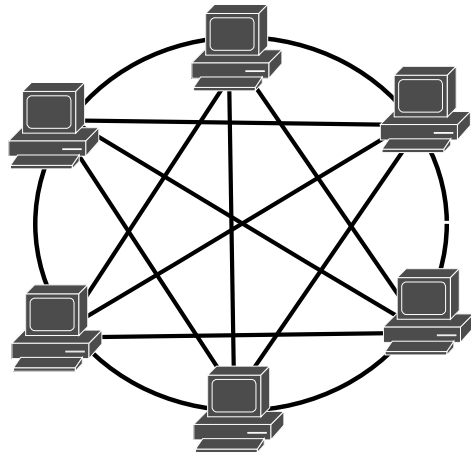


Network Design Models

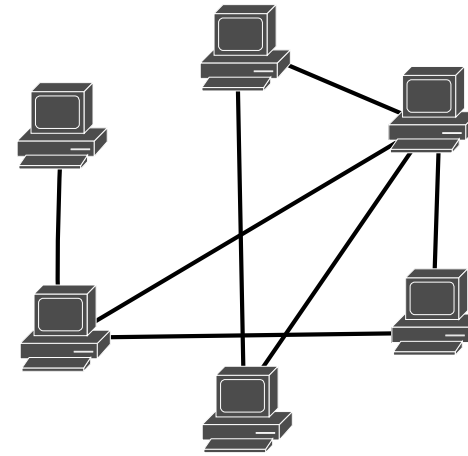
Redes de Comunicações II

**Licenciatura em
Engenharia de Computadores e Informática
DETI-UA**

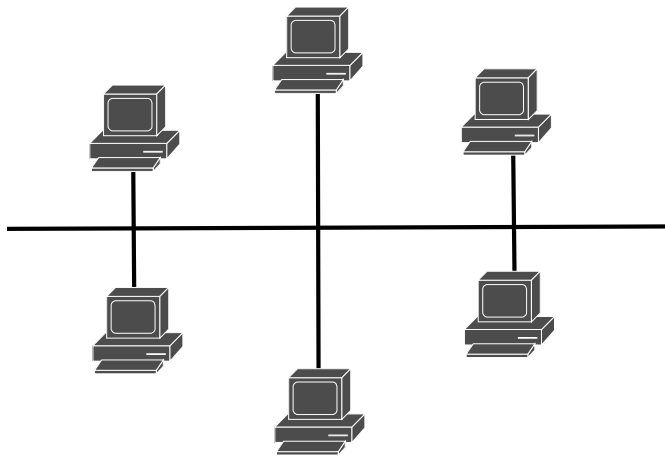
Types of Network Topology



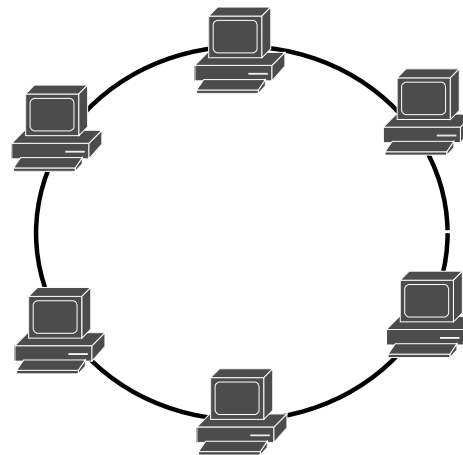
Fully Connected



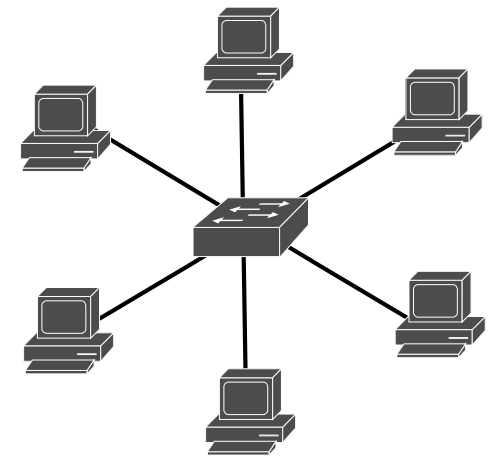
Mesh



Common Bus



Ring



Star

Objectives of Network Design

- Network should be **Modular**

- Support growth and change.
- Scaling the network is eased by adding new modules instead of complete redesigns.

- Network should be **Resilient**

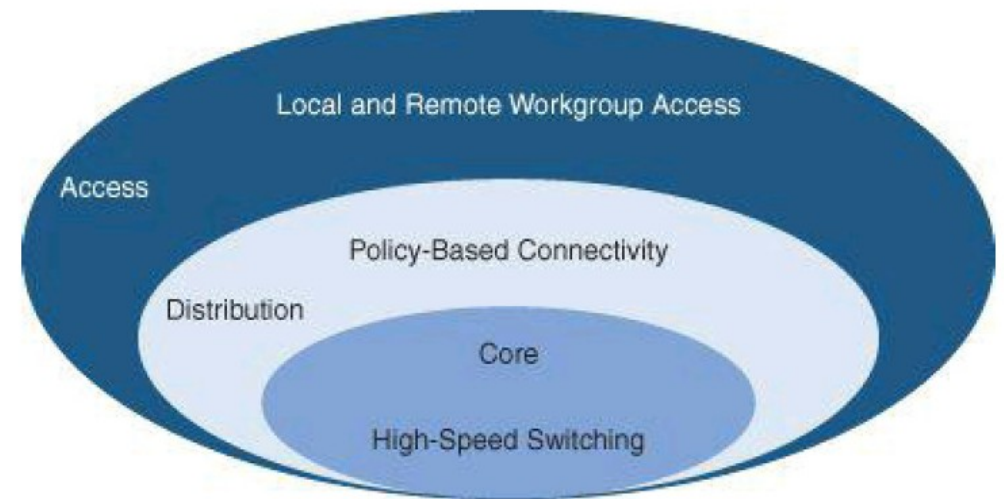
- Up-time close to 100 percent.
 - If network fails in some companies (e.g. financial), even for a second, may represent millions of lost revenue.
 - If network fails in a modern hospital, this may represent lost of lives.
- Resilience has costs.
 - Resilience level should be a trade-off between available budget and acceptable risk.

- Network should have **Flexibility**

- Businesses change and evolve.
- Network should adapt quickly.



Hierarchical Network Model



- **Access layer**

- ◆ Provides user access to network.
- ◆ Generally incorporates switched LAN devices that provide connectivity to workstations, IP phones, servers, and wireless access points.
- ◆ For remote users or remote sites provide an entry to the network across WAN technology.

