
Chapter 7

Backbone Networks

Chapter 7: Outline

7.1 - Introduction

7.2 - Backbone Network Components

– **Switches, Routers, Gateways**

7.3 - Backbone Network Architectures

7.4 - The Best Practice Backbone Design

7.5 - Improving Backbone Performance

7.6 – Implications

Backbone Networks

- **High speed networks that links LANs**
 - **Connects to other backbones, MANs, and WANs**
- **Also referred to as:**
 - **An enterprise network**
 - **A campus-wide network**
 - **A backbone**

7.2 Backbone Components

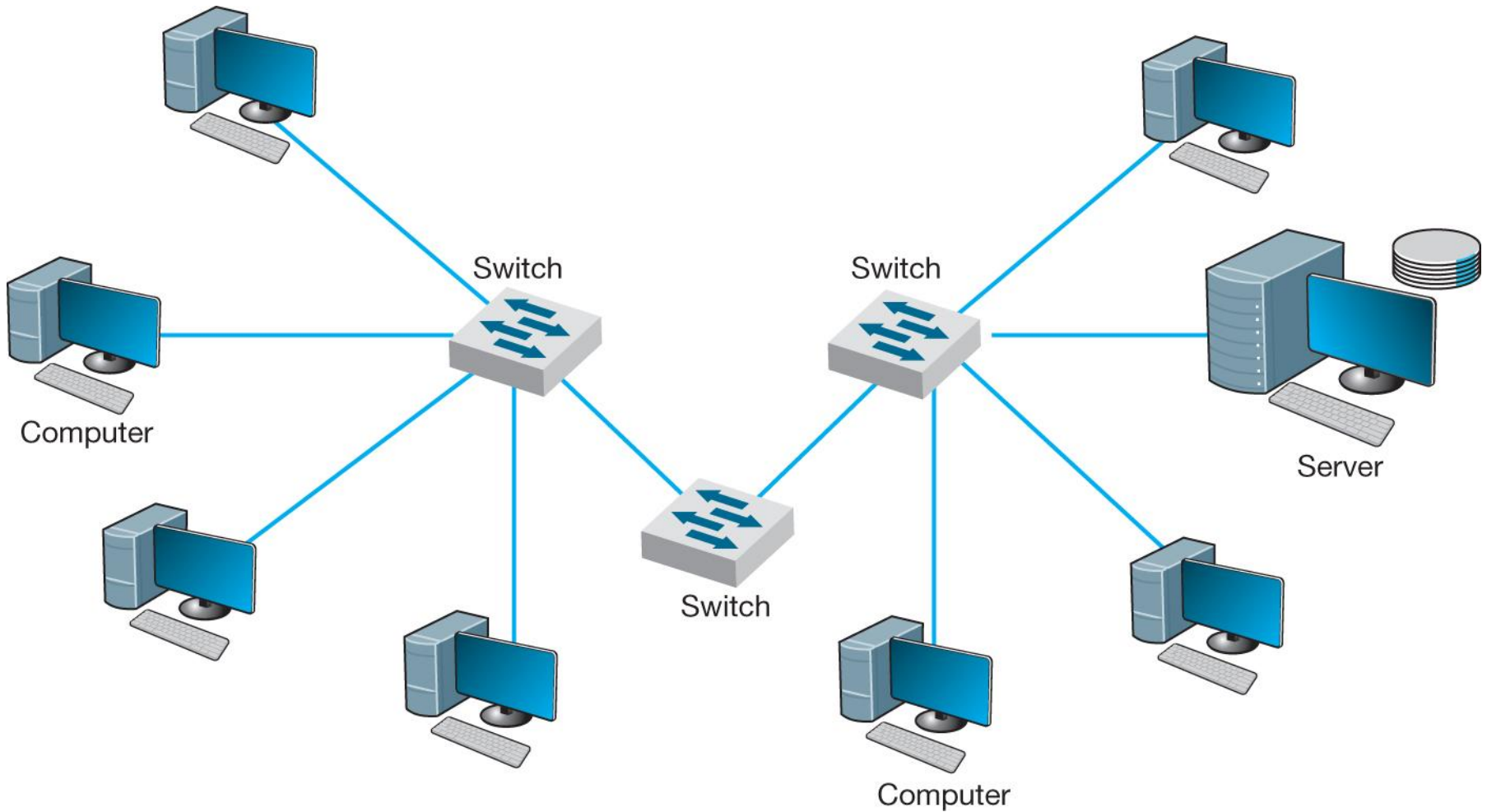
- **Cable**
 - **Conventional LAN functionality**
 - **Optical fiber - Commonly chosen for higher data rates**
- **Hardware**
 - **Switches**
 - **Routers**
 - **Gateways**

Backbone Devices

Device	Operates At	Packets	Physical Layer	Data Link Layer	Network Layer
Switch	Data link layer	Filtered using data link layer addresses	Same or different	Same	Same
Router	Network layer	Routed using network layer addresses	Same or different	Same or different	Same
Gateway	Network layer	Routed using network layer addresses	Same or different	Same or different	Same or different

*Be careful, definition of gateway is context sensitive.
For example, a proxy server can also be considered a gateway.
And a proxy can operate at the application layer.*

