CIS 375
CHAPTER 8

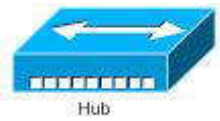
Backbone Networks

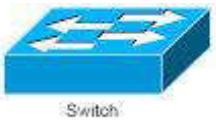
Outline

- Introduction
- Architecture
  - Switched Backbones
  - Routed Backbones
  - Virtual LANs
- Best Practice Backbone Design
- Improving Backbone Performance
- Implications for Cyber Security

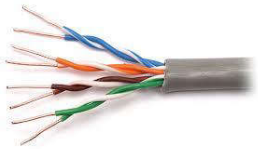
Introduction

devices

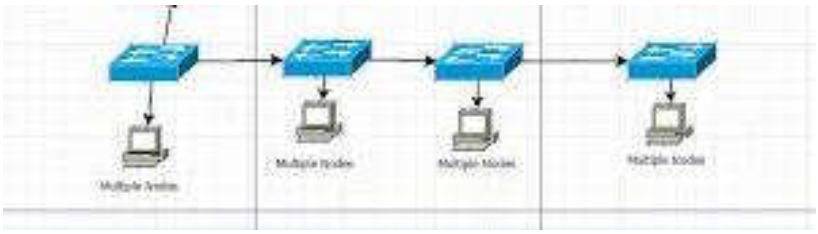


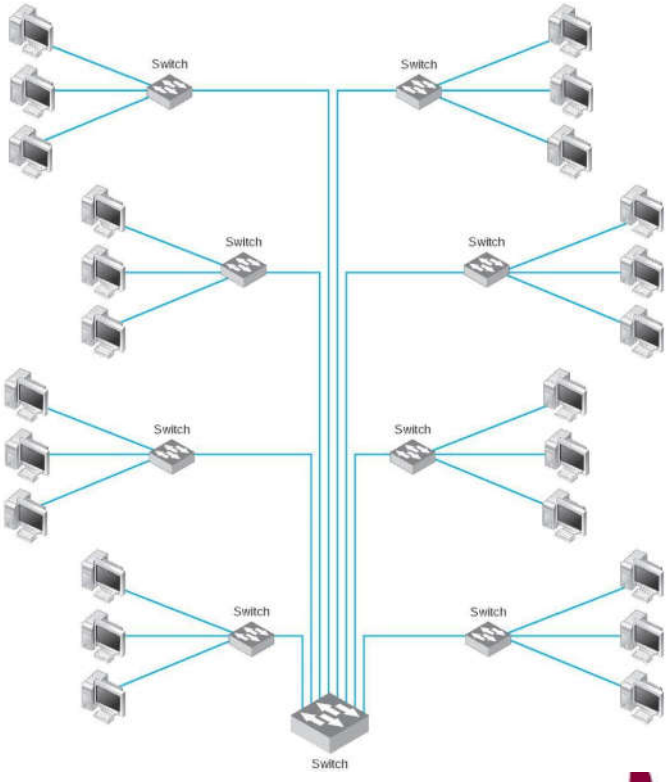


Network cable

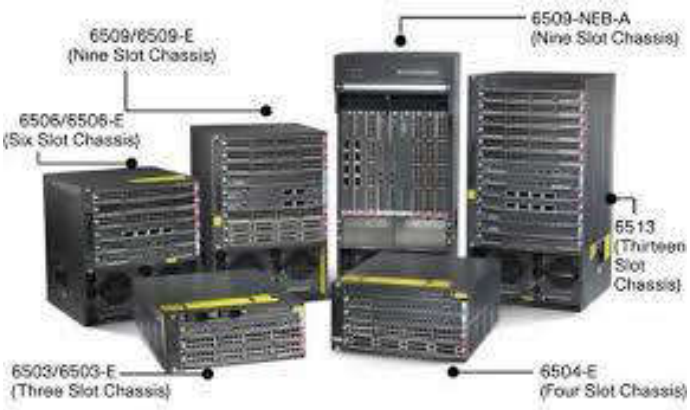


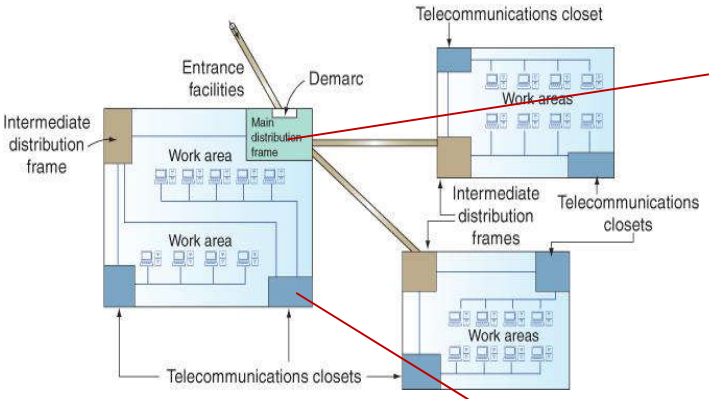
Switched Backbones





Switched Backbones (cont.)





