**DATA AND COMPUTER COMMUNICATIONS**

# Lecture 1 Overview - Data Communications, Data Networks, and the Internet

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Based on Lecture slides by William Stallings

1

OUTLINE

- Data Communications and Networking for Today's Enterprise
- A Communications Model
- Data Communications
- Networks
- The Internet

2

## DATA COMMUNICATIONS AND NETWORKING FOR TODAY'S ENTERPRISE

- Trends
  - Three forces that drive the architecture and evolution of data communications and networking

**Traffic growth at a high & steady rate**

- **Development of new services**
- **Advances in technology**

3

| Speed (kbps) | 9.6 | 14.4 | 28 | 64 | 144 | 384 | 2000 |
|---|---|---|---|---|---|---|---|
| Transaction processing | Good | Good | Good | Good | Good | Good | Good |
| Messaging/text apps | Good | Good | Good | Good | Good | Good | Good |
| Voice | Good | Good | Good | Good | Good | Good | Good |
| Location services | Adequate | Good | Good | Good | Good | Good | Good |
| Still image transfers | Poor | Adequate | Adequate | Good | Good | Good | Good |
| Internet/VPN access | Poor | Poor | Adequate | Good | Good | Good | Good |
| Database access | Poor | Poor | Adequate | Good | Good | Good | Good |
| Enhanced Web surfing | Poor | Poor | Adequate | Adequate | Good | Good | Good |
| Low-quality video | Poor | Poor | Adequate | Adequate | Good | Good | Good |
| High-end audio | Poor | Poor | Adequate | Adequate | Good | Good | Good |
| Large file transfer | Poor | Poor | Poor | Adequate | Good | Good | Good |
| Moderate video | Poor | Poor | Poor | Adequate | Adequate | Good | Good |
| Interactive entertainment | Poor | Poor | Poor | Poor | Adequate | Adequate | Good |
| High-quality video | Poor | Poor | Poor | Poor | Poor | Adequate | Good |

VPN: virtual private network

Performance:
Poor  Adequate  Good

4

## TECHNOLOGY TRENDS

- Four technology trends are particularly notable:
  - The trend toward faster and cheaper, both in computing and communications, continues
  - Both voice-oriented telecommunications networks and data networks are more "intelligent" than ever
  - The Internet, the Web, and associated applications have emerged as dominant features of both business and personal world
  - There have been a trend toward ever-increasing mobility for decades

