decentralized network
- Client/server
  - Servers hold data and provide resources
  - Clients remotely access data and resources
  - Large scale
  - Centralized network

Peer-to-peer model

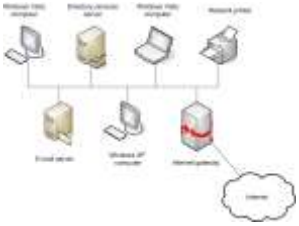
- All hosts have equal authority
- Each host controls own resources
- Individual user responsibility
- Hosts can have different OSes
- Wired or wireless connections



Peer-to-peer authentication

- Valid user credentials for computer use
- User name and password – authentication, validation, logging on
- User account exists on single computer
- Can create additional user accounts
- User account includes
  - User name
  - Password
  - Permissions
- Can share local resources with other users

Client/server model



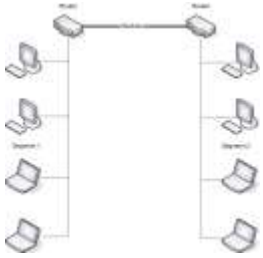
- Network operating system on server
- Servers manages resources
- User accounts exist on directory server
- Requires trained administrator
- Also called domain model

Client/server authentication

- Client OS sends login information to directory server
- Directory server responsible for user authentication
- Login process – client communicates with NOS on server
- Novell NOS requires special client component for Windows

Segments and backbones

- Break down large networks
- Delineated by network transmission device
- Benefits
  - Extend cable length
  - Improve performance
  - Increase security
- Backbone is high-speed link
- Direct data



Network wiring

- Pathway to connect network nodes
- Connections
  - Physical
  - Wireless
- Wiring is critical to performance
- Post-building wiring is more difficult

Fiber optic

- Carries light-based data
- Strands of glass or plastic
- No thicker than a human hair
- Fastest/most expensive
- Components
  - Core
  - Glass tube
  - Rubberized jacket
- Two types
  - Single-mode
  - Multi-mode

Twisted pair

- Unshielded (UTP) or shielded (STP)
- Features
  - Four pairs of wires
  - Each pair are twisted around each other (to cancel out EMI)
  - Pairs twisted together
  - Bundled with covering
  - Max run length = 100 meters

continued

Twisted pair, continued

- Categorized by
  - Use
  - Number of twists per foot
  - Speed
- More twists = less crosstalk and EMI
- Cat3
  - up to 10 Mbps
  - 2 to 3 twists/foot
- Cat5 and 5e
  - 100 Mbps for Cat5
  - 1 Gbps for Cat5e
  - 20 twists/foot
- Cat6
  - 2.5 Gbps
- Cat6a
  - 10 Gbps

Composite cable

- Best wiring value and expansion capability
- Combines
  - Cat5 or Cat6
  - Other transmission cables
  - Single PVC jacket
- Top-the-line, "future-proof" version
  - Cat5 or Cat6
  - RG-6
  - Fiber Optic

Coaxial

- Components
  - Core
  - Layer of plastic or rubber
  - Layer of braided wire or foil
  - Outside insulating layer
- Types
  - Ethernet RG-58
  - Low-power video and RF signal RG-59
  - Cable TV RG-6
  - Ethernet backbone RG-8 and RG-11

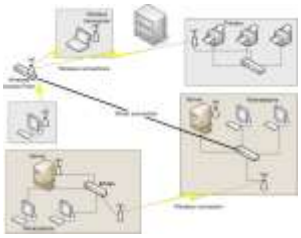
Serial

- Direct cable connection between two computers
- Null modem cable
  - Transmit and receive lines
- RS232 connectors
  - 9 pin or 25 pin

Duplex

- Single
  - Data transmitted in a single direction
- Half
  - Data transmitted in both directions, but only one direction at a time
- Full
  - Data transmitted in both directions at the same time

Wireless LAN



- Uses radio waves or infrared light
- Wireless NIC with antenna
- Convenient where physical cables aren't
- Devices communicate
  - Directly
  - With LAN through WAP

Benefits/drawbacks of WLANs

- Increased flexibility and mobility
- Supports a network where difficult to run physical cables
- Security is a problem – wireless transmissions can be intercepted