TIA/EIA structured cabling in an enterprise

Patch Cable

Backbone Networks

- High-speed network that connects other networks together (LANs, WANs)
- Distribution layer BNs connect access LANs
- Core layer BNs connect different buildings

Backbone Network Components

- Network cables (often fiber for higher data rates)
- Switches

  - **Layer-2 switches** are “transparent” devices that do not change messages, only read and forward them (see Ch. 7)
    - **Managed switches** have configuration options and management features
      - e.g., spanning tree protocol (STP) or SNMP

  - **VLAN switches** or **layer-3 switches** are a devices combine the features of Layer-2 switches and routers, primarily for virtual LANs

Backbone Network Components

- Routers

  - Network layer devices that connect different networks
  - TCP/IP gateways
  - Not “transparent” devices
    - Messages are passed up to the network layer including stripping off data link layer frames
    - Routers respond to ARP (and other messages)
  - Read IP addresses and determine best route
  - Routing requires more processing than switches

Backbone Network Layers

- Separate from the layers of the Internet or OSI models, sections of backbone networks are referred to as three different hierarchical layers
  1. **Access layer -** How users access network (LAN, WLAN)
  2. **Distribution layer -** BN that connects access layer to core layer (within building)
  3. **Core layer -** Connects BNs between buildings and to WAN/Internet

Backbone Network Architectures

- Three major types of BNs are based on the devices used
  1. **Switched backbones**
  2. **Routed backbones**
  3. **Virtual LANs**

- In practice, it is most common to use a combination of these architectures

Switched Backbone Networks

- Most common type of BN used in the distribution layer
- Uses layer-2 switches
- Switches come in different form factors
  - Desktop
  - Rack-mounted
  - Chassis
- Star topology
- Physical location of devices
  - More common to locate centrally in **main distribution facility (MDF)** or other wiring closets

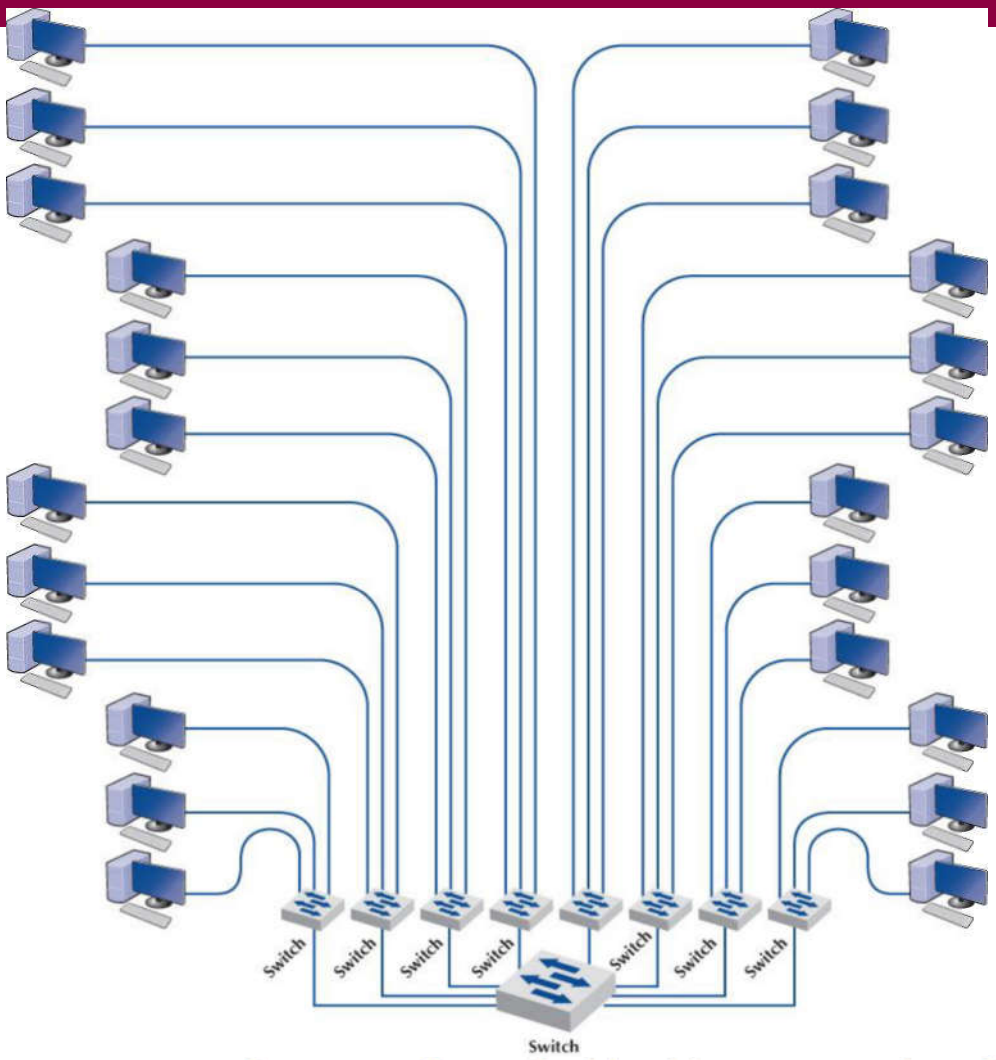
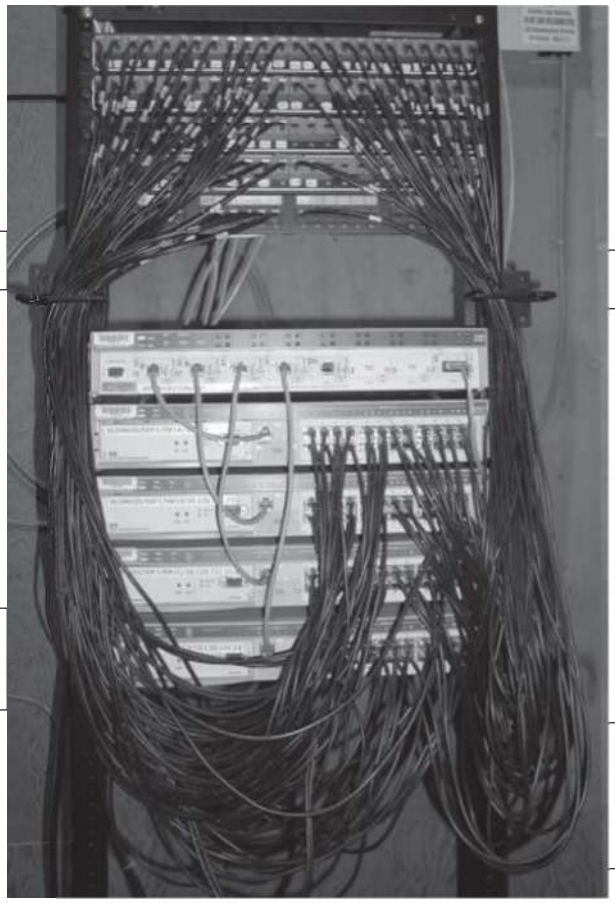


