Data Communication

STANDARTS
AREA NETWORKS

Data Communications, Data Networks

- *Ders Sunumları,*
  Murat İSKEFİYELİ, Sakarya Üniversitesi
- *Veri ve Bilgisayar Haberleşmesi Ders Notları, İbrahim ÖZÇELİK, Sakarya Üniversitesi*
- *Data and Computer Communications, William Stallings, Prentice Hall, 2007 (Lecture Slides)*

Grading

- Quiz-1 % 5
- Quiz-2 % 5
- Project % 25
- Midterm % 65

} % 50

- Final

} % 50

Introduction

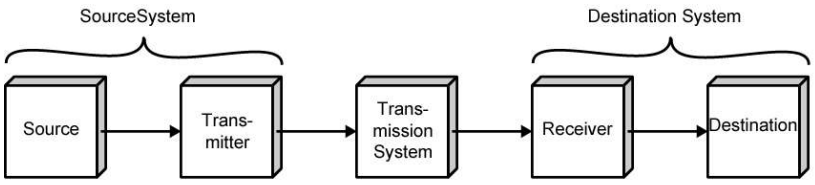
- Service : People
- Purpose : Communication
- Method :

	Before	Now
Local	Speaking	
	Written doc.	Electronic doc.
Remote	Mail	E-mail
	Telephone	Wireless tel.
	TV	Video conference

Modern Data Comms

- trends
  - traffic growth at a high & steady rate
  - development of new services
  - advances in technology
- significant change in requirements
  - emergence of high-speed LANs
  - corporate WAN needs
  - digital electronics

A Communications Model



(a) General block diagram

(b) Example

Communications Tasks

Transmission system utilization	Addressing
Interfacing	Routing
Signal generation	Recovery
Synchronization	Message formatting
Exchange management	Security
Error detection and correction	Network management
Flow control	

Need For Protocol Architecture

- data exchange can involve complex procedures, cf. file transfer example
- better if task broken into subtasks
- implemented separately in layers in stack
  - each layer provides functions needed to perform comms for layers above
  - using functions provided by layers below
- peer layers communicate with a protocol

Key Elements of a Protocol

- syntax - data format or structure
  - Frame format: source and target address, data
- semantics - control info & error handling
  - Is this address mine?
- timing - speed matching & sequencing

Standard Organizations-1

- ISO: International Organization for Standardization; a network of the national standards institutes of some 140 countries, with a central office in Geneva, Switzerland, that coordinates the system and publishes the finished standards
- ANSI: American National Standards Institute; a private organization that administers and coordinates the United States voluntary standardization and conformity assessment systems
- EIA: Electronic Industries Alliance; a national trade organization that includes US manufacturers representing the electronics industry; a partnership of electronic and high-tech associations and companies whose mission is to promote market development and competitiveness of the US high-tech industry through domestic and international policy efforts
- IEEE: Institute of Electrical and Electronics Engineers; an international membership organization serving industry with standards programs
- ITU: International Telecommunication Union; an international organization within which governments and the private sector could work together to coordinate the operation of telecommunication networks and services and advance the development of communications technology

Standard Organizations-2

- IAB: Internet Architecture Board; a committee of the Internet Engineering Task Force (IETF); responsible for oversight of IETF activities, Internet Standards Process oversight and appeal, and is responsible for the management of publication of the RFC Series and the management of the IETF protocol parameter registry, operated by the IANA

- ***De facto*** is a Latin expression that means "by [the] fact"
- ***De jure*** is an expression that means "concerning law", as contrasted with *de facto*

- HTML is a good example of "*de facto* and *de jure*" standard.

- Ethernet is a de facto, and IEEE 802.3 is a de jure.
- Ethernet is name of project developed by Xerox.
- IEEE 802.3 is the rule (law) of Ethernet.

