Al-Mustaqbal Univerity
College of Science
Intelligent Medical Systems Departement
Computer Networks - 3rd Class

Lecture 3:
Hierarchical Network Model

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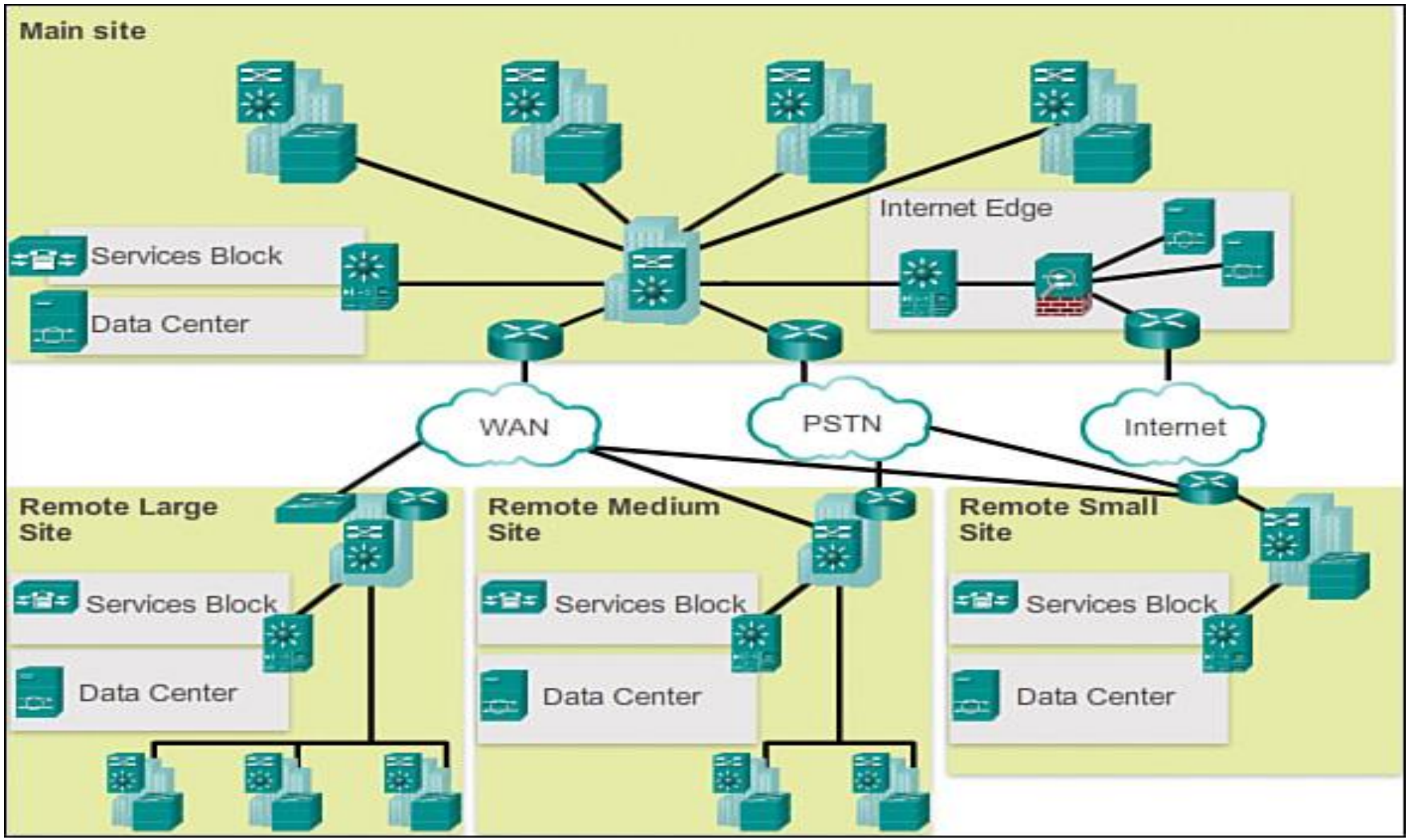
Network Requirements

- Small network: Provides services for up to 200 devices.
- Medium-size network: Provides services for 200 to 1,000 devices.
- Large network: Provides services for 1,000+ devices.