FIGURE 8-1 Rack-mounted switched backbone network architecture

Switched Backbone Networks



Source:
Photo courtesy of the author, Alan Dennis

Patch Panels

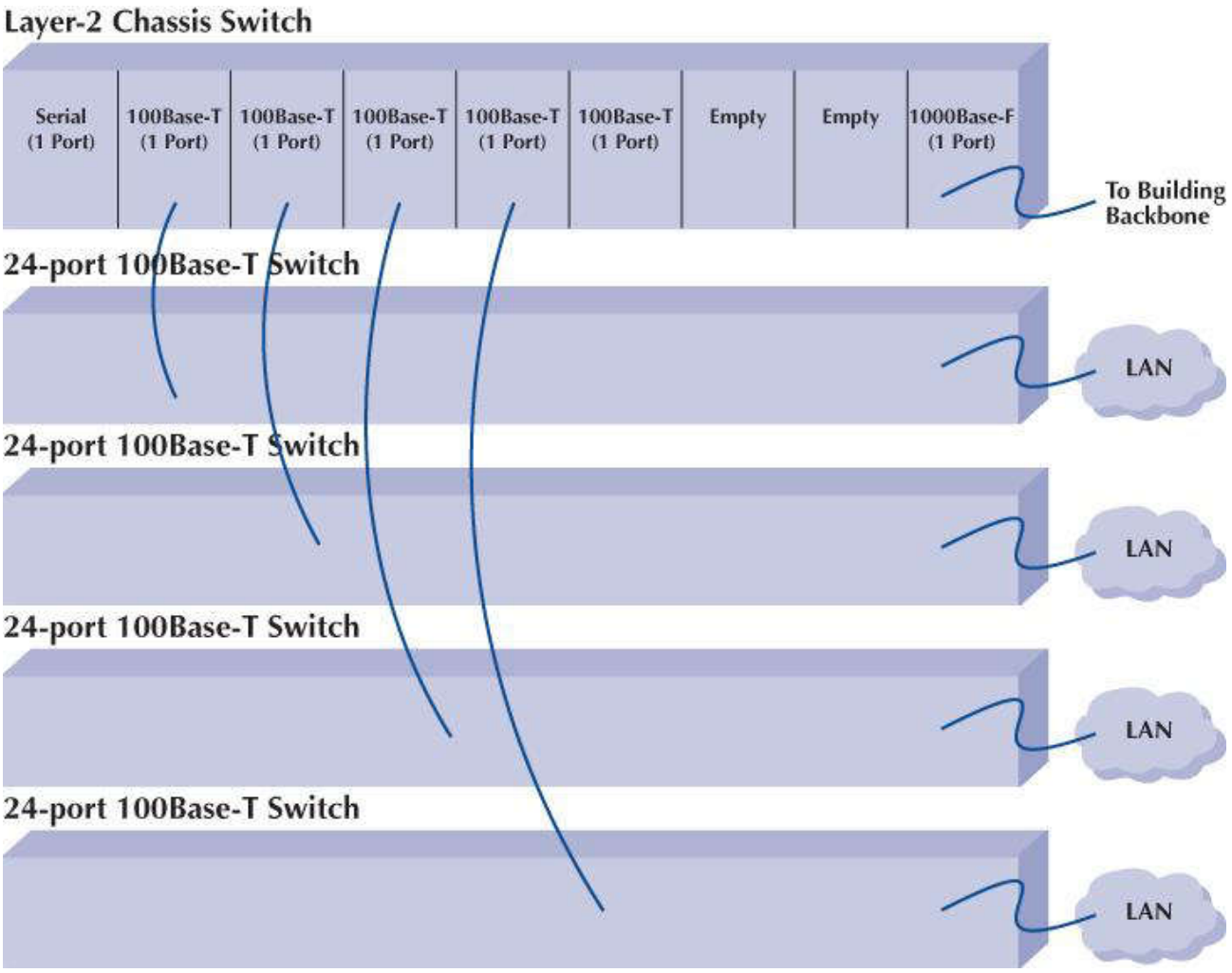
Patch Cables

Chassis Switch
(4 - 100Base-T ports)

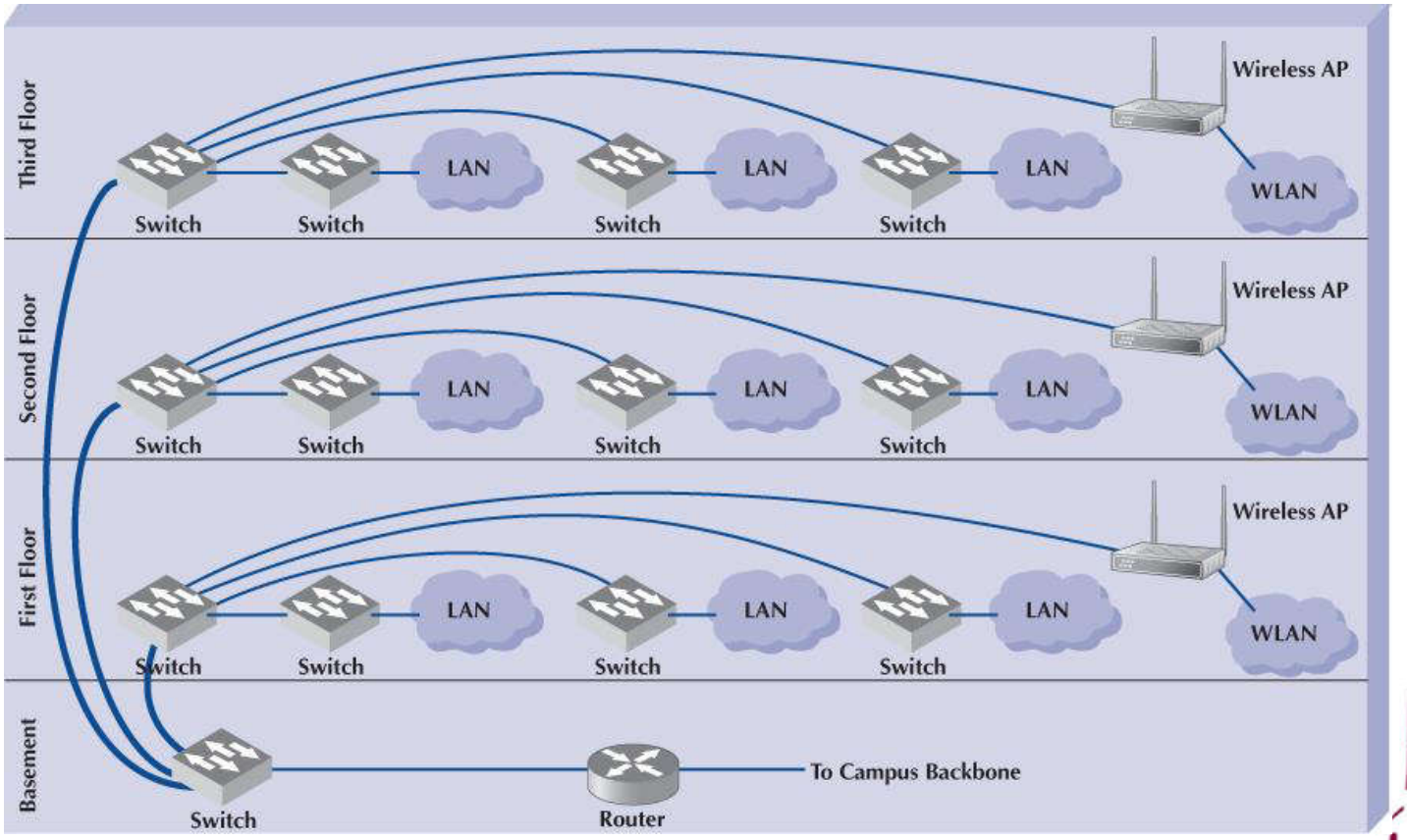
Switches
(24 port, 100Base-T)