- **Distribution layer**

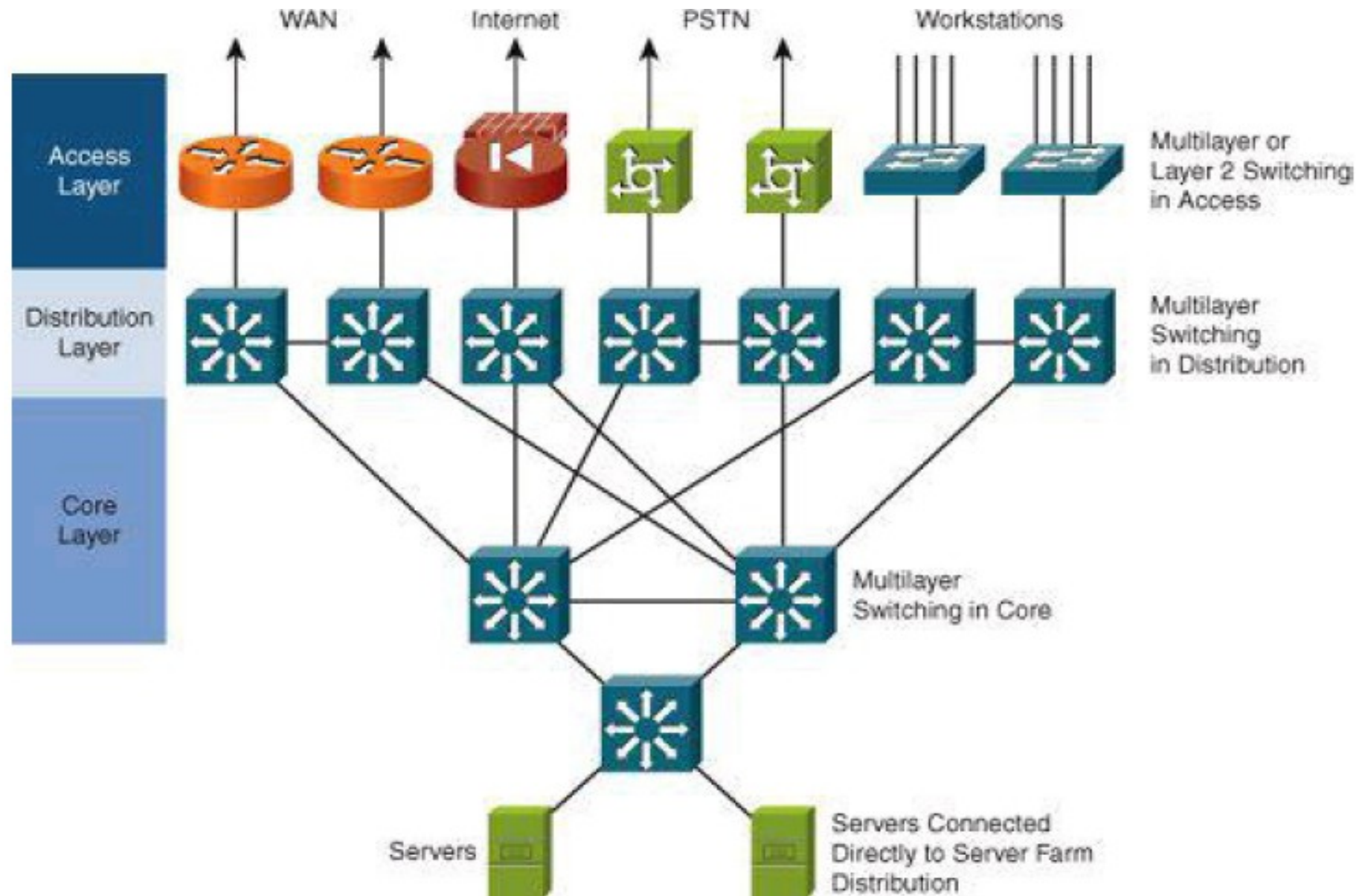
- ◆ Aggregates LAN devices.
- ◆ Segments work groups and isolate network problems.
- ◆ Aggregates WAN connections at the edge of the campus and provides policy-based connectivity.
- ◆ Implements QoS policies.

- **Core layer**

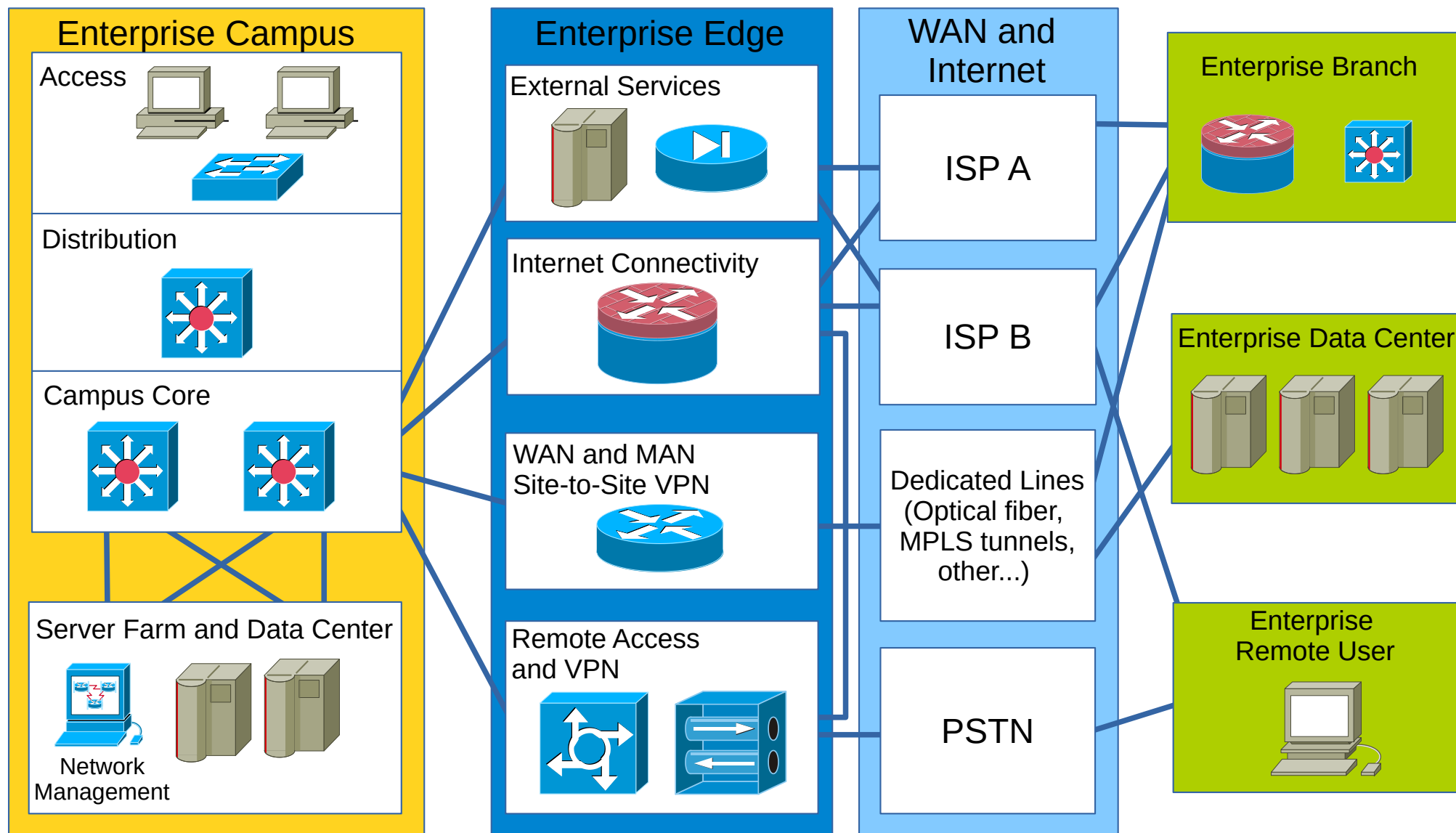
- ◆ A high-speed backbone.
- ◆ Core is critical for connectivity, must provide a high level of availability and adapt quickly to changes.
- ◆ Should provide scalability and fast convergence.
- ◆ Should provide an integration point for data center.