Network protocols

- Communication language between network devices
- Sends data in packets
- Common network protocols used in Windows
  - TCP/IP
  - IPX/SPX
  - AppleTalk
  - NetBEUI

Wireless network protocols

- Wi-Fi (Wireless Fidelity)
- Bluetooth
- 802.11a
- WiMAX (IEEE 802.16 Air Interface Standard)

- Topic A: Network concepts
- Topic B: Network topologies
- Topic C: The OSI model

Network architecture

- Design of wiring or radio wave connections
- Configuration of other physical components
- Software
- Protocols
- Common types
  - Ethernet
  - Token Ring
  - Wireless

❑ A ***network topology*** is a network specification that determines the network's overall layout and the network's data flow patterns.

❑ The primary network topologies are:

- Physical Bus Topology
- Physical Star Topology
- Physical Ring Topology
- Physical Mesh Topology
- Hybrid Topology
- Logical Bus Topology
- Logical Ring Topology
- Logical Star Topology

Physical bus topology

❑ A ***physical bus topology*** is a physical topology in which network nodes are arranged in a linear format, with each node connected directly to the network cable with a T-connector or tap.

Physical star topology

❑ A ***physical star topology*** is a network topology that uses a central connectivity device, such as a hub, with separate connections to each node.

Physical ring topology

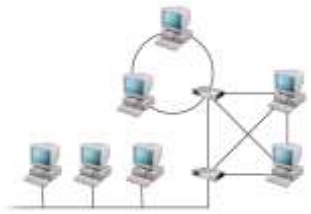
❑ A ***physical ring topology*** is a network topology in which all network nodes are connected in a continuous circle.

Physical mesh topology

❑ A ***physical mesh topology*** is a network topology in which each node has a direct connection to every other node.

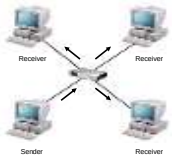
Hybrid topology

- A ***hybrid topology*** is any topology that exhibits characteristics of more than one standard physical topology.



Logical bus topology

- A ***logical bus topology*** is a network topology in which all nodes see the network signal at the same time, regardless of the physical wiring layout of the network.

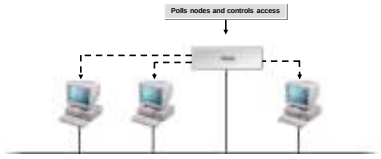


Logical ring topology

- A ***logical ring topology*** is a network topology in which each node receives data only from its upstream neighbor and retransmits it only to its downstream neighbor, regardless of the physical layout of the network.

Logical star topology

- A ***logical star topology*** is a network topology in which all the nodes might be wired onto the same bus cable, but a central device polls each node to see if it needs to transmit data.



Packet versus circuit switching

- Packet switching
  - Data is broken up into packets
  - Packets can be sent along different routes
  - Packets are queued at destination
  - Original data is reassembled from packets in queue
- Circuit switching
  - Dedicated line allocated for data transmission between two nodes
  - Quick transmission
  - Need for data arrival order

Ethernet

- 10 Gigabit Ethernet (10GbE)
  - Fastest of the Ethernet standards
  - Data rate of 10 gigabits per second
- 1000-Mbps Ethernet (Gigabit Ethernet)
  - Data rate of 1000 Mbps (1 gigabit per second)
  - Used for large, high-speed LANs and heavy-traffic server connections
- 100-Mbps Ethernet (Fast Ethernet)
  - Data rate of 100 Mbps
  - Can handle data at 10 Mbps for device compatibility
- 10-Mbps Ethernet (Twisted Pair Ethernet)
  - Data rate of 10 Mbps
  - Ethernet IEEE 802.3

DATA COMMUNICATIONS AND COMPUTER NETWORKS

Ethernet mediums

- BASE-X and BASE-R — fiber optic cable
- BASE-W — Wide Area Network Physical Layer (WAN PHY)
  - Fiber optic cables
  - Same types of fiber and support the same distances as 10GBASE-R
  - Ethernet frames encapsulated in SONET frames
- BASE-T — STP or UTP
- BASE-CX standards — Shielded copper twisted pair