Backbone Connection
(1000 Base-F)

Switched Backbone Networks

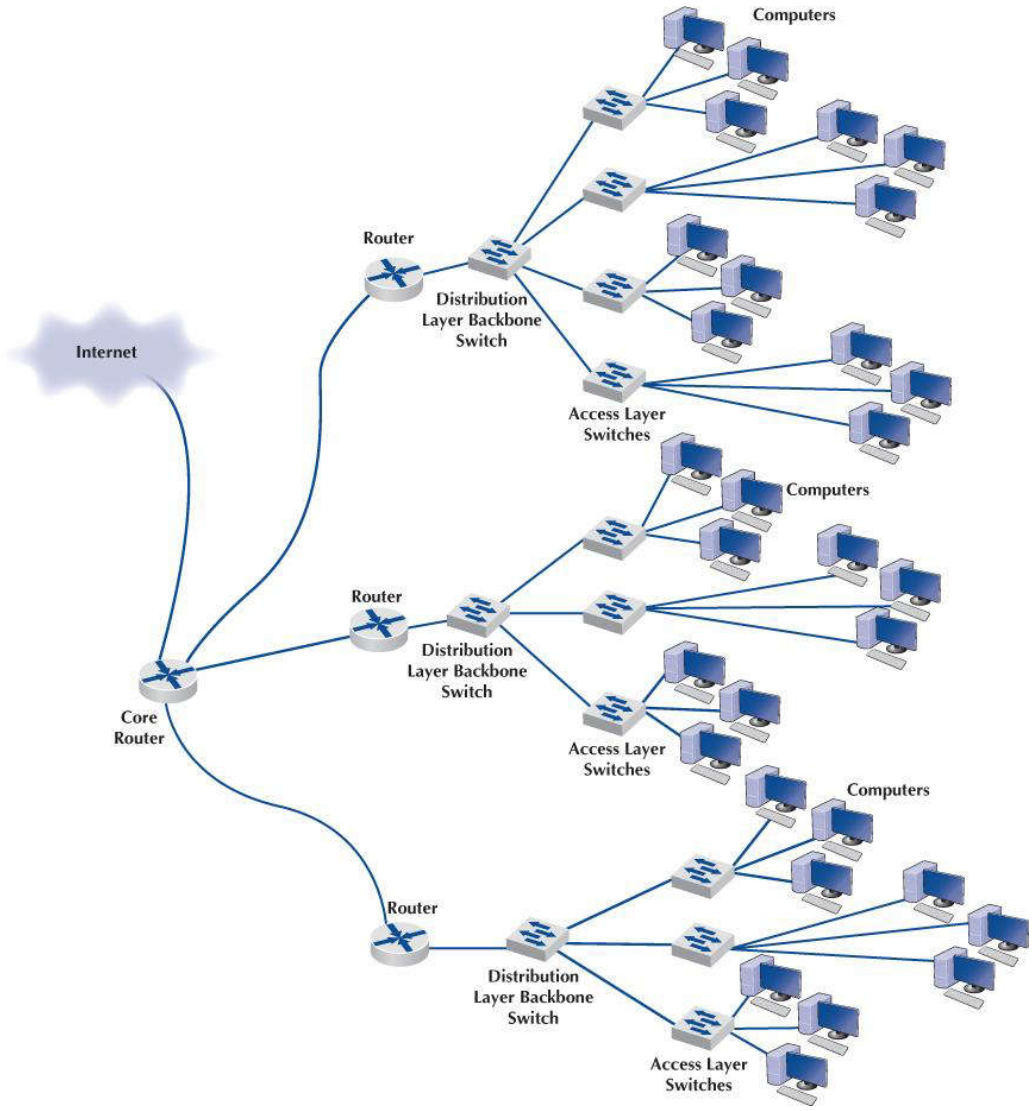


Switched Backbone Networks



Routed Backbone Networks

- Sometimes called subnetted backbones or hierarchical backbones
- Typically used at core layer, but sometimes at distribution layer
- Advantages
  - LAN segmentation
- Disadvantages
  - Tend to be slower
  - More expensive
  - Harder to manage


Computers
Router
Distribution
Layer Backbone
Switch
Internet
Access Layer
Switches
Computers
Router
Distribution
Layer Backbone
Switch
Core
Router
Access Layer
Switches
Computers
Router
Distribution
Layer Backbone
Switch
Access Layer
Switches

Virtual LANs (VLANs)