## TECHNOLOGY TRENDS (CONT'D)
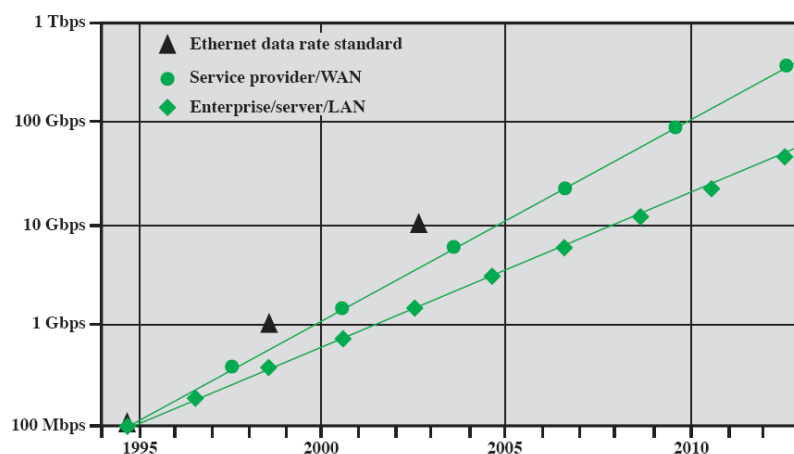


6

## SIGNIFICANT CHANGES IN REQUIREMENTS

- Emergence of high-speed LANs
  - Examples: centralized server farms, power workgroups, and high-speed local backbone
- Corporate WAN needs
  - Driven by the needs of centralized data processing model and distribution of multiple offices.
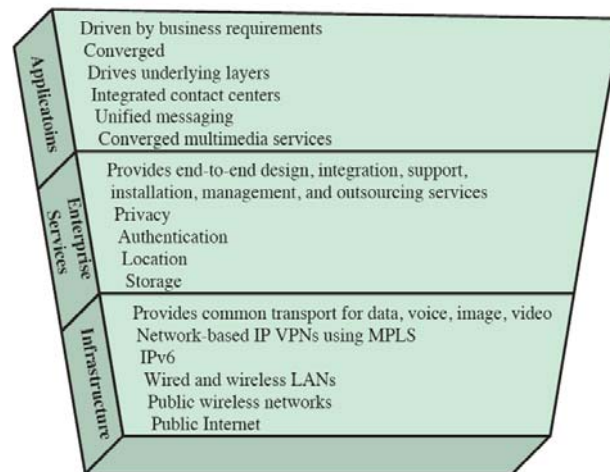- Digital electronics

7

## CONVERGENCE

- The merger of previously distinct telephony and information technologies and markets
- Layers:
  - applications
    - these are seen by the end users
  - enterprise services
    - services the information network supplies to support applications
  - infrastructure
    - communication links available to the enterprise

8

## CONVERGENCE LAYERS



Applications
- Driven by business requirements
- Converged
- Drives underlying layers
- Integrated contact centers
- Unified messaging
- Converged multimedia services

Enterprise Services
- Provides end-to-end design, integration, support, installation, management, and outsourcing services
- Privacy
- Authentication
- Location
- Storage

Infrastructure
- Provides common transport for data, voice, image, video
- Network-based IP VPNs using MPLS
- IPv6
- Wired and wireless LANs
- Public wireless networks
- Public Internet

9

## BENEFITS

○ Convergence benefits include:

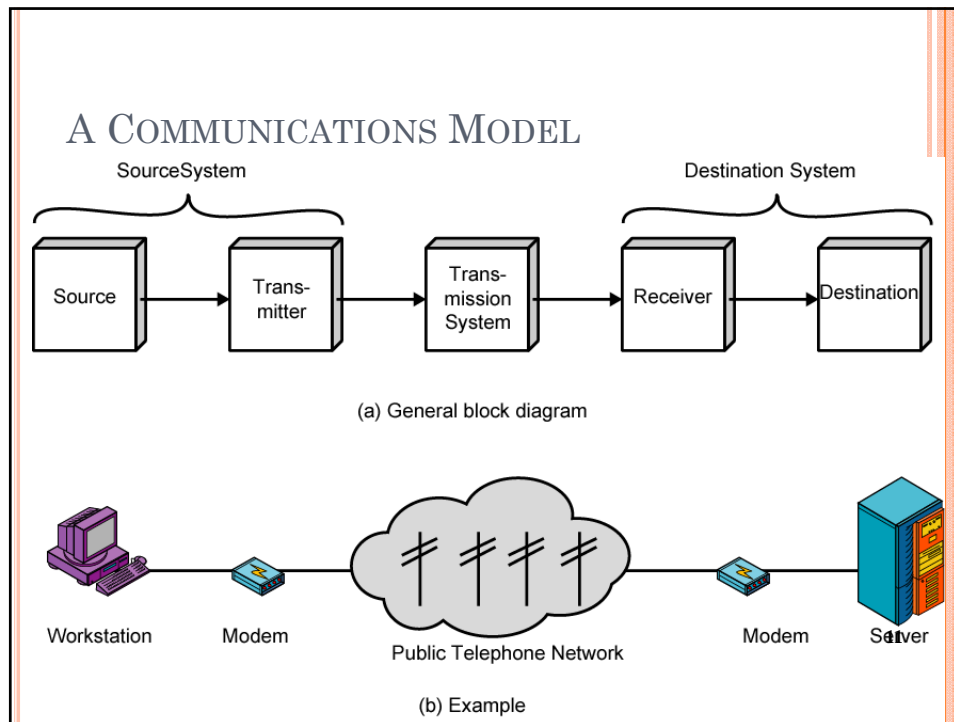| Efficiency | Effectiveness | Transformation |
|---|---|---|
| • better use of existing resources, and implementation of centralized capacity planning, asset and policy management | • the converged environment provides users with flexibility, rapid standardized service deployment and enhanced remote connectivity and mobility | • enables the enterprise-wide adoption of global standards and associated service levels |