DATA COMMUNICATIONS AND COMPUTER NETWORKS

Ethernet standards

- 10 Gigabit Ethernet
  - 10GBASE-T
  - 10GBASE-SR
    10GBASE-SW
  - 10GBASE-LR
    10GBASE-LW
  - 10GBASE-ER
    10GBASE-EW
  - 10GBASE-ZR
    10GBASE-ZW
- Gigabit Ethernet
  - 1000BASE-T
  - 1000BASE-CX
  - 1000BASE-LX
  - 1000BASE-LX10
  - 1000BASE-BX10
  - 1000BASE-LH
  - 1000BASE-ZX
  - 1000BASE-SX

DATA COMMUNICATIONS AND COMPUTER NETWORKS

Ethernet standards, continued

- Fast Ethernet
  - 100BASE-TX
  - 100BASE-T4
  - 100BASE-T2
  - 100BASE-FX
  - 100BASE-SX
  - 100BASE-BX

DATA COMMUNICATIONS AND COMPUTER NETWORKS

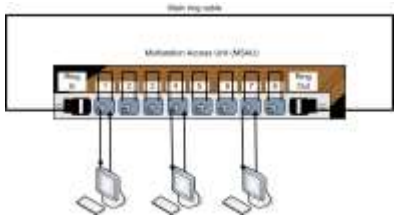
Channel access methods

- Determines physical methodology data sent across transmitting media
- Two methods
  - CSMA/CD
    - Carrier sensing
    - Multiple access
    - Collision detection
  - CSMA/CA
    - Avoids, not detects, collisions
    - Uses alert messages

DATA COMMUNICATIONS AND COMPUTER NETWORKS

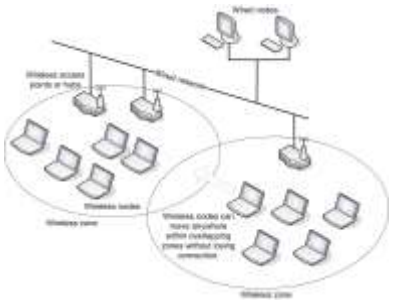
Token Ring networks

- Slower speeds than Ethernet
- 4 Mbps or 16 Mbps
- Physically arranged in a star
- Data travels in a ring



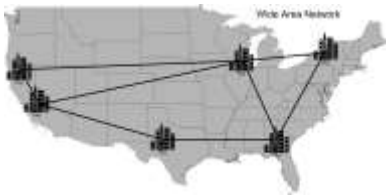
DATA COMMUNICATIONS AND COMPUTER NETWORKS

Wireless LANs



DATA COMMUNICATIONS AND COMPUTER NETWORKS

Wide Area Networks



- Spans larger geographical distances
- Connects multiple LANs using high-speed communication lines
- Expand beyond own premises
- Typically lease data lines from public carrier

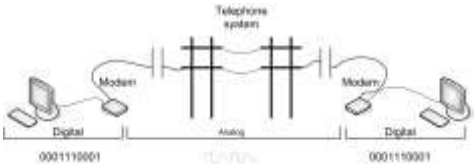
DATA COMMUNICATIONS AND COMPUTER NETWORKS

WAN connections

- Dial-up (DUN)
- Virtual Private Network (VPN)
- Digital Subscriber Line (DSL)
- Cable
- Satellite
- Wireless
- Cellular
- T and E lines
- X.25 and frame relay
- ATM

DATA COMMUNICATIONS AND COMPUTER NETWORKS

POTS/PSTN



- Dial-up system over telephone lines
- Connection isn't continuous
- Phone and data share line - only one can be used at a time
- Max data speed 56 Kbps
- Modem bonding combines speed of multiple modems

DATA COMMUNICATIONS AND COMPUTER NETWORKS

ISDN

- Uses phone lines
  - 2 phone circuits
  - Control signal circuit
- Data isn't converted to analog
- Digital modem
- Each data circuit can transmit data at up to 64 Kbps
- The two circuits can be combined to move data at a speed of 128 Kbps
- Basic Rate Interface (BRI)
- PRI – 23 channels + control channel

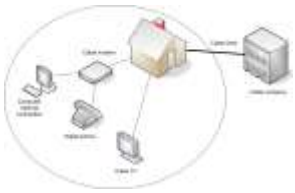
DATA COMMUNICATIONS AND COMPUTER NETWORKS