- Routers segment networks based on physical location (i.e., the cables connected to it)
- Devices in different physical locations may need to access to the same LAN resources
- VLANs perform flexible LAN segmentation so that it can based on logical instead of physical design
- VLANs are enabled by high-speed layer-3 switches
- Much more complex to manage and typically only used in large networks

Virtual LANs (VLANs)

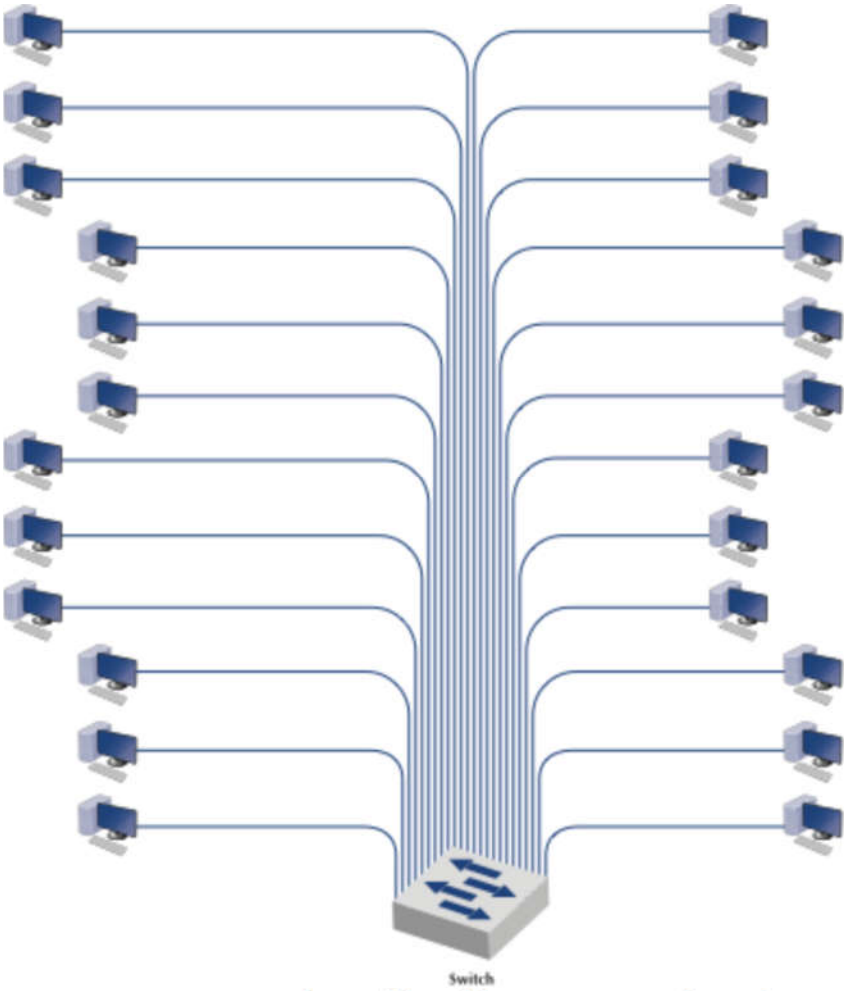


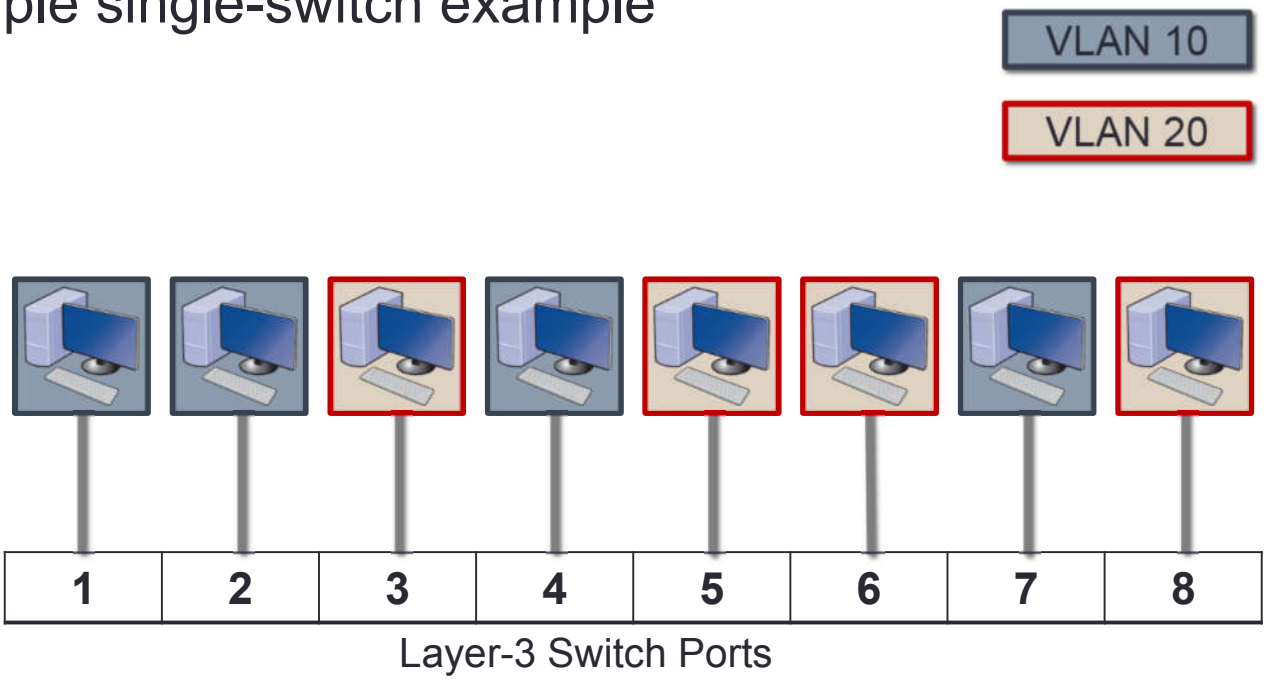
FIGURE 8-6 VLAN-based backbone network architecture

