



## Chapter 1

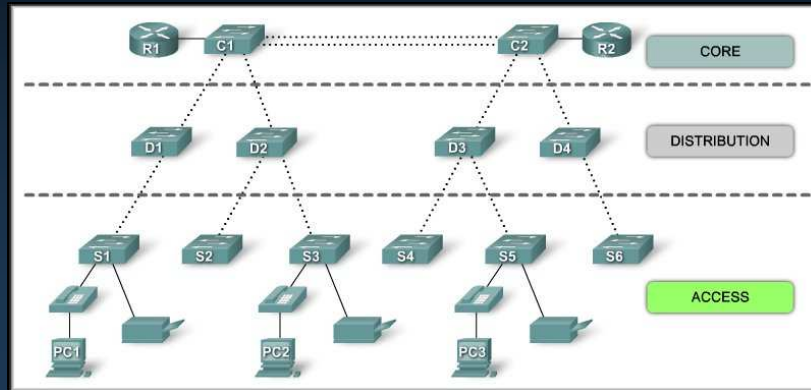
# LAN Design

## Note for Instructors

- These presentations are the result of a collaboration among the instructors at St. Clair College in Windsor, Ontario.
- Thanks must go out to Rick Graziani of Cabrillo College. His material and additional information was used as a reference in their creation.
- If anyone finds any errors or omissions, please let me know at:
  - [tdame@stclaircollege.ca](mailto:tdame@stclaircollege.ca).

## LAN Design

### Switched LAN Architecture



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Chapter 1

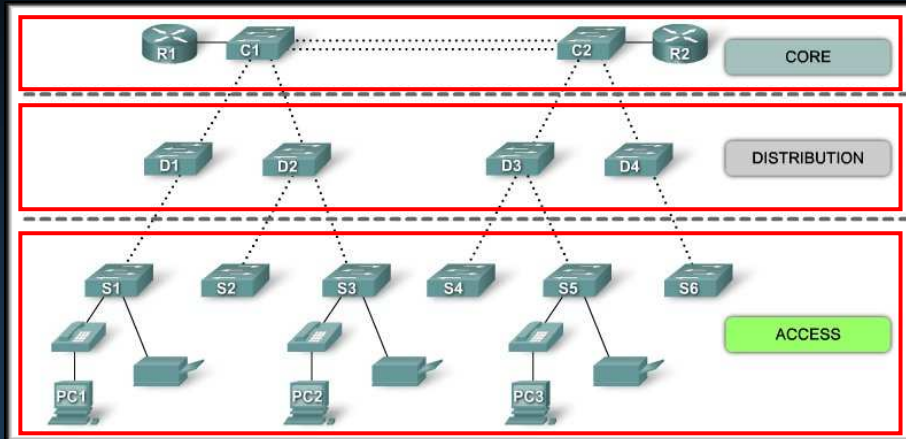
### Switched LAN Architecture

- When building a LAN that satisfies the needs of a small or medium-sized business, your plan is more likely to be successful if a **hierarchical design model** is used.
  - Divided into discrete layers.
  - Each layer has a specific purpose.
  - Becomes modular – maintenance, performance.

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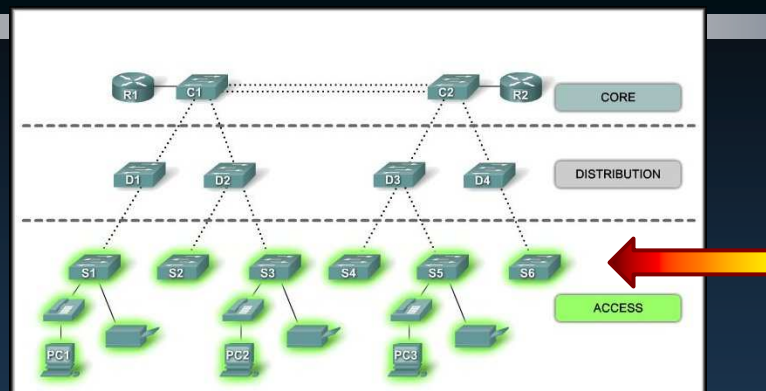
## Switched LAN Architecture



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## Access Layer

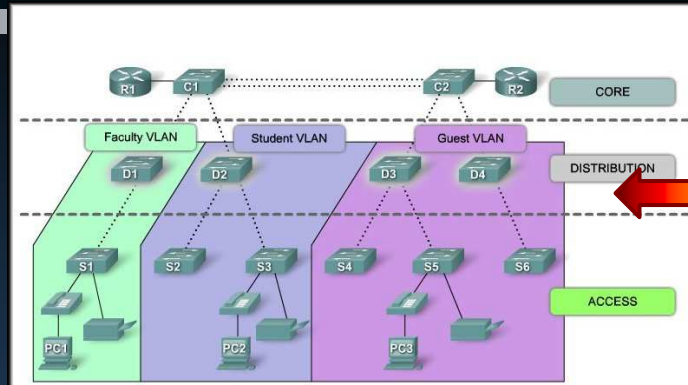


- Interfaces with end devices.
- Routers, switches, bridges, wireless access points.
- Provides a means of connecting and controlling which devices are allowed to communicate on the network.