A Hierarchical Network



Modular Network Design



Network Modules (1)

- Campus

- ◆ Operating center of an enterprise.
- ◆ This module is where most users access the network.
- ◆ Combines a core infrastructure of intelligent switching and routing with mobility, and advanced security.

- Data Center

- ◆ Redundant data centers provide backup and application replication.
- ◆ Network and devices offer server and application load balancing to maximize performance.
- ◆ Allows the enterprise to scale without major changes to the infrastructure.
- ◆ Can be located either at the campus as a server farm and/or at a remote facility.

- Branch

- ◆ Allows enterprises to extend head-office applications and services to remote locations and users or to a small group of branches.
- ◆ Provides secure access to voice, mission-critical data, and video applications.
- ◆ Should provide a robust architecture with high levels of resilience for all the branch offices.



Network Modules (2)

- WAN and MAN

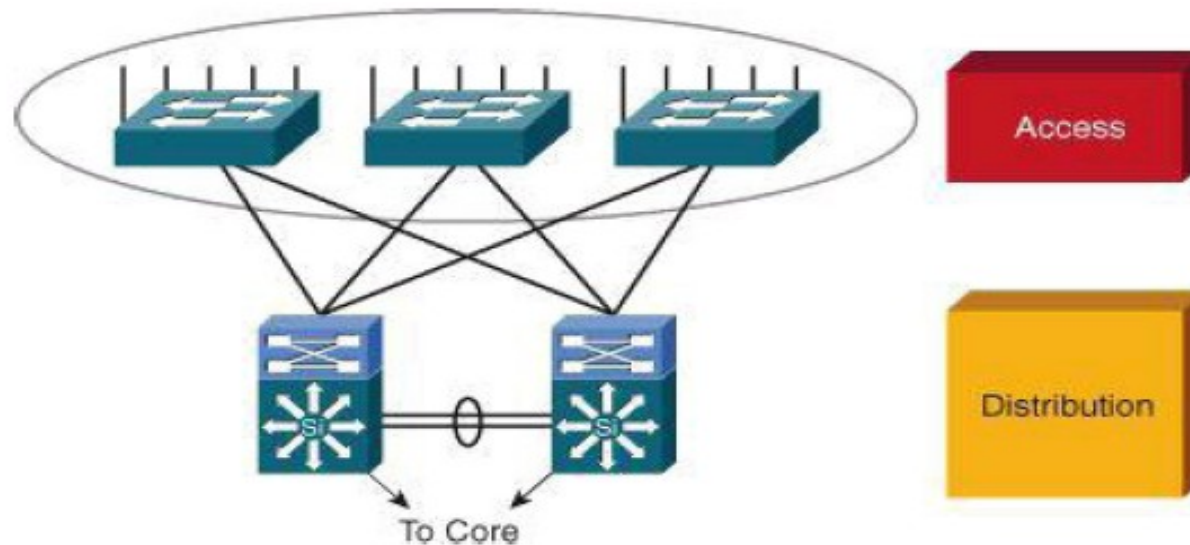
- Offers the convergence of voice, video, and data services.
- Enables the enterprise a cost-effectively presence in large geographic areas.
- QoS, granular service levels, and comprehensive encryption options help ensure the secure delivery to all sites.
- Security is provided with multiservice VPNs (IPsec and MPLS) over Layer 2 or Layer 3 communications.

- Remote User

- Allows enterprises to securely deliver voice and data services to a remote small office/home office (SOHO) over a standard broadband access service.
- Allows a secure log in to the network over a VPN and access to authorized applications and services.



Designing the Access Layer



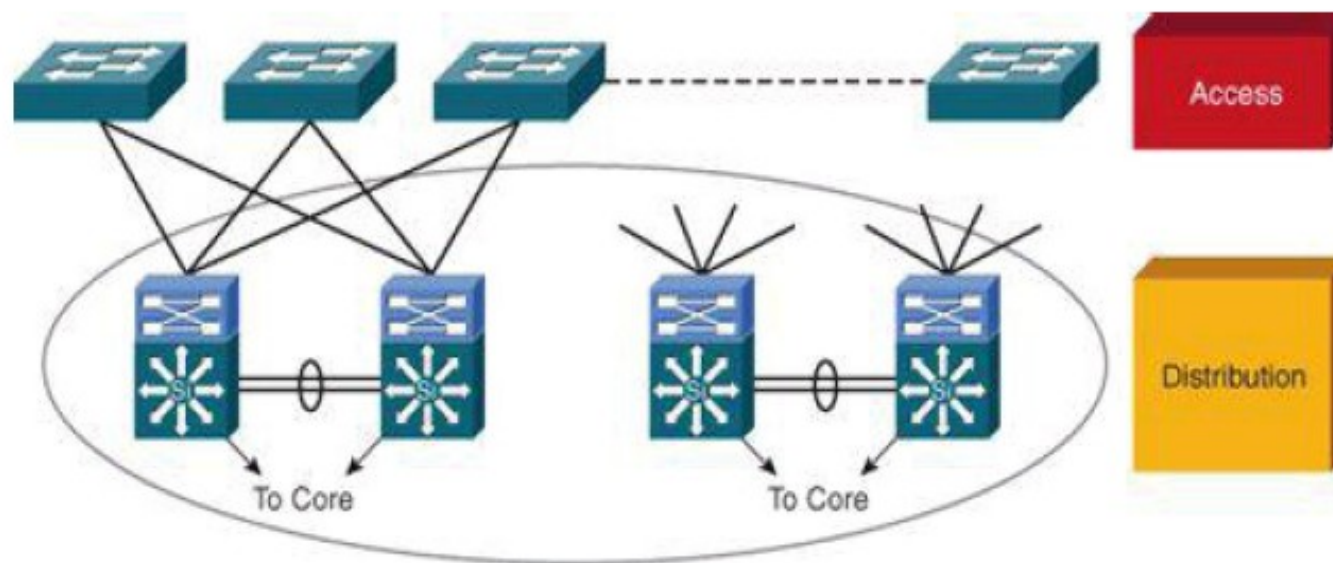
- High availability

- ◆ Default gateway redundancy using multiple connections from access switches to redundant distribution layer switches.
- ◆ Redundant power supplies.