Virtual LANs (VLANs)

- Each VLAN identified by **VLAN ID** which is mapped to traditional IP subnet
- Each device assigned into a VLAN based on the physical port
- VLANs are transparent
- Require router or Layer-3 switch

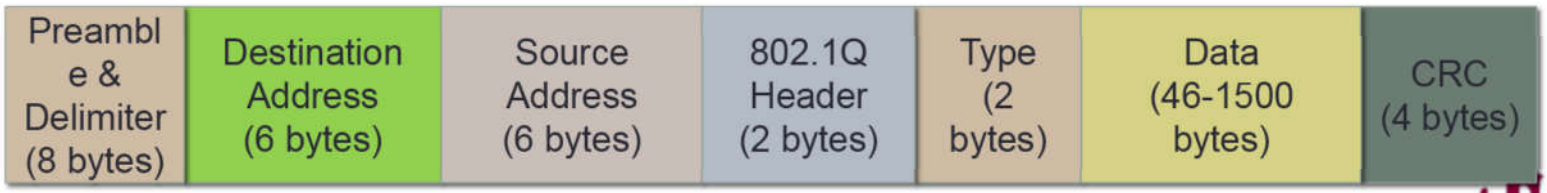
Virtual LANs (VLANs)

- Simple single-switch example

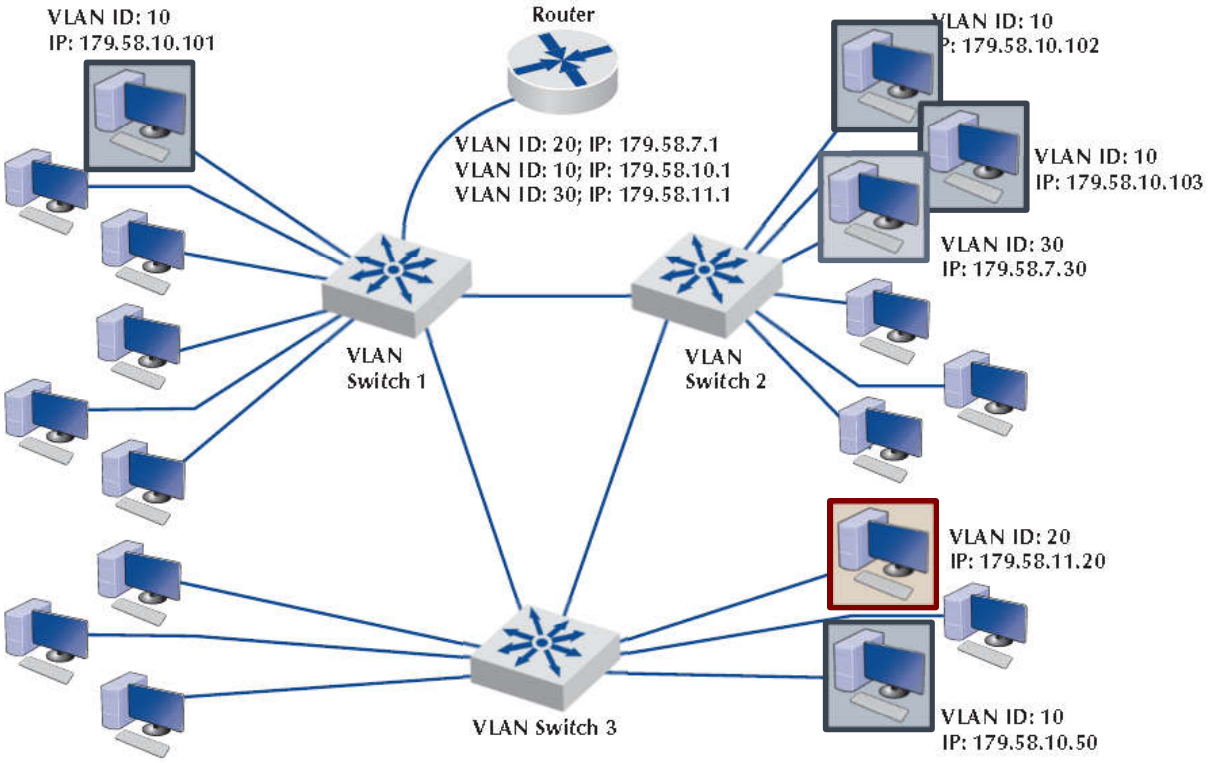


Virtual LANs (VLANs)