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## Distribution Layer

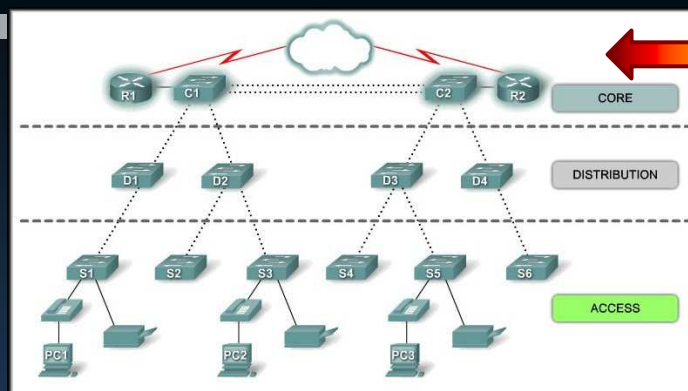


- Aggregates (funnels) Access Layer traffic.
- Controls traffic flow with security or routing policies.
- Defines broadcast domains.
- Routing of VLANs (Virtual LANs).

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## Core Layer



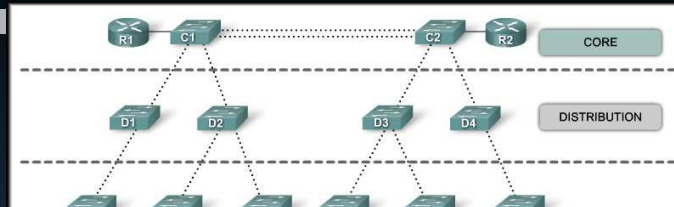
- **High speed backbone** of the network.
- Must be **highly available** and **redundant**.
- Must be capable of **quickly forwarding large amounts** of data.
- Smaller networks – collapsed model (Core and Distribution).

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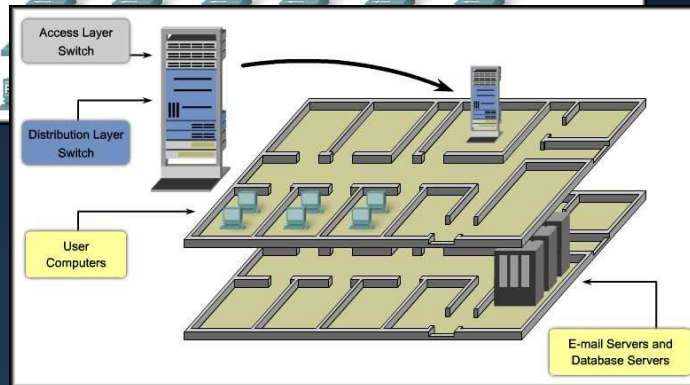
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## Medium Sized Business

Logical  
Layout



Physical  
Layout



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## Benefits of a Hierarchical Network

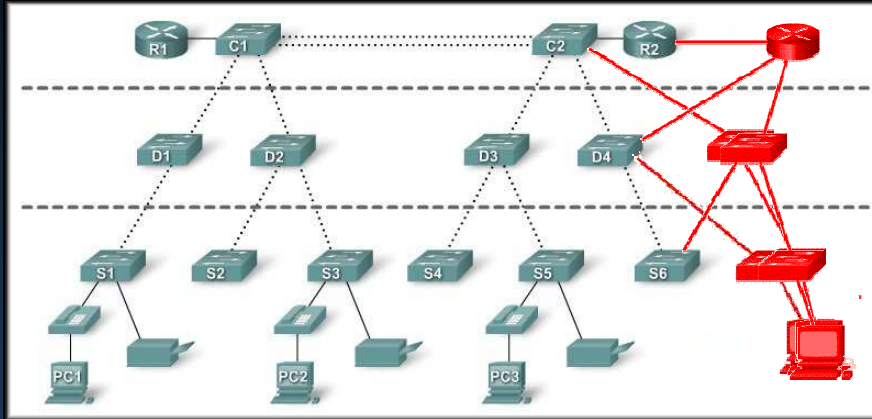
- **Benefits:**
  - Scalability
  - Redundancy
  - Performance
  - Security
  - Manageability
  - Maintainability