- Other considerations

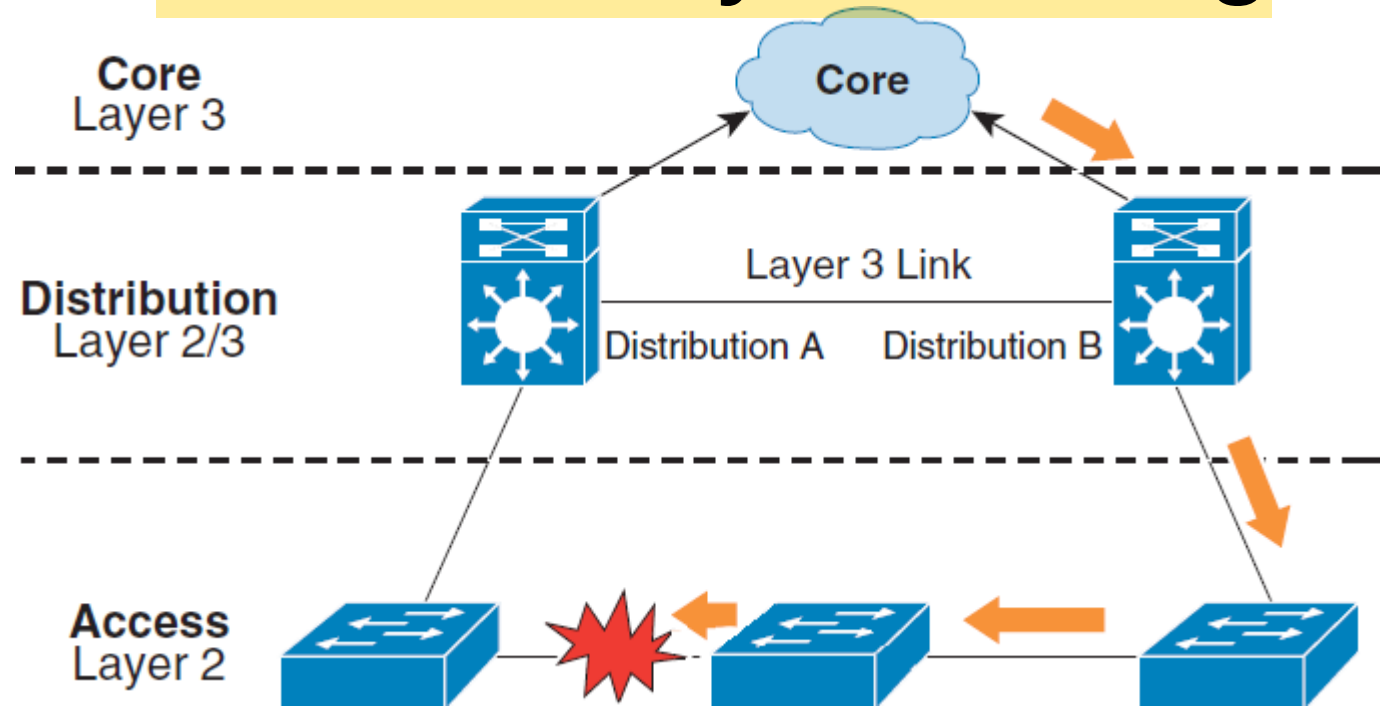
- ◆ Convergence: the access layer should provide seamless convergence of voice into data network and providing roaming wireless LAN (WLAN).
- ◆ Security: for additional security against unauthorized access to the network, the access layer should provide tools such as IEEE 802.1X, port security, DHCP snooping and dynamic ARP inspection (DAI).
- ◆ Quality of service (QoS): The access layer should allow prioritization of critical network traffic using traffic classification and queuing as close to the ingress of the network as possible.
- ◆ IP multicast: the access layer should support efficient network and bandwidth management using features such as Internet Group Management Protocol (IGMP) snooping.

Designing the Distribution Layer



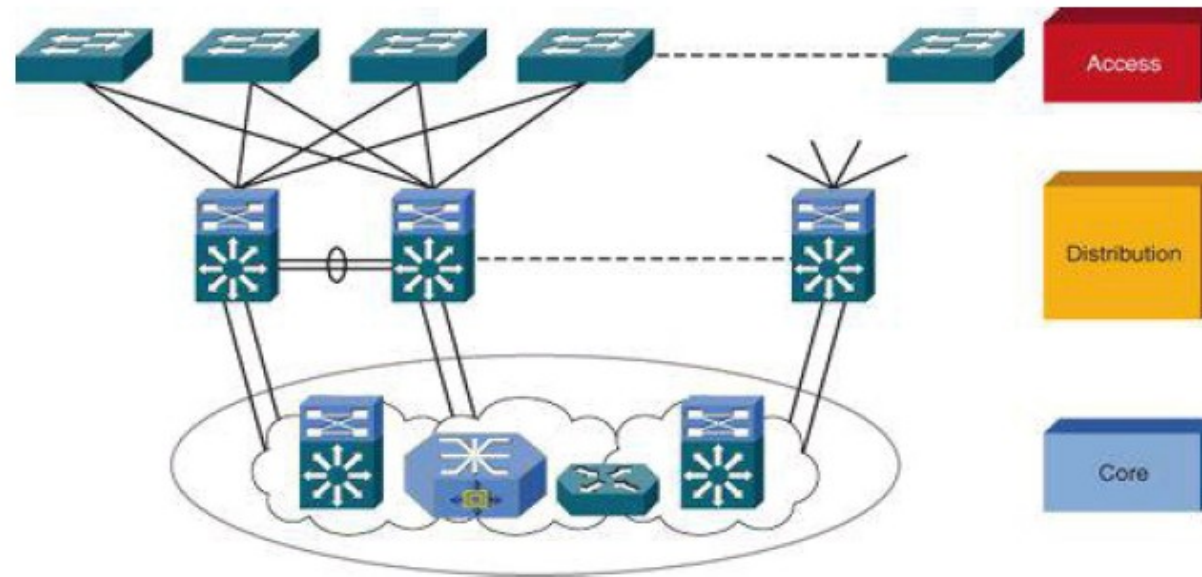
- Uses a combination of Layer 2 and multilayer switching to segment workgroups and isolate network problems, preventing them from impacting the core layer.
- Connects network services to the access layer and implements QoS, security, traffic loading balancing, and implements routing policies.
- Major design concerns: high availability, load balancing, QoS, and provisioning.
- In some networks, offers a default route to access layer routers and runs dynamic routing protocols when communicating with core routers.
- The distribution layer it is usually used to terminate VLANs from access layer switches.
- To further improve routing protocol performance, summarizes routes from the access layer.
- To implement policy-based connectivity, performs tasks such as controlled routing and filtering and QoS.

Avoid Daisy Chaining



- When using a L3 link between Distribution layer switches
 - ♦ In Access layer, any path from a switch should not require another switch from the Access layer.
 - ♦ In Distribution layer, any path between Distribution layer switches should not require a switch from the Access layer.
- When using a L2 link between Distribution layer switches
 - ♦ Daisy chain is acceptable, however
 - ➔ Could overload some Access layer switches.
 - ➔ Could increase STP convergence in case of failure.