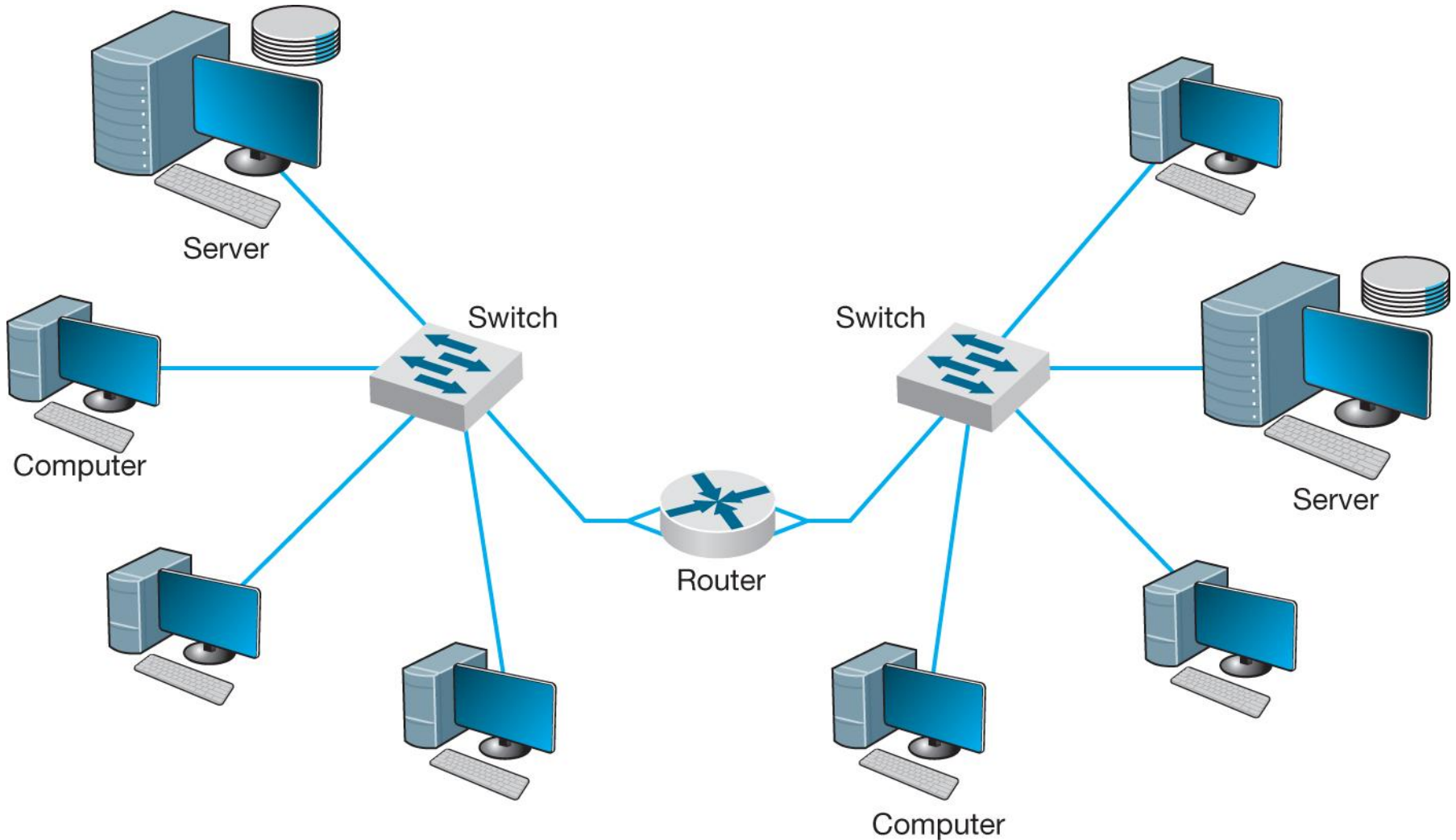
Switches Level Two



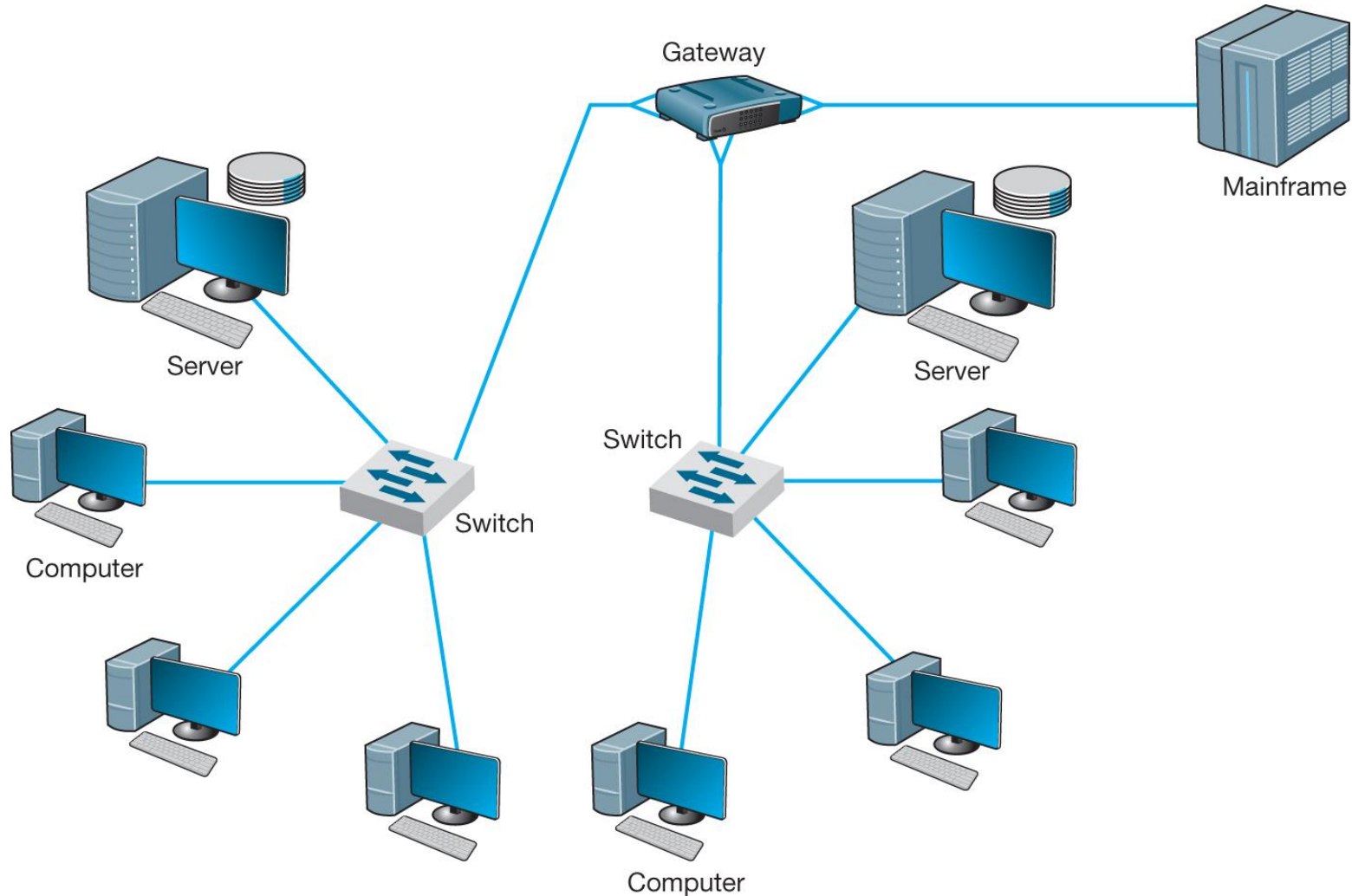
Switches

- **Most switches operate at data link layer**
- **Connect two or more network segments that use the same data link and network protocol**
- **May connect the same or different types of media**
- **Forwards packets between network segments using data link layer address**

