APPLIED IT FOR BUSINESS

Chapter

6

Telecommunications and Networks

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Learning Objectives

- Understand the concept of a network
- Apply Metcalfe's law in understanding the value of a network
- Identify major developments and trends in the industries, technologies, and business applications of telecommunications and Internet technologies
- Provide examples of the business value of Internet, intranet, and extranet applications

Learning Objectives

- Identify the basic components, functions, and types of telecommunications networks used in business
- Explain the functions of major components of telecommunications network hardware, software, media, and services
- Explain the concept of client/server networking

Learning Objectives

- Understand the two forms of peer-to-peer networking
- Explain the difference between digital and analog signals

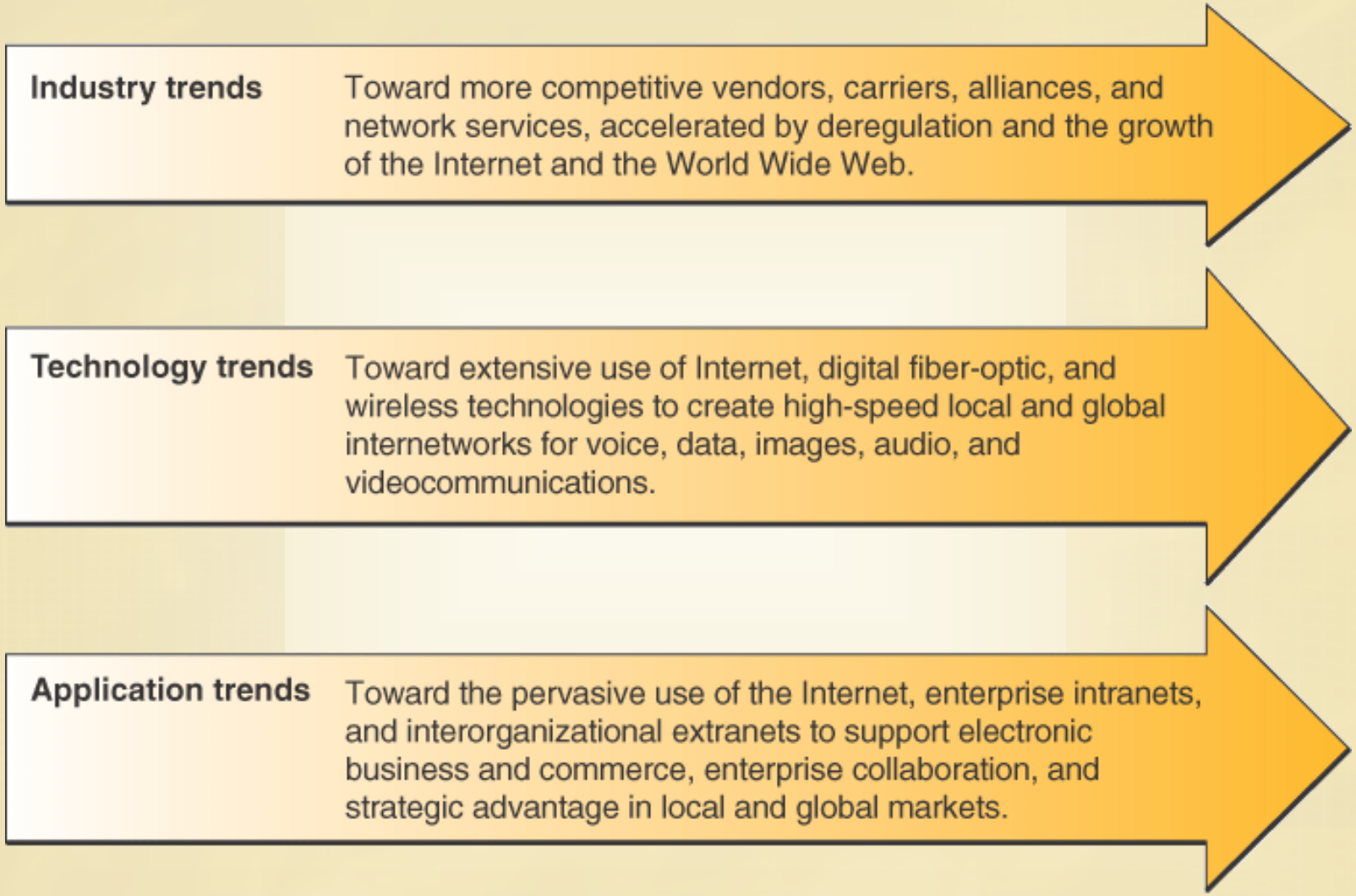
Network Concepts

- A network is an interconnected or interrelated chain, group, or system
- The number of possible connections on a network is $N(N–1)$ or $N^2 – N$
  - N = number of nodes (points of connection)
  - Example: 10 computers on a network = 10(10–1) = 10x9 = 90 possible connections

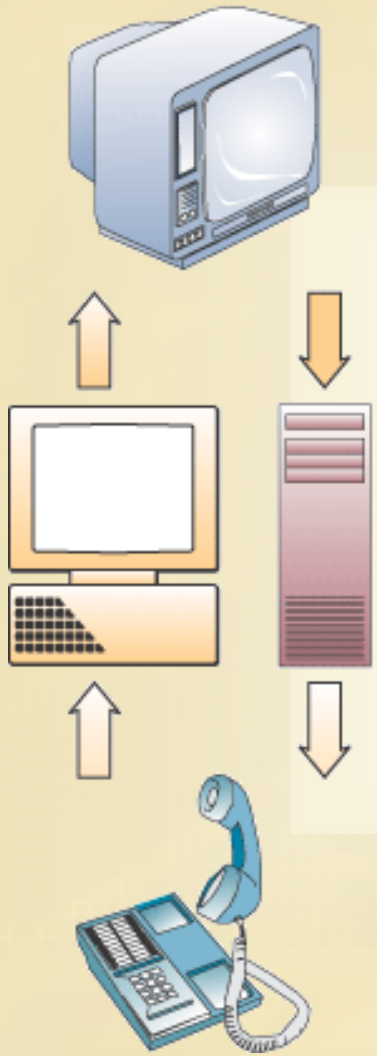
Metcalfe's Law

- The usefulness, or utility, of a network equals the square of the number of users
  - The more users on a network, the more useful it becomes
- Until critical mass is reached, a change in technology only affects the technology
  - Once critical mass is attained, social, political, and economic systems change
  - Example: The Internet is growing exponentially. We can expect more value, for less cost, virtually every time we log on.

Telecommunication Trends



Telecommunications-Based Services



Full Service Spectrum

- Broadcast TV
- High-definition TV
- Enhanced pay-per-view
- Video-on-demand
- Interactive TV
- Interactive video games
- Video catalog shopping
- Distance learning
- Multimedia services
- Image networking
- Transaction services
- Internet access
- Telecommuting
- Videoconferencing
- Video telephony
- Wireless access
- Cellular/PCS systems
- POTS—Plain old telephone service

Internet Networking Technologies

- Internet networking technologies are being used as technology platform
  - Web browser suites
  - HTML Web page editors
  - Network management software
  - Firewalls
- Being applied in Internet, intranet, and extranet applications
- Reinforces previous move toward client/server networks based on open-systems architecture

Open Systems

- Open systems use common standards for hardware, software, applications, and networks
  - Internet networking technologies are a common standard for open systems
- Connectivity
  - Open systems provide greater connectivity and network interoperability
  - Middleware may be needed to help diverse systems work together

Middleware

- Middleware
  - A general term for any programming that mediates between two separate programs
  - Allows a particular database to access other databases without custom programming
- Commonly known as the “plumbing” of an information system
  - It routes data and information between back-end data sources and end user applications
  - An essential component of any IT infrastructure

Digital Network Technologies

- Telecommunications are being revolutionized by switch from analog to digital
  - Analog: voice-oriented transmission
  - Digital: discrete pulse transmission
- Benefits
  - Higher transmission speeds
  - Moves larger amounts of information
  - Greater economy and much lower error rates
  - Transmits multiple types of communications (data, voice, video) on the same circuits

Wireless Technologies

- Fiber-optic
  - Uses pulses of laser-generated light
  - Reduced size and installation effort
  - Vastly greater communication capacity
  - Faster transmission speeds
  - Freedom from electrical interference
- Satellite Transmission
  - Can move massive quantities of data, audio, and video over global networks
  - Especially useful in isolated areas

Business Application Trends

- Telecommunications networks now play a vital and pervasive role in Web-enabled…
  - E-business processes
  - Electronic commerce
  - Enterprise collaboration
  - Other applications that support operations, management, and strategic objectives

Internet2

- Next generation of the Internet
  - High-performance
  - Different infrastructure than the current Internet
  - Will not replace the current Internet
  - In use at over 200 universities, scientific institutions, communications corporations
  - May never become totally open
  - Users are connected via Abilene, a backbone that supports throughput of 10 Gbps
  - Infinite bandwidth

Value of Telecommunications Networks

Strategic Capabilities	e-Business Examples	Business Value
Overcome geographic barriers: Capture information about business transactions from remote locations	Use the Internet and extranets to transmit customer orders from traveling salespeople to a corporate data center for order processing and inventory control	Provides better customer service by reducing delay in filling orders and improves cash flow by speeding up the billing of customers
Overcome time barriers: Provide information to remote locations immediately after it is requested	Credit authorization at the point of sale using online POS networks	Credit inquiries can be made and answered in seconds
Overcome cost barriers: Reduce the cost of more traditional means of communication	Desktop videoconferencing between a company and its business partners using the Internet, intranets, and extranets	Reduces expensive business trips; allows customers, suppliers, and employees to collaborate, thus improving the quality of decisions reached
Overcome structural barriers: Support linkages for competitive advantage	Business-to-business electronic commerce websites for transactions with suppliers and customers using the Internet and extranets	Fast, convenient services lock in customers and suppliers

