Technology in Action

Chapter 10

Behind the Scenes: Networking and Security in the Business World
Chapter Topics

• Client/Server Networks and Topologies
  – Client/Server Network Basics
  – Servers and Network Topologies

• Setting Up Business Networks
  – Transmission Media
  – Network Adapters and Network Navigation Devices
  – Network Operating Systems
  – Client/Server Network Security
Basics of Client/Server Networks

• A network is a group of two or more computing devices (nodes)
• Configured to share information and resources
  – Printers, files and databases
• Businesses gain advantages from deploying networks
Basics of Client/Server Networks
Networking Advantages

Benefits of Business Networks

- **Enable resource sharing**
  - Expensive peripherals, such as printers, can be shared
  - Networks can share a single internet connection

- **Facilitate knowledge sharing**
  - Data can be accessed by multiple people

- **Enable software sharing**
  - Software can be delivered to client computers from a server

- **Enhance communication**
  - Information sharing is more effective when employees are connected
Basics of Client/Server Networks

Networking Disadvantages

• Disadvantages to using networks
  – Additional personnel required to maintain network
  – Require special equipment and software

• Cost savings and advantages usually outweigh the disadvantages
Basics of Client/Server Networks
Comparing Client/Server and Peer-to-Peer Networks

• Where to find client/server networks
  – Majority of computer networks are client/server
  – Tasks can be handled centrally at server
  – Client/server is considered centralized
  – Peer-to-peer (P2P) is decentralized
Basics of Client/Server Networks

Comparing Client/Server and Peer-to-Peer Networks

• Why businesses use client/server networks
  – Make data flow more efficiently than P2P
  – Responds to requests from large number of clients at same time
  – Can be configured to perform specific tasks efficiently
Basics of Client/Server Networks

Comparing Client/Server and Peer-to-Peer Networks

• Why P2P networks aren’t used more in business settings
  – Difficult to administer beyond 10 users
  – Inefficient with large number of computers
  – Security can’t be implemented centrally
  – Client computers are freed up for processor-intensive tasks
### Basics of Client/Server Networks

#### Types of Client/Server Networks

<table>
<thead>
<tr>
<th>Network Type</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LAN (Local Area Network)</strong></td>
<td>A network consisting of nodes covering a small geographic area</td>
<td>In small businesses or self-contained units of a large business (such as one or more floors of the same office building)</td>
</tr>
<tr>
<td><strong>WAN (Wide Area Network)</strong></td>
<td>Two or more LANs connected together, often over long distances</td>
<td>Connecting business LANs over long distances such as between branches in two cities</td>
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<tr>
<td><strong>MAN (Metropolitan Area Network)</strong></td>
<td>WANs constructed by municipalities to provide connectivity in a specific geographic area</td>
<td>Although not deployed by businesses, employees often use them while traveling</td>
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</tbody>
</table>
Basics of Client/Server Networks

Types of Client/Server Networks

• Virtual Private Networks (VPNs) keep information secure

• VPNs work using tunneling
  – Data packets placed into other data packets
  – Encrypted so only understood by sending and receiving hardware (tunnel interface)
  – Hardware is optimized for efficiency
Basics of Client/Server Networks

Types of Client/Server Networks

- Virtual Private Network (VPN) illustrated
Basics of Client/Server Networks
Key Components

- **Network interface card (NIC)**
  - Installed in each client

- **Client Computer #1**

- **Client Computer #2**

- **Switch**
  - Network navigation device

- **Server**

- **Cable**
  - Transmission media

- **Network operating software**
  - Included in operating system software for client computers

- **Network operating software**
  - Installed on server
Servers

• Workhorses of client/server network
• Interface with many network users
• Assist with variety of tasks
• Number and types of servers depend on network size and workload
Major Categories of Servers

Print Servers
- Manage all printing jobs for client computers

Application Servers
- Serve as a repository for application software

Database Servers
- Provide client computers with database access

Authentication Servers
- Keep track of users logged onto the network

File Servers
- Store and manage files for network user

E-Mail Servers
- Process and deliver incoming and outgoing e-mail

Communications Servers
- Handle all communications between the network and other networks

Web/Cloud Servers
- Host websites to make them available through the Internet
Servers

Authentication and File Servers

• Authentication servers
  – Keep track of who is logging on to network
  – Keep track of which services are available to each user
  – Act as overseers for the network
  – Manage and coordinate services provided by dedicated servers