Transmission Terminology

- data transmission occurs between a transmitter & receiver via some medium
- guided medium
  - eg. twisted pair, coaxial cable, optical fiber
- unguided / wireless medium
  - eg. air, water, vacuum

Transmission Terminology

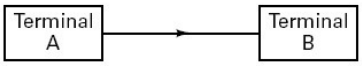
- direct link
  - no intermediate devices
- point-to-point
  - direct link
  - only 2 devices share link
- multi-point
  - more than two devices share the link

Transmission Terminology

- simplex
  - one direction
    - eg. television
- half duplex
  - either direction, but only one way at a time
    - eg. police radio
- full duplex
  - both directions at the same time
    - eg. telephone

Communication Modes

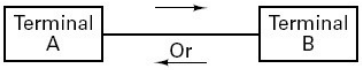
Simplex



Transmission in only one direction

(a)

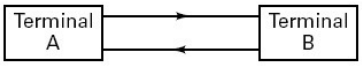
Half Duplex



Transmission in either direction, but not simultaneously

(b)

Full Duplex



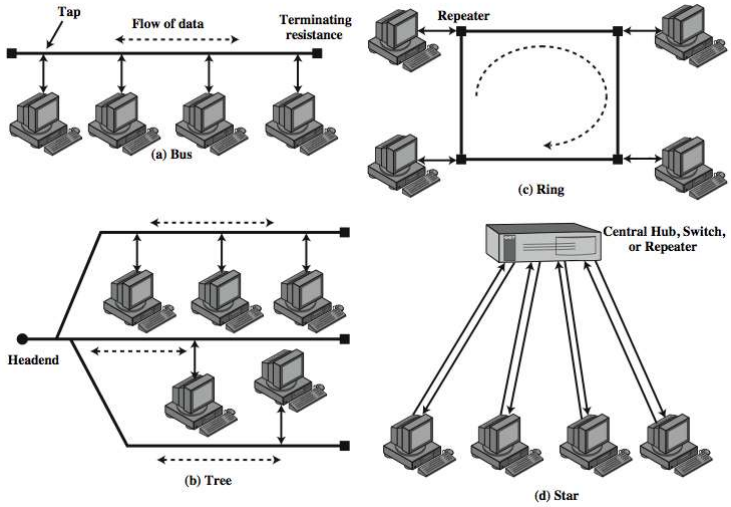
Transmission in both directions simultaneously

(c)

LAN Architecture

- topologies
- transmission medium
- layout

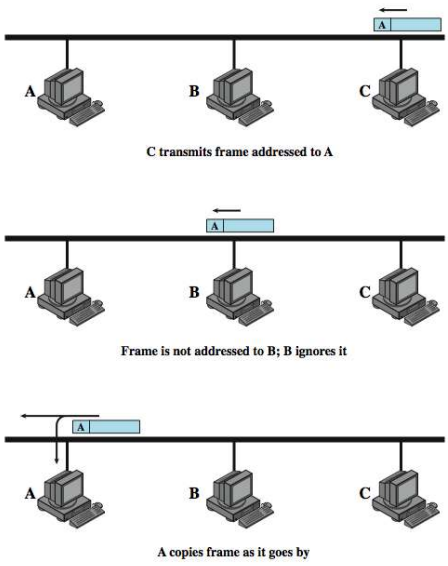
LAN Topologies



Bus and Tree

- used with multipoint medium
- transmission propagates throughout medium
- heard by all stations
- full duplex connection between station and tap
  - allows for transmission and reception
- need to regulate transmission
  - to avoid collisions
- terminator absorbs frames at end of medium
- tree a generalization of bus
- headend connected to branching cables

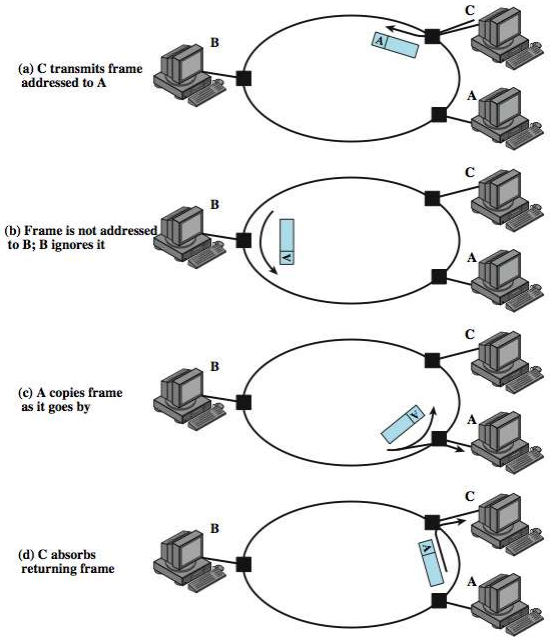
Frame Transmission on Bus LAN



Ring Topology

- a closed loop of repeaters joined by point to point links
- receive data on one link & retransmit on another
  - links unidirectional
  - stations attach to repeaters
- data in frames
  - circulate past all stations
  - destination recognizes address and copies frame
  - frame circulates back to source where it is removed
- media access control determines when a station can insert frame