The Internet Revolution

- The Internet has become a global information superhighway
  - Millions of smaller, private networks operating independent of, or in harmony with, each other
  - 10 servers in 1991 to over 46 million today
  - Sustained growth in excess of 1 million servers per month
  - No central computer system
  - No governing body
  - Based on common standards

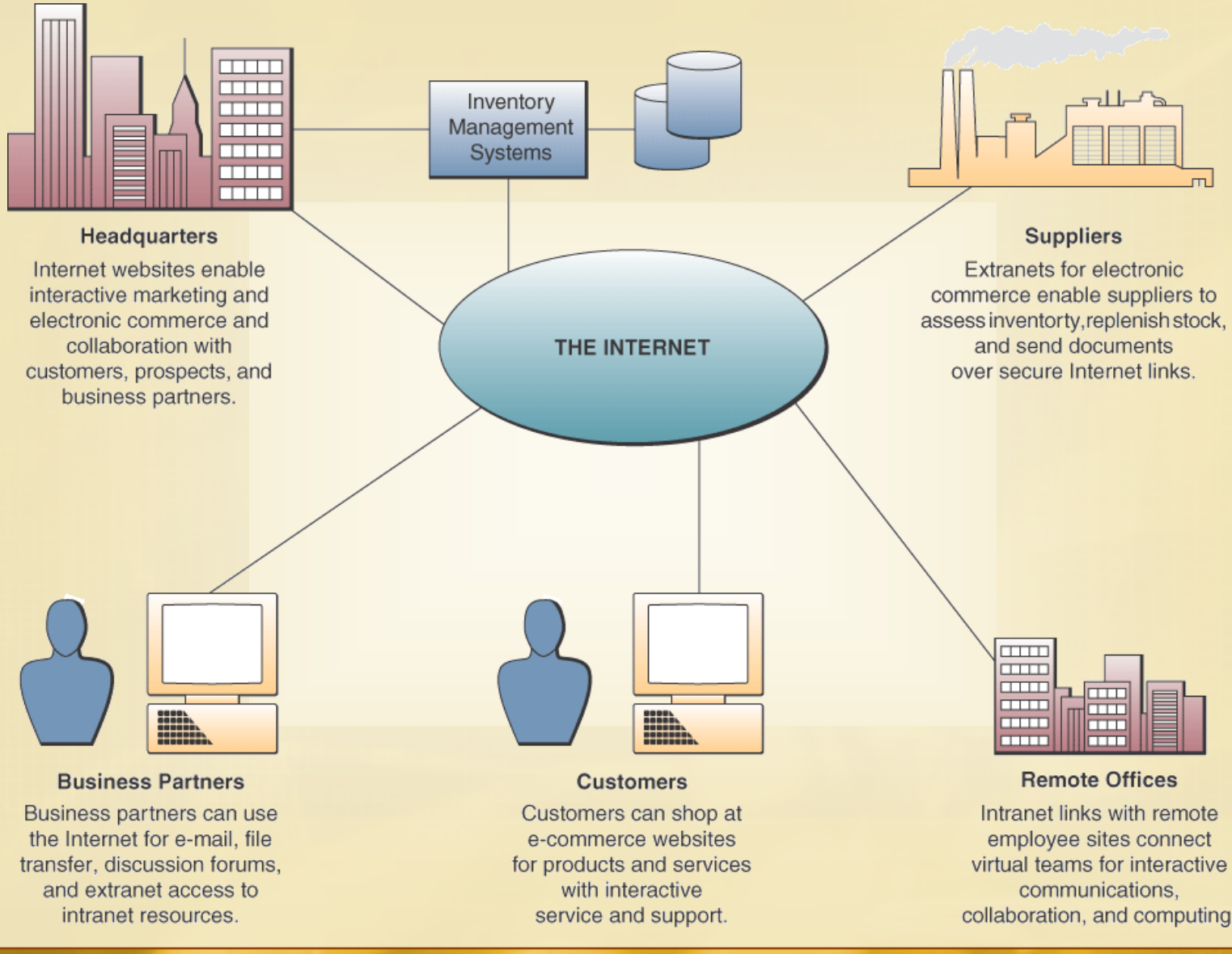
Internet Service Providers

- ISP
  - A company that specializes in providing easy access to the Internet
  - For a monthly fee, provides software, user name, password, and Internet access
- ISPs themselves are connected to one another through network access points
  - One ISP can easily connect to another to obtain addresses of websites or user nodes

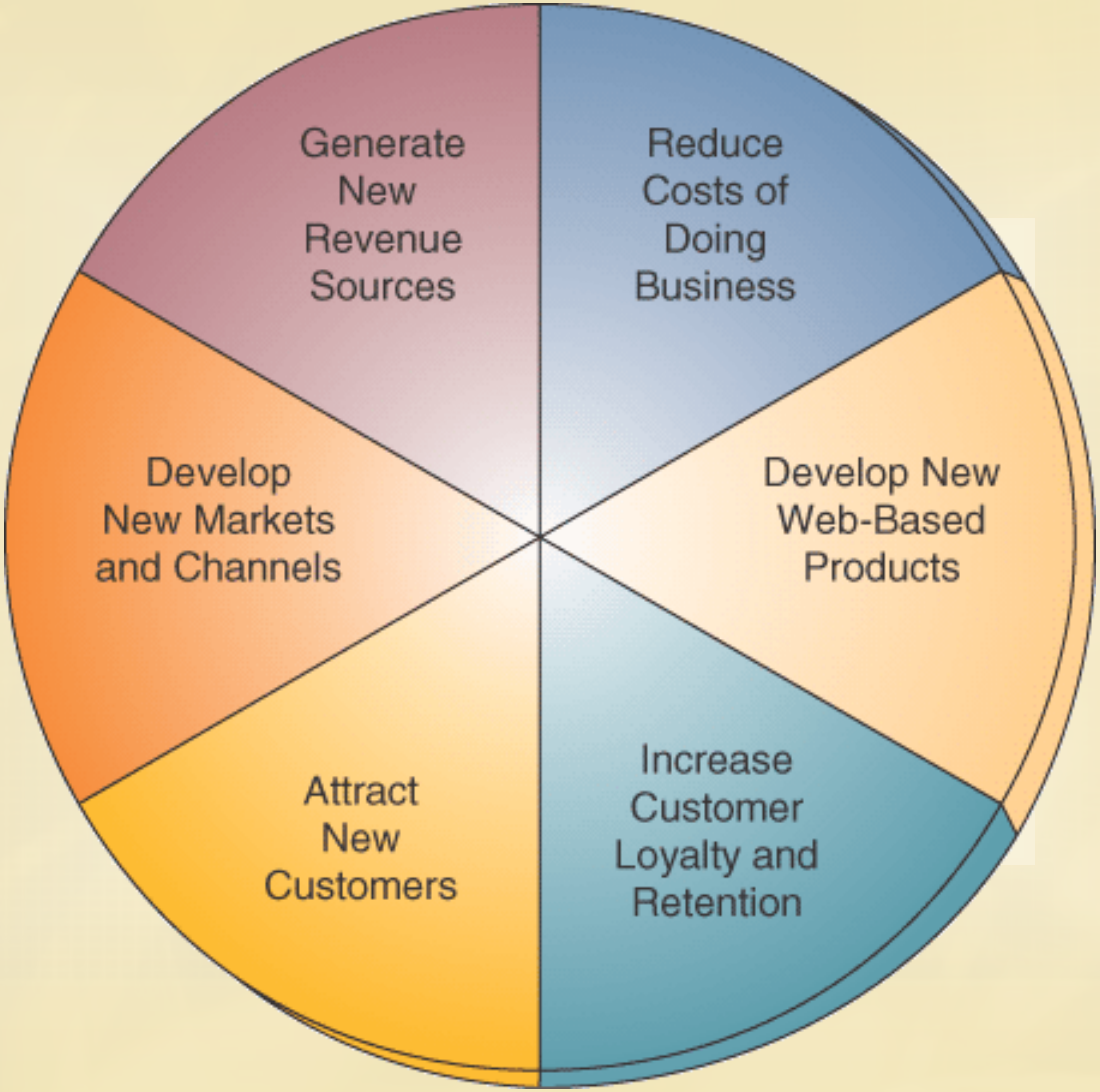
Internet Applications

- Most popular Internet applications and uses
  - E-mail
  - Instant messaging
  - Browsing the Web
  - Newsgroups
  - Chat rooms
  - Publish opinions, subject matter, creative work
  - Buy and sell
  - Downloading (data, software, reports, pictures, music, videos)

Business Use of the Internet



Business Value of the Internet



The Role of Intranets

- Many companies have sophisticated and widespread intranets, offering…
  - Detailed data retrieval
  - Collaboration
  - Personalized customer profiles
  - Links to the Internet
- Intranets use Internet technologies
  - Web browsers and servers
  - TCP/IP network protocols
  - HTML publishing and databases

