CHAPTER 10
SELECTING TECHNOLOGIES AND DEVICES FOR CAMPUS NETWORKS

Expected Outcomes
Able to select appropriate technologies and devices for an affordable Campus Network design
Selecting Technologies and Devices

- We now know what the network will look like
- We also know what capabilities the network will need
- We are now ready to start picking out technologies and devices
- Chapter 10 has guidelines for campus networks
Campus Network Design Steps

- Develop a cabling plant design
- Select the types of cabling
- Select the data-link-layer technologies
- Select internetworking devices
  - Meet with vendors
Cabling Plant Design Considerations

- Campus and building cabling topologies
- The types and lengths of cables between buildings
- Within buildings
  - The location of telecommunications closets and cross-connect rooms
  - The types and lengths of cables for vertical cabling between floors
  - The types and lengths of cables for horizontal cabling within floors
  - The types and lengths of cables for work-area cabling going from telecommunications closets to workstations
Centralized Versus Distributed Cabling Topologies

• A centralized cabling scheme terminates most or all of the cable runs in one area of the design environment. A star topology is an example of a centralized system.

• A distributed cabling scheme terminates cable runs throughout the design environment. Ring, bus, and tree topologies are examples of distributed systems.
Centralized Campus Cabling

Cable Bundle

Building A

Building B

Building C

Building D
Distributed Campus Cabling
Types of Media Used in Campus Networks

- Copper media
- Optical media
- Wireless media
Copper Media Advantages

- Conducts electric current well
- Does not rust
- Can be drawn into thin wires
- Easy to shape
- Hard to break
Copper Media

- Coaxial
- Twisted-Pair
  - Shielded Twisted-Pair (STP)
  - Unshielded Twisted-Pair (UTP)
Coaxial Cable

● Solid copper conductor, surrounded by:
  ◦ Flexible plastic insulation
  ◦ Braided copper shielding
  ◦ Outer jacket

● Can be run without as many boosts from repeaters, for longer distances between network nodes, than either STP or UTP cable
  ◦ Nonetheless, it’s no longer widely used
Twisted-Pair Cabling

- A “twisted pair” consists of two copper conductors twisted together
- Each conductor has plastic insulation
- Shielded Twisted Pair (STP)
  - Has metal foil or braided-mesh covering that encases each pair
- Unshielded Twisted Pair (UTP)
  - No metal foil or braided-mesh covering around pairs, so it’s less expensive
UTP Categories

- **Category 1.** Used for voice communication
- **Category 2.** Used for voice and data, up to 4 Mbps
- **Category 3.** Used for data, up to 10 Mbps
  - Required to have at least 3 twists per foot
  - Standard cable for most telephone systems
  - Also used in 10-Mbps Ethernet (10Base-T Ethernet)
- **Category 4.** Used for data, up to 16 Mbps
  - Must also have at least 3 twists per foot as well as other features
  - Used in Token Ring
- **Category 5.** Used for data, up to 100 Mbps
  - Must have 3 twists per inch!
- **Category 5e.** Used in Gigabit Ethernet
- **Category 6.** Used in Gigabit Ethernet and future technologies
Optical Media

- Multimode Fiber (MMF)
- Single-mode Fiber (SMF)
Copper Vs Fiber-Optic Cabling

- Twisted-pair and coax cable transmit network signals in the form of current
- Fiber-optic cable transmits network signals in the form of light
- Fiber-optic cable is made of glass
  - Not susceptible to electromagnetic or radio frequency interference
  - Not as susceptible to attenuation, which means longer cables are possible
  - Supports very high bandwidth (10 Gbps or greater)
  - For long distances, fiber costs less than copper
<table>
<thead>
<tr>
<th>Multimode</th>
<th>Single-mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larger core diameter</td>
<td>Smaller core diameter</td>
</tr>
<tr>
<td>Beams of light bounce</td>
<td>Less bouncing around;</td>
</tr>
<tr>
<td>off cladding in multiple</td>
<td>single, focused beam of</td>
</tr>
<tr>
<td>ways</td>
<td>light</td>
</tr>
<tr>
<td>Usually uses LED source</td>
<td>Usually uses LASER source</td>
</tr>
<tr>
<td>Less expensive</td>
<td>More expensive</td>
</tr>
<tr>
<td>Shorter distances</td>
<td>Very long distances</td>
</tr>
</tbody>
</table>
Wireless Media