• File servers
  – Store and manage files for network users
Servers

Print Servers

• Manage all client-requested printing jobs
  – Help computers be more productive
  – Free up CPU to do other jobs

• Print queue (print spooler) is a holding area for print jobs
  – Each printer has its own named print queue
  – Jobs print in order
  – Queue can be set to prioritize jobs
Servers

Application Servers

• An application server:
  – Acts as repository for application software
  – Delivers software when client computer makes request
  – Eases installation and upgrading
  – Application is installed or upgraded on application server
Servers

Database Servers

• Provides clients with information stored in databases
• Many people can access the database at one time
• Database resides only on the database server
Servers

E-Mail Servers

• How e-mail is handled on a large client/server network
  – Processes and delivers incoming and outgoing e-mail
  – Large volume could overwhelm a server that handled other tasks
  – Handles routing and delivery of messages
Servers

Communications Servers

• Handle communications between network and other networks
• Manage Internet connectivity
• Have a heavy workload in most organizations
• Are only devices connected directly to Internet
• Provide single point of contact, make it easier to secure network from hackers
Servers

Web Servers

• Functions of a web server
  – Hosts a website
  – Makes it available to the Internet
  – Runs specialized software
  – Many businesses use hosting company instead
Cloud Servers

- Cloud servers
  - Not physically located at company office
  - Maintained by hosting companies
  - Connected to networks via the Internet
  - Can be used for any type of server
  - Can save money for small businesses
Network Topologies

- Physical: layout of the “real” components of the network
- Logical: virtual connections among network nodes
  - Determined by protocols instead of physical layout or paths that signals follow
Network Topologies

• Network protocols
  – Sets of rules for exchanging information
  – Most common topologies are bus, ring, and star
  – Type of topology affects a network’s performance and scalability
Network Topologies

Bus Topology

A cable break here cuts off Computer #1 and Computer #2 from the rest of the network.
Network Topologies

Bus Topology

• Bus (linear) topology
  – All computers are connected in sequence with single cable
  – Data collisions happen when two computers send data at same time
  – Data is broadcast to all devices on network in packets
  – Passive topology (when each node does nothing to move data along)
Network Topologies

Bus Topology

• Advantages
  – Simplicity
  – Low cost

• Disadvantages
  – If cable breaks, the network is disrupted
  – Adding a large number of nodes limits performance and causes delays
Network Topologies

Ring Topology

STEP 1: The token travels around the ring until a computer needs to transmit data.

STEP 2: Computer #2 needs to print and grabs the token.

STEP 3: Computer #2 completes the transmission and releases the token.

STEP 4: A cable break stops movement of the token and data transmission.

Computer #1

Computer #2

Computer #3

Computer #4

Printer
Network Topologies
Ring Topology

• Configuration resembles a loop
• Data flows around the circle in one direction in special packets (tokens)
• Token is passed until grabbed by a computer that needs to transmit data
• Computer “holds” token until finished transmitting data
Network Topologies

Ring Topology

• Advantages of a ring topology
  – Provides fairer allocation of resources
  – Enables nodes to have equal chance
  – Acceptable performance with many users

• Disadvantages of a ring topology
  – If one computer fails, entire network can fail
  – Problems can be hard to find
  – Ceases to function while node is installed
Network Topologies
Star Topology

A cable break here means Computer #1 cannot communicate with the network. However, all other computers and devices can still communicate with each other.
Network Topologies

Star Topology

• Nodes connect to central device in a star pattern
  – Node picks up transmissions addressed to it
  – Jam signal causes original nodes to stop transmitting when data collides
    – After random amount of time nodes try transmitting again
Network Topologies

Star Topology

• Advantages
  – Failure of one computer doesn’t affect rest of network
  – Easy to add nodes
  – Performance remains acceptable even with large number of nodes

• Disadvantage
  – Requires more cable
# Network Topologies
Comparing Topologies

## Advantages and Disadvantages of Bus, Ring, and Star Topologies

<table>
<thead>
<tr>
<th>TOPOLOGY</th>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
</table>
| Bus      | - Uses a minimal amount of cable.  
           - Installation is easy, reliable, and inexpensive. | - Breaks in the cable can disable the network.  
           - Large numbers of users decrease performance because of high volumes of data traffic. |
| Ring     | - Allocates access to the network fairly.  
           - Performance remains acceptable even with many users. | - Adding/removing nodes disables the network.  
           - Failure of one node can bring down the network.  
           - Problems in data transmission can be difficult to find. |
| Star     | - Failure of one node doesn’t affect other nodes on the network.  
           - Centralized design simplifies troubleshooting and repairs.  
           - High scalability: Adding computers is easy.  
           - Performance remains acceptable even with many users. | - Requires more cable (and possibly higher installation costs) than a bus or ring topology.  
           - The switch is a single point of failure; if it fails, all computers connected to it are affected. |
Check Your Understanding

• What are the advantages of a business network?