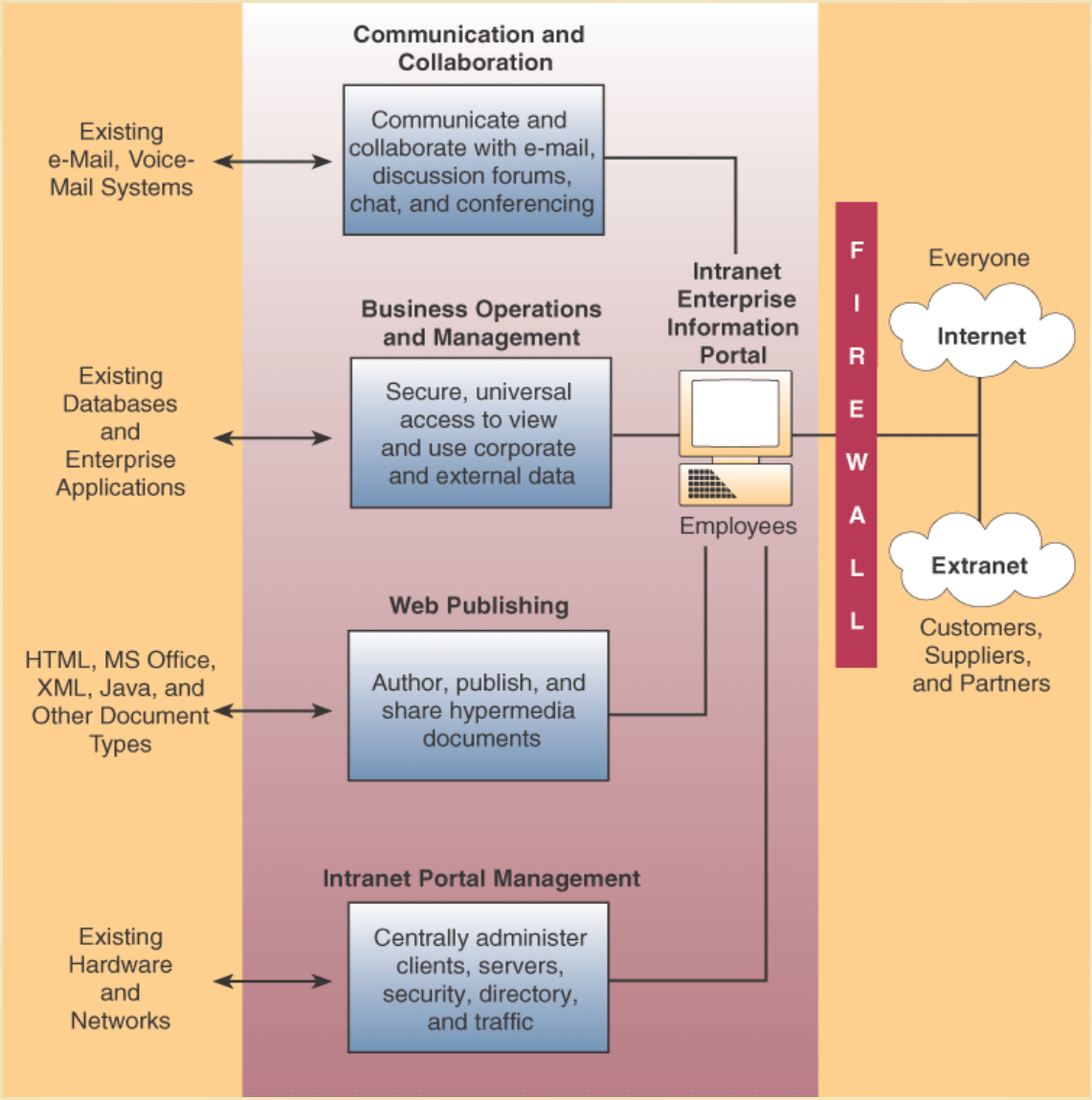
Intranets

- Intranets are protected by…
  - Passwords
  - Encryption
  - Firewalls
- Customers, suppliers, and other business partners can access an intranet via extranet links

Business Value of Intranets

- Intranets support
  - Communications and collaboration
  - Business operations and management
  - Web publishing
  - Intranet portal management

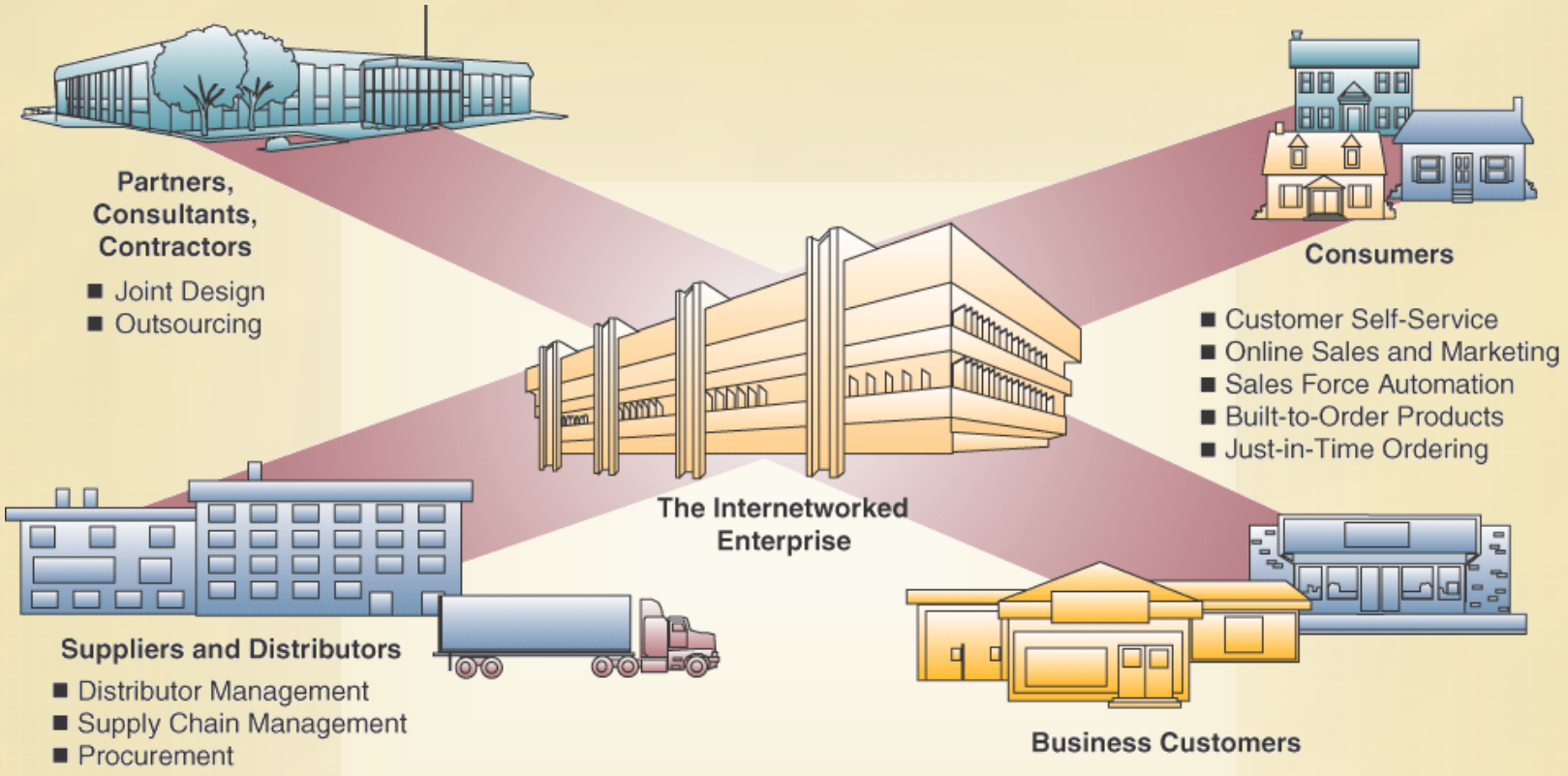
Intranets as Information Portals



Extranets

- Network links that use Internet technologies to connect the intranet of a business to the intranets of another
- Virtual Private Networks
  - Direct private network links, or private secure Internet links between companies
- Unsecured Extranet
  - Link between a company and others via the Internet, relying on encryption of sensitive data and firewall security systems

Extranet Connectivity



Business Value of Extranets

- Web browser technology makes customer and supplier access to intranets easier and faster
- Another way to build and strengthen strategic relationships
- Enables and improves collaboration between a business, customers, and partners
- Facilitates online, interactive product development and marketing

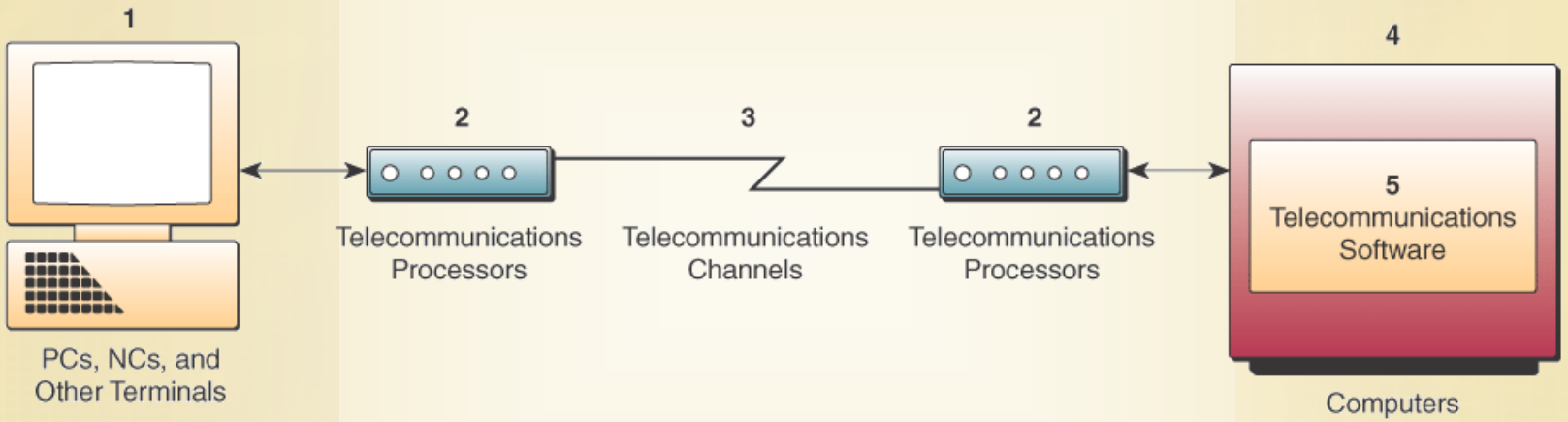
Telecommunications Network Alternatives

- Telecommunications is a highly technical, rapidly changing field
  - Most business professionals don't need detailed technical knowledge
  - However, understanding basic components and their characteristics is necessary
  - Can help you make informed decisions about telecommunications alternatives