Routers Level Three



Gateways *Level 7 Shown Here*



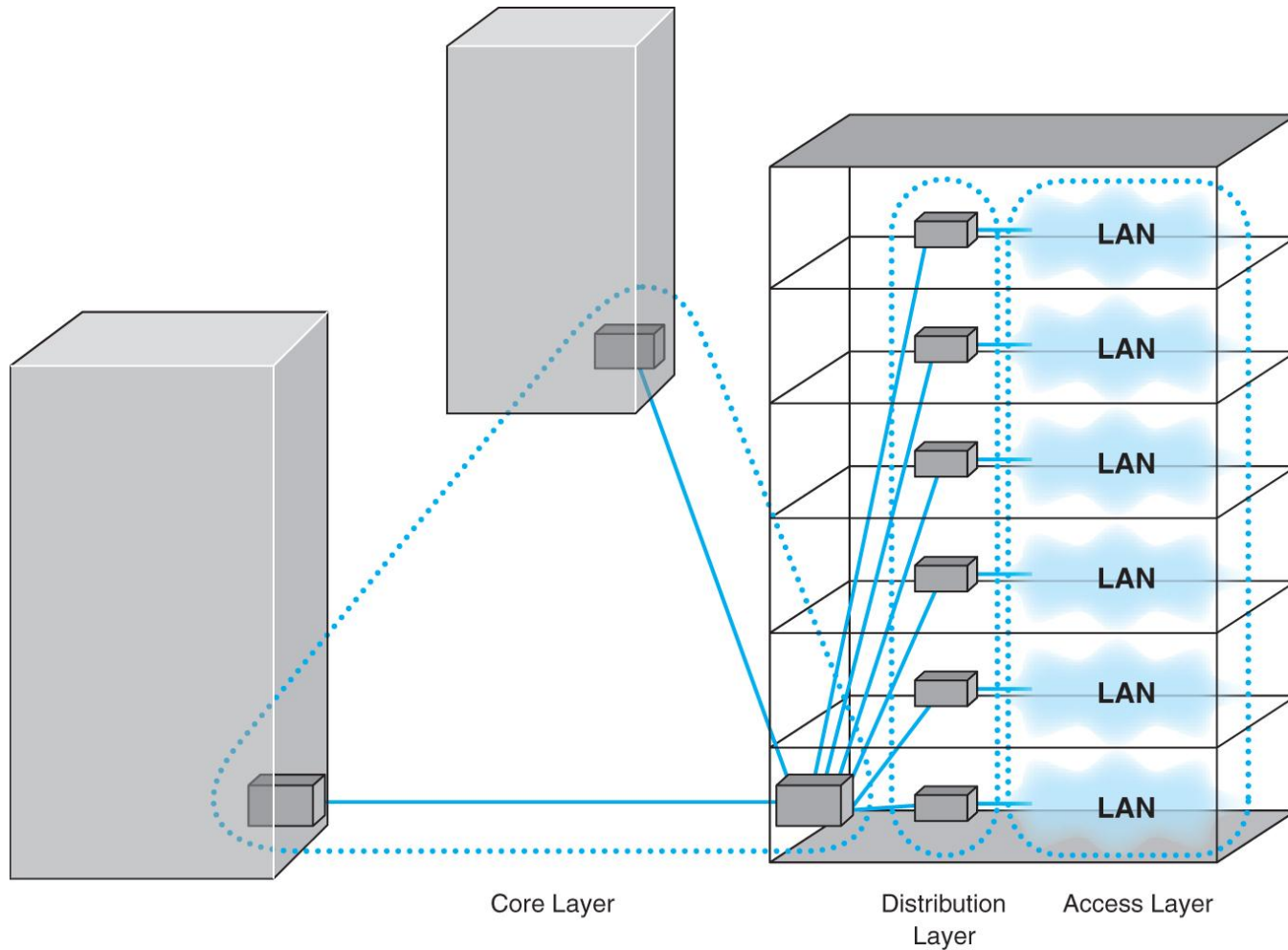
Gateways

- **May also operate at network layer**
 - Uses network layer addresses
 - More complex than switches or routers
- **Connects two or more networks that use the same or different data link and network protocols**
- **May also work at application layer**
 - Only process messages addressed to them

