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

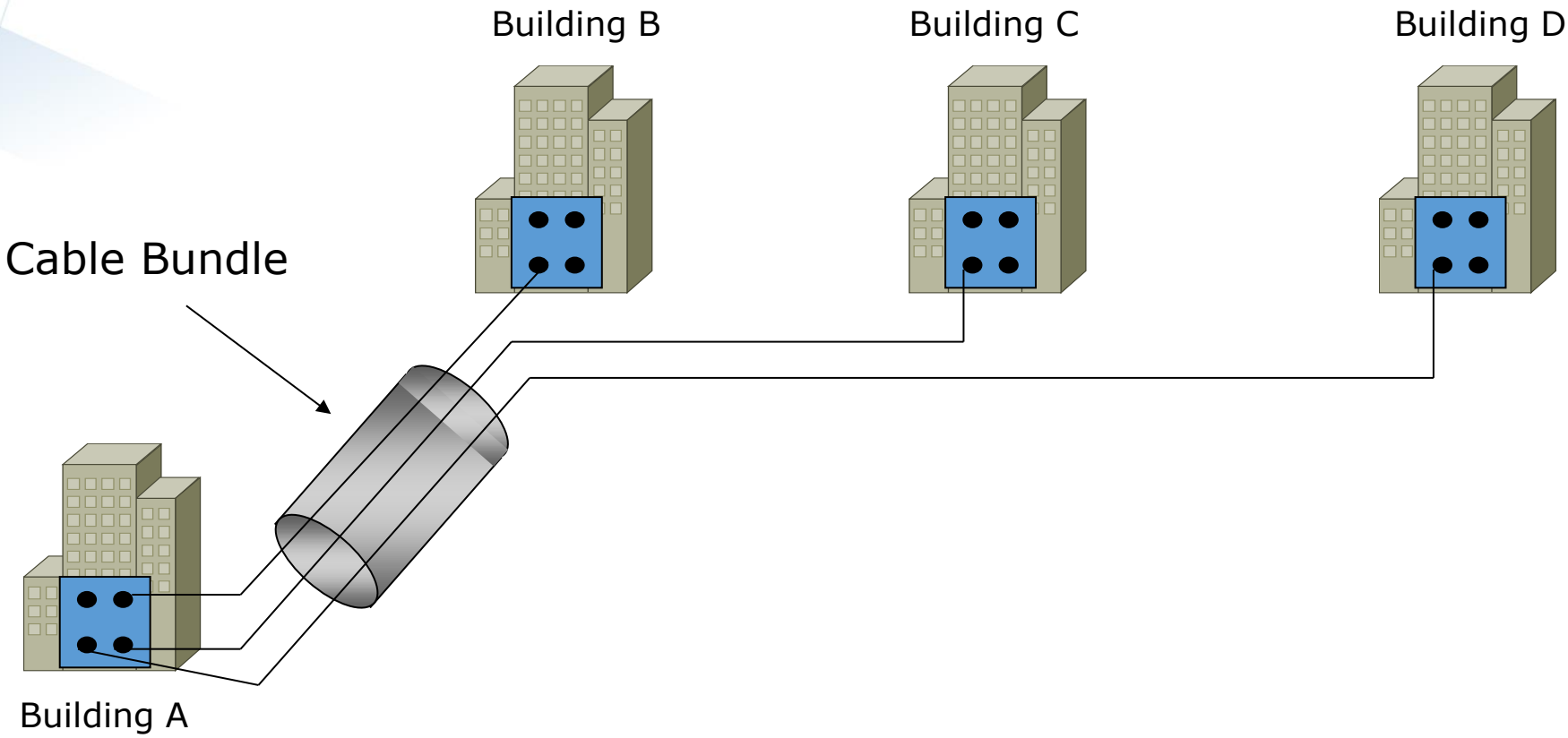
Cabling Plant Design Considerations