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## Benefits of a Hierarchical Network

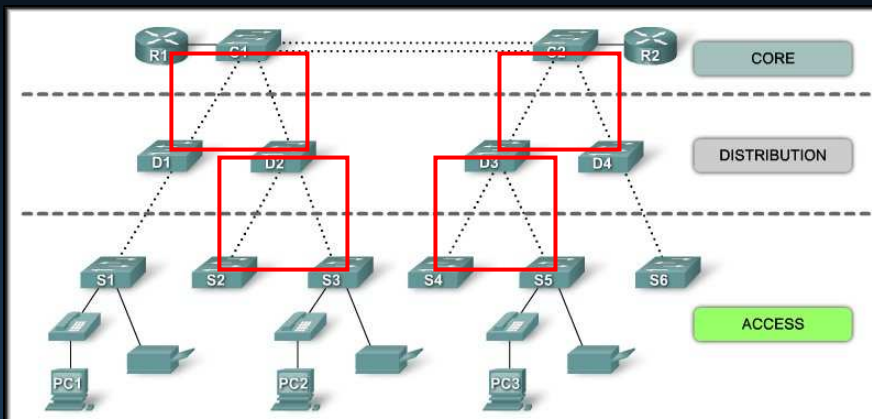
### Scalability



Hierarchical Networks can be expanded easily.

## Benefits of a Hierarchical Network

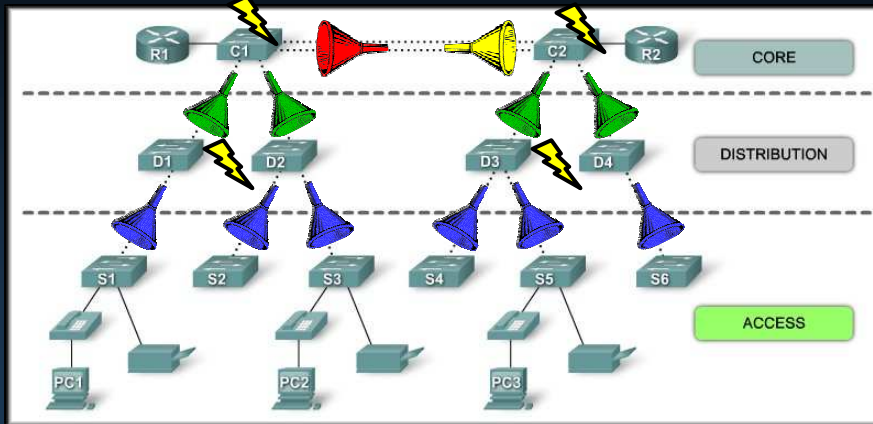
### Redundancy



Redundancy at the core and distribution layers ensure availability.

## Benefits of a Hierarchical Network

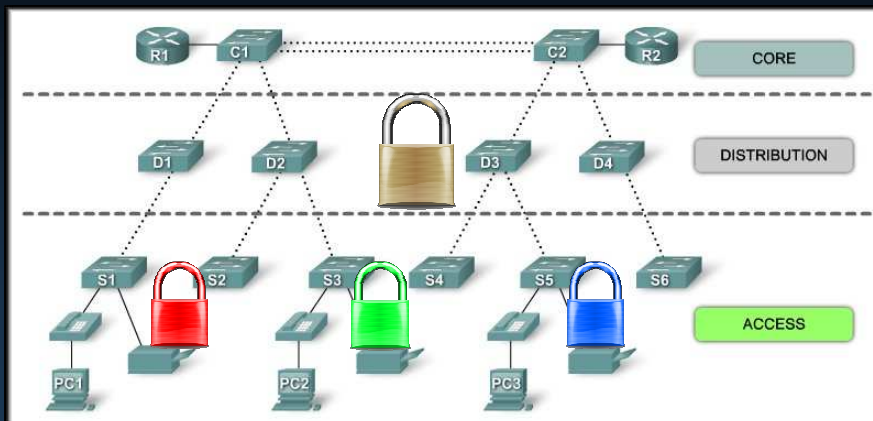
### Performance



Link aggregation and high performance distribution and core layer switches provide near-wire speed at all layers.