7.3 Backbone Architectures

- **Identifies the way backbone interconnects LANs**
- **Manages way packets move from one network through the backbone to other networks**
- **Three layers:**
 1. ***Access layer:* used in LANs attached to BB**
 2. ***Distribution layer:* connects LANs together**
 3. ***Core layer:* connects different backbone networks together in enterprise network**

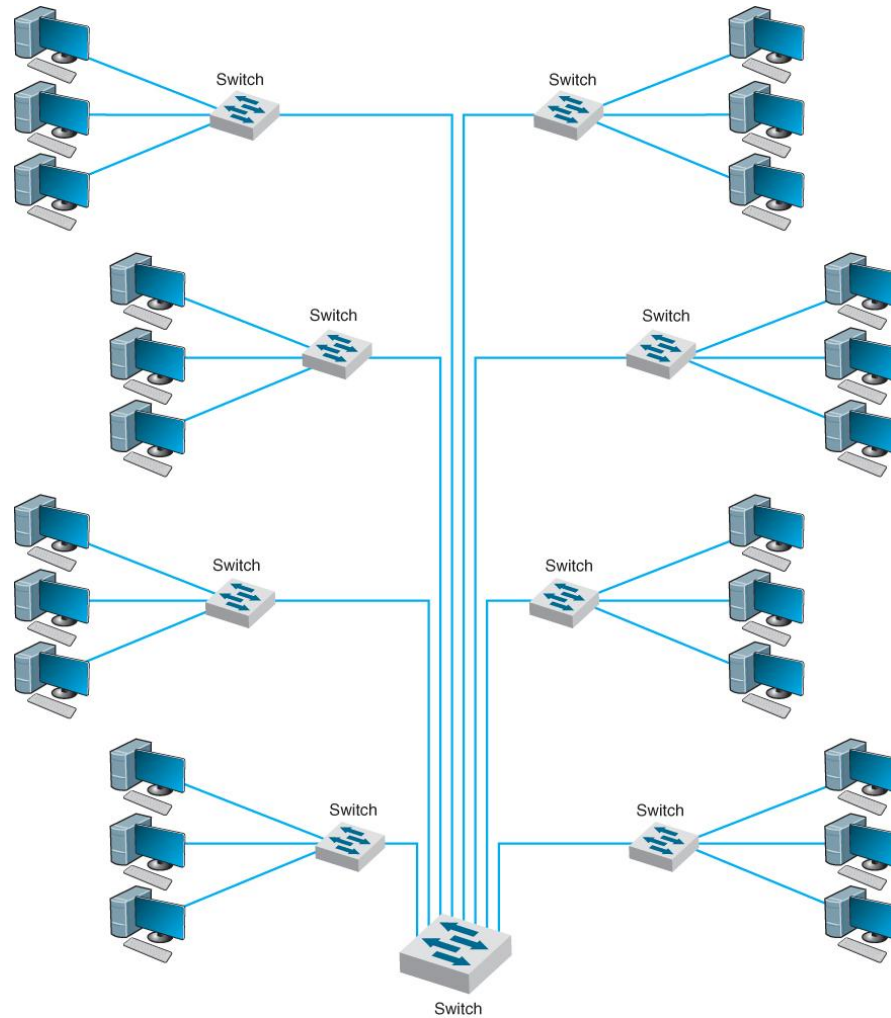
Backbone Network Design Layers



Fundamental Backbone Architectures

- ***Switched Backbones:*** most common...
 - Rack or chassis based.
- ***Routed Backbones:*** move packets based on network layer address
 - Sometimes called subnetted backbone
- ***Virtual LANs:*** networks in which computers are assigned into LAN segments by software rather than by hardware
 - Can be single switch or multiswitch VLANs.
 - Popular.