- 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

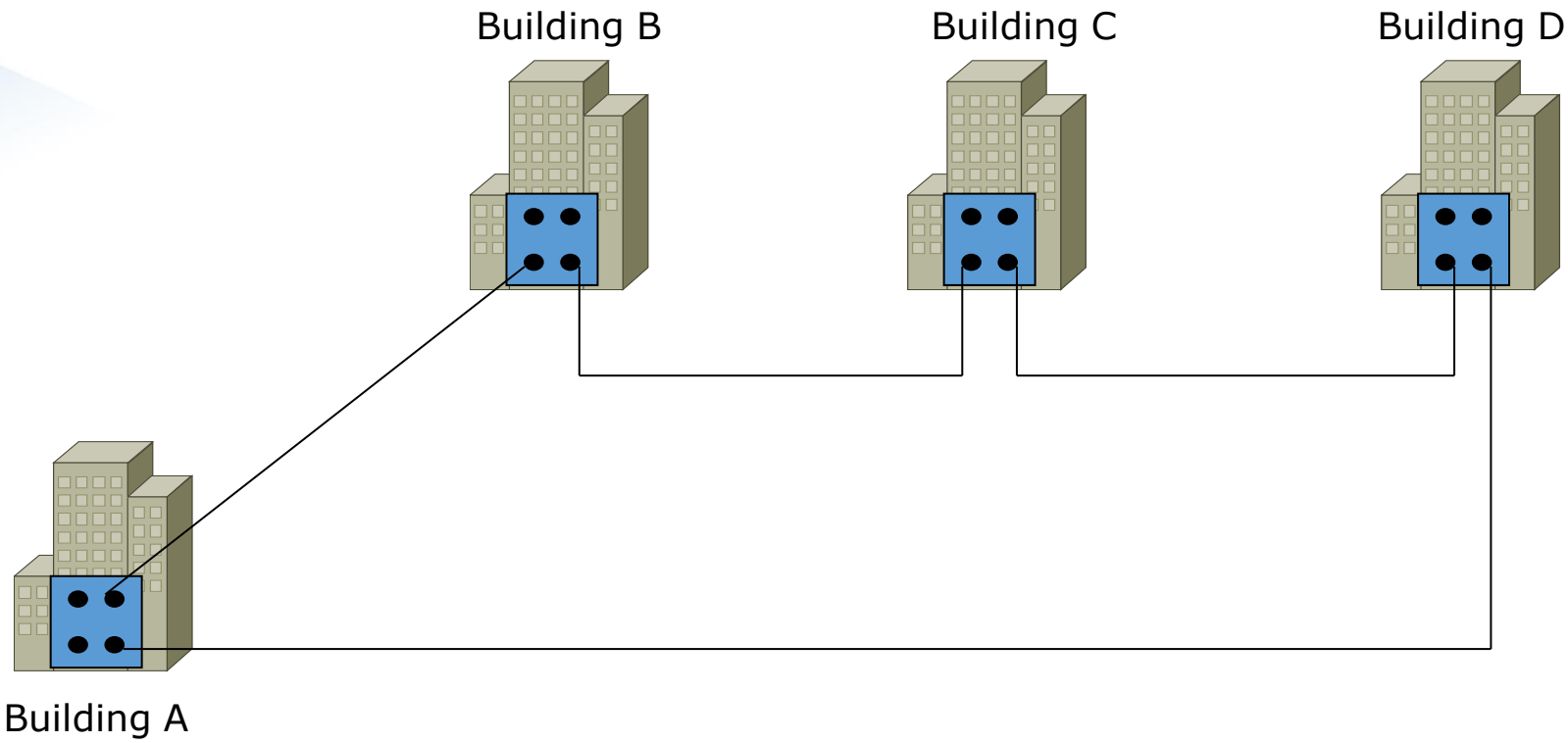
Centralized Versus Distributed Cabling Topologies