## Benefits of a Hierarchical Network

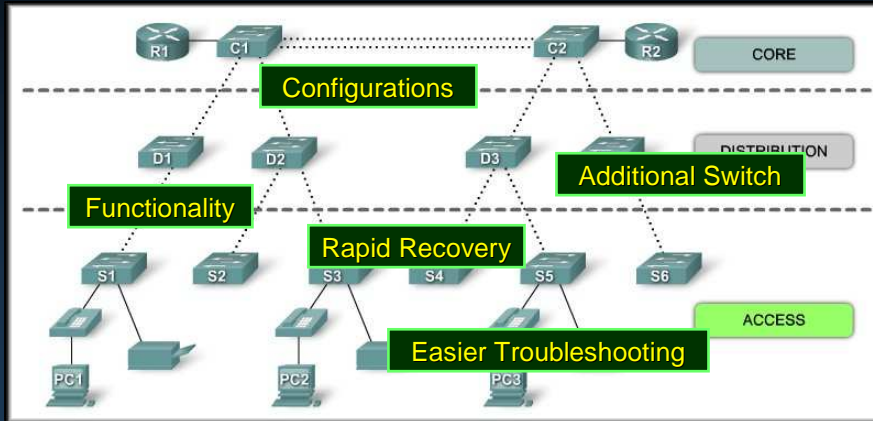
### Security



Port security at the access layer and policies at the distribution layer make the network more secure.

## Benefits of a Hierarchical Network

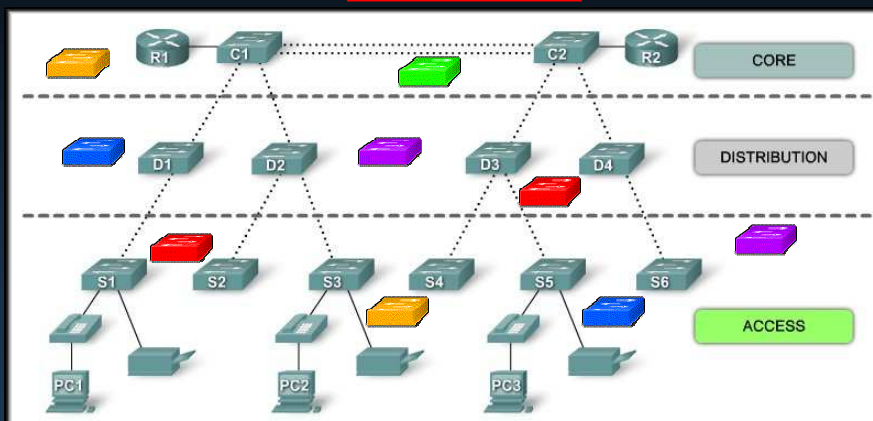
### Manageability



Consistency among switches at each layer makes management more simple.

## Benefits of a Hierarchical Network

### Maintainability



The modular design allows a network to scale easily without becoming over-complicated or burdensome.



## Principles of Hierarchical Network Design

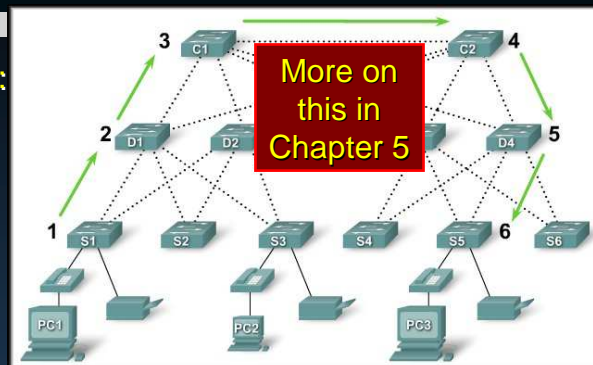
- *Just because a network is hierarchical, it doesn't mean it's well designed.*
  - **Network Diameter:**
    - The number of devices that a packet has to cross before it reaches its destination.
  - **Bandwidth Aggregation:**
    - After the bandwidth requirements of the network are known, links between specific switches can be aggregated or combined to provide higher bandwidth.
  - **Redundancy:**
    - The practice of providing multiple paths to a destination or multiple instances of a device.

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## Principles of Hierarchical Network Design

- **Network Diameter:**
  - For PC1 to communicate with PC3, the data must traverse 6 intermediate switches.
  - In this case, **the network diameter is 6.**
  - Each switch introduces some latency.
  - In a hierarchical network, network diameter is always going to be a **predictable number of hops** between the source and destination devices.