DSL

- High-speed data and voice transmission line
- Uses telephone wires for data transmission
- Carries digital data at frequencies above voice transmission
- Can transmit voice and digital data on the same line at the same time
- 1.5 Mbps in both directions
- ADSL — 640 Kbps upstream and 7.1 Mbps downstream

DATA COMMUNICATIONS AND COMPUTER NETWORKS

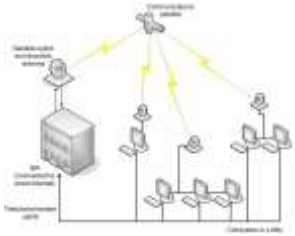
Cable



- Uses transceiver (cable modem) to send/receive data
- Uses same line as cable TV
- Different frequencies
- Speed: 500 Kbps up to 5 Mbps
- Optional Voice over IP

DATA COMMUNICATIONS AND COMPUTER NETWORKS

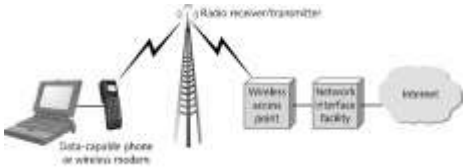
Satellite



- Attractive in rural areas
- Uses dish mounted on building to communicate with stationary satellite in orbit
- Downlink – satellite (up to 1.5 Mbps)/uplink dial-up

DATA COMMUNICATIONS AND COMPUTER NETWORKS

Wireless WAN



- Public radio, cellular telephones, one-way paging, satellite, infrared, and private, proprietary radio
- More expensive to install and use
- Health concerns/wireless network can interfere with other devices
- Two types: fixed-point wireless and mobile wireless

DATA COMMUNICATIONS AND COMPUTER NETWORKS

Cellular

- Provided by major cellular phone companies
- Access via cell signal with Internet capable phone or laptop using a cellular network PC card
- Faster than dial-up, but slower than DSL or cable
- Three connection technologies
  - EDGE
  - EV-DO
  - HSDPA

DATA COMMUNICATIONS AND COMPUTER NETWORKS

T and E lines

- First digitized voice transmission
- Works with a leased digital communications line
- Transmit both voice & data
- T1
  - 24 channels
  - 64 Kbps each
  - Total of 1.544 Mbps
- T3
  - 672 channels
  - Total of 44.736 Mbps

DATA COMMUNICATIONS AND COMPUTER NETWORKS

T and E lines, continued

- E carrier – European equivalent
  - E1: 2.048 Mbps
  - E3: 34.368 Mbps
- T and E use four wires: two for receiving and two for sending
- STP preferred over coaxial
- Repeaters every 6,000 ft.
- Business lines
  - T1: coaxial, microwave, or fiber optic
  - T3: microwave or fiber optic
- Can lease fractional line in 64 Kbps increments

DATA COMMUNICATIONS AND COMPUTER NETWORKS

X.25 and frame relay

- Packet-switching communication protocols
- Designed for long distance data transmission
- Packet-switching technology
  - Divides data into packets
  - Sends each packet separately
  - Used on the Internet
  - Uses bandwidth efficiently
- Frame relay – digital up to 1.544 Mbps
  X.25 – analog up to 56 Kbps

X.25 and frame relay, continued

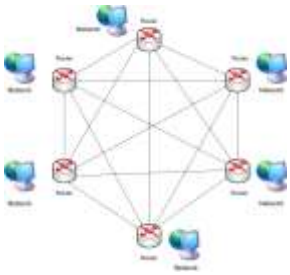
- Both use a permanent virtual circuit (PVC)
- PVCs aren't dedicated lines
  - You specify
    - The nodes (two endpoints)
    - The amount of bandwidth required
  - Carrier sends the data along any number of paths between the two endpoints
- Advantage: pay for only the amount of bandwidth you require
- International businesses use frame relay