- 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



Distributed Campus Cabling

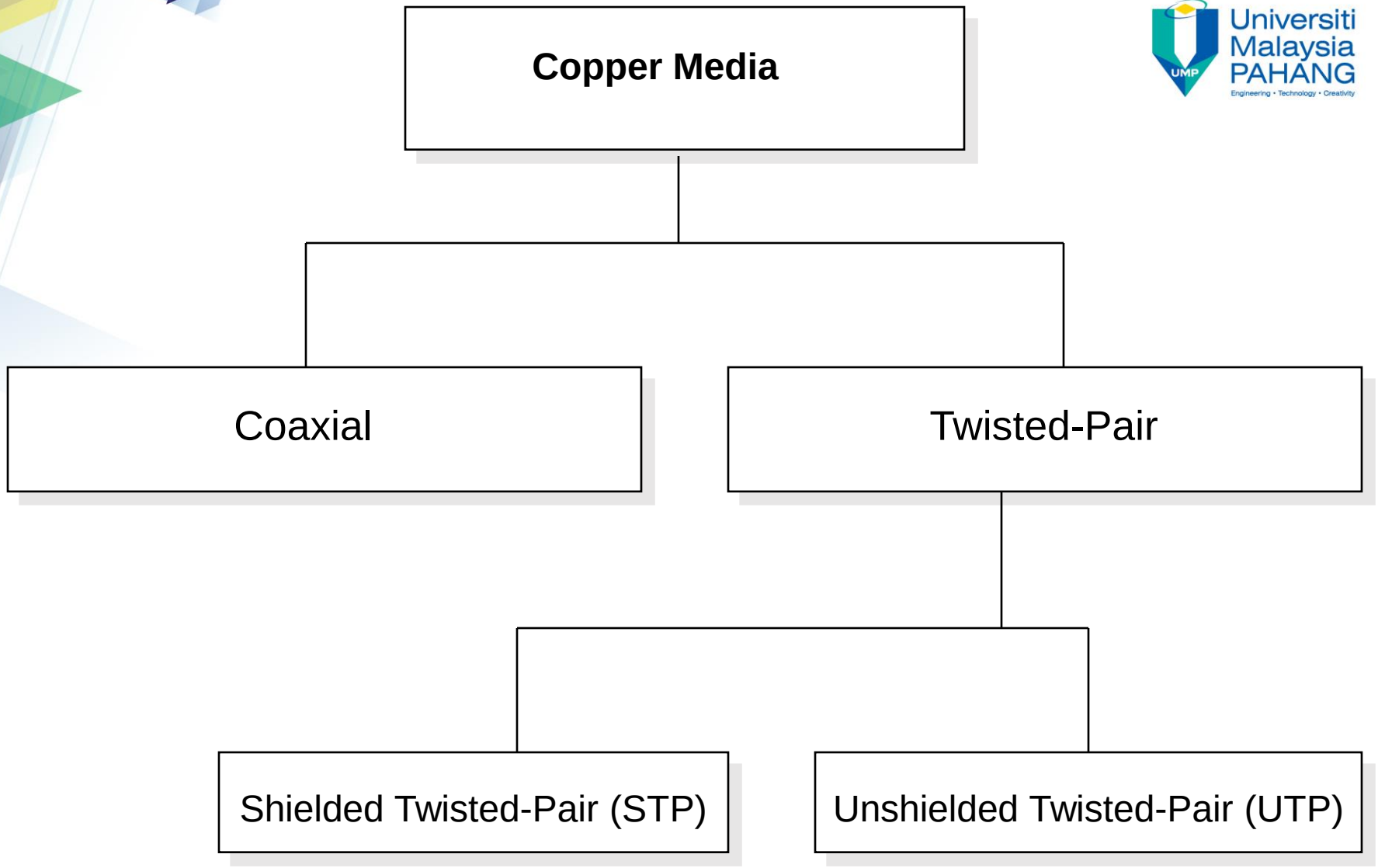


Types of Media Used in Campus Networks

- 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

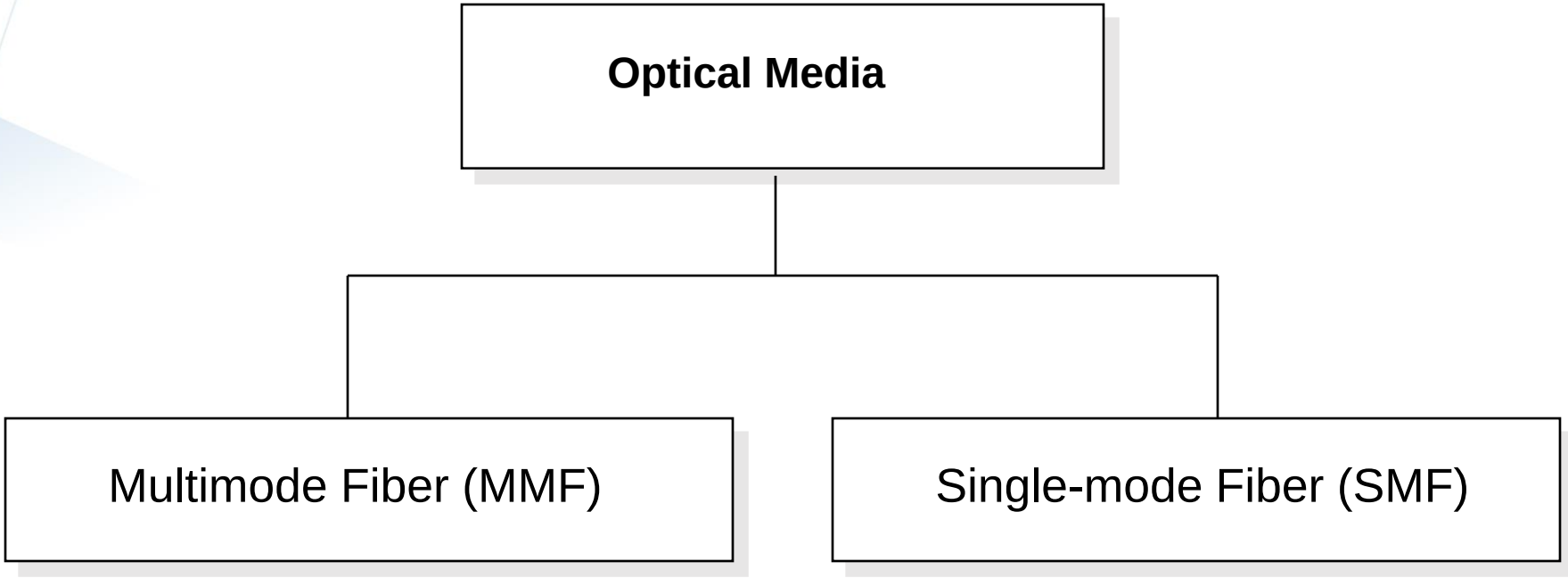
- Solid copper conductor, surrounded by:
  - Flexible plastic insulation
  - Braided copper shielding
  - Outer jacket
- Can be run without as many boosts from repeaters, for longer distances between network nodes, than either STP or UTP cable
  - Nonetheless, it's no longer widely used

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

Multimode Single-mode

Multimode	Single-mode
• Larger core diameter • Beams of light bounce off cladding in multiple ways • Usually uses LED source • Less expensive • Shorter distances	• Smaller core diameter • Less bouncing around; single, focused beam of light • Usually uses LASER source • More expensive • Very long distances