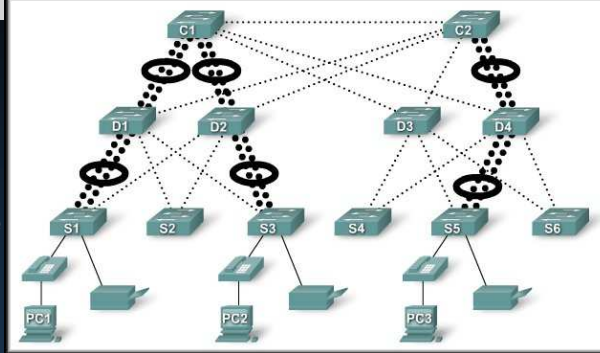
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## Principles of Hierarchical Network Design

- **Bandwidth Aggregation:**

- Link aggregation allows multiple switch port links to be combined so as to achieve higher throughput between switches.
- The determining factor is using link aggregation is the requirements of the user applications.



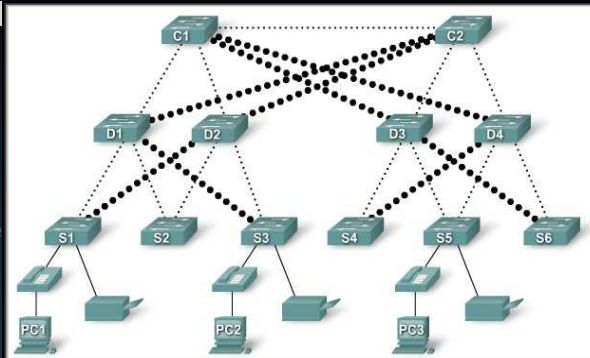
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## Principles of Hierarchical Network Design

- **Redundancy:**

- Redundancy is one part of creating a highly available network.
- Multiple links between switches or multiple devices.
- It can get expensive and most likely will not be done on the access layer because of the cost and variety of devices.
- It is feasible at the distribution and core layers.



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## What is a Converged Network?

- A **Converged Network** is one where voice and video communications have been combined on a single data network.
  - **Legacy Equipment:**
    - Until now, mainly feasible on large enterprise networks.



Large Telephone Switches



Small PBX Systems

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## What is a Converged Network?

- **Advanced Technology:**
  - More popular to medium and small sized businesses.
  - Can be a difficult decision considering current investments in technology.
  - Benefit:
    - Only one network to manage.



Medium to Large Businesses

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## What is a Converged Network?

- **New Options:**
  - You can now tie voice and video communications directly into an employee's personal computer system.
  - Software integrated on a PC eliminates an expensive handset.
  - Add a webcam and video conference.



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## LAN Design

### Matching Switches to Specific LAN Functions

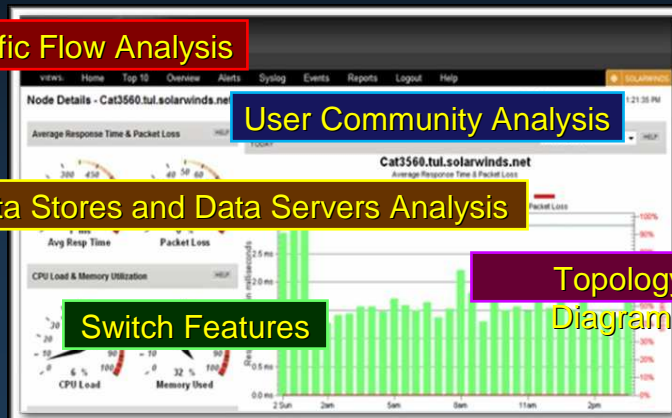
Traffic Flow Analysis

User Community Analysis

Data Stores and Data Servers Analysis

Switch Features

Topology Diagrams



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## Considerations for Network Switches

- **Traffic Flow Analysis:**

- The process of measuring the bandwidth usage on a network and analyzing the data.

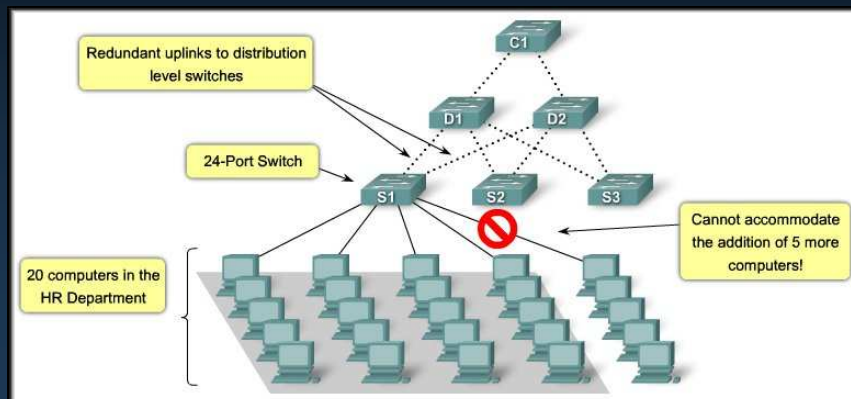


- Performance tuning.
- Capacity planning.
- Hardware improvement decisions.