Telecommunications Network Model

- A telecommunications network is any arrangement where
  - A **sender** transmits a message
  - To a **receiver**
  - Over a **channel**
  - Consisting of some sort of **medium**

Telecommunications Network Model



Telecommunications Network Components

- Terminals
  - Any input/output device that uses networks to transmit or receive data
- Telecommunications processors
  - Devices that support data transmission, reception
- Telecommunications channels
  - Media over which data are transmitted, received
- Computers
  - All sizes and types

Telecommunications Network Components

- Telecommunications control software
  - Controls telecommunications activities
  - Manages the functions of telecommunications networks
- Includes network management programs of all kinds
  - Telecommunications monitors (mainframes)
  - Network operating systems (network servers)
  - Web browsers (microcomputers)

Network Component Alternatives

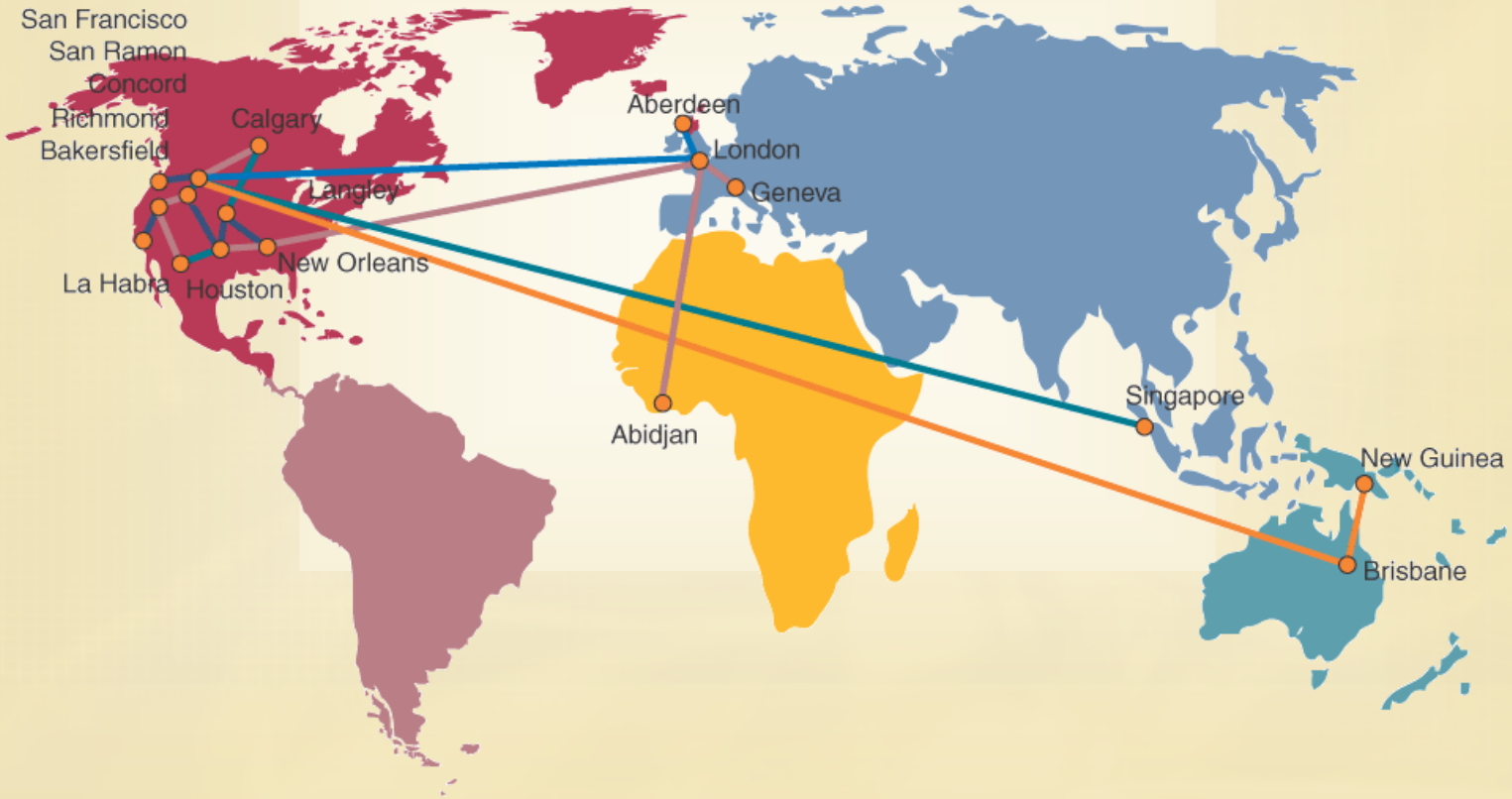
Network Alternative	Examples of Alternatives
Networks	Internet, intranet, extranet, wide area, local area, client/server, network computing, peer-to-peer
Media	Twisted-pair wire, coaxial cable, fiber optics, microwave radio, communications satellites, cellular and PCS systems, wireless mobile and LAN systems
Processors	Modems, multiplexers, switches, routers, hubs, gateways, front-end processors, private branch exchanges
Software	Network operating systems, telecommunications monitors, Web browsers, middleware
Channels	Analog/digital, switched/nonswitched, circuit/message/packet/cell switching, bandwidth alternatives
Topology/architecture	Star, ring, and bus topologies, OSI and TCP/IP architectures and protocols

Types of Communications Networks

- Primary types of communications networks
  - Wide Area
  - Local Area
  - Virtual Private
  - Client/Server
  - Peer-to-peer

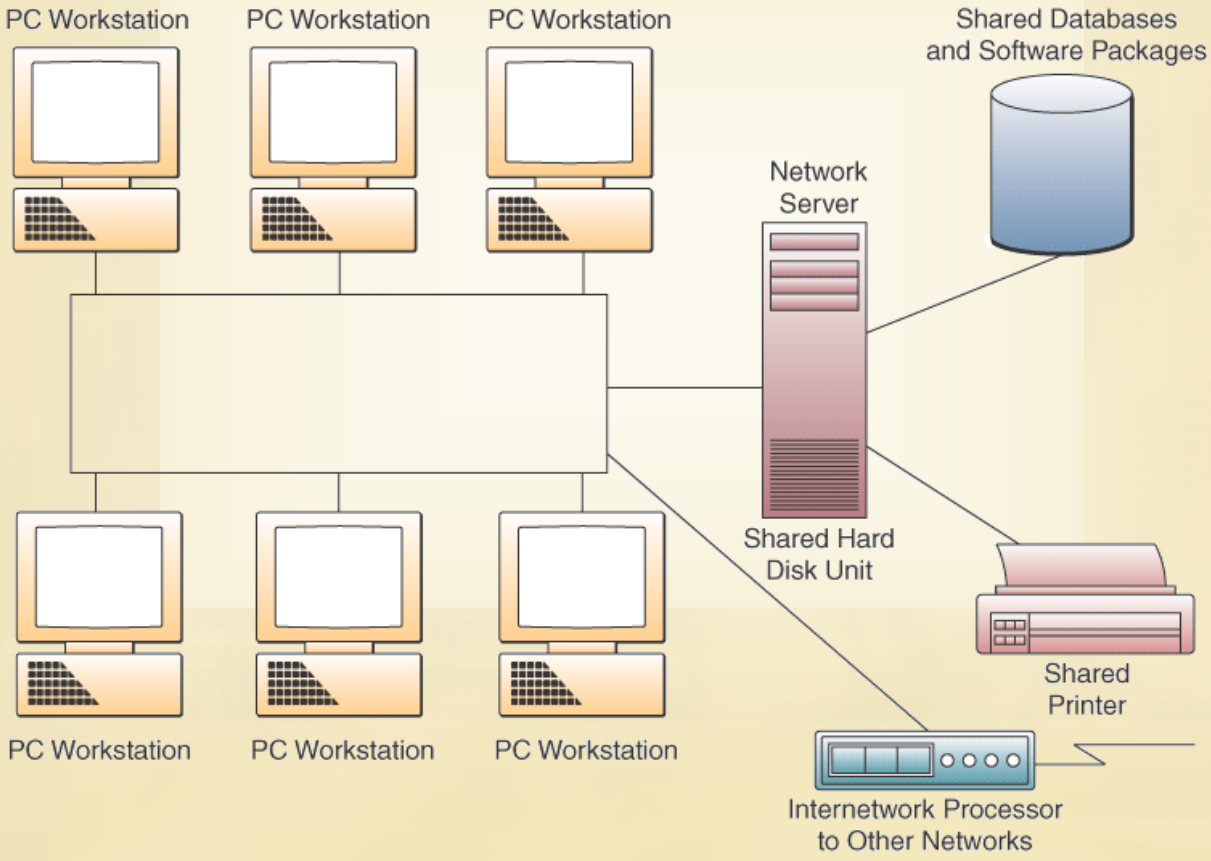
Wide Area Network (WAN)