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

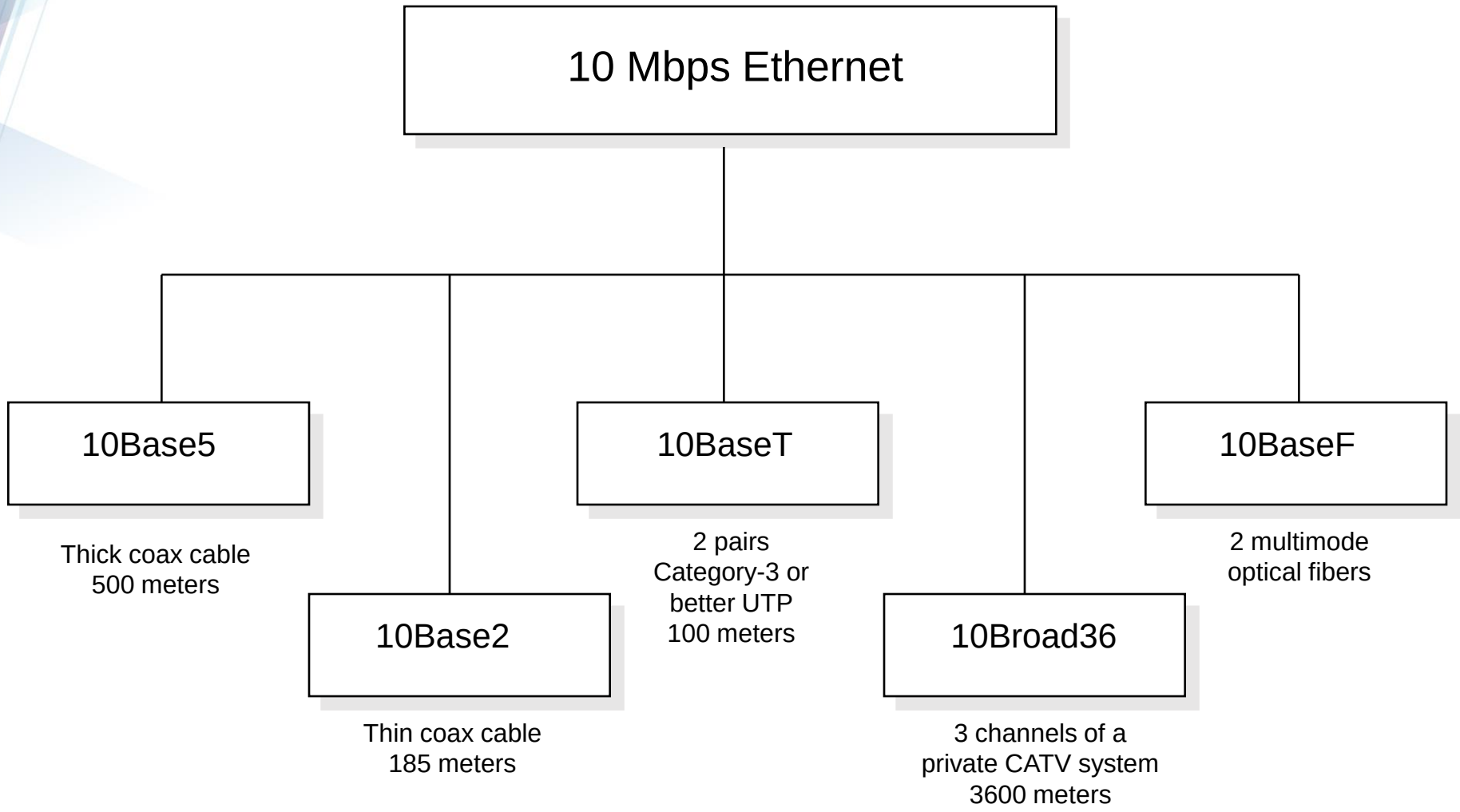
Cabling Guidelines

- 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