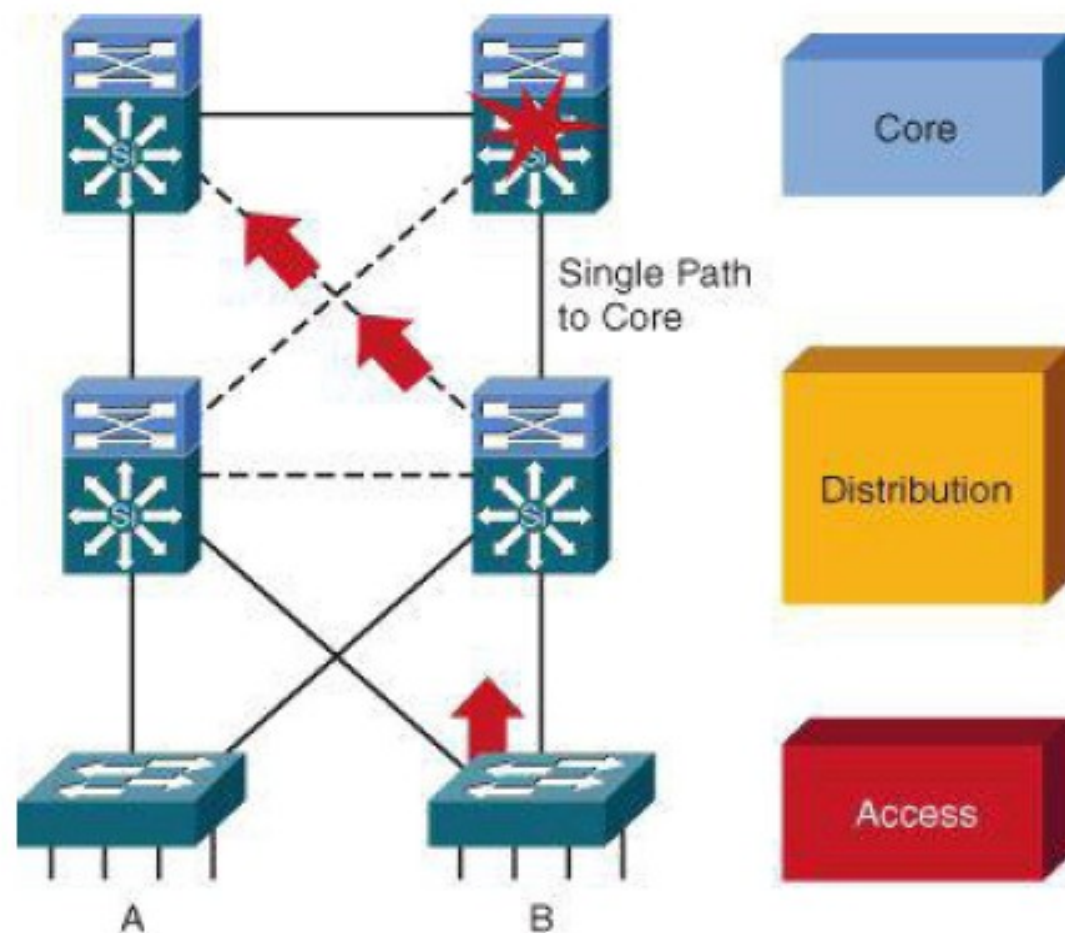
Designing the Core Layer



- Backbone for campus connectivity and is the aggregation point for the other layers.
- Should provide scalability, high availability, and fast convergence to the network.
 - ◆ The core layer should scale easily.
 - ◆ High-speed environment that should use hardware-acceleration, if possible.
 - ◆ The core should provide a high level of redundancy and adapt to changes quickly.
 - Core devices should be more reliable
 - Accommodate failures by rerouting traffic and respond quickly to changes in the network topology.
 - ◆ Implements scalable protocols and technologies.
 - ◆ Provides alternate paths and load balancing.
 - ◆ Packet manipulation should be avoided, such as checking access lists and filtering, which could slow down the switching of packets.
- Not all campus implementations require a campus core.
- The core and distribution layer functions can be combined at the distribution layer for a smaller campus.

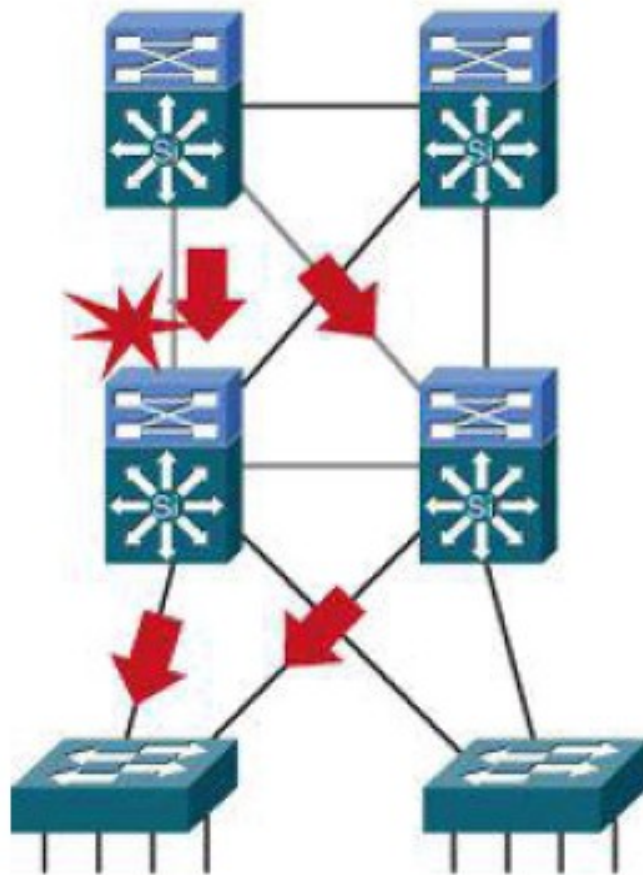
Provide Alternate Paths

- An additional link providing an alternate path to a second core switch from each distribution switch offers redundancy to support a single link or node failure.



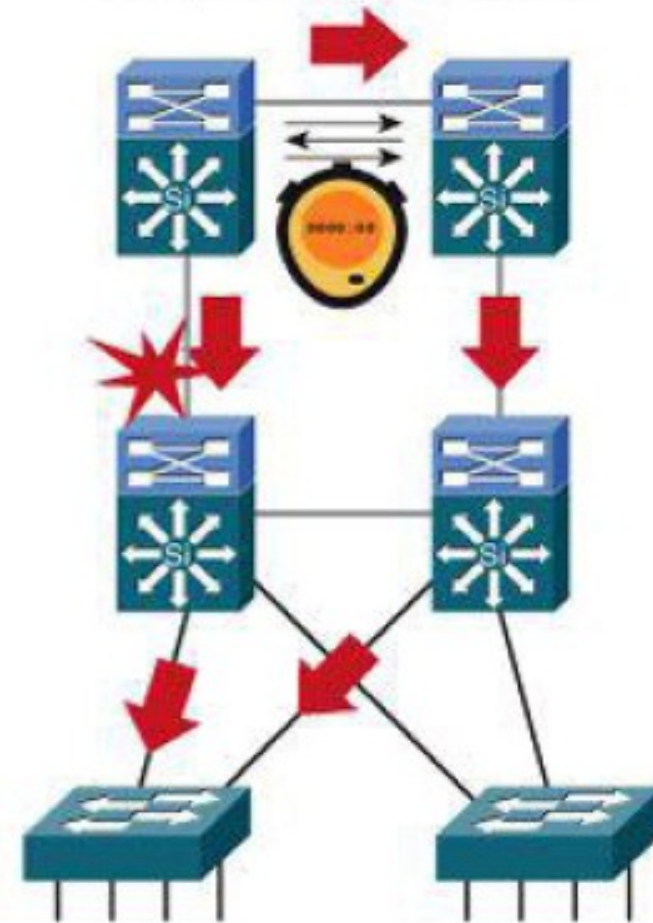
Core Redundant Triangles

Triangles: Link or box failure does *not* require routing protocol convergence.