ATM

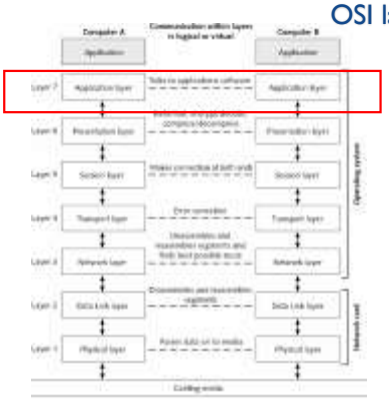
- Very fast network technology
- Used with LANs and WANs
- Uses cells to transmit data, voice, video, and frame relay traffic
- Each cell is 53 bytes
  - 48 bytes of data
  - 5-byte header
- Uses virtual circuits
  - PVCs
  - SVCs
- Throughput of 622 Mbps
- Best with fiber optic cable; can use TP

Mesh networks

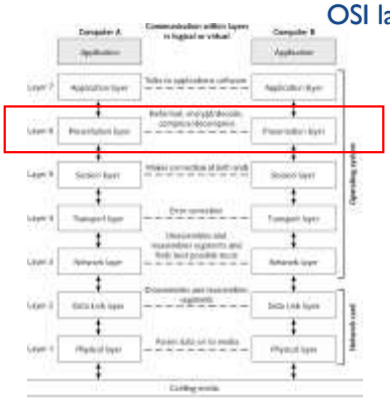
- Highly reliable
- Multiple point-to-point links between routers
- Routers search for best path
- Added security
- Fault tolerant



OSI layer 7



OSI layer 6



DATA COMMUNICATIONS AND COMPUTER NETWORKS

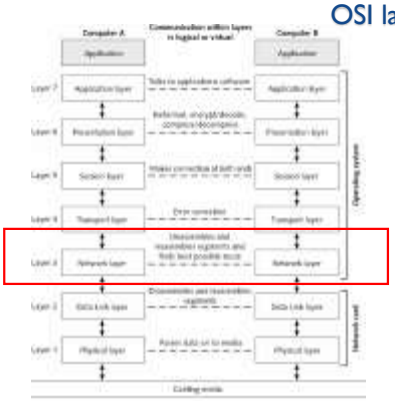
OSI layer 5

DATA COMMUNICATIONS AND COMPUTER NETWORKS

OSI layer 4

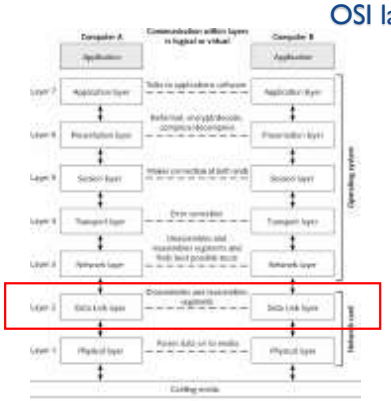
DATA COMMUNICATIONS AND COMPUTER NETWORKS

OSI layer 3



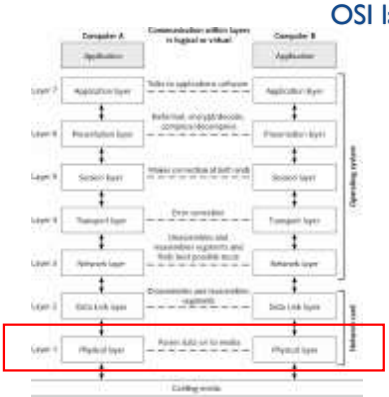
DATA COMMUNICATIONS AND COMPUTER NETWORKS

OSI layer 2



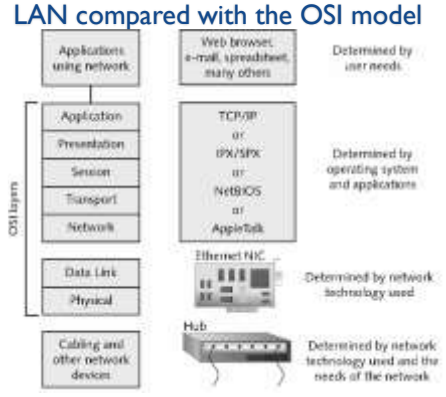
DATA COMMUNICATIONS AND COMPUTER NETWORKS

OSI layer 1



DATA COMMUNICATIONS AND COMPUTER NETWORKS

LAN compared with the OSI model



Unit summary

- Described the basic components of a network
- Identified characteristics of network technologies
- Analyzed the OSI model