- Telecommunication network that covers a large geographic area



Local Area Network (LAN)

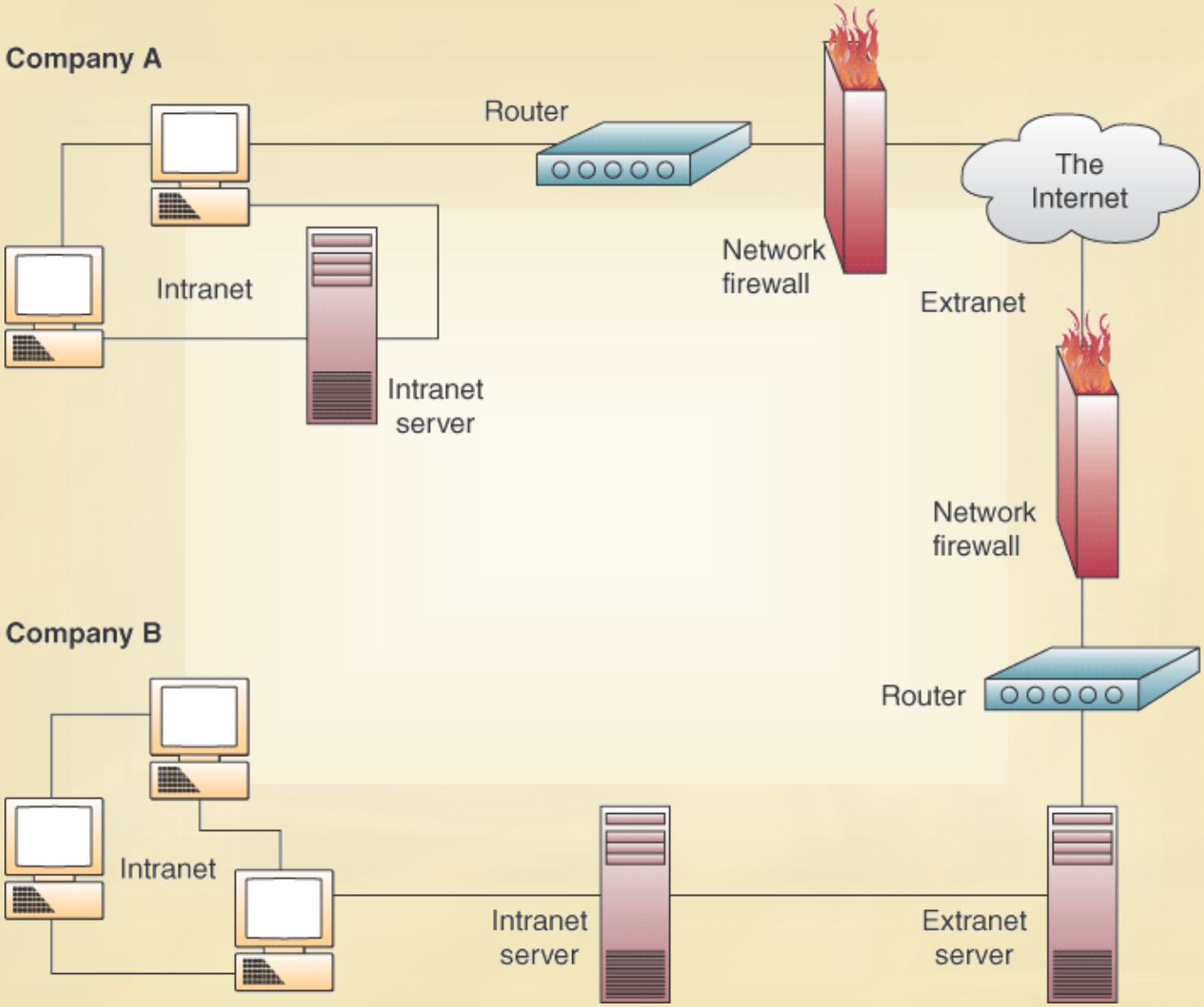
- Connects computers within a limited physical area, such as an office, classroom, or building



Virtual Private Networks (VPN)

- Used to establish secure intranets and extranets
  - The Internet is the main backbone network
  - Relies on network firewalls, encryption, and other security features to build a “pipe” through the Internet
  - Creates a private network without the high cost of a separate proprietary connection

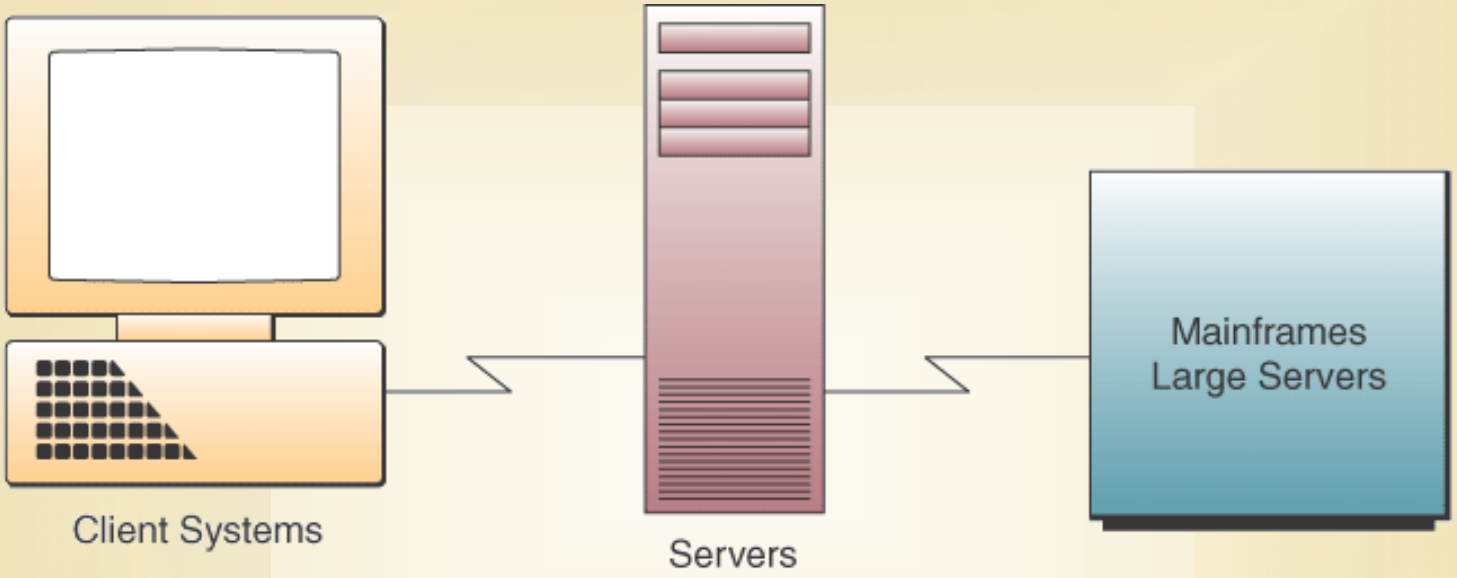
Virtual Private Network



Client/Server Networks

- Clients
  - End user personal computers or networked computers
- Servers
  - Used to manage the networks
- Processing
  - Shared between the clients and servers
  - Sometimes called a two-tier architecture
- Larger computer systems are being replaced with multiple client/server networks

Client/Server Network



- Functions: Provide user interface, perform some/most processing on an application.
- Functions: Shared computation, application control, distributed databases.
- Functions: Central database control, security, directory management, heavy-duty processing.

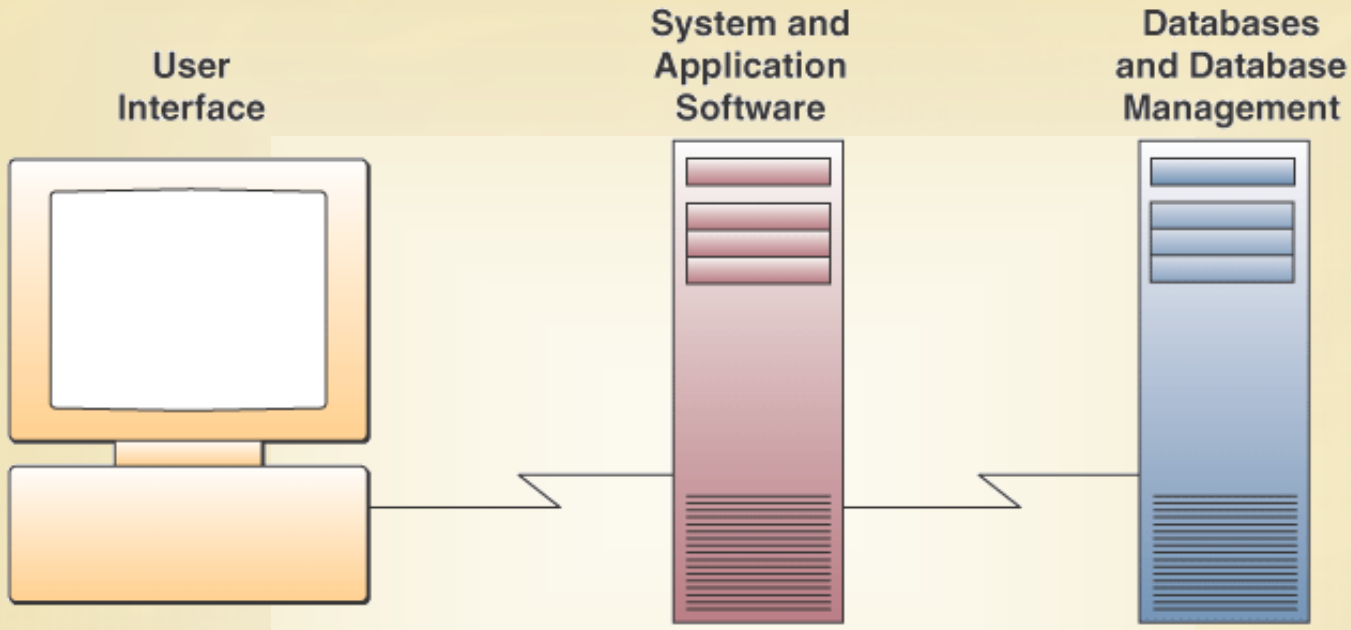
Network Computing

- Networks are the central computing resource of the organization
  - Thin clients provide a browser-based user interface for processing applets
- Thin clients include
  - Network computers
  - Net PCs
  - Other low-cost network devices or information appliances

Network Computing

- Application and database servers provide
  - The operating system
  - Application software
  - Applets
  - Databases
  - Database management software
- Sometimes called a three-tier client/server model because it consists of
  - Thin clients
  - Application servers
  - Database servers

Network Computing



- Network computers and other clients provide a browser-based user interface for applet processing.
- Application servers for multi-user operating systems, Web server software, and application software applets.
- Database servers for Internet/intranet Web databases, operational databases, and database management software.