• Resources (such as printers) can be shared

• Facilitation of knowledge sharing

• Software can be shared

• Information sharing is more effective
Check Your Understanding

• How does a client/server network differ from a peer-to-peer network?

• Servers exercise control over the network
• Data flows more efficiently in client/server networks
• Client/server networks are more scalable
Check Your Understanding

- What are the main classifications of client/server networks?
  - Local area networks (LANs)
  - Wide area networks (WANs)
  - Metropolitan area networks (MANs)
Check Your Understanding

• What components are needed to construct a client/server network?

• Servers
• Topology
• Transmission media
• Network adapters
• Network navigation devices
• Network operating system (NOS) software
Check Your Understanding

• What do the various types of servers do?

• Authentication servers – control access
• File servers – store and manage user files
• Print servers – manage printing jobs
• Application servers – provide access to application software
• Database servers – store database files
• E-mail servers – manage e-mail traffic
• Communications servers – control flow of information to other networks
• Web servers – host websites
• Cloud servers – provide storage and access to data on the Internet
Check Your Understanding

• What are the various network topologies?
  
• Bus
• Ring
• Star
• Hybrid – blending of two or more topologies
Transmission Media

• Transmission media
  – Comprise the physical system that data travels between devices on the network
  – Network devices would be unable to communicate without transmission media
  – Most corporate networks use a combination of wired and wireless media
Transmission Media
Wired Transmission Media

• Why wired connections are used in business networks
  – Provide higher throughput and better security
  – Desktop computers are still popular choices
  – Permanence of desktop installation lends itself to wired connections

• Three main cable types (twisted-pair, coaxial, fiber-optic)
Transmission Media

Wired Transmission Media

• Six factors need to be considered
  – Maximum run length
  – Bandwidth
  – Bend radius (flexibility)
  – Cable cost
  – Installation cost
  – Interference
Transmission Media

Wired Transmission Media

• Causes of interference with data signals
  – Electromagnetic interference (EMI)
  – Radio frequency interference (RFI)
  – Fiber-optic cable is virtually immune to interference
Transmission Media
Twisted-Pair Cable

• Twisting the wires:
  – Causes magnetic fields to intermingle
  – Reduces amount of crosstalk
  – Shielded twisted-pair (STP) has foil shielding
  – Unshielded twisted-pair (UTP) is more susceptible to interference
  – Because of lower cost UTP is most often used
Transmission Media
Twisted-Pair Cable Anatomy

(a) unshielded twisted-pair (UTP) cable
(b) shielded twisted-pair (STP) cable
Transmission Media
Coaxial Cable

- Coaxial cable in business networks
  - Not as popular, but still used when there is heavy electrical interference
Transmission Media
Coaxial Cable

• Four main components of coax cable
  – Core for transmitting signal
  – Solid layer of nonconductive insulating material surrounds core
  – Layer of metal shielding covers insulation to reduce interference
  – External jacket covers protect internal cable components from damage
Transmission Media
Fiber-Optic Cable

• What fiber-optic cable looks like
  – Three major components
    • Glass (or plastic) fiber (or bundle of fibers) through which data is transmitted
    • Protective layer of glass or plastic wrapped around core to protect it
    • Outer jacket (sheath) made of durable material
  – Transmission passes in only one direction, so most cables have at least two fibers (cores)
Transmission Media
Fiber-Optic Cable Anatomy

- Protective sheath
- Glass or plastic cladding
- Optical glass fiber
Transmission Media
Wireless Media Options

• Wireless media options
  – Most businesses use the same Ethernet standards as home networks
  – Wireless access points provide coverage wherever portable devices will be used
Transmission Media
Comparing Transmission Media

• Best medium for business networks
  – Network engineers are responsible for selecting the appropriate topologies and media
    • Topology to be used
    • Length of cable runs
    • Amount of interference
    • Need for wireless connectivity
  – Most use a mix of media types
Network Adapters

• Network adapters
  – Perform specific tasks
  – Enable nodes to communicate on network
  – Referred to as network interface cards (NICs)
  – Break data into packets
  – Act as gatekeepers for information flowing to and from client computer
Network Adapters
What Do They Do?