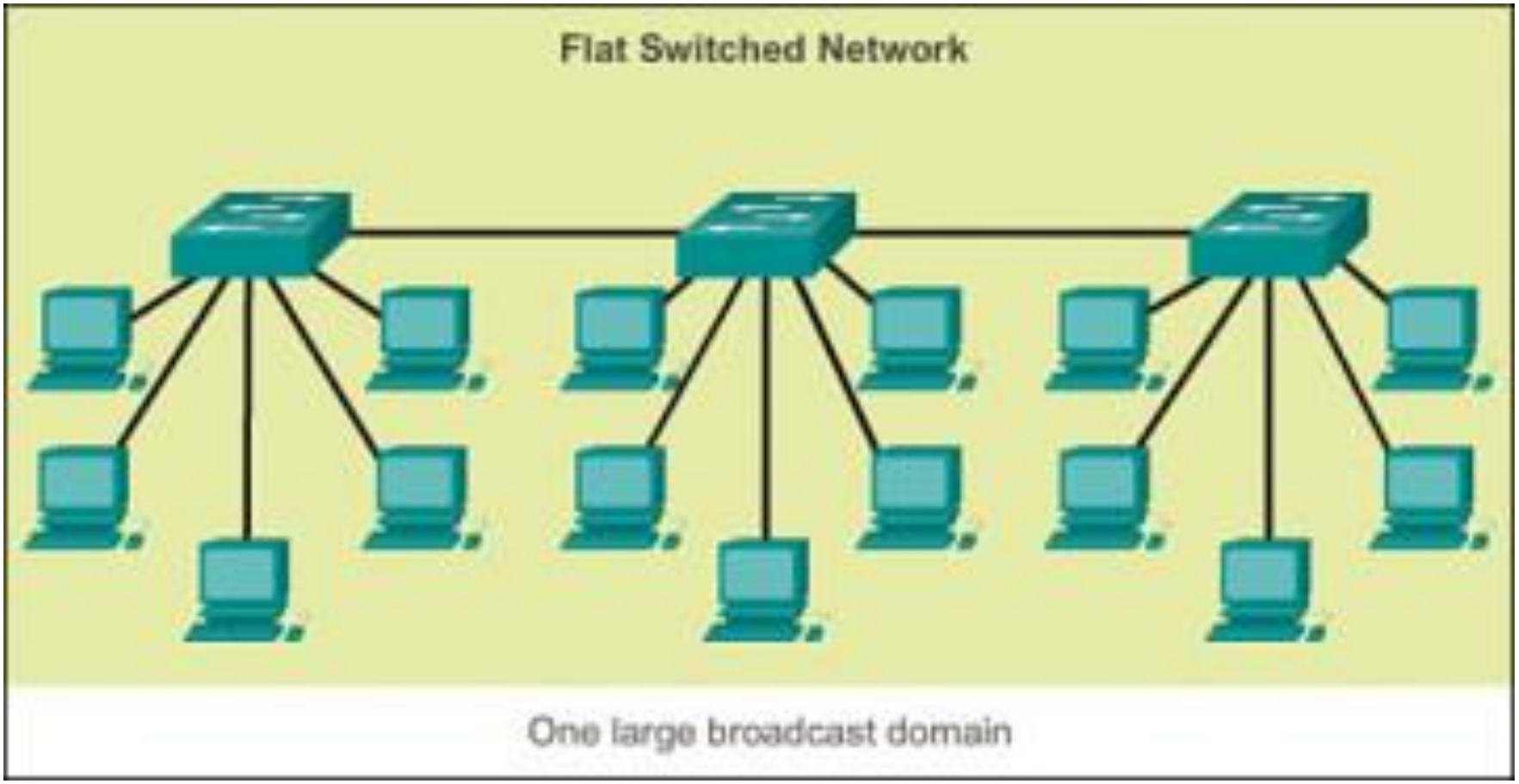
Large Enterprise Network



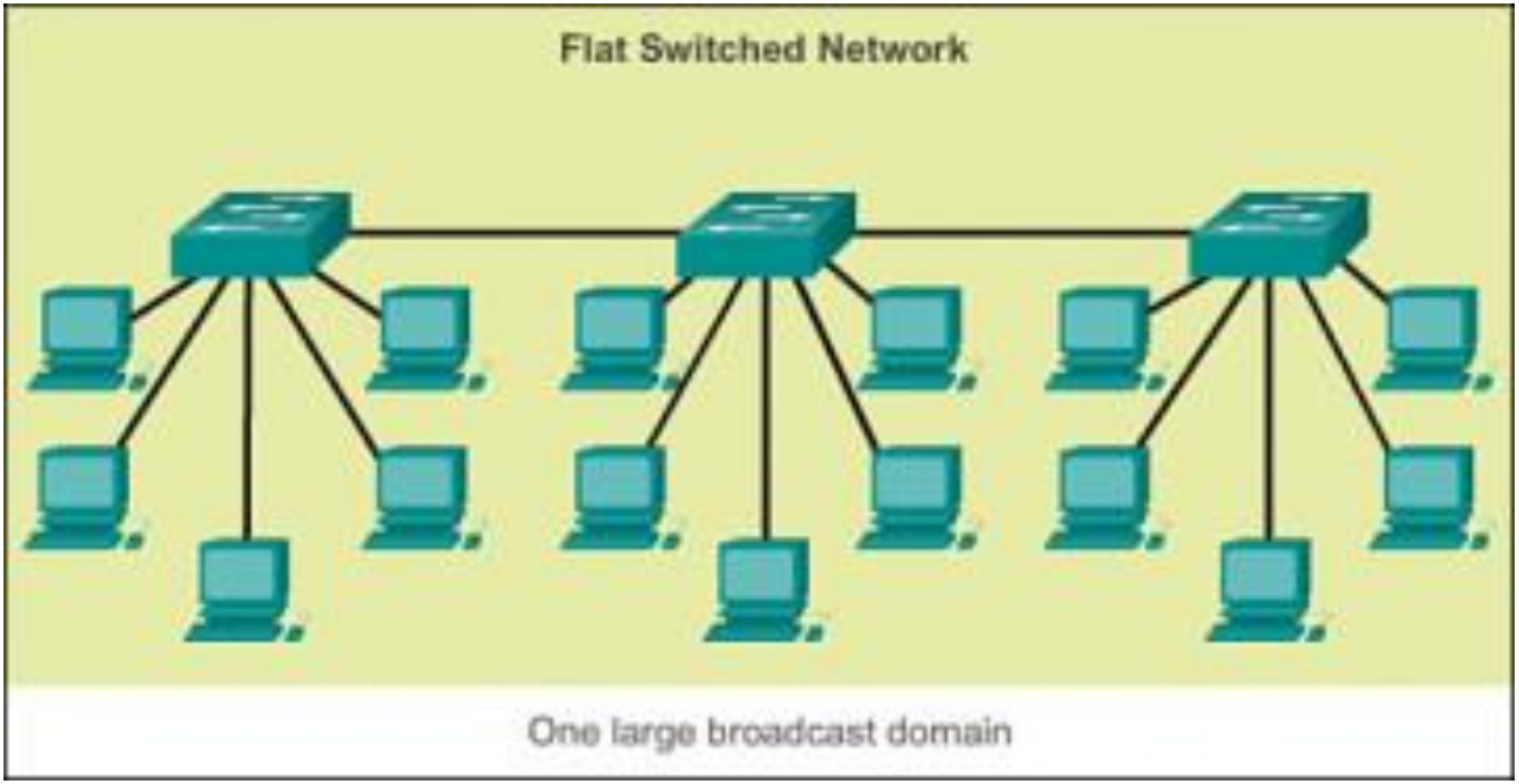
Hierarchical Network Model

- The hierarchical network model provides a framework that network designers can use to help ensure that the network is flexible and easy to implement and troubleshoot.
- Modularity such as data center and Interest Edge
- Resiliency : continuing in normal and abnormal
- Flexibility : increase capacity and scalability

Why Hierarchical Network?