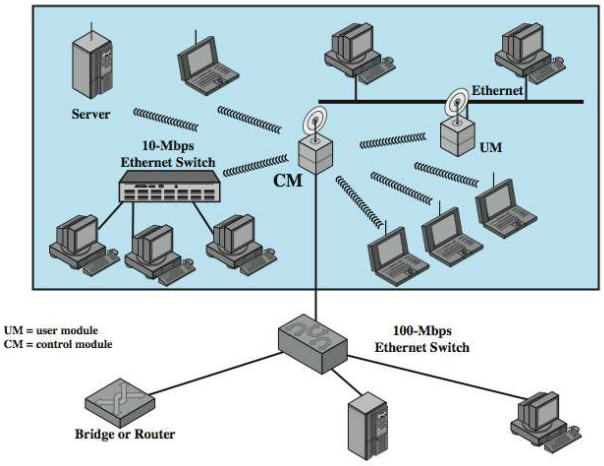
Frame Transmission Ring LAN



Star Topology

- each station connects to central node
  - usually via two point to point links
- either central node can broadcast
  - physical star, logical bus
  - only one station can transmit at a time
- or central node can act as frame switch

Single Cell Wireless LAN



Choice of Topology

The choice of topology depends on a variety of factors;

- reliability
- expandability
- performance
- needs considering in context of:
  - medium
  - wiring layout
  - access control

Bus LAN
Transmission Media (1)

- twisted pair
  - early LANs used voice grade cable
  - didn't scale for fast LANs
  - not used in bus LANs now
- baseband coaxial cable
  - uses digital signalling
  - original Ethernet

Bus LAN
Transmission Media (2)

- broadband coaxial cable
  - as in cable TV systems
  - analog signals at radio frequencies
  - expensive, hard to install and maintain
  - no longer used in LANs
- optical fiber
  - expensive taps
  - better alternatives available
  - not used in bus LANs
- less convenient compared to star topology twisted pair
- coaxial baseband still used but not often in new installations

Ring and Star Usage

- ring
  - very high speed links over long distances
  - single link or repeater failure disables network
- star
  - uses natural layout of wiring in building
  - best for short distances
  - high data rates for small number of devices

Choice of Medium

- constrained by LAN topology
- capacity
- reliability
- types of data supported
- environmental scope

Media Available

- Voice grade unshielded twisted pair (UTP)
  - Cat 3 phone, cheap, low data rates
- Shielded twisted pair / baseband coaxial
  - more expensive, higher data rates
- Broadband cable
  - even more expensive, higher data rate
- High performance UTP
  - Cat 5+, very high data rates, witched star topology
- Optical fibre
  - security, high capacity, small size, high cost

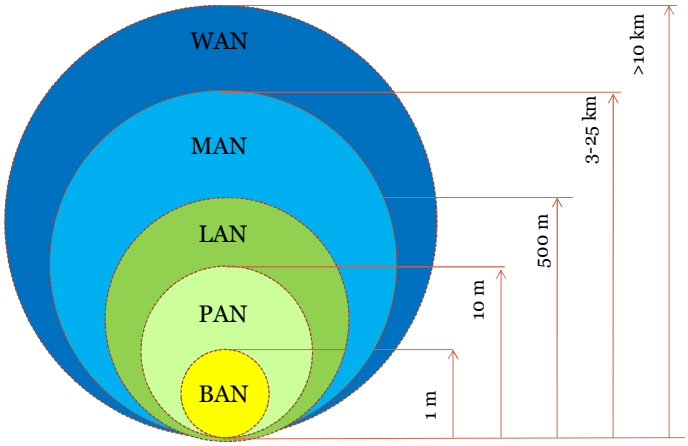
Types of Area Network

- BAN-Body Area Network
  - IEEE 802.15.3
- PAN- Personal Area Network
  - Bluetooth, ZigBee
- LAN- Local Area Network
  - Office or building distance
  - 10 Mbps-1 Gbps
  - Ethernet, IEEE 802.11, Token Ring, Token Bus, ATM
- MAN- Metropolitan Area Network
  - IEEE 802.16
- WAN- Wide Area Network
  - No limit for distance
  - Leased telephone line
  - X.25, Frame Relay, ISDN, ATM, GSM