- IEEE 802.11a, b, and g
- Laser
- Microwave
- Cellular
- Satellite
Cabling Guidelines

• At the access layer use
  ◦ Copper UTP rated for Category 5 or 5e, unless there is a good reason not to
  ◦ To future proof the network
    • Use 5e instead of 5
    • Install UTP Category 6 rated cable and terminate the cable with Cat 5 or 5e connectors
    • Then only the connectors need to be changed to move up in speed
  ◦ In special cases
    • Use MMF for bandwidth intensive applications
    • Or install fiber along with the copper
Cabling Guidelines

• At the distribution layer use
  • MMF if distance allows
  • SMF otherwise
  • Unless unusual circumstances occur and cable cannot be run, then use a wireless method
• To future proof the network
  • Run both MMF and SMF
LAN Technologies

- Half-duplex Ethernet (becoming obsolete)
- Full-duplex Ethernet
- 10-Mbps Ethernet (becoming obsolete)
- 100-Mbps Ethernet
- 1000-Mbps (1-Gbps or Gigabit) Ethernet
- 10-Gbps Ethernet
- Metro Ethernet
- Long Range Ethernet (LRE)
- Cisco’s EtherChannel
IEEE 802.3 10-Mbps Ethernet

10 Mbps Ethernet

- **10Base5**: Thick coax cable, 500 meters
- **10Base2**: Thin coax cable, 185 meters
- **10BaseT**: 2 pairs Category-3 or better UTP, 100 meters
- **10BaseF**: 2 multimode optical fibers
- **10Broad36**: 3 channels of a private CATV system, 3600 meters
IEEE 802.3 100-Mbps Ethernet

100BaseT

100BaseX

100BaseTX

2 pairs Category-5 or better UTP
100 meters

100BaseFX

2 multimode optical fibers
2000 meters (full duplex)

100BaseT4

4 pairs
Category-3 or better UTP
100 meters

100BaseT2

2 pairs
Category-3 or better UTP
100 meters
IEEE 802.3 Gigabit Ethernet

1000BaseX

1000BaseSX
2 multimode optical fibers using shortwave laser optics
550 meters

1000BaseLX
2 multimode or single-mode optical fibers using longwave laser optics
550 meters multimode, 5000 meters single-mode

1000BaseCX
2 pairs STP
25 meters

1000BaseT
4 pairs Category-5 UTP
100 meters
IEEE 802.3 10-Gbps Ethernet

10GBaseX

10GBaseLX4
- Multimode or single-mode optical fibers
- 300 meters multimode, 10 km single-mode

10GBaseS
- Multimode optical fibers
- 300 meters

10GBaseL
- Single-mode optical fibers
- 10 km

10GBaseE
- Single-mode optical fibers
- 40 km
Metro Ethernet

• Service offered by providers and carriers that traditionally had only classic WAN offerings
• The customer can use a standard Ethernet interface to reach a MAN or WAN
• The customer can add bandwidth as needed with a simple configuration change
Long-Reach Ethernet

- Enables the use of Ethernet over existing, unconditioned, voice-grade copper twisted-pair cabling
- Used to connect buildings and rooms within buildings
  - Rural areas
  - Old cities where upgrading cabling is impractical
  - Multi-unit structures such as hotels, apartment complexes, business complexes, and government agencies
Cisco’s EtherChannel

Data Center Switch

800 Mbps EtherChannel

West Fiber Run
400 Mbps

East Fiber Run
400 Mbps

Wiring Closet Switch
Internetworking Devices for Campus Networks

- Hubs (becoming obsolete)
- Switches
- Routers
- Wireless access points
- Wireless bridges
Selection Criteria for Internetworking Devices

- The number of ports
- Processing speed
- The amount of memory
- Latency when device relays data
- Throughput when device relays data
- LAN and WAN technologies supported
- Media supported
Summary

- Once the logical design is completed, the physical design can start.
- A major task during physical design is selecting technologies and devices for campus networks:
  - Media
  - Data-link layer technology
  - Internetworking devices
- Also, at this point, the logical topology design can be developed further by specifying cabling topologies.
Review Questions

• What are three fundamental media types used in campus networks?
• What selection criteria can you use to select an Ethernet variety for your design customer?
• What selection criteria can you use when purchasing internetworking devices for your design customer?
• Some people think Metro Ethernet will replace traditional WANs. Do you agree or disagree and why?