Peer-to-Peer Networks

- Central Server Architecture
  - P2P file-sharing software connects all PCs to a central server
  - When a PC requests a file, the server searches all active peers on the network
  - The server sends the requesting PC a list of links to all active peers who have the file
  - Clicking a link connects the two PCs and automatically transfers the file to the requesting PC

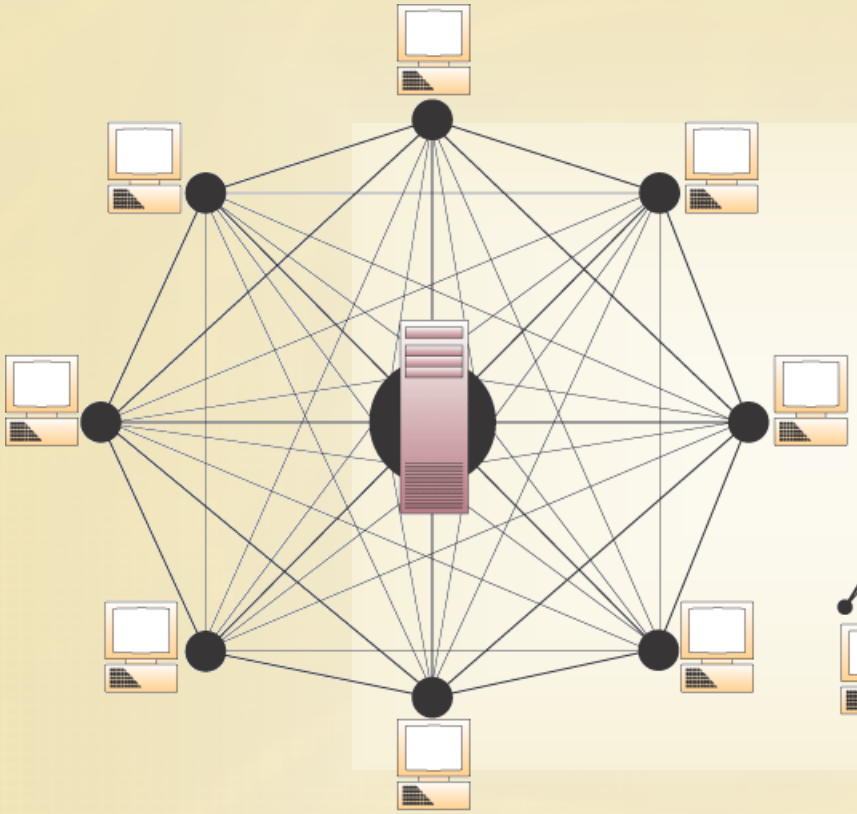
Peer-to-Peer Networks

- Pure Peer-to-Peer Architecture
  - No central directory or server
  - File-sharing software connects one PC to another online user
  - When you request a file, the software searches every online user and sends you a list of active file names
  - Clicking a link automatically transfers the file from that user's hard drive to yours

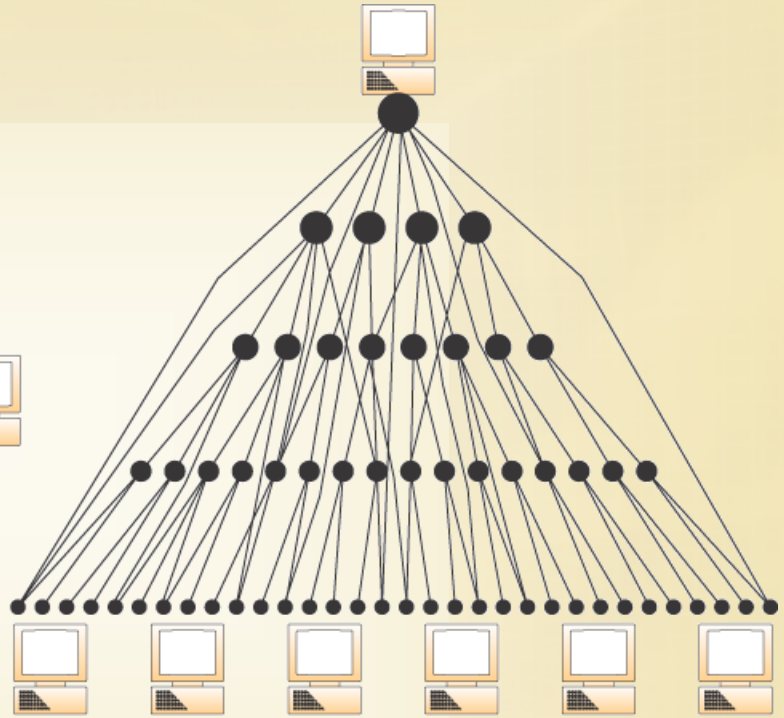
Central Server Peer-to-Peer Networks

- Advantages
  - Can better protect the integrity and security of the content and users of the network
- Disadvantages
  - Directory server can be slowed or overwhelmed by too many users or technical problems

Peer-to-Peer Network Diagrams



■ A peer-to-peer network architecture with a directory of all peers on a central server



■ A pure peer-to-peer network architecture with no central directory server

Digital and Analog Signals

- Analog or digital refers to the method used to convert information into an electrical signal
  - **Analog**: an electrical current is generated that is proportional to the quantity being observed
  - **Digital**: the quantity being observed is expressed as a number
    - Analog: if the temperature is 83 degrees, a measuring device would generate 8.3 volts
    - Digital: a measurement of 83 degrees would be displayed as the number 83

Telecommunications Media

- Twisted-Pair Wire
  - Ordinary telephone wire
  - Copper wire is twisted into pairs

Telecommunications Media

- Coaxial Cable
  - Sturdy copper or aluminum wire wrapped with spacers to insulate and protect it

Telecommunications Media

- Fiber-Optic Cable
  - One or more hair-thin filaments of glass fiber wrapped in a protective jacket

The Problem of "The Last Mile"

- Network providers use fiber optic cable as a communications backbone
  - Houses connected to the backbone are wired with twisted pair
  - Users don't benefit from the faster, better technology

Wireless Technologies

- Terrestrial Microwave
  - Earthbound microwave systems transmit high-speed radio signals
  - Follows a line-of-sight path between relay systems spaced about 30 miles apart
- Communications Satellites
  - Serve as relay stations
  - Use microwave radio signals
  - Earth stations beam signals to the satellites
  - Not suitable for interactive, real-time processing

Wireless Technologies

- Cellular and PCS Telephone and Pager Systems
  - Geographic areas are divided into cells
  - Each cell has a low-power transmitter or radio relay antenna
  - Computers and other communications processors coordinate and control the transmissions to and from mobile users