Model A

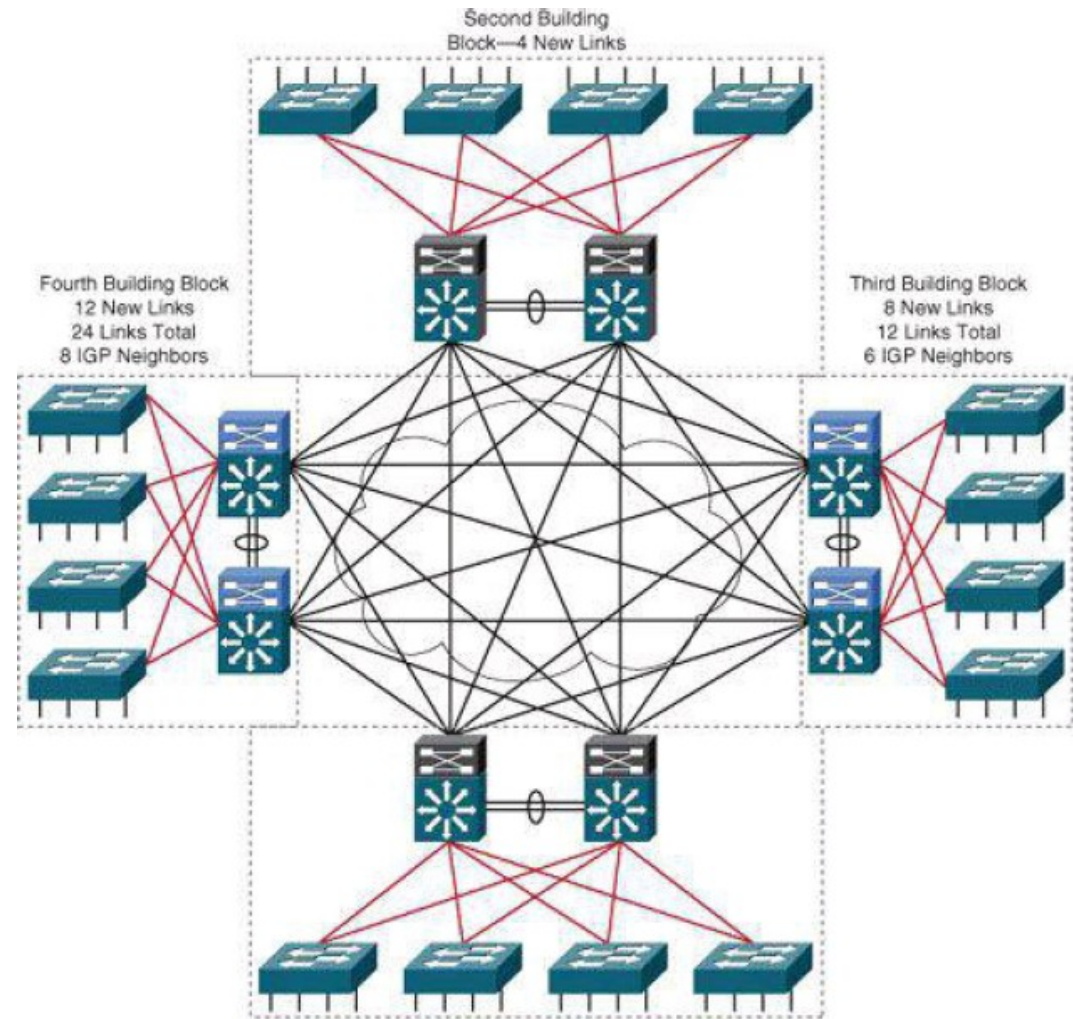
Squares: Link or box failure requires routing protocol convergence.



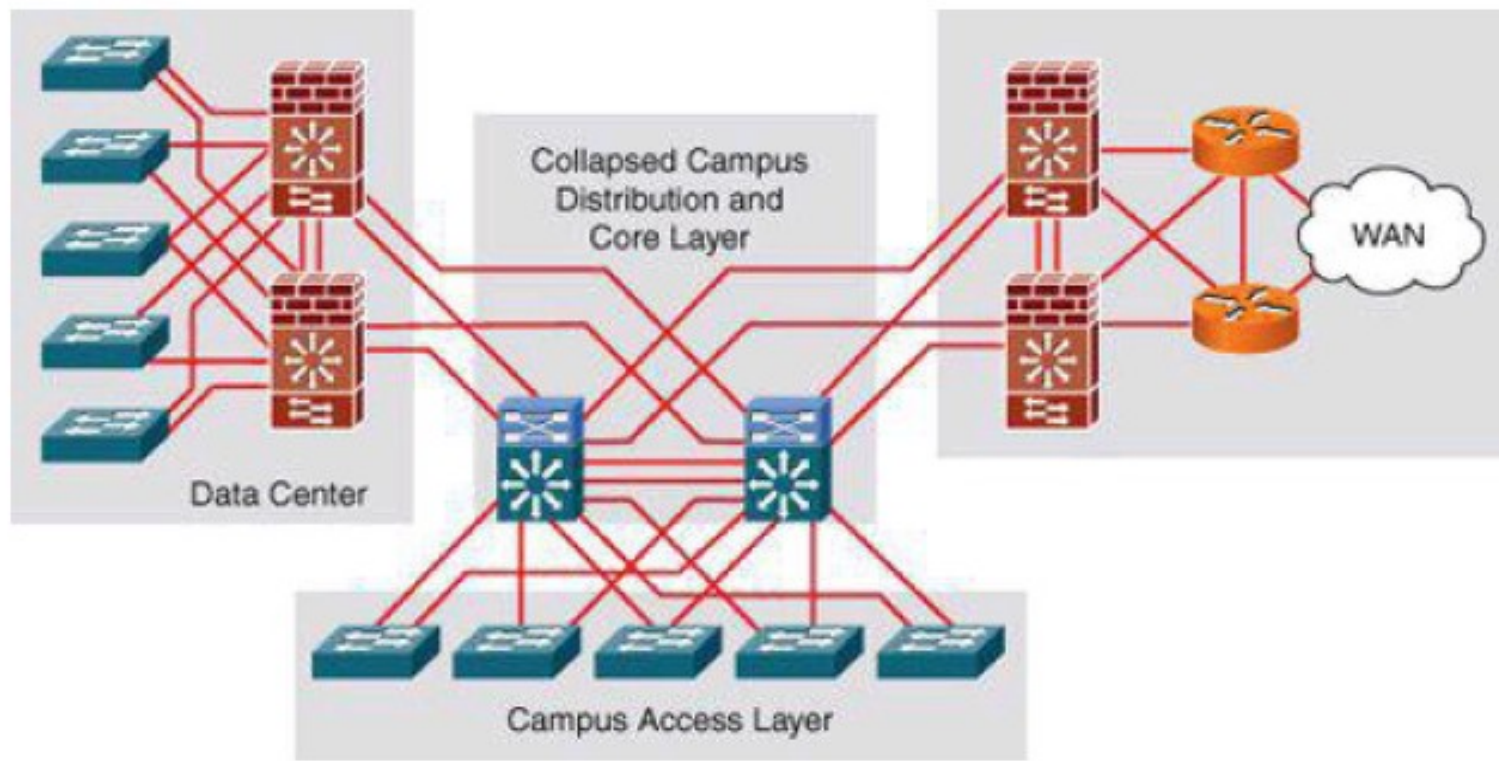
Model B

Without a Core Layer

- The distribution layer switches need to be fully meshed.
- Can be difficult to scale.
- Increases the cabling requirements.
- Routing complexity of a full-mesh design increases as new neighbors are added.
- Can be used in small campus with no perspective of growing.