10

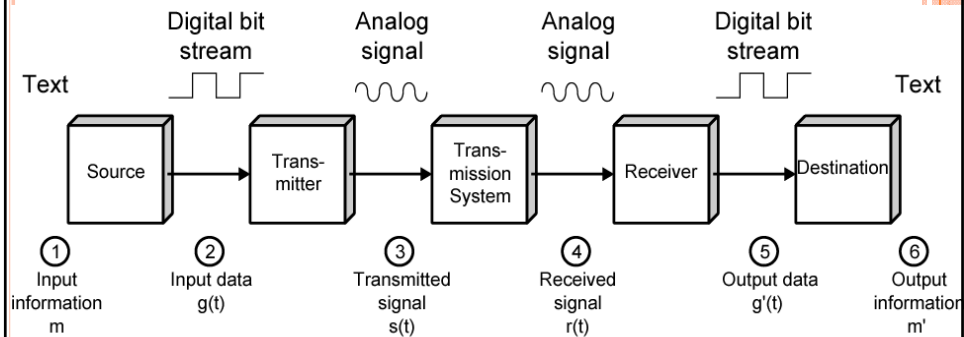## A COMMUNICATIONS MODEL

Source System

Destination System

Source → Trans-mitter → Trans-mission System → Receiver → Destination

(a) General block diagram

Workstation — Modem — Public Telephone Network — Modem — Server

(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 | 12 |

## DATA COMMUNICATIONS MODEL

| | Digital bit stream | Analog signal | Analog signal | Digital bit stream | |
|---|---|---|---|---|---|
| Text | | | | | Text |

Source → Trans-mitter → Trans-mission System → Receiver → Destination

① Input information m

② Input data g(t)

③ Transmitted signal s(t)

④ Received signal r(t)

⑤ Output data g'(t)

⑥ Output information m'

13

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# Transmission Lines

- The basic building block of any communications facility is the transmission line.
- The business manager is concerned with a facility providing the required capacity, with acceptable reliability, at minimum cost.

Capacity

Reliability

Cost

**Transmission Line** 14

## TRANSMISSION MEDIUM

- selection is a basic choice
  - internal use entirely up to business
  - long-distance links made by carrier
- rapid technology advances change mix
  - fiber optic

  - wireless

15

## NETWORKING

- growth of number & power of computers is driving need for interconnection
- also seeing rapid integration of voice, data, image & video technologies
- two broad categories of communications networks:
  - Local Area Network (LAN)
  - Wide Area Network (WAN)

16

## WIDE AREA NETWORKS

- span a large geographical area
- cross public rights of way
- rely in part on common carrier circuits
- alternative technologies used include:
  - leased line
  - circuit switching
  - packet switching: X.25, frame relay
  - Asynchronous Transfer Mode (ATM)