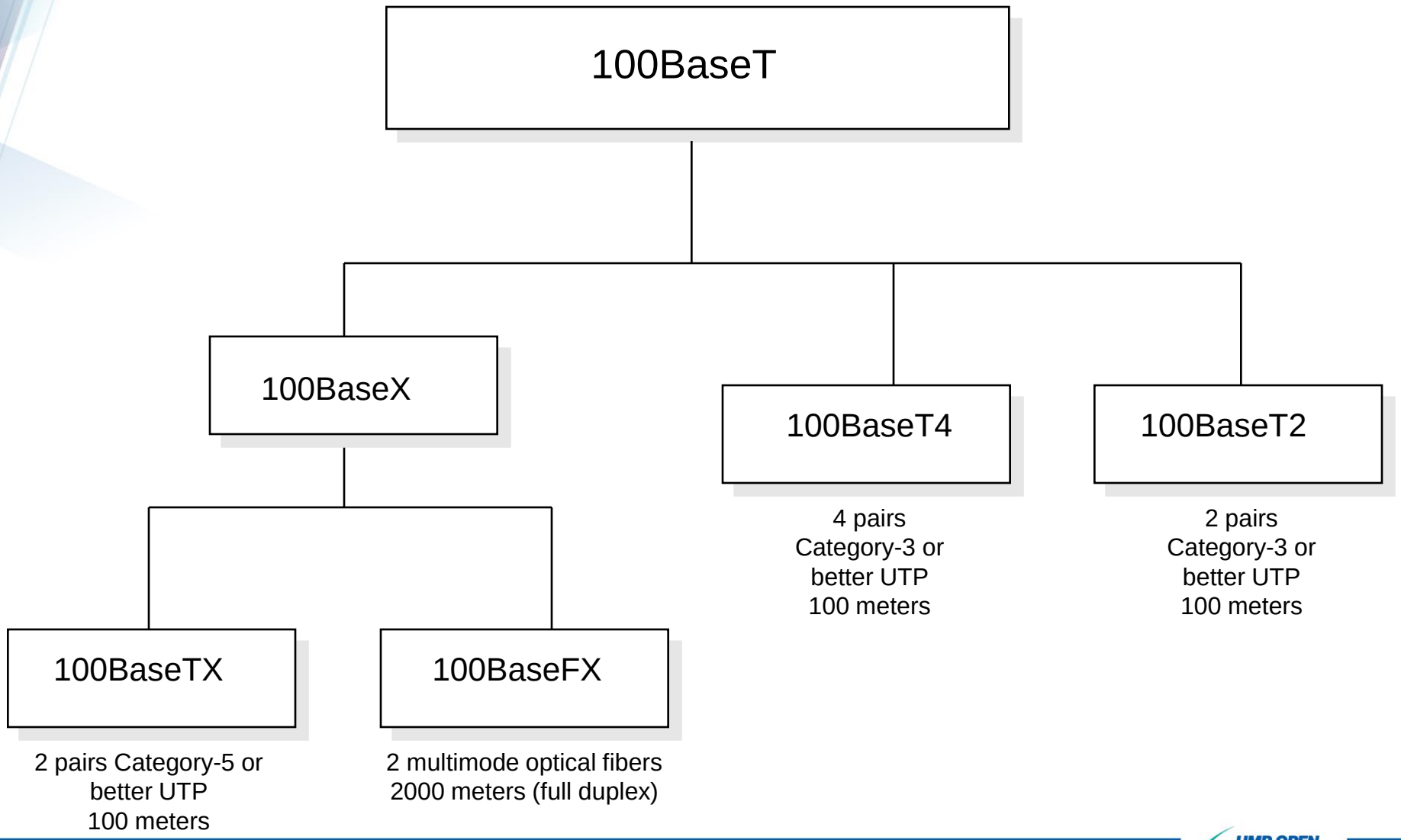
LAN Technologies

- 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

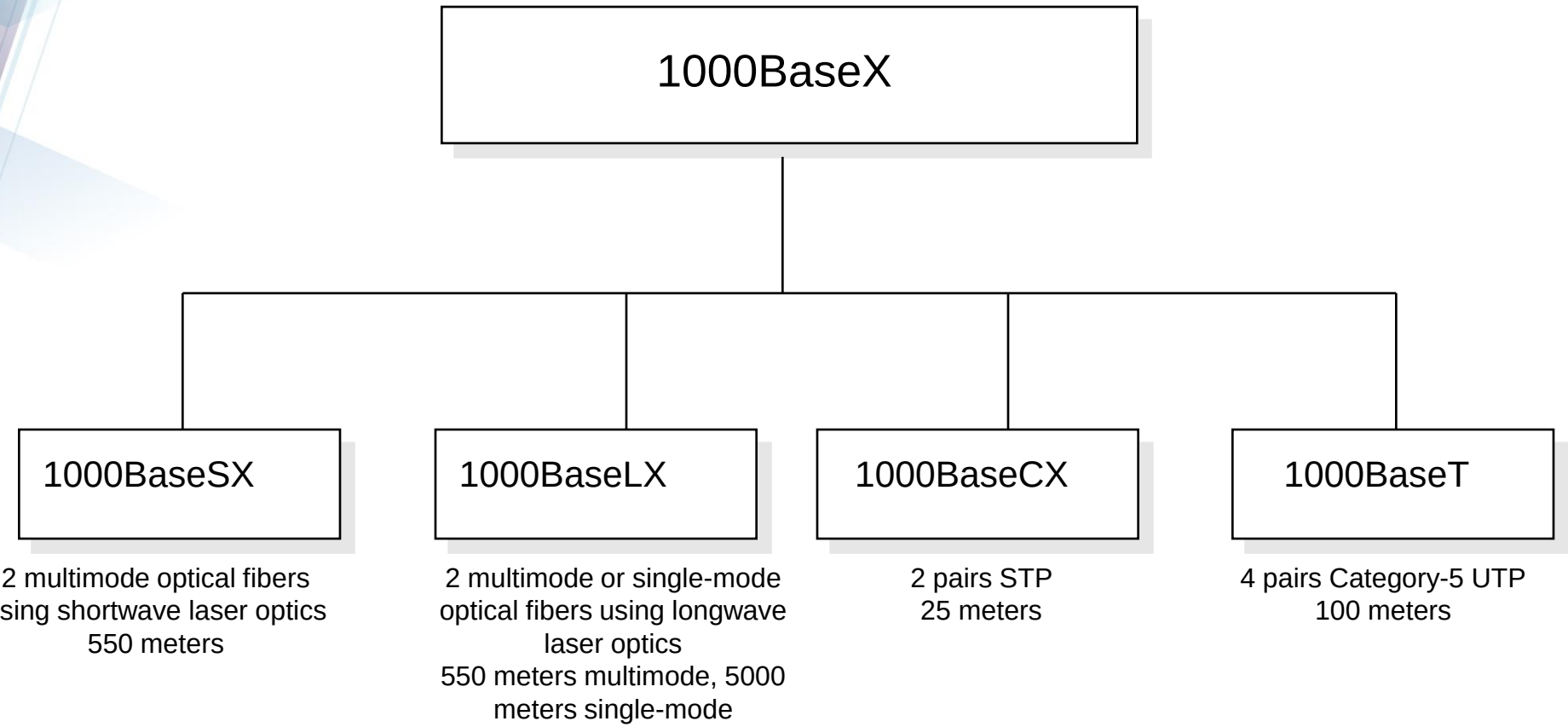