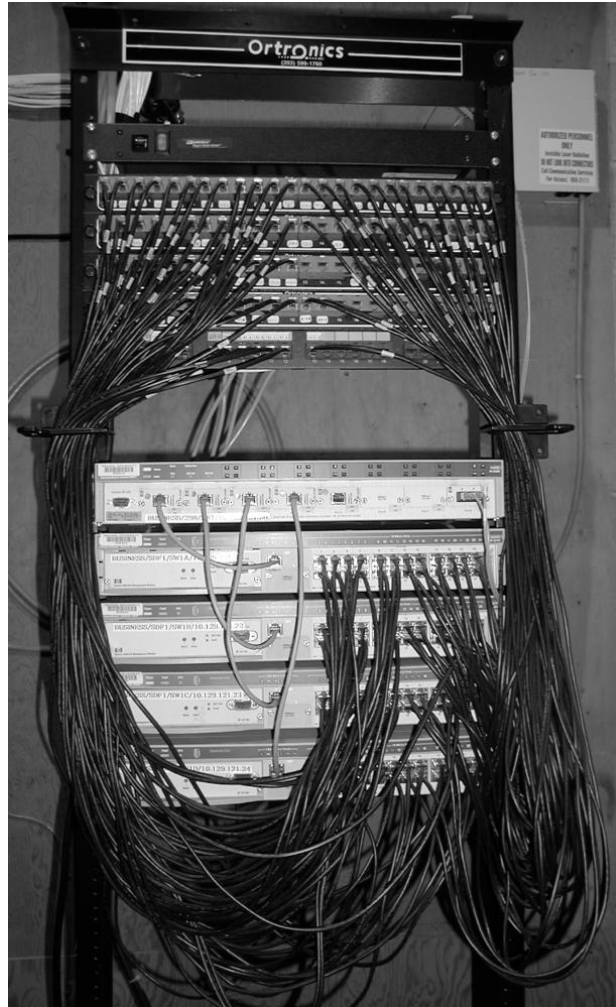
Switched Backbone



Switched Backbones

- **Replaces many routers**
 - More cables, fewer devices
 - Switch is backbone.
- **Advantages:**
 - Improved performance (200-600% higher) due to simultaneous access of switched operations
 - A simpler more easily managed network – less devices