## Considerations for Network Switches

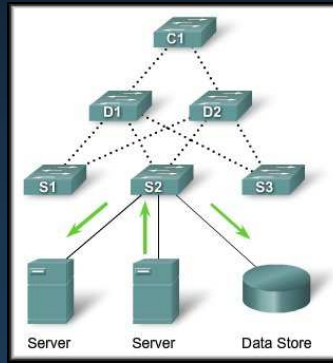
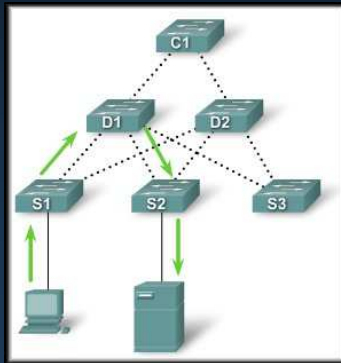
- **User Community Analysis:**

- The process of identifying various groupings of users and their impact on network performance.



## Considerations for Network Switches

- **Data Stores and Data Servers Analysis:**
  - When analyzing traffic on a network, consider the location of the data stores and data servers.
  - Consider both **client-server** and **server-server** traffic.

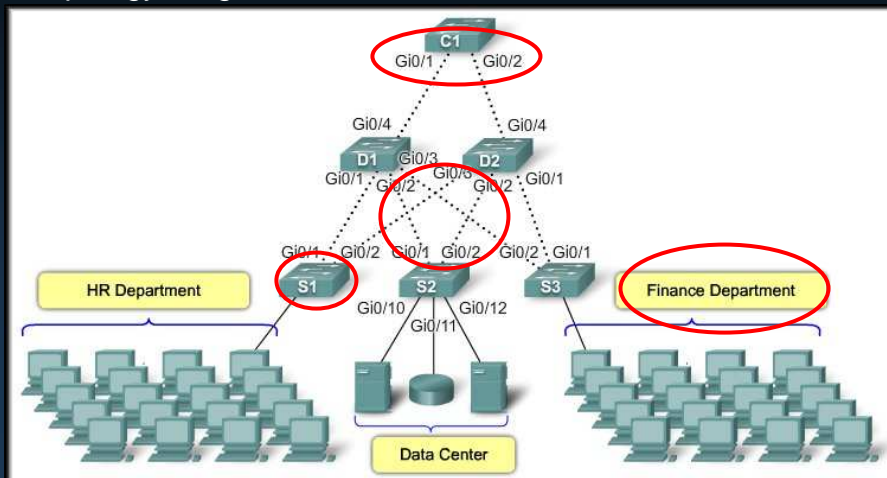


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## Considerations for Network Switches

- **Topology Diagram:**



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## Switch Features

- **Switch Form Factors:**
  - When selecting a switch, you need to decide between
    - Fixed configuration or modular configuration.
    - Stackable or non-stackable.
  - The switch form factor (**physical size**) is important depending upon where the switch will be installed.
    - Wiring closet with limited space.
    - Computer room with free standing racks.
    - Shelf in a central area.

## Switch Features

- **Fixed Configuration Switches:**
  - Fixed in their configuration.
  - You **cannot add features or options** to the switch beyond those that originally came with the switch.



## Switch Features

- **Modular Switches:**
  - Offer more **flexibility**.
  - Typically come with **different sized chassis** that allow for the installation of different numbers of modular **line cards**.
  - The line cards actually contain the ports.



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Chapter 1

## Switch Features

- **Stackable Switches:**
  - Interconnected using a special **backplane cable** that provides high-bandwidth throughput between the switches (Cisco StackWise).
  - The stacked switches effectively **operate as a single, larger switch**.
  - Desirable when **fault tolerance and bandwidth availability are critical** and a modular switch is too costly to implement.



CCNA3-32

Chapter 1



## Switch Performance

- When selecting a switch for the access, distribution, or core layer, consider the ability of the switch to support:
  - Port Density.
  - Forwarding Rate.
  - Bandwidth Aggregation Requirements.

## Switch Performance

- **Port Density:**
  - Port density is the number of ports available on a single switch.

24 Port

48 Port



Very high density.  
Catalyst 6500 - 1,000 Ports

## Switch Performance

- **Forwarding Rate:**
  - Defines the processing capabilities of a switch by rating how much data the switch can process per second.
  - If the switch forwarding rate is too low, **it cannot accommodate full wire-speed** communication across all of its switch ports.
    - A 48 port Gigabit switch is capable of switching 48 Gigabits of traffic.