IEEE 802.3 10-Mbps Ethernet



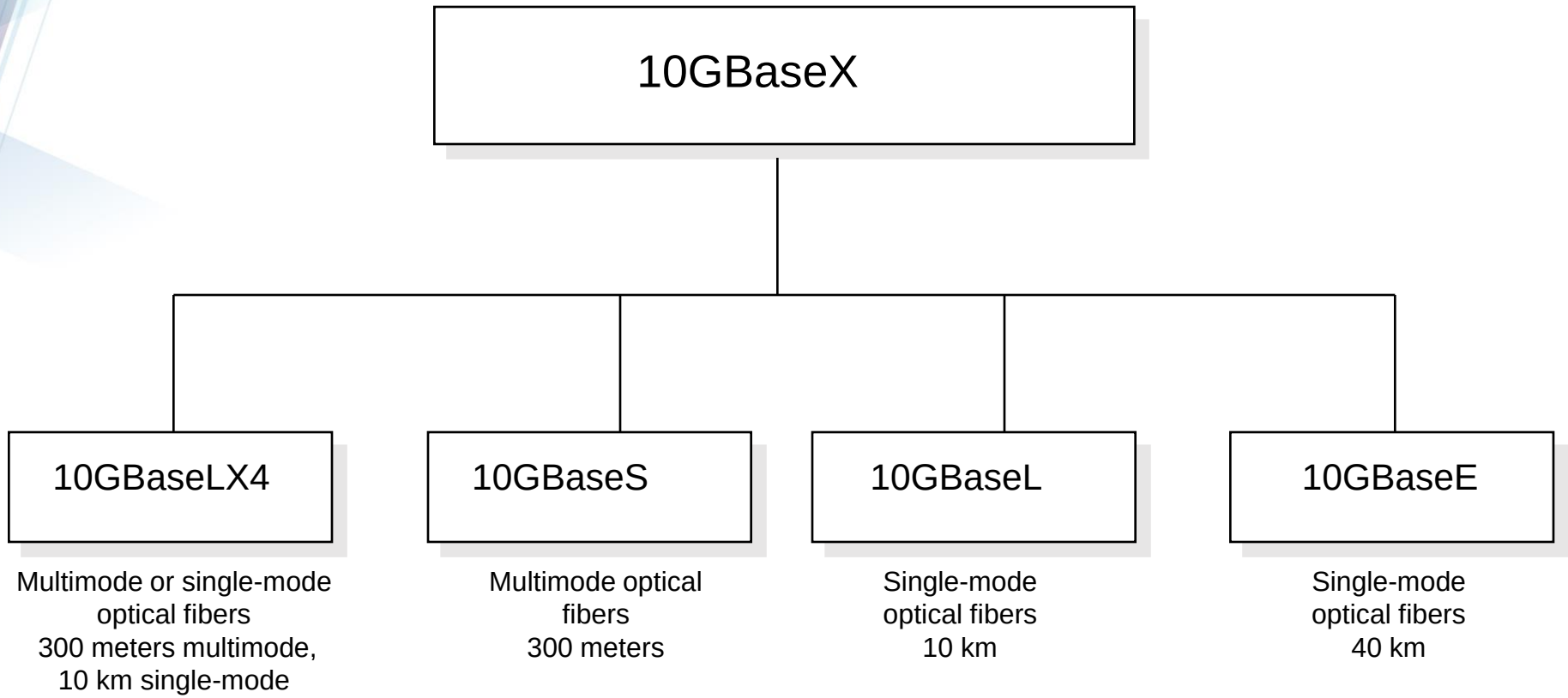
IEEE 802.3 100-Mbps Ethernet



IEEE 802.3 Gigabit Ethernet



IEEE 802.3 10-Gbps Ethernet