Why Hierarchical Network?
See the Flat network Below



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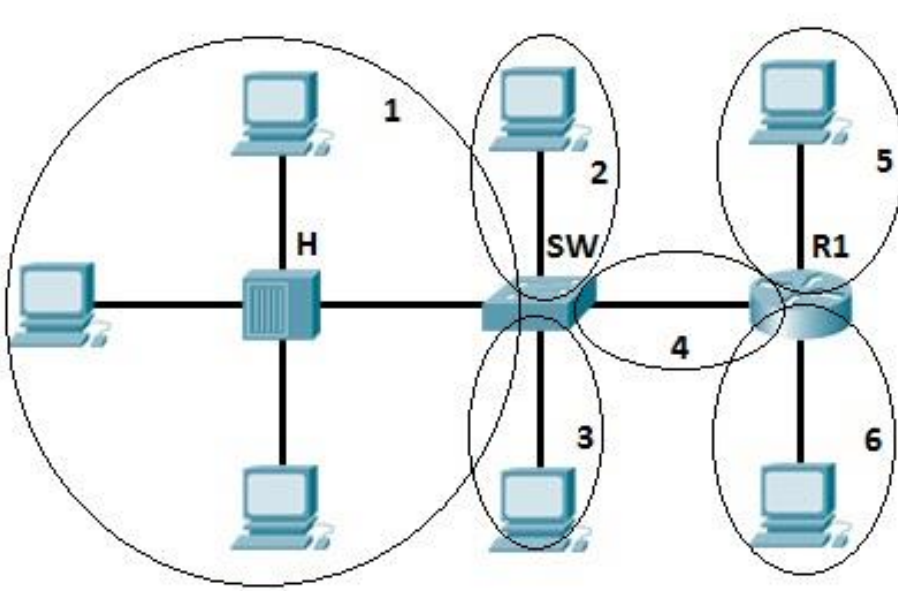
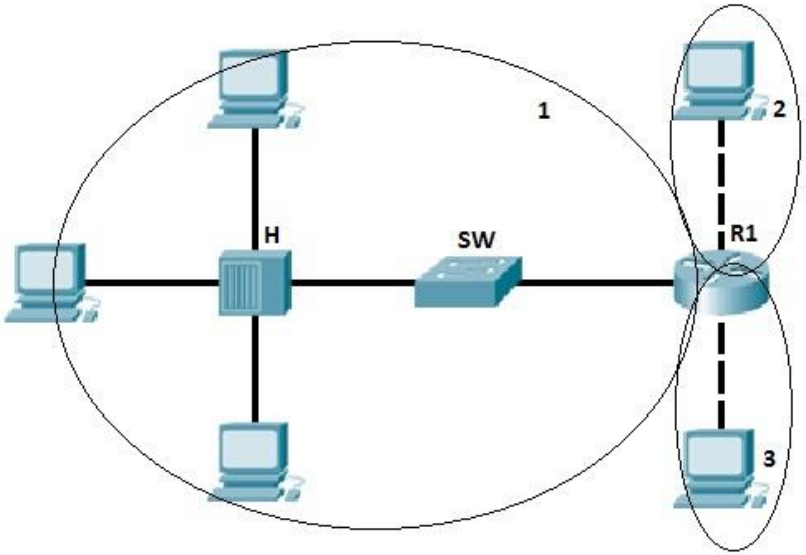
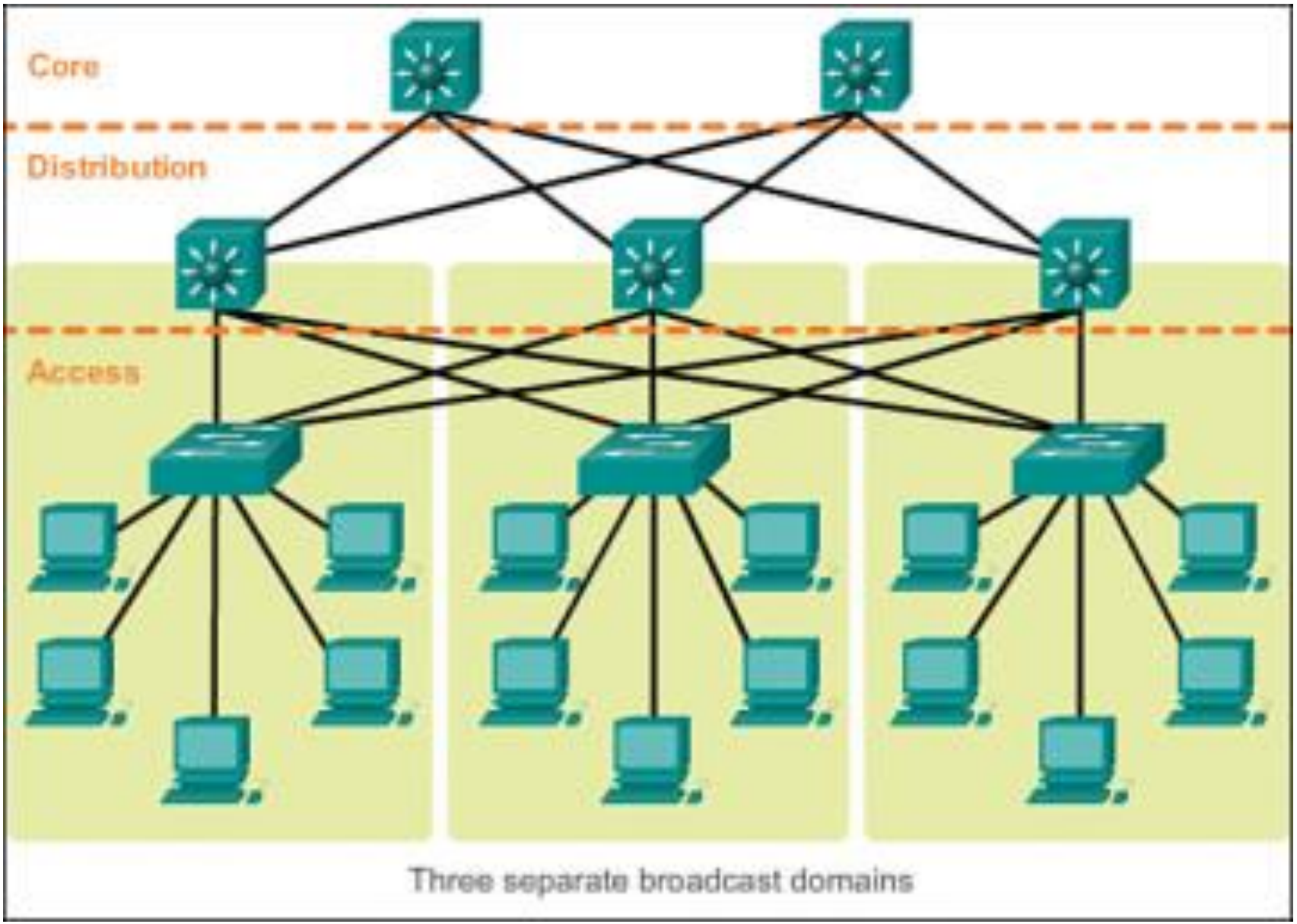




The packets collide and both devices must send the packets again, which reduces network efficiency. Collisions are often in a hub environment, because each port on a hub is in the same collision domain. By contrast, each port on a bridge, a switch or a router is in a separate collision domain.

A broadcast domain is a domain in which a broadcast is forwarded. A broadcast domain contains all devices that can reach each other at the data link layer (OSI layer 2) by using broadcast. All ports on a hub or a switch are by default in the same broadcast domain. All ports on a router are in the different broadcast domains and routers don't forward broadcasts from one broadcast domain to another

Why Hierarchical Network?



Hierarchical Network Model

Hierarchical Network Design Layers:

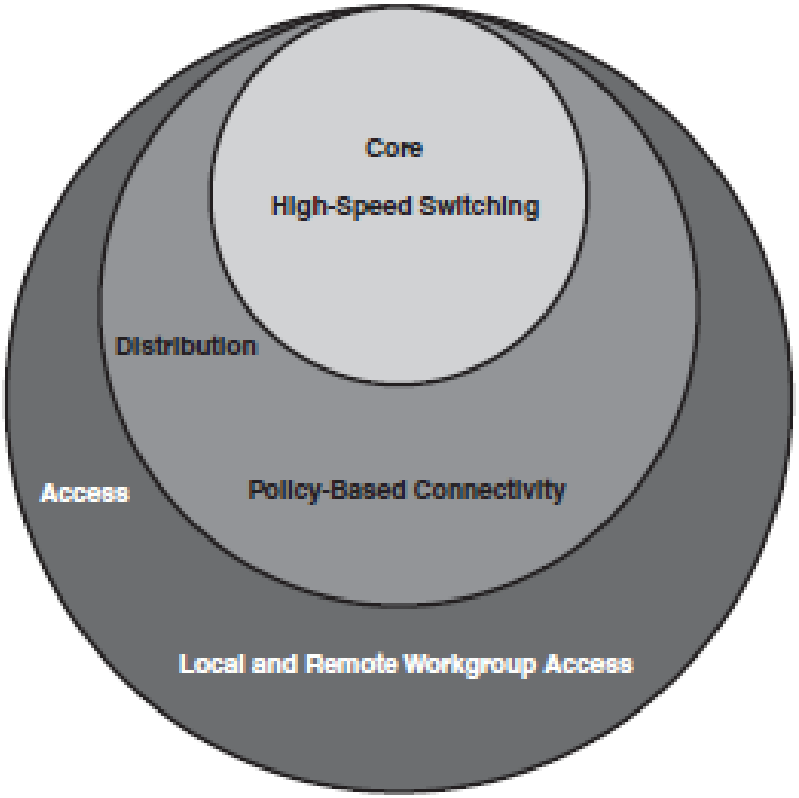
A typical enterprise hierarchical LAN campus network design includes the following three layers:

- Access layer: Provides workgroup/user access to the network
- Distribution layer: Provides policy-based connectivity and controls the boundary between the access and core layers
- Core layer: Provides fast transport between distribution switches within the enterprise campus

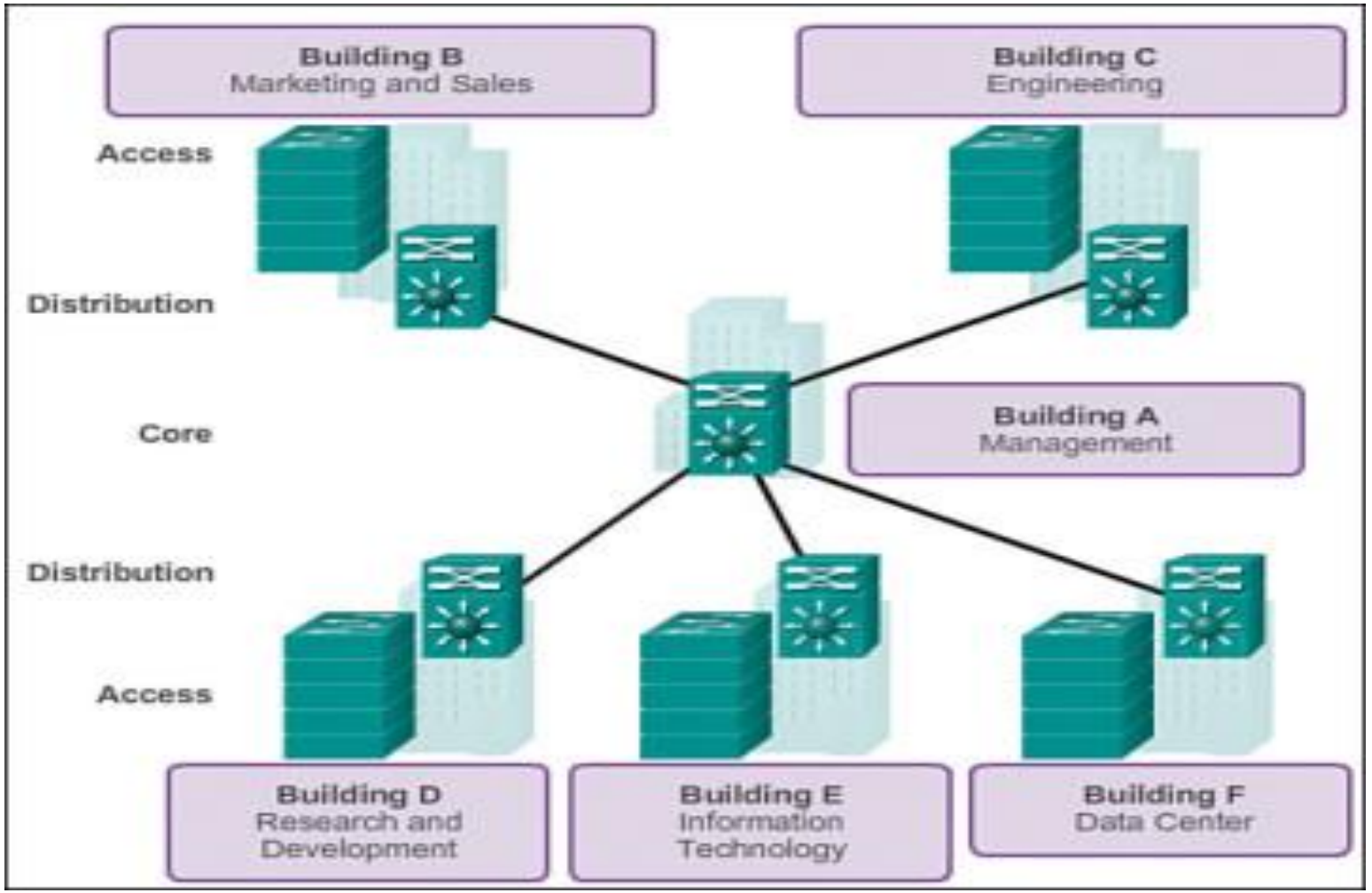
Hierarchical Network Model

Each hierarchical layer focuses on specific functions, thereby allowing the network designer to choose the right systems and features based on their function within the model.

This approach helps provide more accurate capacity planning and minimize total costs.



Hierarchical Network Model



Hierarchical Network Model

The actual manner in implementing the layers depends on the needs of the network to be designed. Each layer can be implemented in routers or switches. A particular layer can be omitted, but hierarchy should be maintained for optimum performance.

Hierarchical Network Model

The Access Layer – The Role:

- The access layer is the concentration point at which clients access the network.
- Access layer devices control traffic by localizing service requests to the access media.
- The purpose of the access layer is to grant user access to network resources.

Hierarchical Network Model

The Access layer - Characteristics:

- In the campus environment, the access layer typically incorporates switched LAN devices with ports that provide connectivity for workstations and servers.

- In the WAN environment, the access layer for teleworkers or remote sites provides access to the corporate network across some wide-area technology, such as Frame Relay.

Hierarchical Network Model

The Access layer - Characteristics:

■ In order not to compromise network integrity, access is granted only to authenticated users or devices (such as those with physical address or logical name authentication).

For example, the devices at the access layer must detect whether a telecommuter who is dialing in is legitimate.

Hierarchical Network Model

The Access layer:

■ Access can be provided to end users as part of either a Layer 2 (L2) switching environment or a multilayer switching environment.

Note: multilayer switching is a synonym for Layer 3 switching

Hierarchical Network Model

Using Layer 2 Switching in the Access Layer

- Access to local workstations and servers can be provided using shared or switched media LANs.

- VLANs may be used to segment the switched LANs. Each LAN or VLAN is a single broadcast domain.

- The access layer aggregates end-user switched ports and provides Fast Ethernet, and Gigabit Ethernet uplinks to the distribution layer to satisfy connectivity requirements.