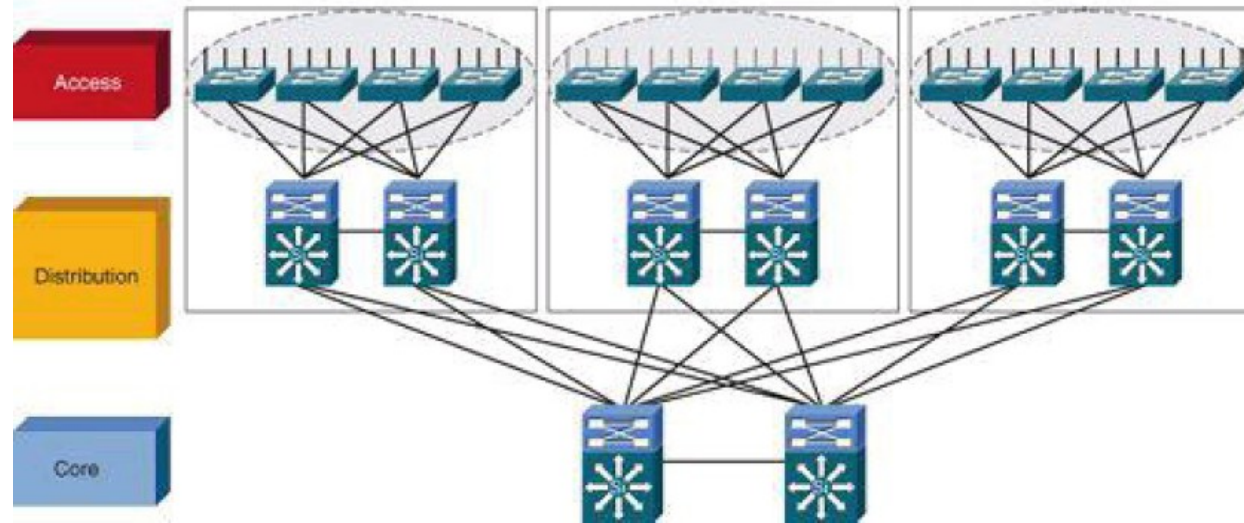


Collapsed Core Layer Architecture



- In smaller networks, the core and the distribution layer can be only one,
 - Eliminates the need for extra switching hardware and simplifies the network implementation.
- However, eliminates the advantages of the multilayer architecture, specifically fault isolation.

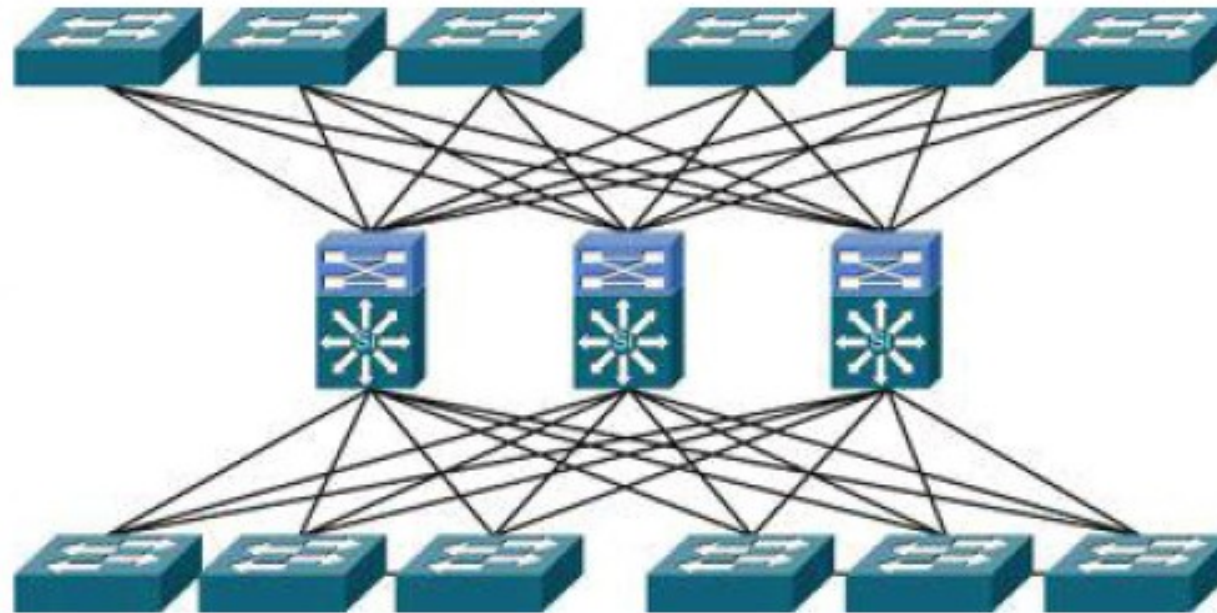
Avoid Single Points of Failure



- With an hierarchical design,

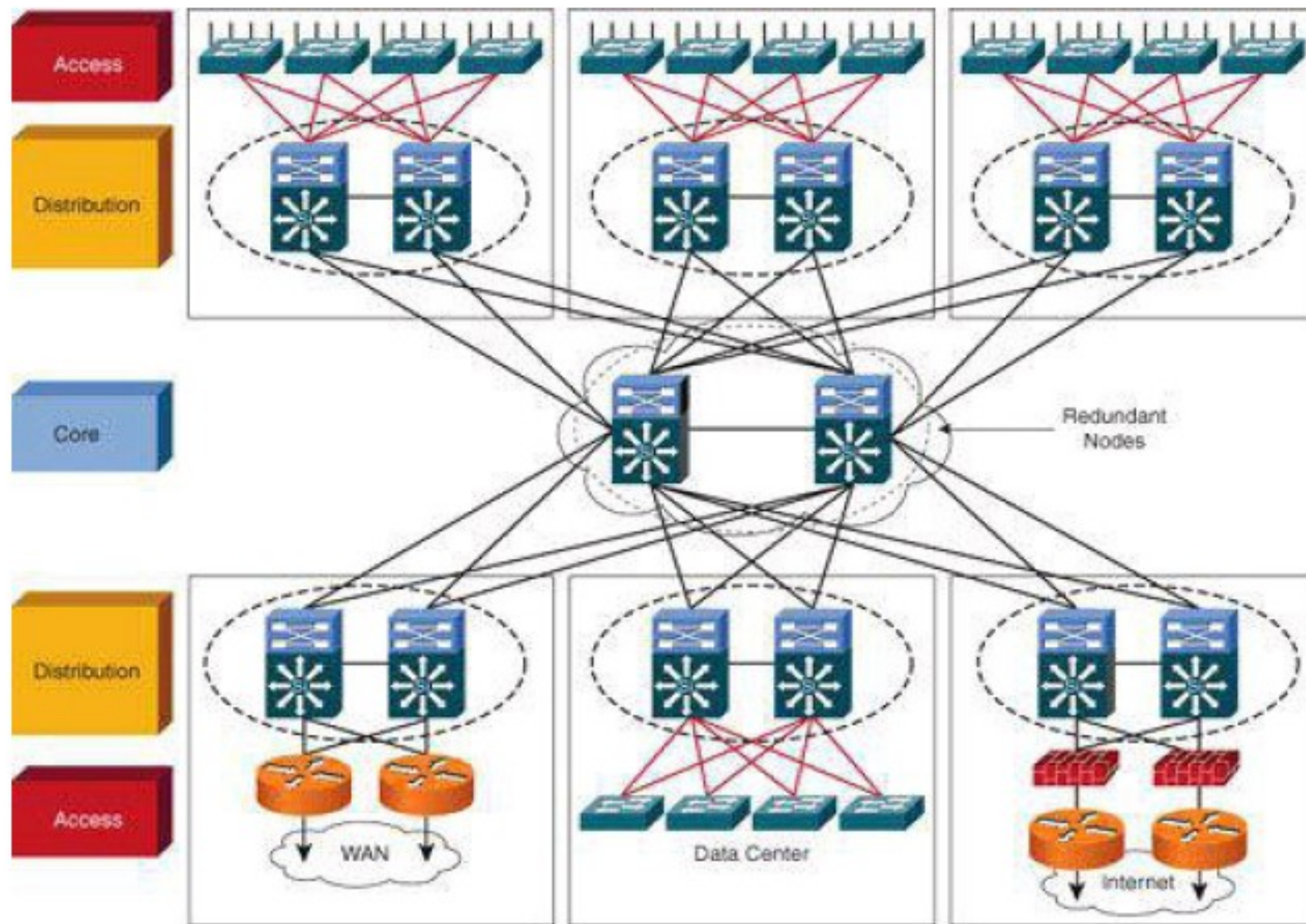
- ◆ In Distribution and Core Layers the single points of failure are easy to avoid with redundant links.
 - Don't forget redundant power and cooling!
- ◆ In Access Layer, all L2 switches are single points of failure (only) to the user connected to them,
 - Solution 1, redundant backup hardware activated by a (proprietary) supervision mechanism to “replace” faulty equipment.
 - Copies full configuration and state to backup hardware.
 - Solution 2, have multiple connections between each user terminal and different access switches
 - Requires multiple network cards in user terminals and more plugs/wiring.
 - Cheaper?