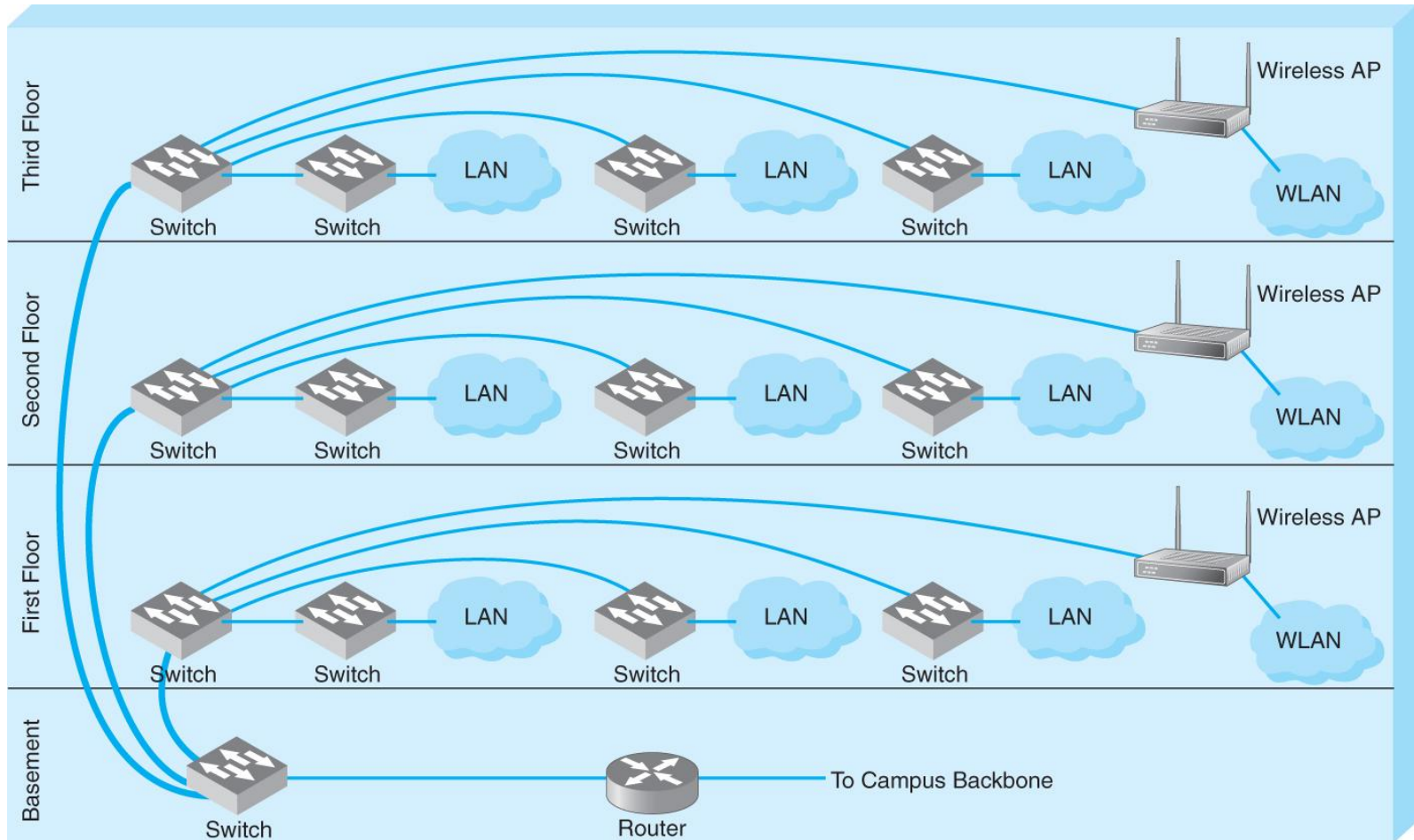
Rack-Mounted Switched Backbones



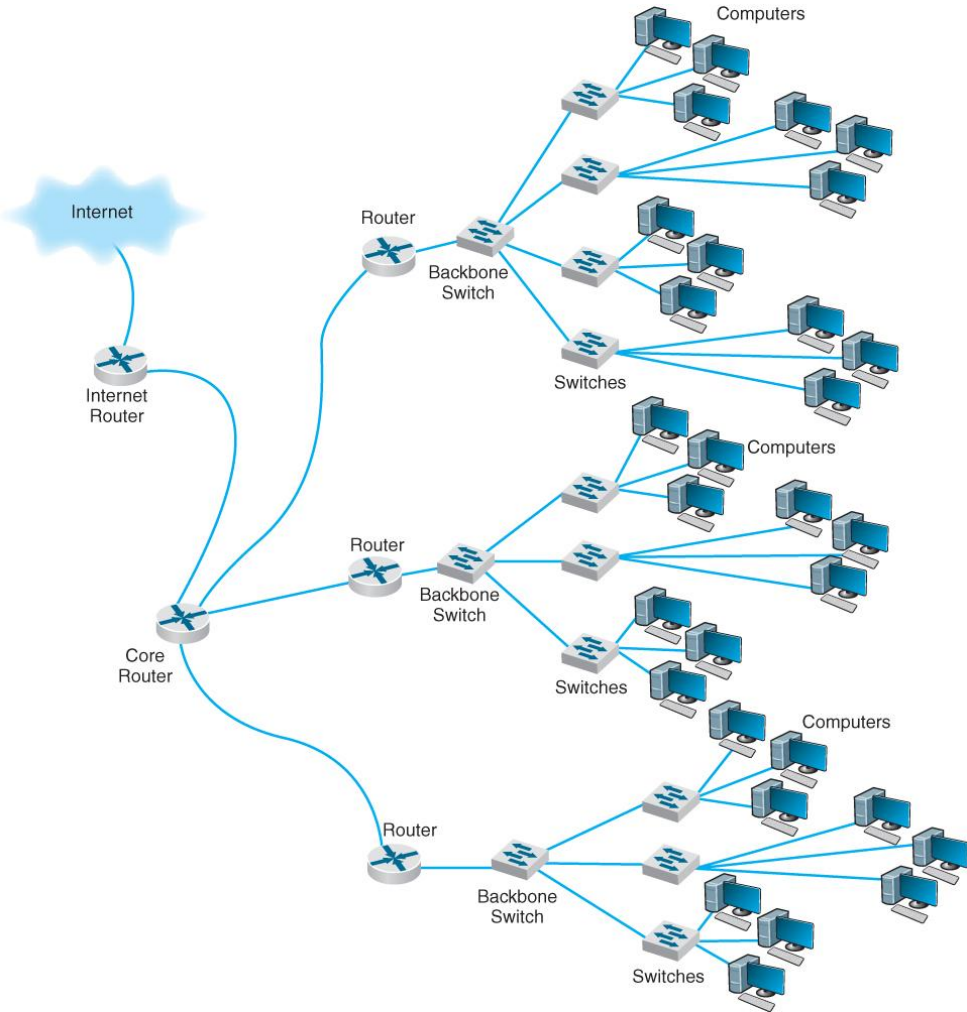
Rack-Based Switched Backbones

- **All network switch equipment physically in one room**
 - Easy maintenance/upgrade
 - Requires more cable
- **Main Distribution Facility (MDF) or Central Distribution Facility (CDF)**
 - Another name for the rack room
 - Place where many cables come together
 - Patch cables used to connect devices on the rack
- **Easier to move computers among LANs**

Indiana Univ. Switched Backbone



Routed Backbone



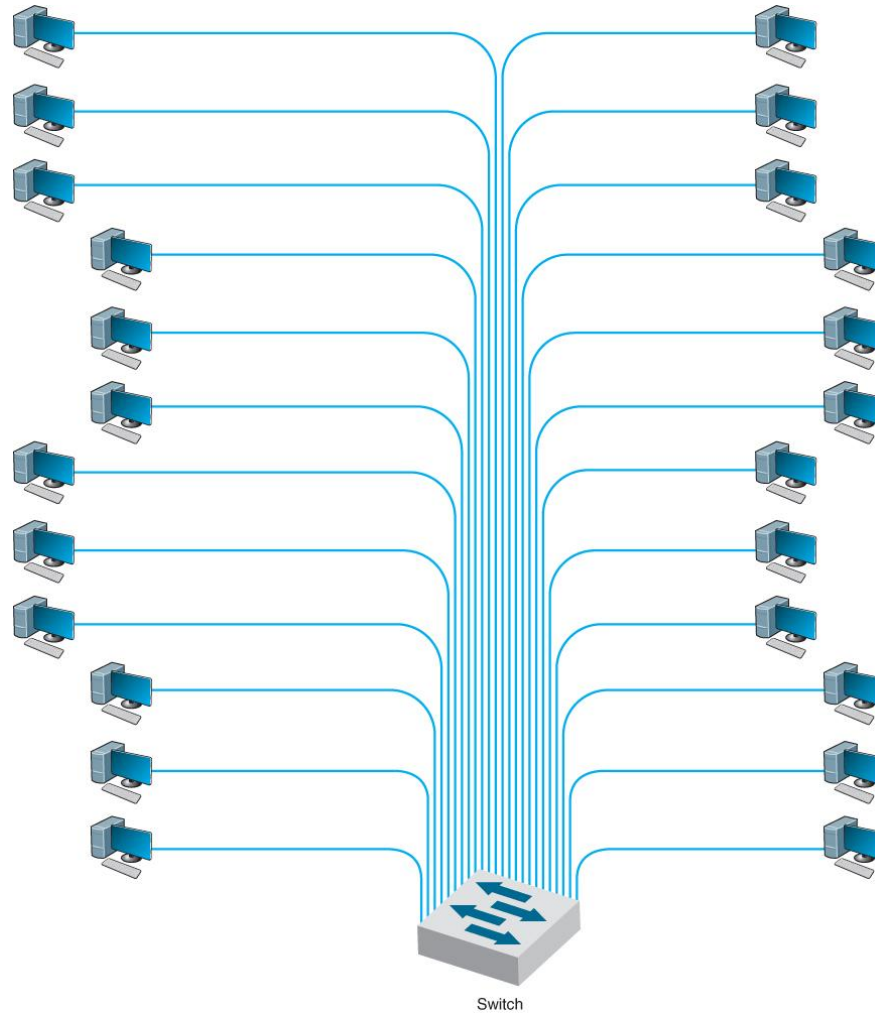
Routed Backbones

- **Moves packets using network layer addresses**
- **Commonly, core layer**
 - **Connecting LANs in different campus buildings**
 - **Can be used at the distribution layer as well**
- **LANs can use different data link layer protocols**
- **Main advantage: LAN segmentation**
 - **Each message stays in one LAN; unless addressed outside the LAN**
 - **Easier to manage, LANs are separate entities**
- **Main disadvantages**
 - **Tend to impose time delays**
 - **Require more management than switches**