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Chapter 1

## Switch Performance

- **Forwarding Rate:**
  - Access layer switches typically do not need to operate at full wire speed because they are physically limited by their uplinks to the distribution layer.
  - Allows the use of:
    - Less expensive, lower performing switches at the **access layer**.
    - More expensive, higher performing switches at the **distribution and core layers**, where the forwarding rate makes a bigger difference.

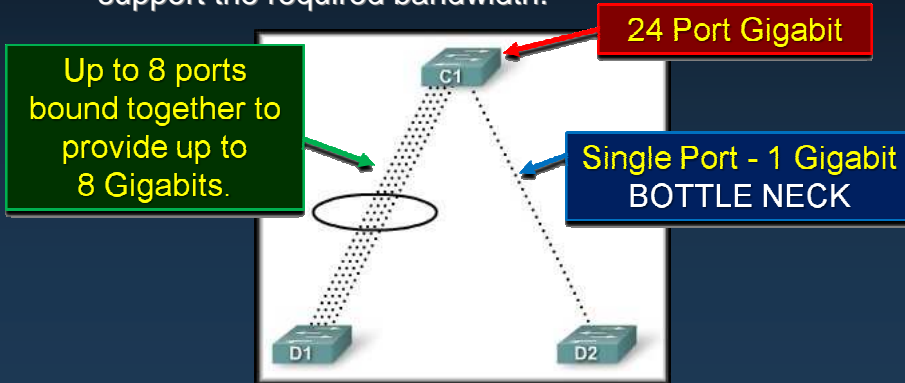


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## Switch Performance

- **Link Aggregation:**
  - As part of bandwidth aggregation, you should determine if there are enough ports on a switch to aggregate to support the required bandwidth.

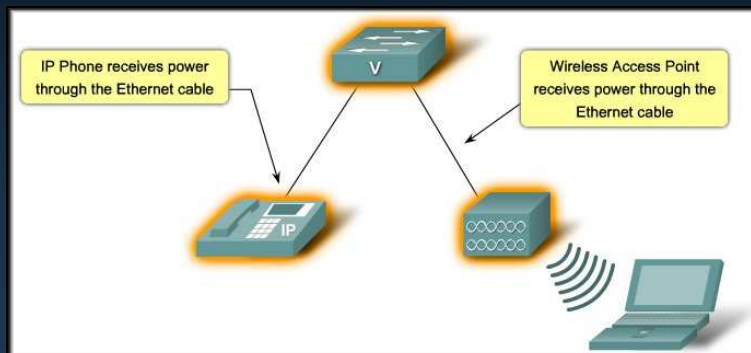


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## Switch Performance

- **Power over Ethernet (PoE):**
  - Allows the switch to deliver power to a device over the existing Ethernet cabling.



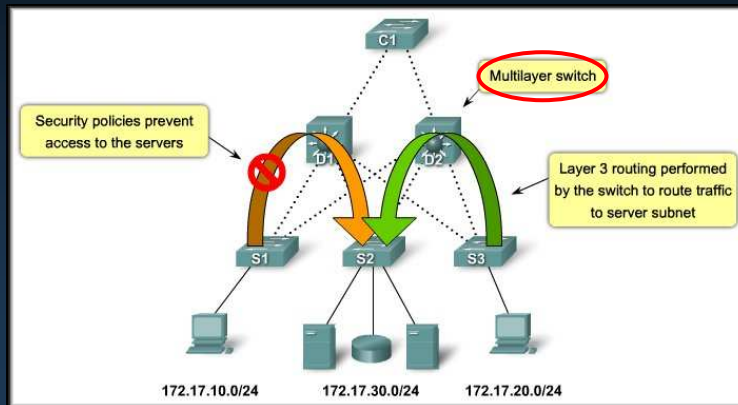
Adds considerable cost to the switch.

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## Switch Performance

- **Layer 3 Functionality:**
  - Switches typically operate at Layer 2 of the OSI Model.