Wireless Technologies

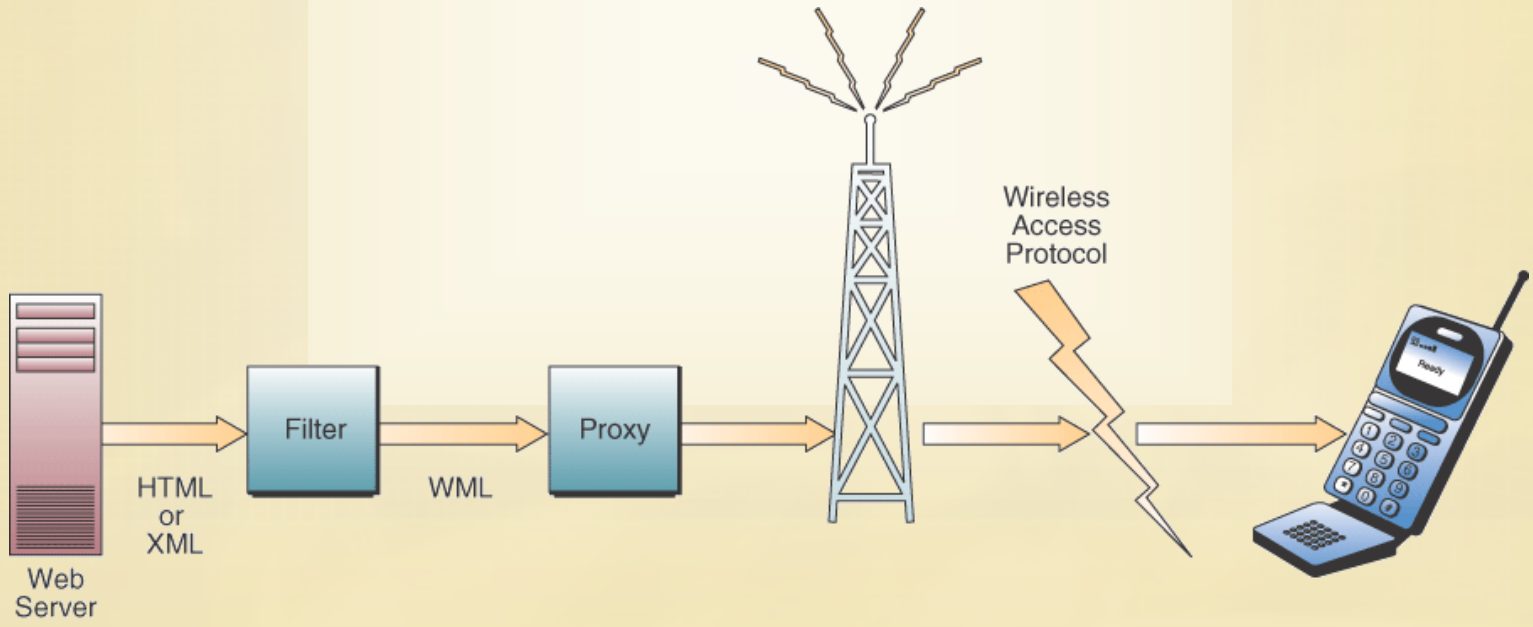
- Wireless LANS
  - Uses wireless radio-wave technology to connect PCs within an office or a building
  - Can be high-frequency, similar to digital cellular, or low frequency (spread spectrum)
- Bluetooth
  - Short-range wireless technology
  - Connects PCs to devices, such as a printer
  - Fairly low cost to implement

Wireless Technologies

- Other Wireless Systems
  - Cellular phones
  - Mobile radio
  - PDAs
- Telecommunications networks now play vital and pervasive roles in
  - Web-enabled e-business processes
  - Electronic commerce
  - Enterprise collaboration
  - Other applications that support business operations, management, and strategic objectives

The Wireless Web

- Wireless Internet access is growing as Web-enabled information appliances proliferate
  - Smart telephones, pagers, PDAs
  - All are very thin clients in wireless networks



Telecommunications Processors

- Modems
  - The most common type of communications processor
  - Converts a digital signal to an analog frequency that can be transmitted over phone lines, then back into a digital signal
    - Modulation and demodulation

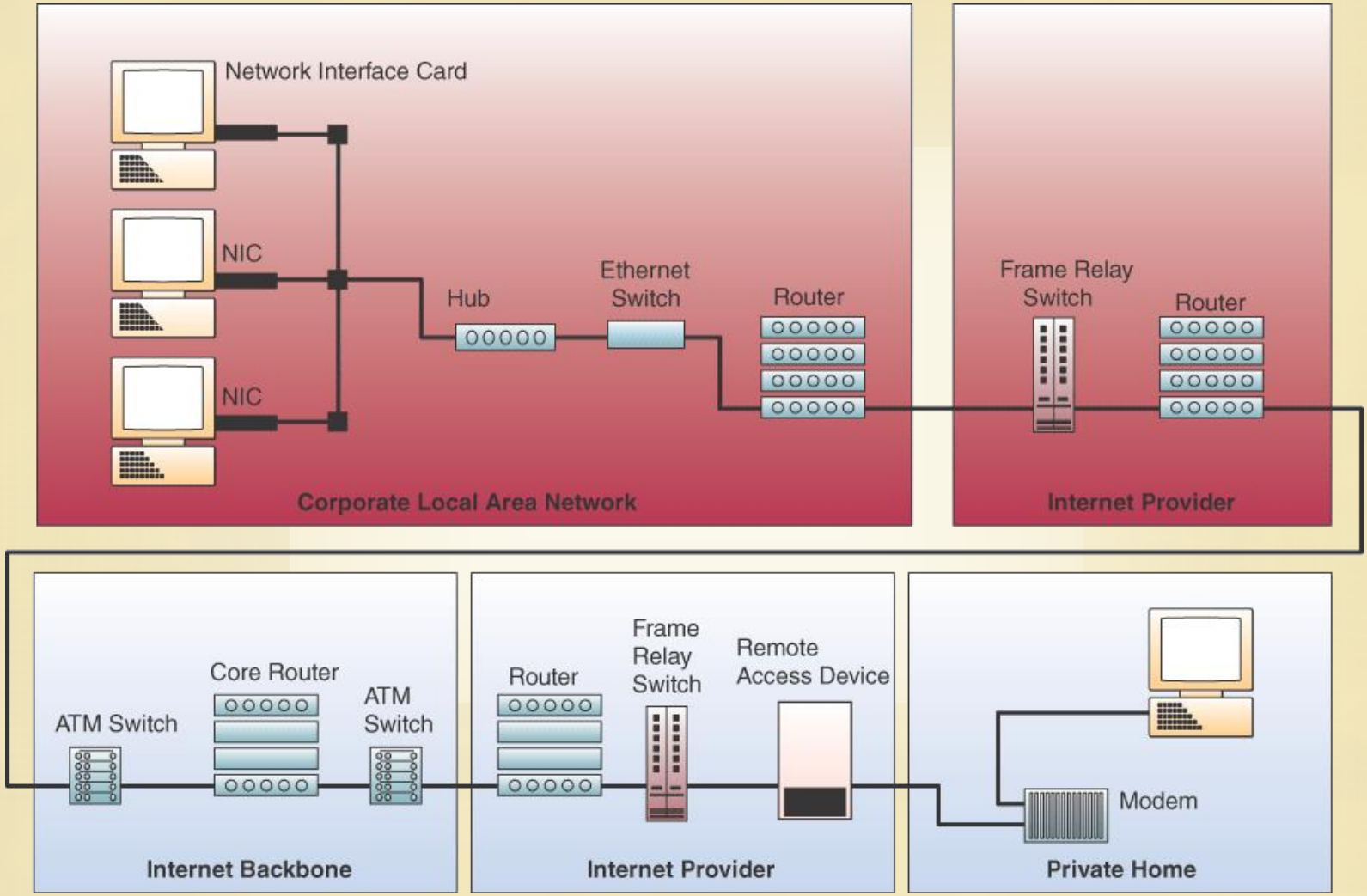
Comparing Technologies

Modem (56 Kbps)	DSL (Digital Subscriber Line) Modem
• Receives at 56 Kbps • Sends at 33.6 Kbps • Slowest technology	• Receives at 1.5 Mbps to 5.0 Mbps • Sends at 128 Kbps to 640 Kbps • Users must be near switching centers
ISDN (Integrated Services Digital Network)	**Cable Modem**
• Sends and receives at 128 Kbps • Users need extra lines • Becoming obsolete	• Receives at 1.5 Mbps to 5 Mbps • Sends at 128 Kbps to 2.5 Mbps • Speed degrades with many local users
Home Satellite	**Local Microwave**
• Receives at 400 Kbps • Sends via phone modem • Slow sending, higher cost	• Sends and receives at 512 Kbps to 1.4 Mbps • Higher cost alternative • May require line of sight to base antenna

Inter-Network Processors

- **Switch**… makes connections between telecommunications circuits in a network
- **Router**… intelligent communications processor that interconnects networks based on different protocols
- **Hub**… a port-switching communications processor
- **Gateway**… connects networks with different communications architectures

Communications Processors



Communications Processors

- **Multiplexer**… allows a single communications channel to carry simultaneous data transmissions from many terminals
  - In time division multiplexing (TDM), the multiplexer divides the time each terminal can use the high-speed into short time slots
- Multiplexers increase the number of transmissions possible
  - Does not increase the number of physical data channels

Telecommunications Software

- May reside in PCs, servers, mainframes, and communications processors
  - Vital part of all telecommunications networks
  - Used to manage network performance
  - WANs often use **telecommunications monitors** or **teleprocessing monitors**
  - Other networks use **operating system** software
  - **Middleware** helps diverse networks communicate with each other

Network Management Functions

- Traffic Management
  - Manage network resources and traffic to avoid congestion and optimize service levels
- Security
  - Provide authentication, encryption, firewall, auditing, and enforcement
- Network Monitoring
  - Troubleshoot and watch over the network, alerting administrators of potential problems

Network Management Functions

- Capacity Planning
  - Survey network resources, traffic patterns, and users' needs
  - Determine the best way to accommodate the needs of the network as it grows and changes