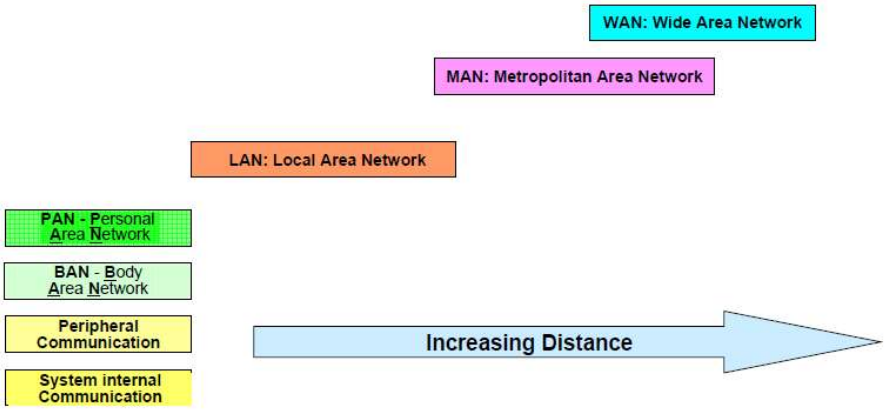
Definition

- A computer network is
  - a system of connected computers
  - with a possibility for fast data exchange
- A computer is
  - an autonomous unit consisting of
  - hardware and software

Coverage Limits of Networks



Classification by Distance



System Internal Communication

Data transfer on shortest distances (several mm)
On a chip or between chips on a board
Often very high data rates
Often realized as bus system

Examples:

- Chip Interconnection (I2C, SMB, SPI)
- Systembus (ISA, EISA, MCA, VLB)
- Multiprocessor Systems (proprietary systems)

Peripheral Communication

Data transfer on short distances (several cm to m)
Between the components of a computer and peripheral devices
Often realized as interface bus

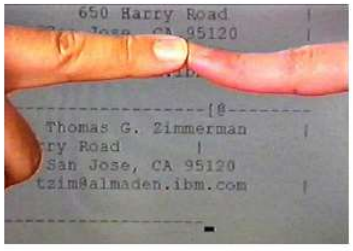
Examples:

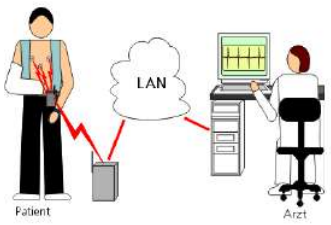
- Mass storage bus (IDE, EIDE, SCSI, ATA, SATA)
- Peripheral interconnect (SCSI, DVI)
- General Pupose Comm. (Serial, parallel interface)

BAN- Body Area Network

Data transfer on short distances with low data rates

- between components of wearables
- between human bodies or parts thereof
- between man and machine





PAN- Personal Area Network

Data transfer on short areas
Between the personal components belonging to a person
Connect printers, cameras, scanners, phones, headset to PC & with each other

Special issue: Security versus convenience
- What is my device?
- How much must I configure?

Example:
- **wired** (serial, parallel, USB, FireWire)
- **wireless** (IR, Bluetooth, WLAN, wireless USB)

LAN- Local Area Network

Connects independent computers
- **in a connected area (building, campus, organizational structure)**
- **under supervision of a single operating entity**
- **several m to km**
- **high communication bandwidth (10, 100, 155 Mbit/s and more)**
- **simple topology (bus, ring, tree, star)**

MAN- Metropolitan Area Network

Fast highspeed network in a regional area, connecting different local area networks (1 to 100 km)

Plays the role of a backbone network

Simple topology (often: glas fibre ring)

Special Issue: Interconnecting LANs

Examples:

- Campusnetworks of a university
- Clinic networks

WAN- Wide Area Network

Connection of LANs and MANs over regional and above regional distances

Heterogeneous mesh networks with

- **packet oriented communication and routing**
- **buffering of packets in intermediary nodes**
- **higher latency times (compared to a LAN)**

Special Issue: Heterogeneous structures

- Different technologies
- Different operating institutions
- Connecting different worlds