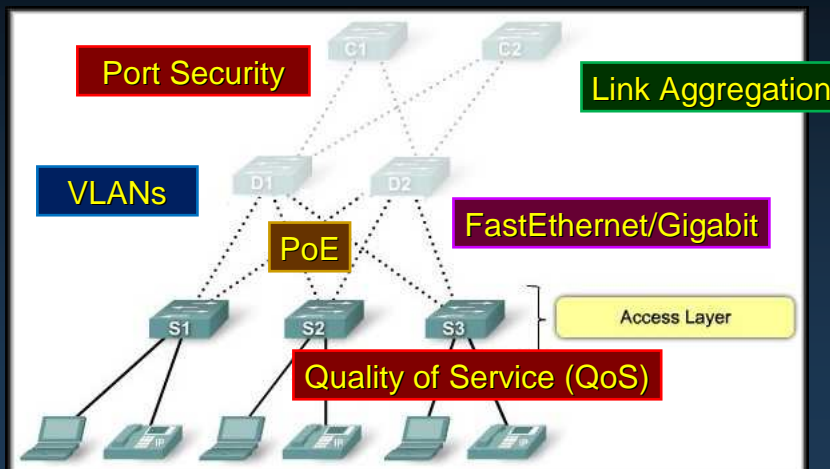


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## Switch Features – Hierarchical Network

- **Access Layer Switch Features:**

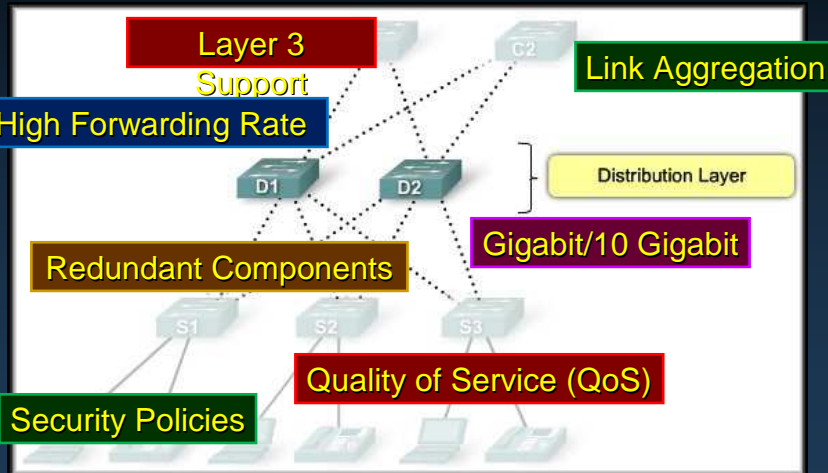


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Chapter 1

## Switch Features – Hierarchical Network

- Distribution Layer Switch Features:

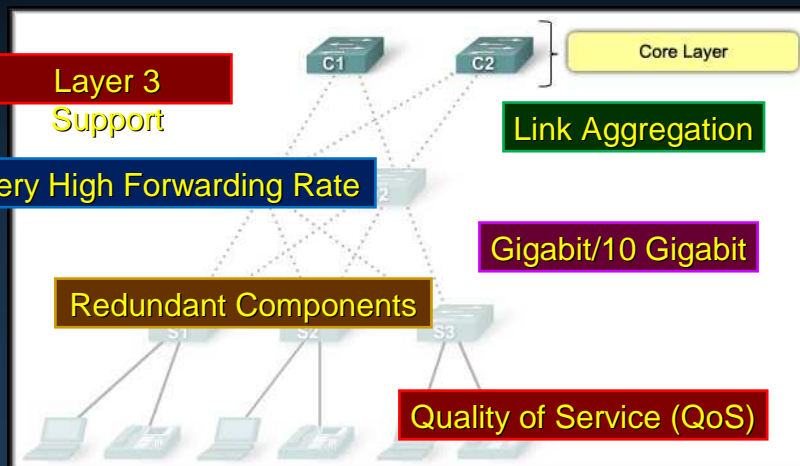


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Chapter 1

## Switch Features – Hierarchical Network

- Core Layer Switch Features:



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## Switches – Small and Medium Business (SMB)

- Cisco has seven switch product lines. Each product line offers **different characteristics and features**, allowing you to find the right switch to meet the functional requirements of your network.
- The Cisco switch product lines are categorized by organization size and density. **Please refer to the text or online curriculum for details on each model.**
  - Catalyst Express 500
  - Catalyst 2960
  - Catalyst 3560
  - Catalyst 3750
  - Catalyst 4500
  - Catalyst 4900
  - Catalyst 6500



CCNA3-43

Chapter 1

## Switches – Small and Medium Business (SMB)

### Summary

	Access	Distribution	Core
Bandwidth (Link) Aggregation	U	U	U
FastEthernet/Gigabit Ethernet	U		
Gigabit Ethernet/10 Gigabit Ethernet		U	U
High Forwarding Rate		U	
Layer 3 Support		U	U
Port Security	U		
Power Over Ethernet (PoE)	U		
Quality of Service (QoS)	U	U	U
Redundant Components		U	U
Security Policies/Access Control Lists		U	
Very High Forwarding Rate			U
VLANs	U		

CCNA3-44

Chapter 1