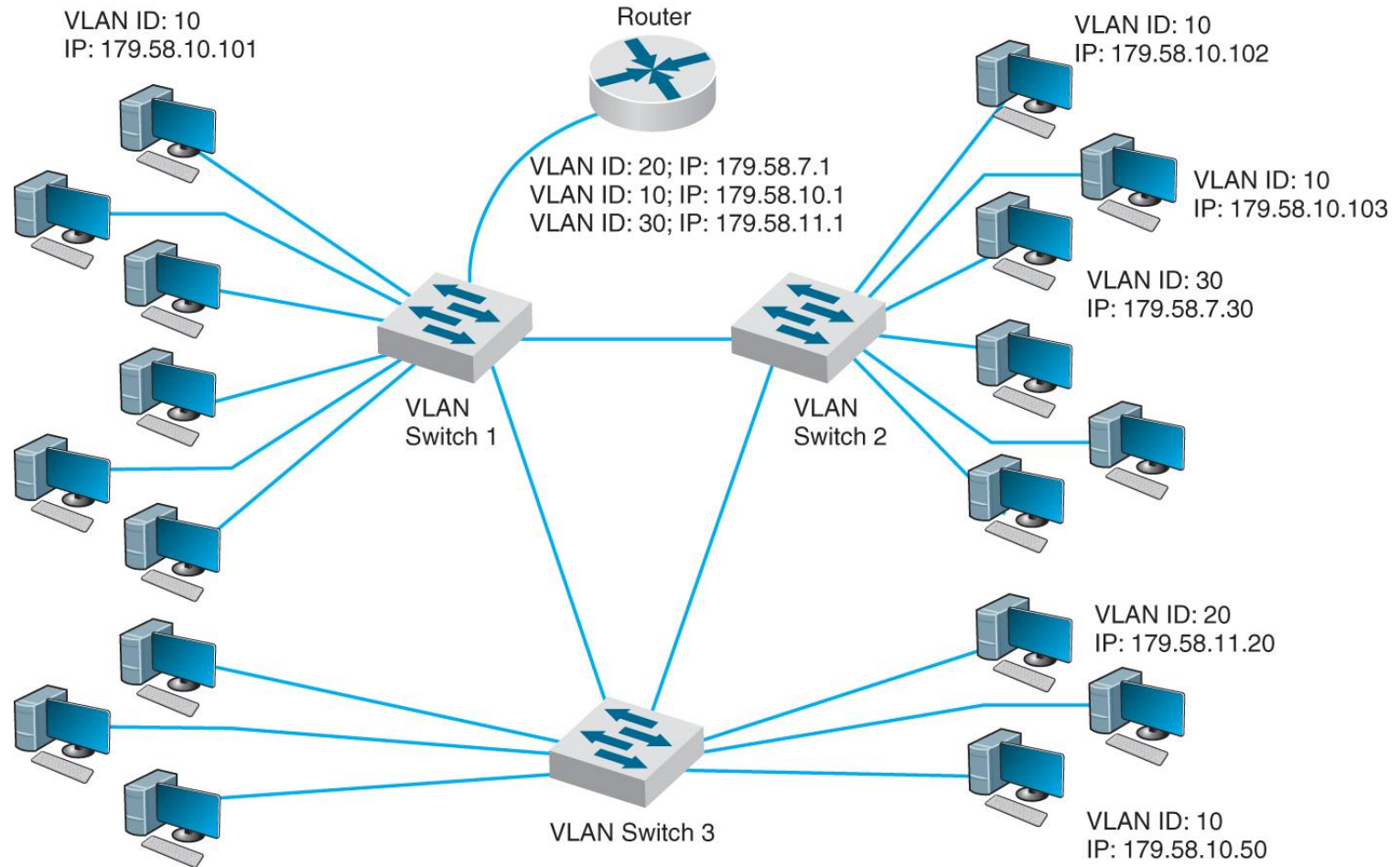
Virtual LANs (VLANs)

- **A new type of LAN-BN architecture**
 - Utilizes high-speed intelligent switches
 - Computers assigned to LAN segments by software
- **Often faster and provide more flexible network management**
 - Much easier to assign computers to different segments
- **More complex, usually used for larger networks**
- **Basic VLAN designs:**
 - Single switch VLANs
 - Multi-switch VLANs

VLAN-based Backbone



Multi-switch VLAN-Based Backbone



How VLANs Work

- Each computer is assigned into a VLAN that has a VLAN ID
- Each VLAN ID is matched to a traditional IP subnet
 - Each computer gets an IP address from that switch
 - Similar to how DHCP operates
- Based on physical port they are plugged into, computers are assigned into the VLAN

Multiswitch VLAN Operations

- **Same as single switch VLAN, except uses several switches, perhaps in core between buildings**
- **Inter-switch protocols**
 - **Must be able to identify the VLAN to which the packet belongs**
- **Use IEEE 802.1q (emerging standard)**
 - **When a packet needs to go from one switch to another**
 - **16-byte VLAN tag inserted into the 802.3 packet by the sending switch**
 - **When the IEEE 802.1q packet reaches its destination switch**
 - **Its header (VLAN tag) stripped off and Ethernet packet inside is sent to its destination computer**