17



18
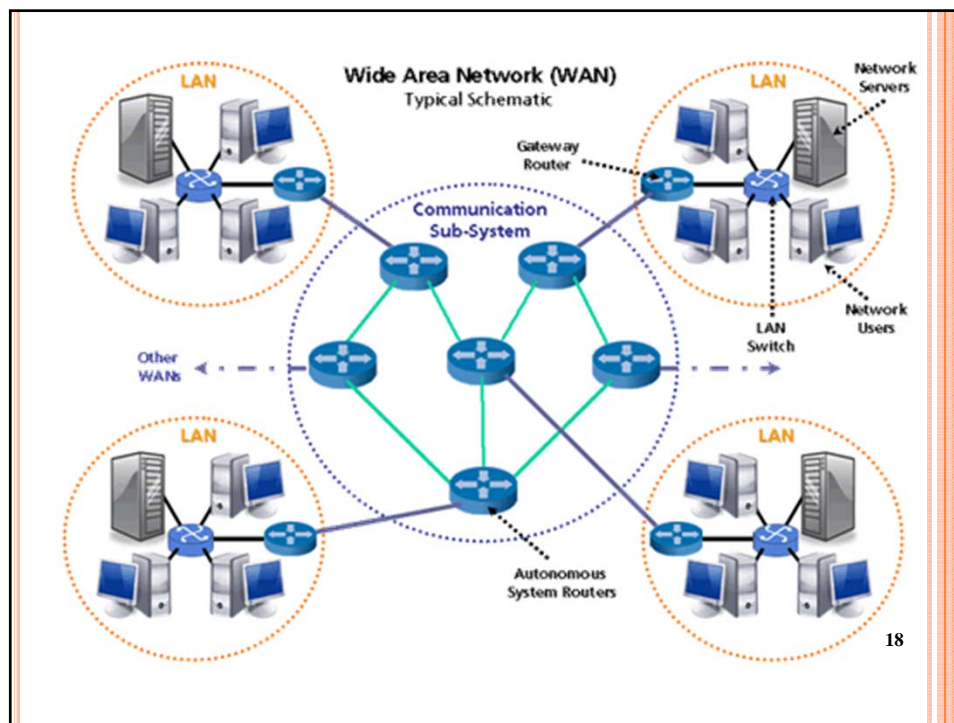
## CIRCUIT SWITCHING

- uses a dedicated communications path established for duration of conversation
- comprising a sequence of physical links
- with a dedicated logical channel
- e.g. telephone network

19

## PACKET SWITCHING

- data sent out in sequence of small chunks (packets)
- packets passed from node to node between source and destination
- used for terminal to computer and computer to computer communications

20

## FRAME RELAY

- Motivation
  - packet switching systems have large overheads to compensate for errors
  - modern systems are more reliable, errors can be caught in end system
- Frame Relay
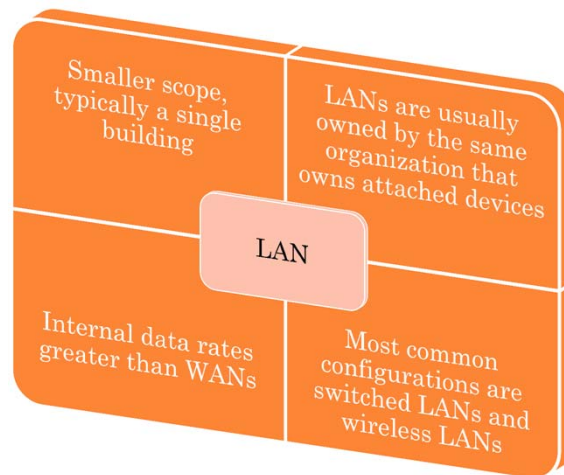  - provides higher speeds with most error control overhead removed, up to 2Mbps

21

## ASYNCHRONOUS TRANSFER MODE

- evolution of frame relay and circuit switching
  - fixed packet (called cell) length via virtual channels
  - with little overhead for error control
  - bandwidth from 10Mbps to Gbps
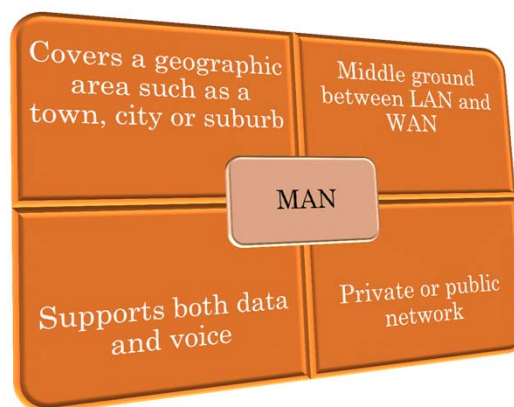  - constant data rate using packet switching technique with multiple virtual circuits