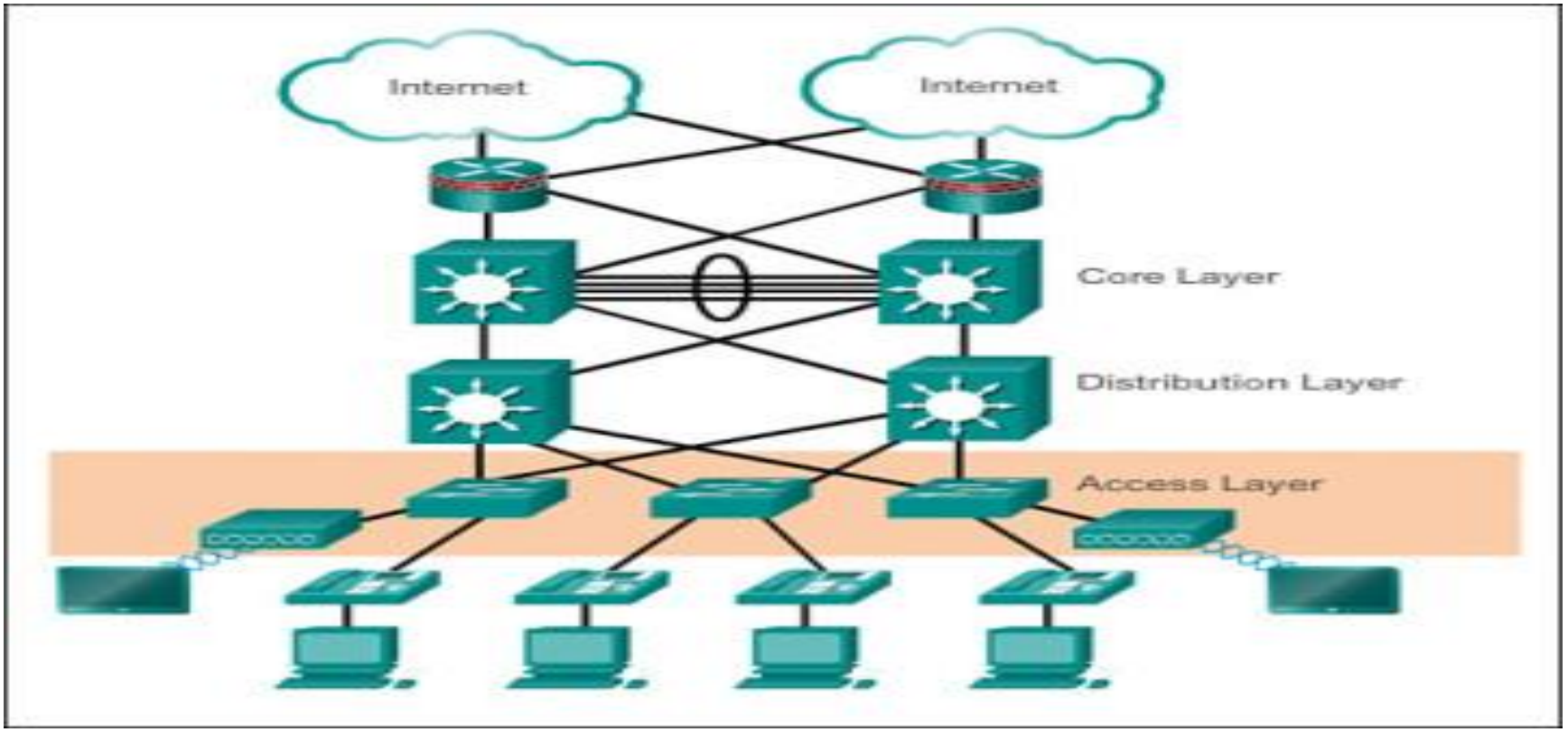
Hierarchical Network Model

Using Multilayer Switching in the Access Layer

The most common design for remote users is to use multilayer switches or routers which is the boundary for broadcast domains and is necessary for communicating between broadcast domains (including VLANs). Access routers provide access to remote office environments using various wide-area technologies combined with multilayer features, such as route propagation, packet filtering, authentication, security, Quality of Service (QoS), and so on.

Hierarchical Network Model

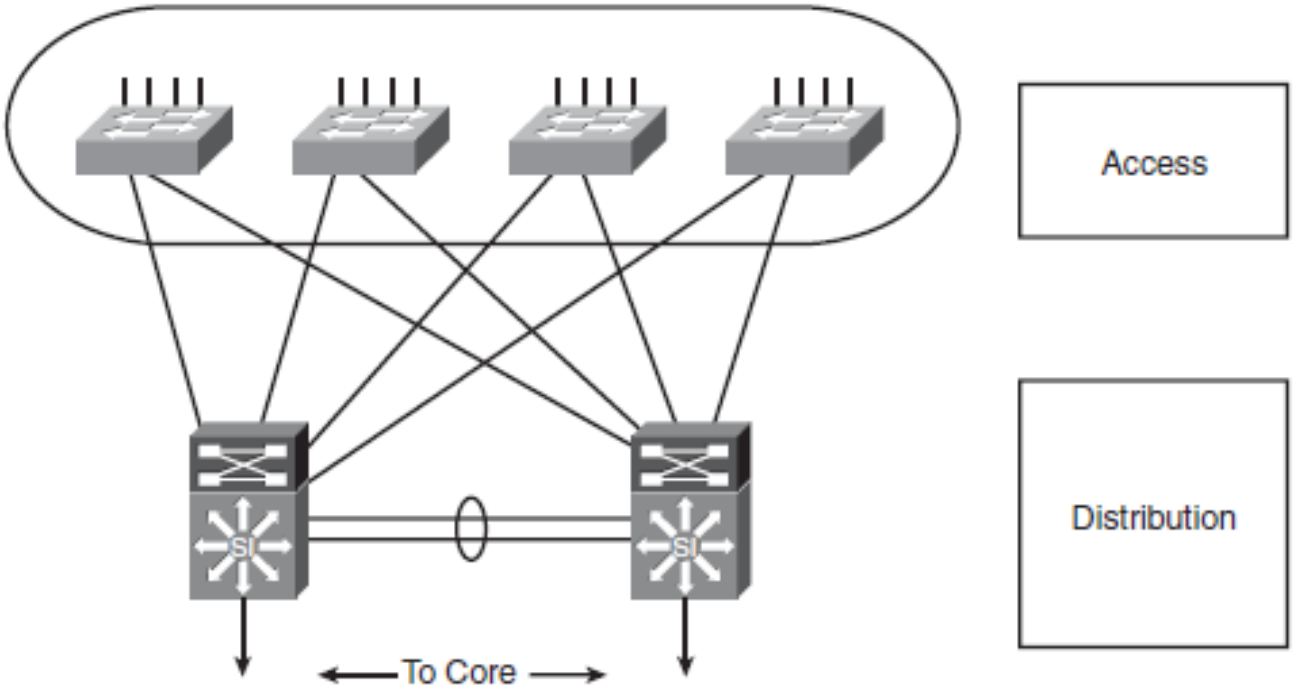
The Access layer - Characteristics:



the access layer for a small business network generally incorporates Layer 2 switches and access points providing connectivity between workstations and servers.

Hierarchical Network Model

The Access layer - Example:



Hierarchical Network Model

The Distribution Layer - The Role :

The distribution layer represents both a separation between the access and core layers and a connection point between the diverse access sites and the core layer.

The distribution layer determines department or workgroup access and provides policy-based connectivity.

Hierarchical Network Model

The Distribution Layer - Policy-based connectivity:

Policy-based connectivity means implementing the policies of the organization. Methods for implementing policies include the following:

- Filtering by source or destination address
- Filtering based on input or output ports
- Providing specific static routes rather than using routes from a dynamic routing protocol.
- Security (for example, certain packets might not be allowed into a specific part of the network)

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The Distribution Layer - The Characteristics :

Distribution layer devices control access to resources that are available at the core layer and must therefore use bandwidth efficiently.

The distribution layer represents a routing boundary between the access and core layers and is where routing and packet manipulation are performed.

The distribution layer allows the core layer to connect diverse sites while maintaining high performance. To maintain good performance in the core, the distribution layer can redistribute between bandwidth-intensive access-layer routing protocols and optimized core routing protocols. Route filtering is also implemented at the distribution layer.