VLAN Operating Characteristics

- **VLAN Advantages**

- **Faster performance: Precise management of traffic flow and ability to allocate resources to different type of applications**
- **Traffic prioritization (via 802.1q VLAN tag)**
 - **Include in the tag: a priority code based on 802.1q**
 - **Can have QoS capability at MAC level**
 - **Similar to RSVP and QoS capabilities at network and transport layers**

- **Drawbacks**

- **Cost**
- **Management complexity**
- **Some “bleeding edge” technology issues to consider**

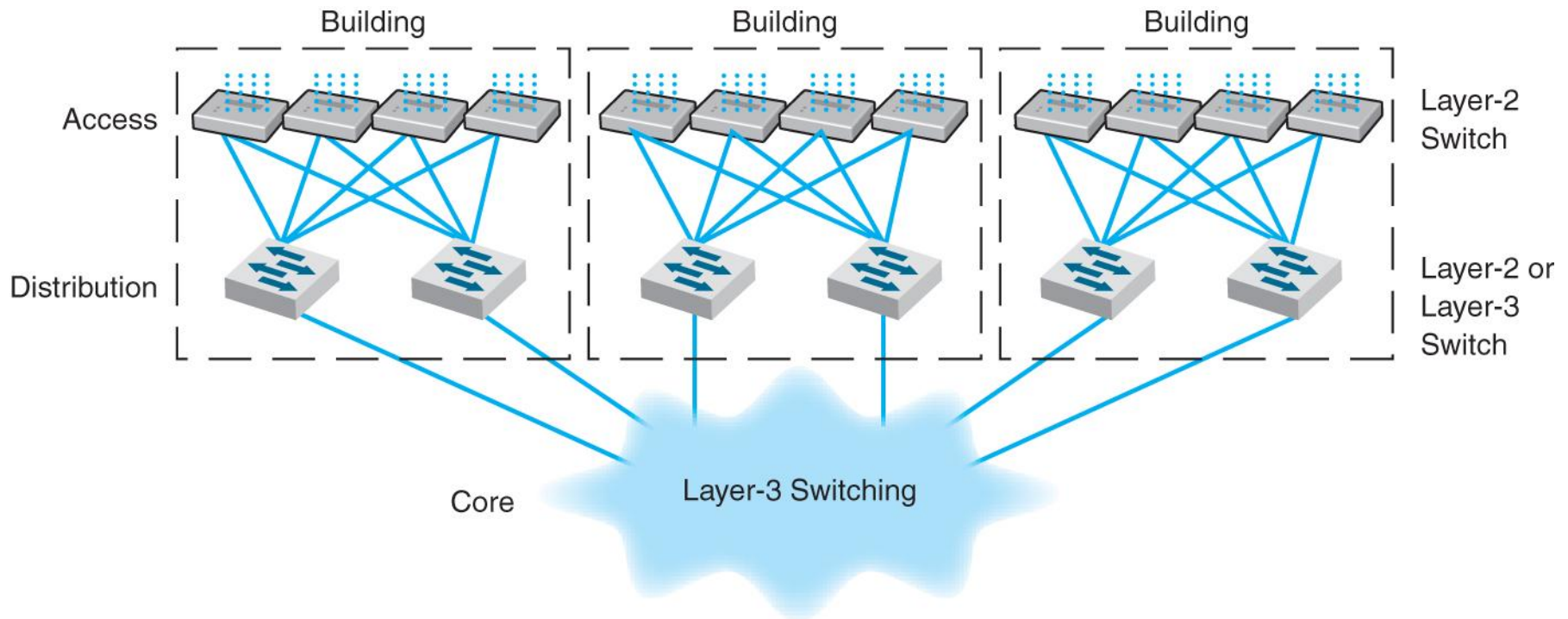
7.4 Best Practice Backbone Design

- Architectures
 - At distribution layer → switched backbone because of performance and cost
 - At core layer → routed backbone
 - VLANs closer but more costly and complex

BB Recommendations

- **Architecture**
 - Switched backbone or VLAN at distribution layer
 - Routed backbone at core layer
- **Technology - Gigabit Ethernet**
- **Design**
 - Mixture of layer-2 and layer-3 Ethernet switches
 - Access Layer
 - 100Base-T Layer 2 switches with cat5e or cat6
 - Distribution Layer
 - 100base-T or 1000BaseT/F Layer 3 switches
 - Core Layer
 - Layer 3 switches running 10GbE or 40GbE over fiber

Best Practice Network Design



7.5 Improving Backbone Performance

- **Improve computer and device performance**
 - Upgrade to faster devices
 - Change to a more appropriate routing protocol
 - Distance vector – typically used on BNs
 - Link state – typically used on WANs and MANs
 - Use gigabit Ethernet as BB (eliminate translations)
 - Increase device memory
- **Improve circuit capacity**
 - Upgrade to a faster circuit
 - Add additional circuits
 - Replace shared circuit BB with a switched BB
- **Reduce network demand**
 - Restrict applications that use a lot of network capacity
 - Reduce broadcast messages (placing filters at switches)

7.6 Implications

- **Amount of traffic is increasing**
 - May require BN be replaced
 - BN should be easily upgradeable
- **Ethernet moving into backbone extensively**
 - One standard technology used for both LANs and BN
 - Cost decreasing , management becoming easier
 - Ethernet backbone performance increasing
- **ATM considered legacy technology**
 - Vendors stopping the production

Questions?