22

## LOCAL AREA NETWORKS (LAN)

Smaller scope, typically a single building

LANs are usually owned by the same organization that owns attached devices

LAN

Internal data rates greater than WANs

Most common configurations are switched LANs and wireless LANs

23

## METROPOLITAN AREA NETWORKS (MAN)

Covers a geographic area such as a town, city or suburb

Middle ground between LAN and WAN

MAN

Supports both data and voice
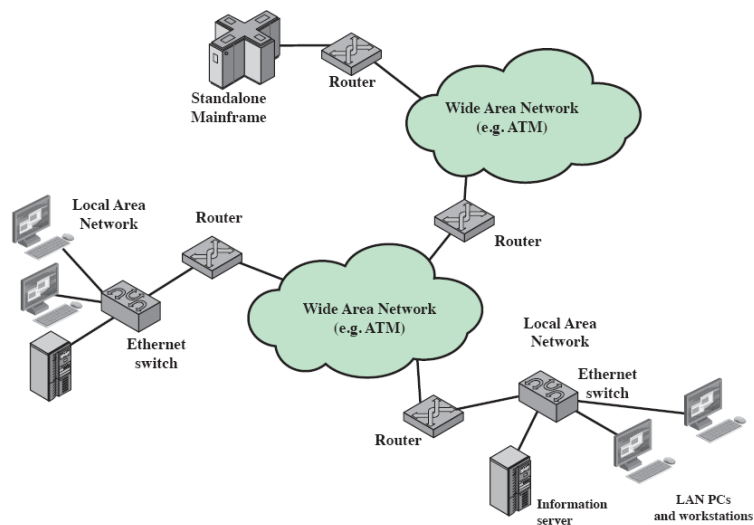
Private or public network

24

## THE INTERNET

○ Internet evolved from ARPANET
- first operational packet network
- applied to tactical radio & satellite nets also
- had a need for interoperability
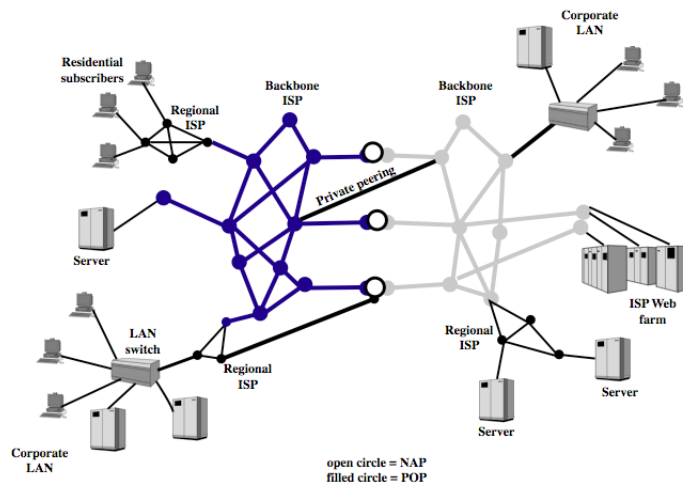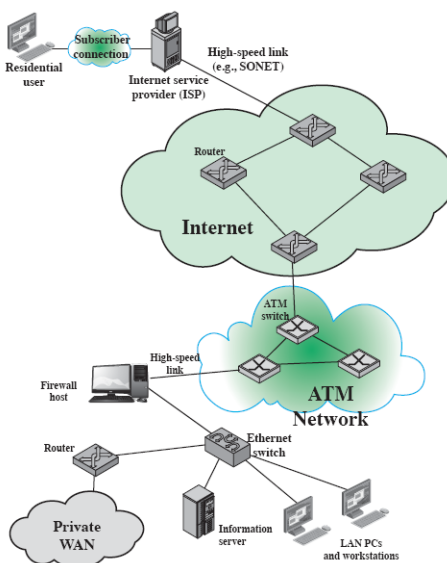- led to standardized TCP/IP protocols

25

## INTERNET ELEMENTS



Standalone Mainframe

Router

Wide Area Network (e.g. ATM)

Local Area Network

Router

Router

Ethernet switch

Wide Area Network (e.g. ATM)

Local Area Network

Ethernet switch

Router

Information server

LAN PCs and workstations

26

# INTERNET ARCHITECTURE



**27**

# EXAMPLE CONFIGURATION



**28**

SUMMARY

- Trends challenging data communications:
  - traffic growth
  - development of new services
  - advances in technology
- Transmission mediums
  - fiber optic
  - wireless
- Network categories:
  - WAN
  - LAN
- Internet
  - evolved from the ARPANET
  - TCP/IP foundation

29