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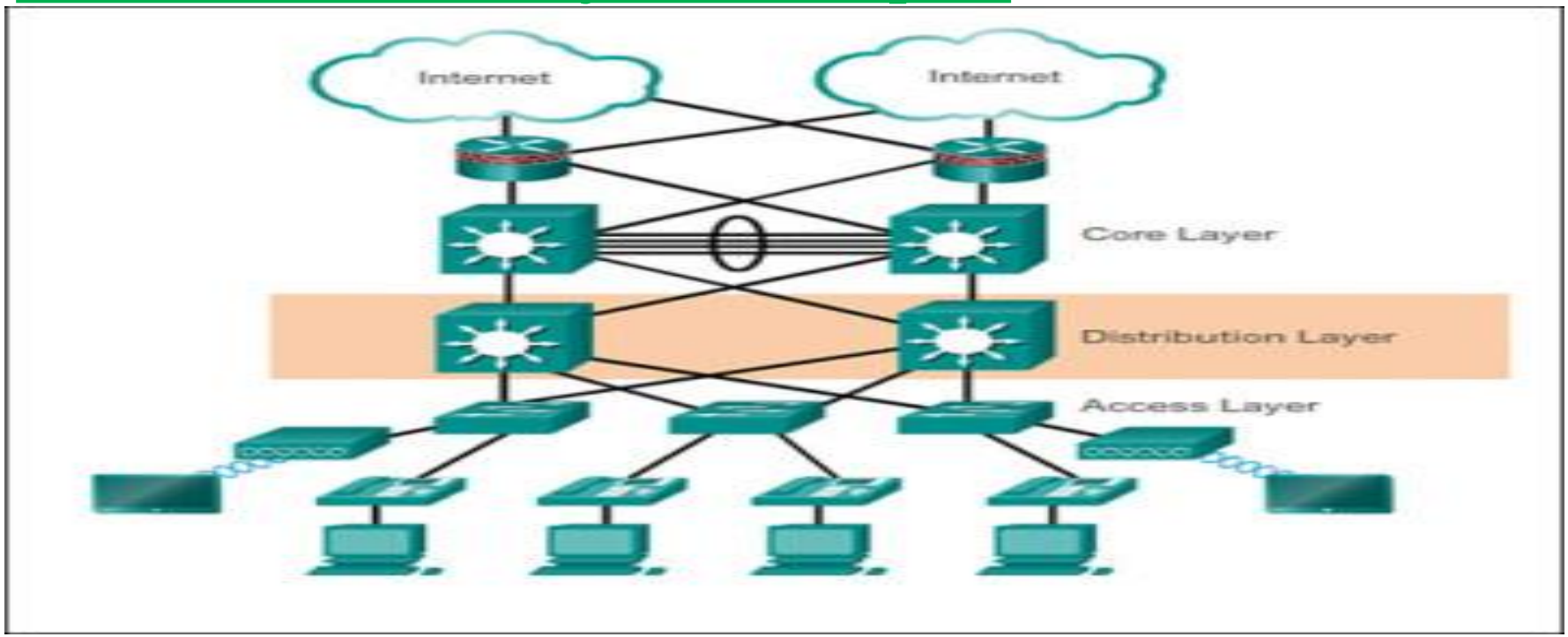
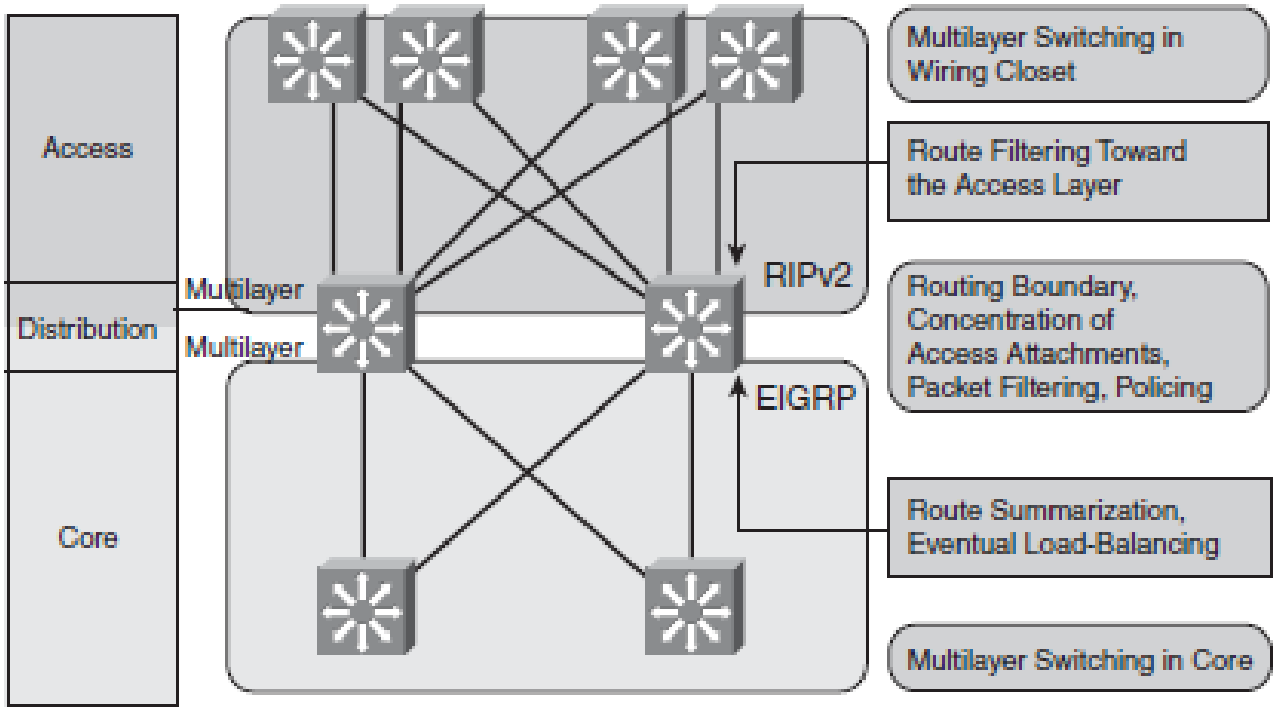
The Distribution Layer - Example :



The ***distribution layer*** aggregates the data received from the access layer switches before it is transmitted to the core layer for routing to its final destination. In the distribution layer is the boundary between the Layer 2 domains and the Layer 3 routed network.

Hierarchical Network Model

The Distribution Layer - Example :



Hierarchical Network Model

The Core Layer - The Role :

The function of the core layer is to provide fast and efficient data transport.

Hierarchical Network Model

The Core Layer - The Characteristics :

The core layer is a high-speed backbone that should be designed to switch packets as quickly as possible to optimize communication transport within the network.

Because the core is critical for connectivity, core layer devices are expected to provide a high level of availability and reliability.

The core layer should not perform any packet manipulation, such as checking access lists or filtering, which would slow down the switching of packets.

Hierarchical Network Model

The Core Layer - The Switching :

Layer 2 switching or multilayer switching (routing) can be used in the core layer.