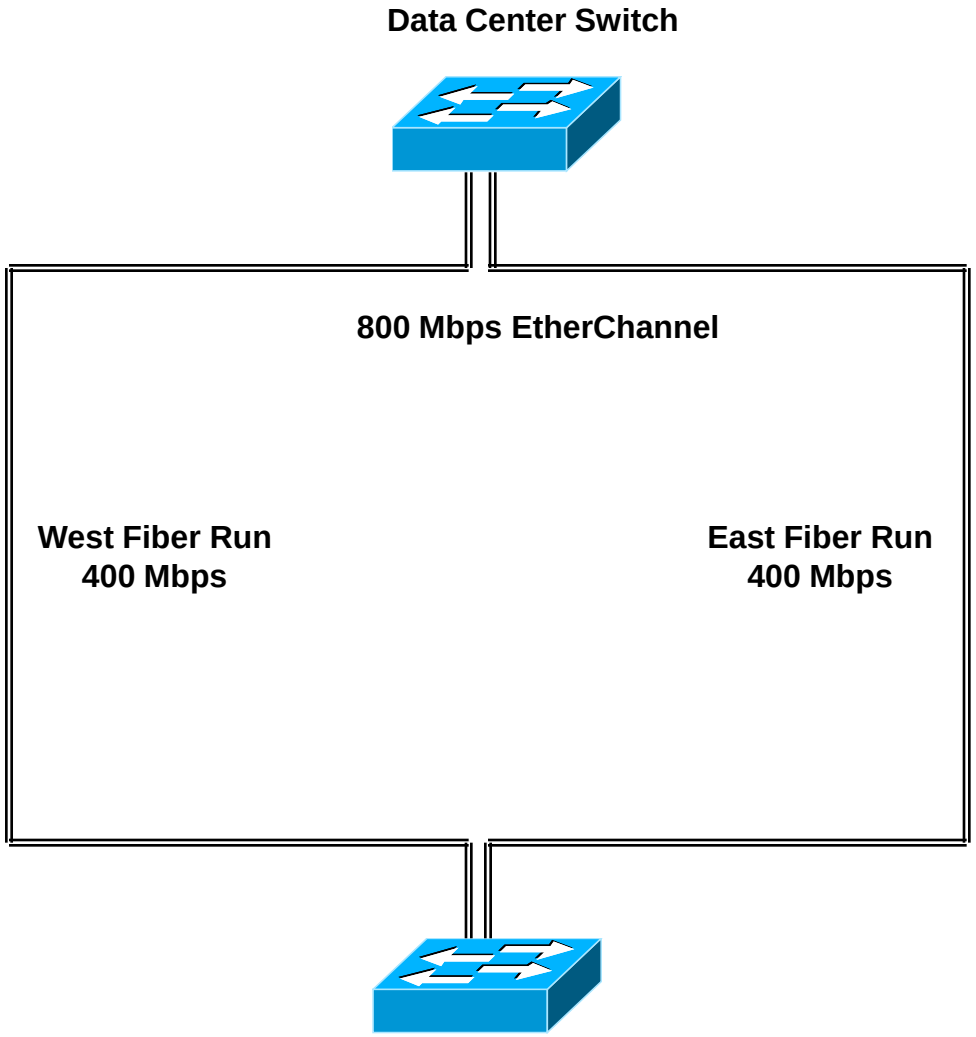
Metro Ethernet

- 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



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?