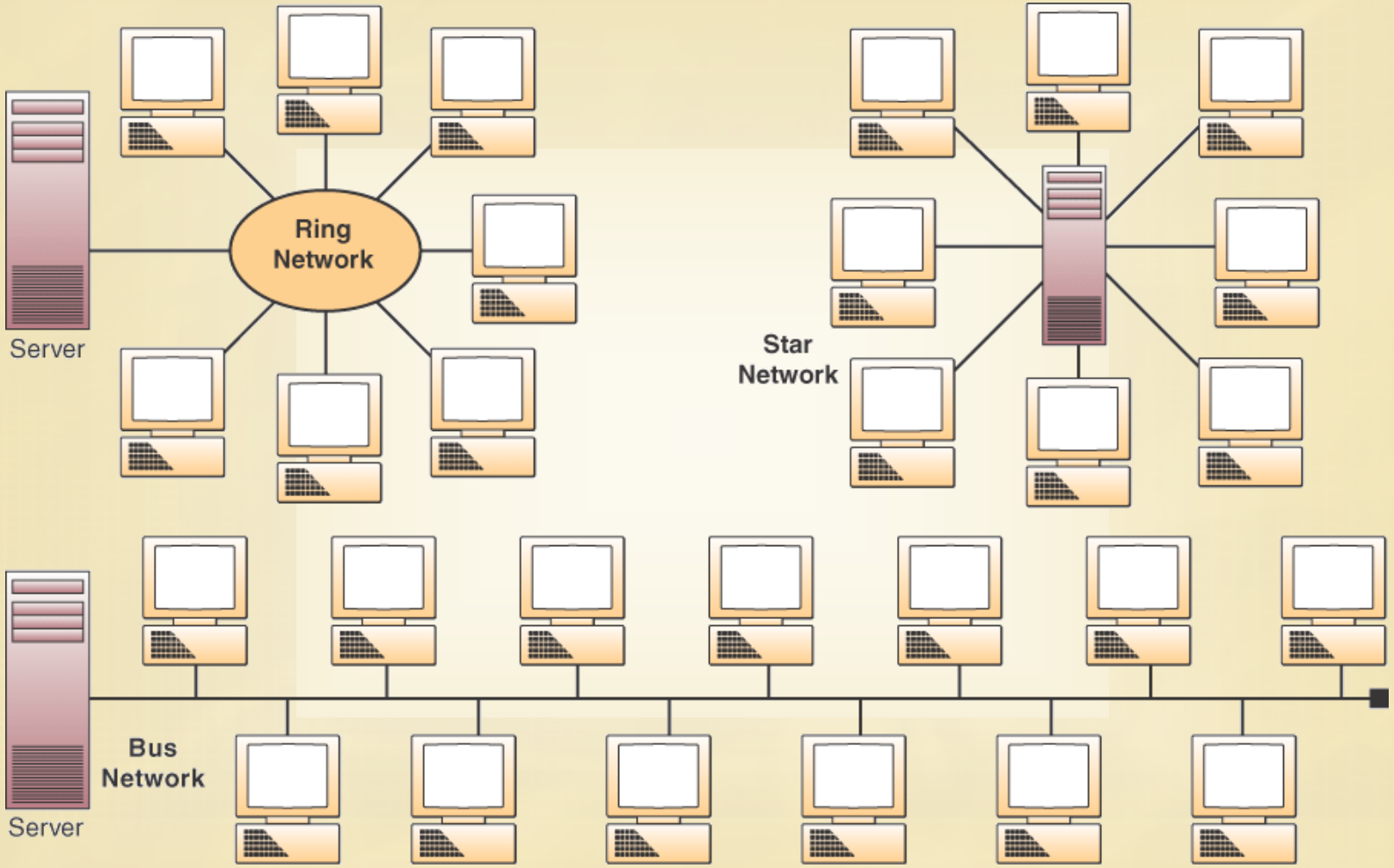
Network Topologies

- Topology
  - The structure of a network
- Star Network
  - Ties end user computers to a central computer
- Ring Network
  - Ties local computer processors together in a ring on a relatively equal basis
- Bus Network
  - Local processors share the same communications channel

Network Topologies

- Mesh Network
  - Uses direct communications lines to connect some or all of the computers in the ring to each other
- Switch
  - A message-switching computer that handles data communication between autonomous local computers

Network Topologies



Network Architectures and Protocols

- Protocol
  - A standard set of rules and procedures for the control of communications in a network
- Handshaking
  - The process of exchanging predetermined signals and characters
  - Establishes a telecommunications session between terminals and computers

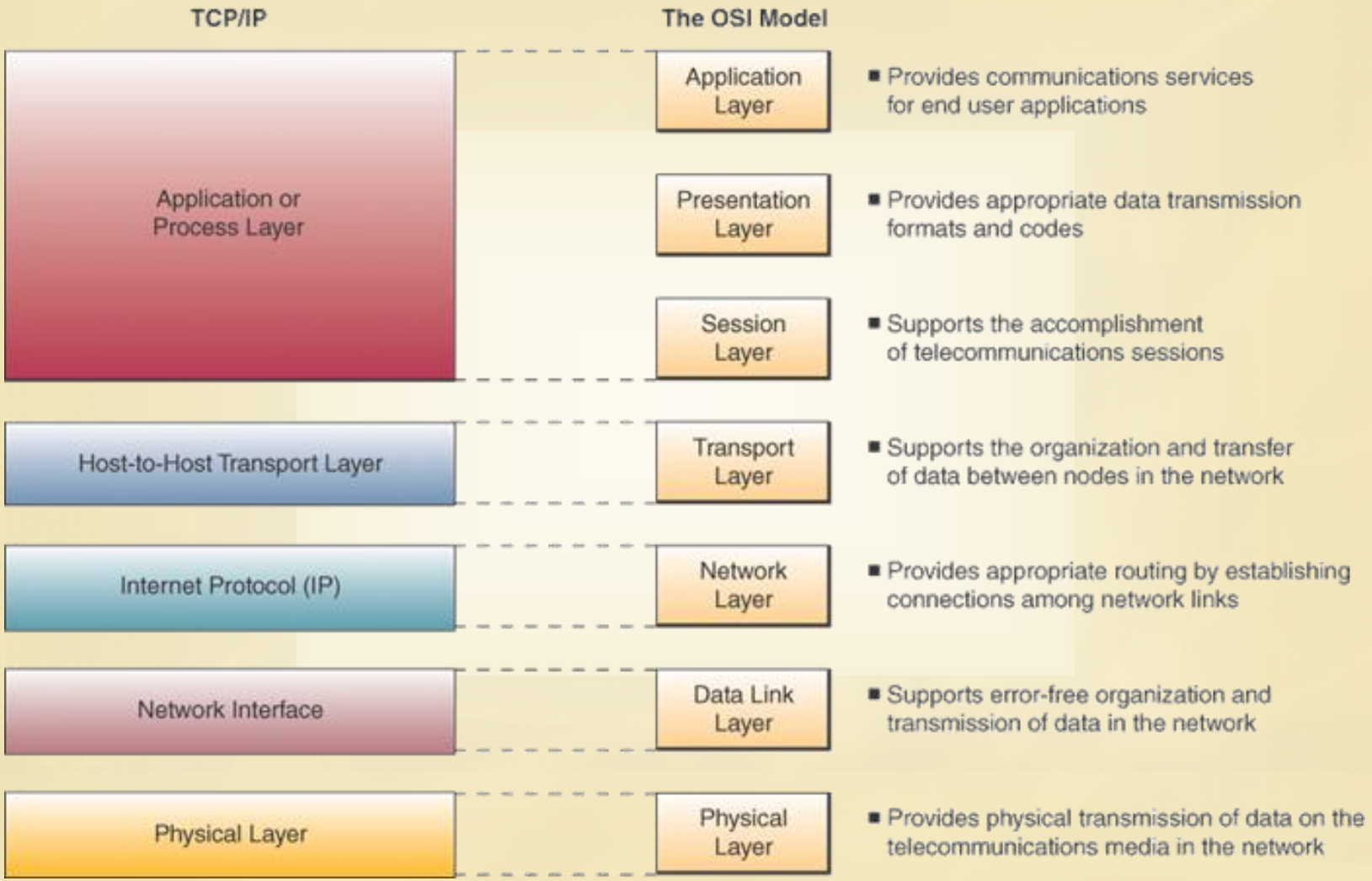
Network Architectures and Protocols

- Network Architecture
  - Master plan of standard protocols, hardware, software, and interfaces between end users and computer systems
  - Goal is to promote an open, simple, flexible, and efficient telecommunications environment

OSI and TCP/IP Models

- Open Systems Interconnection (OSI) Model
  - A seven-layer model that serves as a standard model for network architectures
  - Model for how messages should be transmitted between two points in a network
  - Each layer adds functions
- Transmission Control Protocol/Internet Protocol (TCP/IP)
  - A five-layer telecommunications protocol used by the Internet

OSI and TCP/IP Models



Voice Over IP

- Internet Telephony
  - Using an Internet connection to pass voice data using IP instead of a telephone network
  - Often referred to as voice over IP or VoIP
  - Works like a regular phone, but skips long-distance charges
  - Runs over standard network infrastructure
  - Requires a well-configured network to work smoothly

Bandwidth

- Bandwidth
  - The frequency range of a telecommunications channel that determines the maximum transmission rate
  - Speed and capacity typically measured in bits per second (bps)
  - Sometimes call baud rate
- Transmission Rates
  - Narrow-band = low speed
  - Broadband = high speed

Transmission Speeds

Network Technologies	Typical–Maximum bps
WiFi: wireless fidelity	11–54M
Standard Ethernet or token ring	10–16M
High-speed Ethernet	100M–1G
FDDI: fiber distributed data interface	100M
DDN: digital data network	2.4K–2M
PSN: packet switching network–X.25	64K–1.5M
Frame relay network	1.5M–45M
ISDN: integrated services digital network	64K/128K–2M
ATM: asynchronous transfer mode	25/155M–2.4G
SONET: synchronous optical network	45M–40G
Kbps = thousand bps or kilobits per second. Mbps = million bps or megabits per second.	Gbps = billion bps or gigabits per second.

Switching Alternatives

- Circuit Switching
  - Switch opens a circuit to establish a link between a sender and a receiver
  - It remains open until the communication session is completed
- Packet Switching
  - Breaks messages into groups called packets
  - Transmits packets separately

Network Interoperability

- Ensures that anyone anywhere on one network can communicate with anyone anywhere on another network
  - From a telecommunications perspective, no need to speak a common language
- Telecommunications would be possible without
  - Complete accessibility
  - Transparency
  - Seamless interoperability across all networks

End Of Chapter