- Multiswitch VLANs
  - L3-switches communicate using inter-switch protocols that support VLANs
  - **VLAN trunks** are circuits that connect two VLAN switches
  - **VLAN tag** inserted into Ethernet frame (e.g., 802.1Q) or encapsulates frame (e.g. ISL)



Virtual LANs (VLANs)



Virtual LANs (VLANs)

- Advantages
  - More flexible subnetting
  - Better managed traffic flow which may lead to faster performance
  - Traffic prioritization
    - Can include quality of service information in tag
- Disadvantages
  - Complex
  - May increase management when VLAN memberships change
  - Layer 3 switches are more costly than L2

Best Practices

- Architecture
  - Switched has best cost to performance ratio at the distribution layer
  - Most organizations use routed at the core layer
  - VLANs are becoming more widely used, especially for organizations needing the flexibility
- Technologies
  - Gigabit Ethernet for distribution layer
  - Gigabit Ethernet or faster for core layer
  - Redundant devices and connections

Best Practices

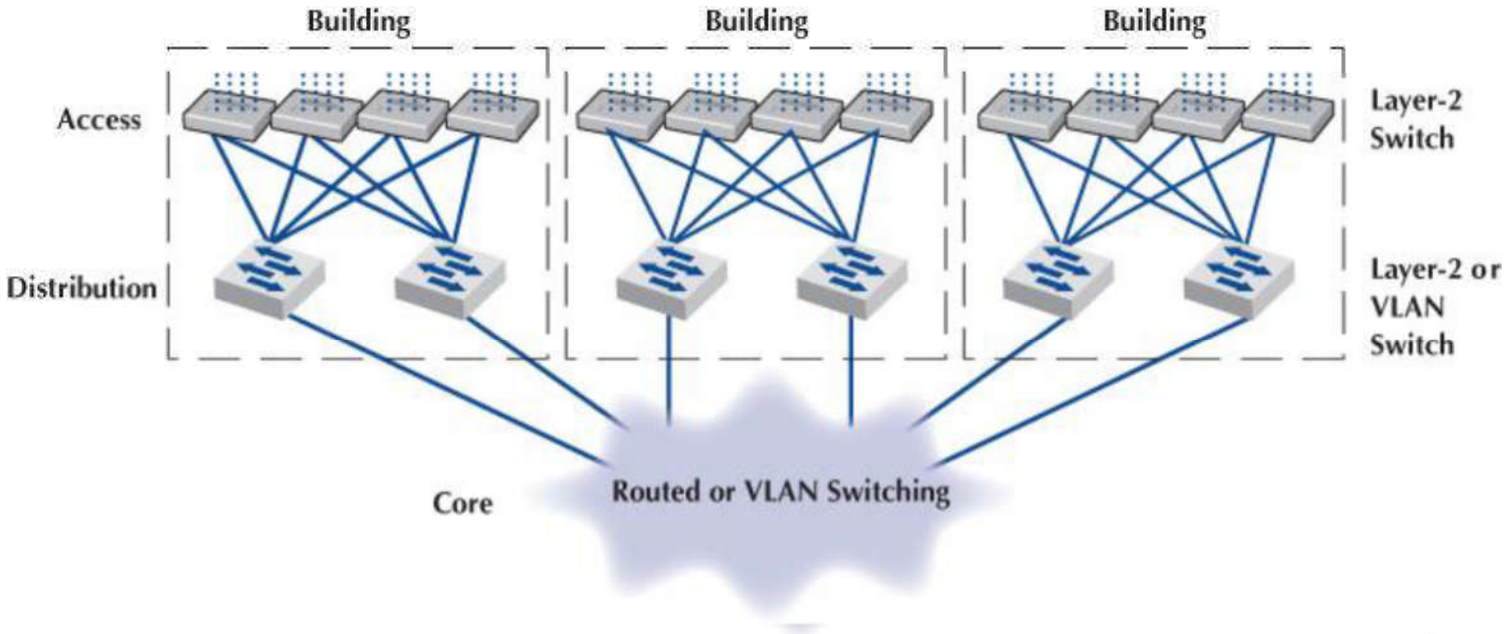


FIGURE 8-8 The best practice network design

Improving Backbone Performance

- Devices
- Circuits
- Demand

Implications for Cybersecurity

- Cost and necessity of upgrading BNs will grow as demand increases
- VLAN backbones provide flexibility and are becoming increasingly popular
- As with LANs, Ethernet is now the predominant protocol in BNs