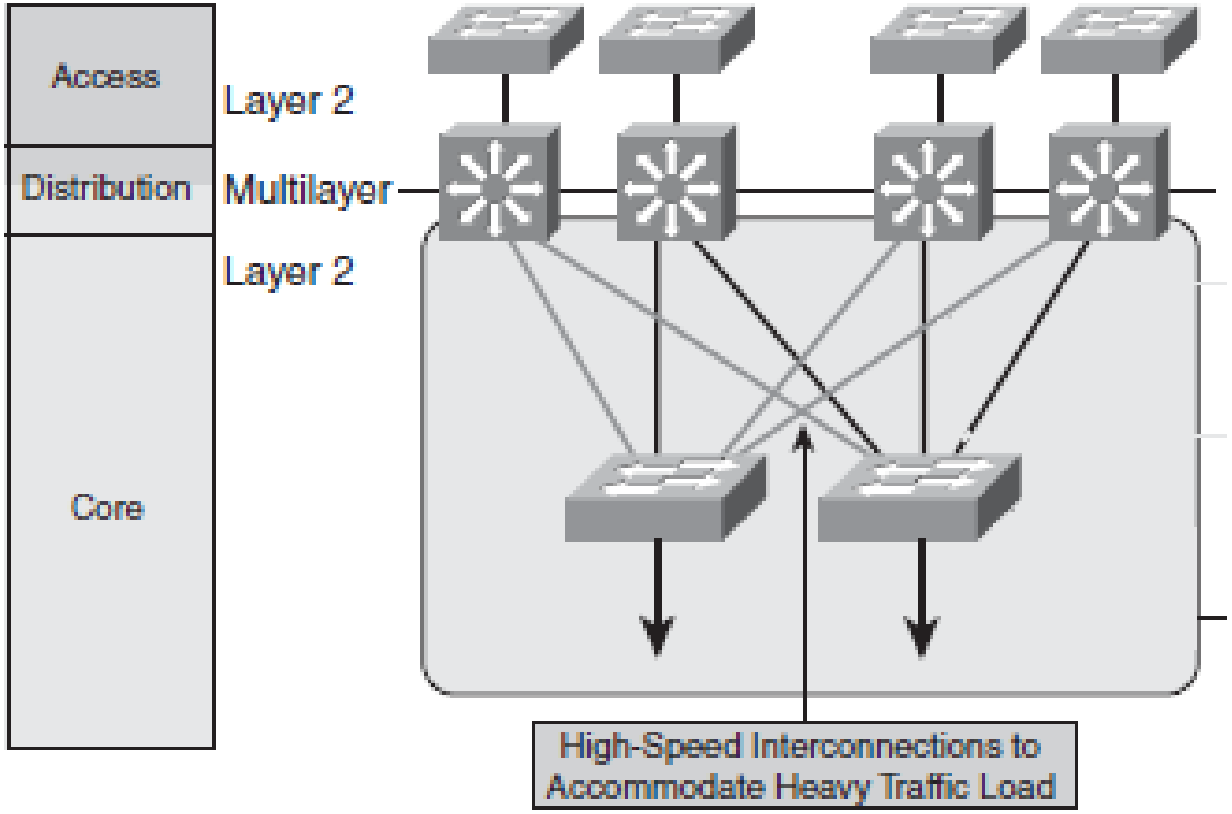
Because core devices are responsible for accommodating failures by rerouting traffic and responding quickly to network topology changes, and because performance for routing in the core with a multilayer switch incurs no cost, most implementations have multilayer switching in the core layer.

The core layer can then more readily implement scalable protocols and technologies, and provide alternate paths and load balancing.

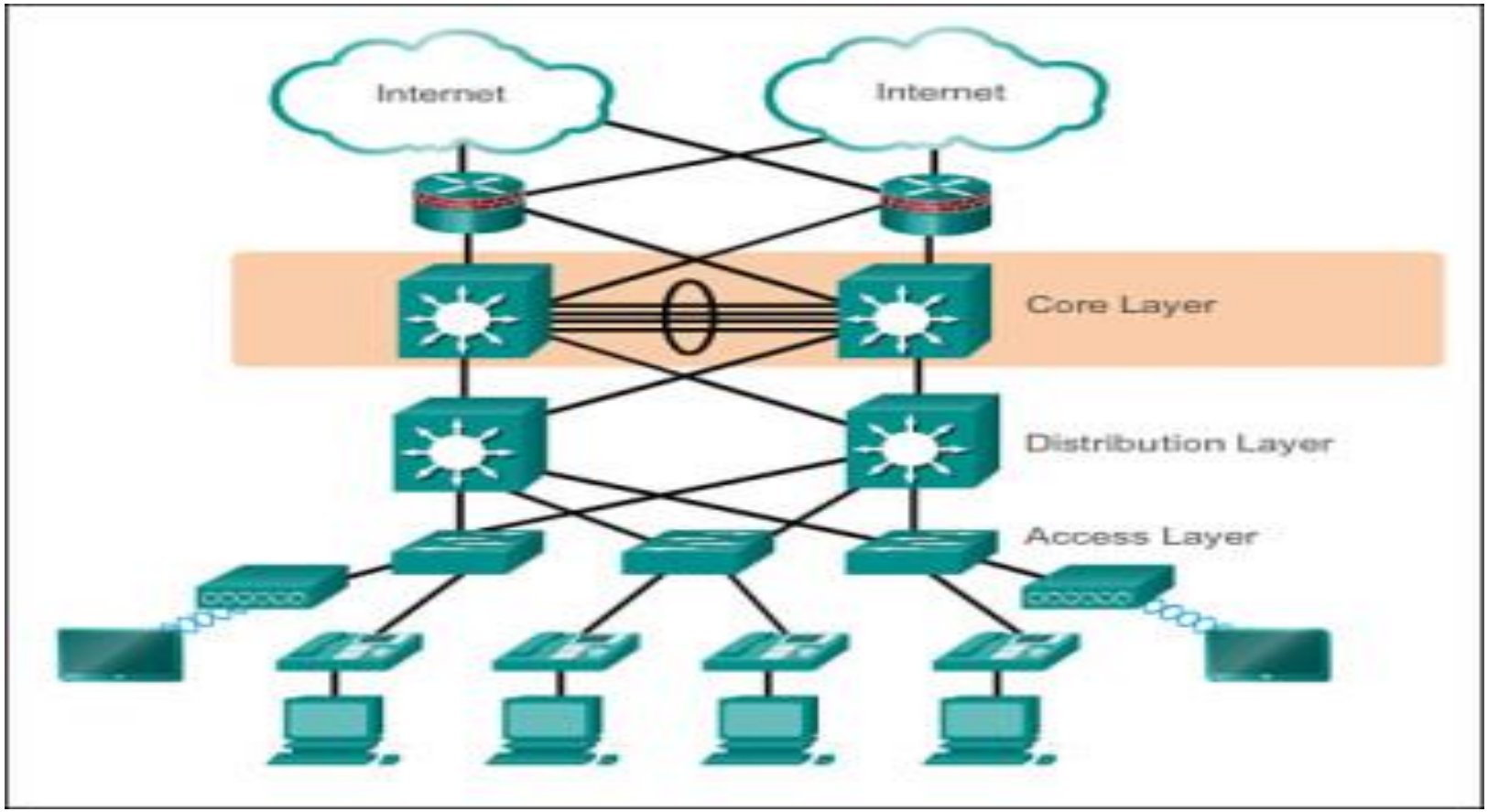
Hierarchical Network Model

The Core Layer - Example:

Layer 2 switching in the campus core…



Hierarchical Network Model



Hierarchical Network Model

The Core Layer - Example:

Layer 2 switching in the campus core…

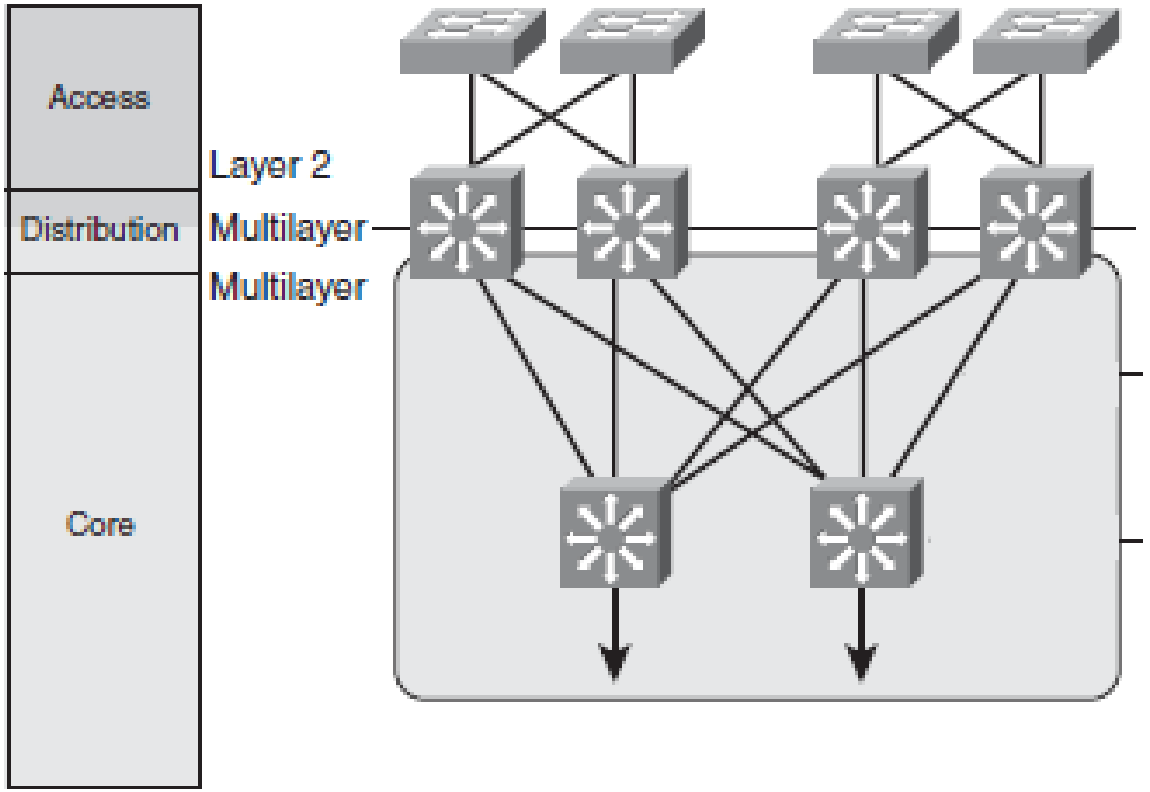
A typical packet between access sites follows these steps:

Step 1 The packet is Layer 2–switched toward a distribution switch.
Step 2 The distribution switch performs multilayer switching toward a core interface.
Step 3 The packet is Layer 2–switched across the LAN core.
Step 4 The receiving distribution switch performs multilayer switching toward an access layer LAN.
Step 5 The packet is Layer 2–switched across the access layer LAN to the destination host.

Hierarchical Network Model

The Core Layer - Example:

Multi Layer switching in the campus core…



Hierarchical Network Model

The Core Layer - Example:

Multi Layer switching in the campus core…

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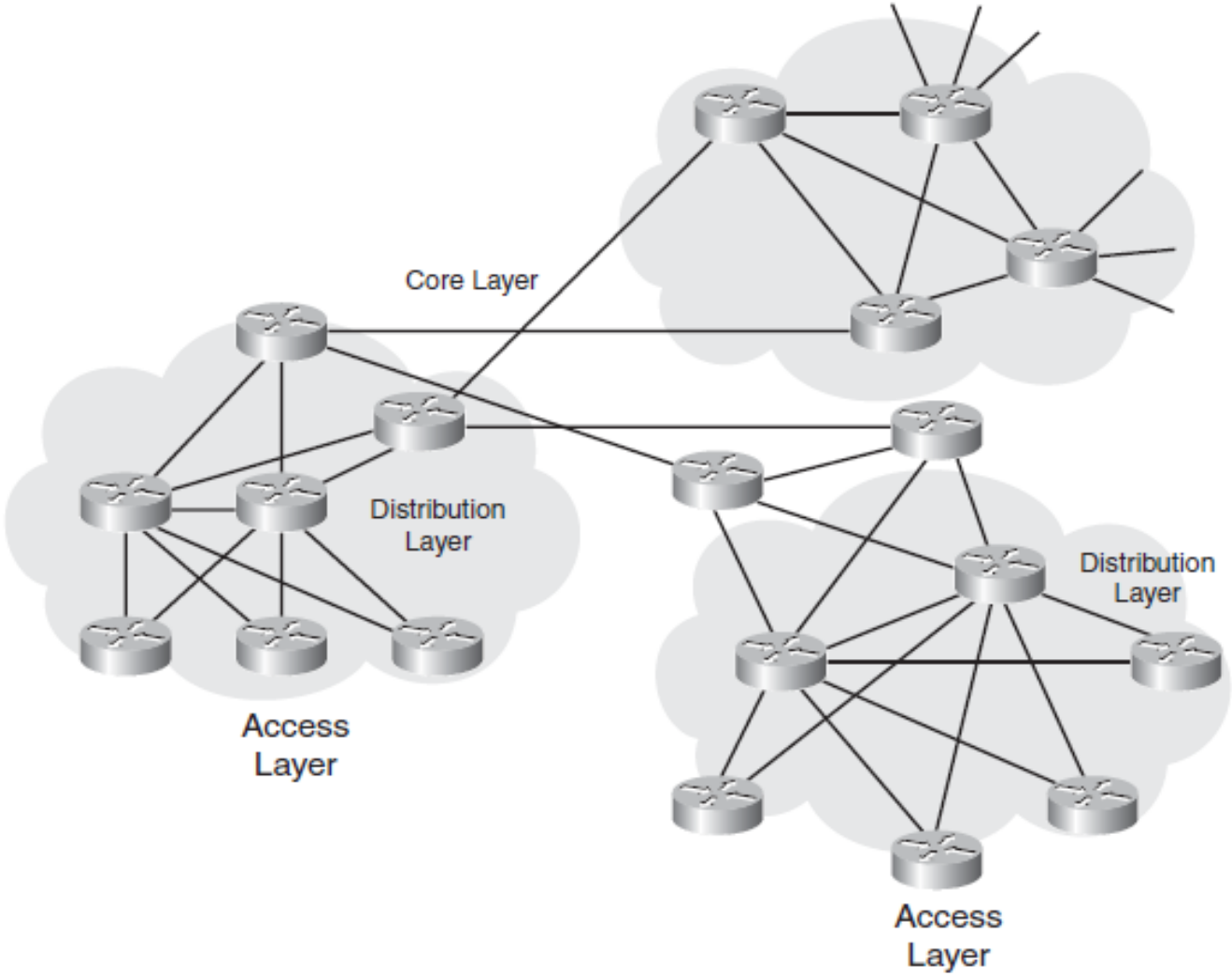
Hierarchical Network Model

Hierarchical Routing in the WAN - Example



Hierarchical Network Model

Hierarchical Routing in the WAN – Example

A typical packet between access sites follows these steps:

Step 1 The packet is Layer 3–forwarded toward the distribution router.

Step 2 The distribution router forwards the packet toward a core interface.

Step 3 The packet is forwarded across the WAN core.

Step 4 The receiving distribution router forwards the packet toward the appropriate access layer router.

Step 5 The packet is Layer 3–forwarded to the destination host's access layer

Thank you