Avoid Too Much Redundancy

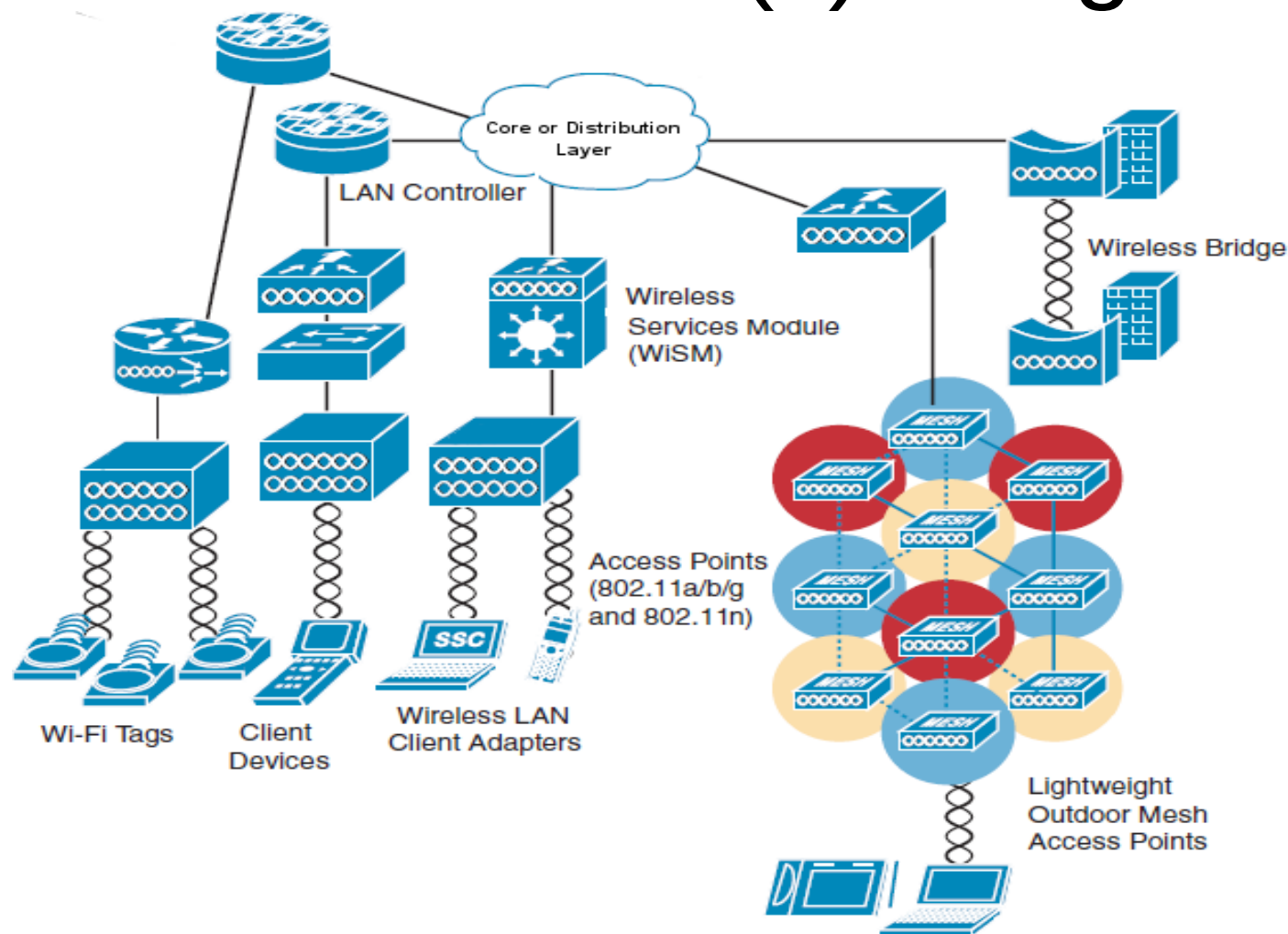


- Increases,
 - ♦ Routing complexity
 - ♦ Number of ports used
 - ♦ Wiring

Optimal Redundancy



Wireless Network(s) Integration



- Wireless networking technologies should have an integration point at core or distribution layers.
- In terms of network architecture a WLAN can be seen as any LAN.
 - ◆ Except that we have mobility and must have seamless roaming while moving.
- A large number of AP can be managed by a (Wireless) LAN Controller.

VLANs on Access Points

- AP have trunk ports to distribution/core switches.
- “Wired” VLANs must/can be extended to the wireless domain.
 - ♦ e.g., VLAN 30 “Green” and VLAN 10 “Red”.
- Each SSID can be mapped to a VLAN.
 - ♦ Different SSID/VLAN can have different security policies.
- **Wireless VLANs should be configured as end-to-end.**
 - ♦ Mobility and AP roaming should not break Layer 3 connectivity.
 - ♦ IP address should be the same → same VLAN with campus.
- A Native VLAN is required to provide management capability and client authentications.
 - ♦ Never extended to the wireless domain!!
 - e.g., VLAN 1.



Datacenter CLOS Topology

- With large-scale data center deployments, three-tier topologies have become scale bottlenecks.
- The classic three-tier topology evolved to a CLOS topology.
 - Original designed by Charles Clos in 1950 to find a more efficient way to handle telephonic call transfers.
- Eliminating the need for STP the network evolved to greater stability and scalability.
- Layer 3 moves to the Access Layer.
- Usually called Spine-and-Leaf Architecture.