**STEP 1:** You request information from the network database.

**STEP 2:** The NIC breaks the request into packets and sends the packets to the server.

**STEP 3:** The server executes the request, assembles the response into packets, and sends the packets to the client.

**STEP 4:** The NIC reassembles the response packets and displays information on your screen.

Your computer (client)

Network interface card (NIC)

Server

Request packet #1

Request packet #2

Request packet #3

Response packet #1

Response packet #2

Response packet #3
Network Navigation Devices
MAC Addresses

• How network adapters know where to send data packets
  – Network adapters have physical address, called a media access control (MAC) address
  – Institute of Electrical and Electronics Engineers (IEEE) allocates MAC addresses to adapter manufacturers
  – Not the same as IP addresses
Network Navigation Devices
Switches and Bridges

• Devices used to route signals through a single network
  – Switches rebroadcast data on specific route
  – Switches make decisions using MAC address
  – Improve network efficiency by ensuring node only receives intended data
  – Switches are not sufficient for moving data efficiently across networks of all sizes
  – Bridges are used to connect network segments (collision domains)
Network Navigation Devices
How a Switch Functions
Network Navigation Devices

Routers

• Routers move data between networks
  – Looks at higher level network addresses
  – When data address is not on network it sends data to another network, or Internet
Network Operating Systems

• Connecting computers doesn’t automatically create client/server network
• Network operating system (NOS) is needed
• Modern operating systems include NOS software for peer-to-peer networking
• Client/server networks usually require sophisticated NOS software
Network Operating Systems

• How the NOS controls network communications
  – Each NOS has proprietary:
    • Communications language
    • File management structure
    • Device management structure
  – Sets and controls protocols for all devices
  – Internet uses open protocol (TCP/IP)
  – Modern NOSs support TCP/IP
Network Security for Client/Server Networks

• Sources of security threats
  – Human errors and mistakes
  – Malicious human activity
  – Natural events and disasters
Authentication

• Authentication is the process of approving which users can use a network
• Hackers can use people’s accounts improperly to log into a network
Access Privileges

- Access privileges are granted when your account is set up.
- Restricting access privileges protects a network.
- Portable storage devices (such as flash drives) facilitate data theft.
- Network administrators must protect networks from portable storage devices.
Physical Protection Measures

- Access card reader
- Retinal scanning
- Fingerprint/palm scanning
- Facial recognition
Network Security for Client/Server Networks
Physical Protection Measures

• Biometric authentication devices use unique characteristic of human biology to identify users

• Problems with biometric devices
  – Don’t always function as intended
  – Future fingerprint readers will use algorithms
  – Future retinal readers might check for blinks or whether pupils contract
Network Security for Client/Server Networks

Firewalls

• Internet connections on client/server networks are vulnerable to hackers

• Firewalls on a client/server network provide protection similar to a personal firewall installed on a home network

• Firewalls on client/server networks are usually more sophisticated than personal firewalls
A bastion host is a heavily secured server on a perimeter network

- Honey pot
- Configured as a Proxy server
  - Acts as go-between connecting internal computers with external network
Network Security for Client/Server Networks

Firewalls (cont.)
Check Your Understanding

• What types of transmission media are used in client/server networks?

• Wireless media
  – Uses radio waves

• Wired media
  – Twisted-pair cable
  – Coaxial cable
  – Fiber-optic cable
Check Your Understanding

• How do network adapters enable computers to participate in a client/server network?

• Network adapters
  – Convert low-power signals from the computer to high-power signals that can traverse media
  – Breaks data into packets
  – Control the flow of data to and from the computer
Check Your Understanding

• What devices assist in moving data around a client/server network?
  • Switches – transmit data from node to node on a network
  • Bridges – transmit data between two segments (collision domains) on the same network
  • Routers – move data between two networks
Check Your Understanding

• What software needs to run on computers attached to a client/server network, and how does this software control network communications?

• Network operating system (NOS) software
• NOS provides common rules (protocols) that control communications between nodes
Check Your Understanding

• What measures are employed to keep large networks secure?

• Authentication procedures restrict access to authorized users

• Access privileges restrict users only to data and systems they need to access

• Access to networking equipment is physically restricted by locked doors and biometric devices
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