Chapter 3
Switching Concepts & Switches

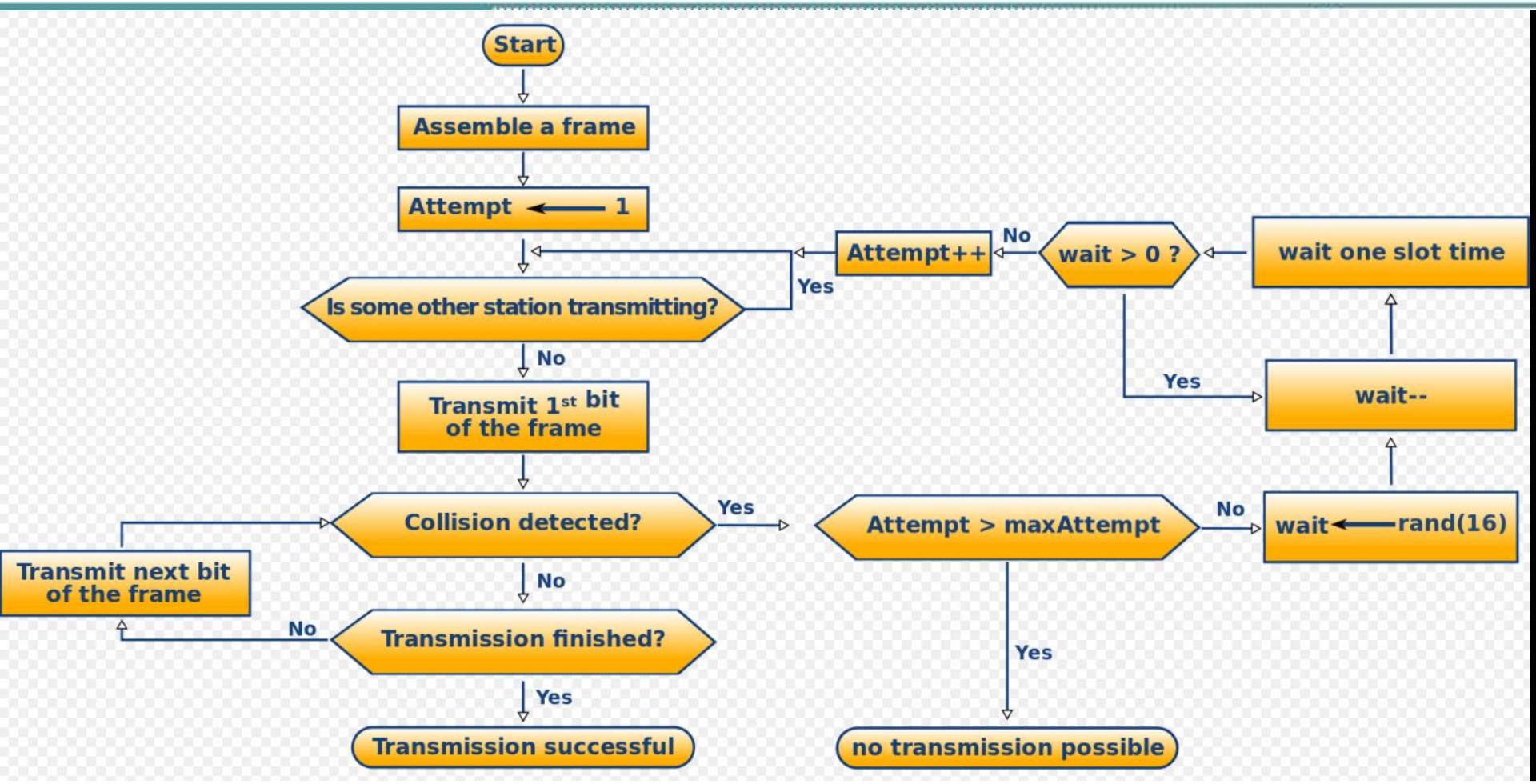
Objectives

- Introduction to Ethernet 802.3 LANs
- Introduction to LAN switching
- Switch operation
- Switches

Ethernet 802.3

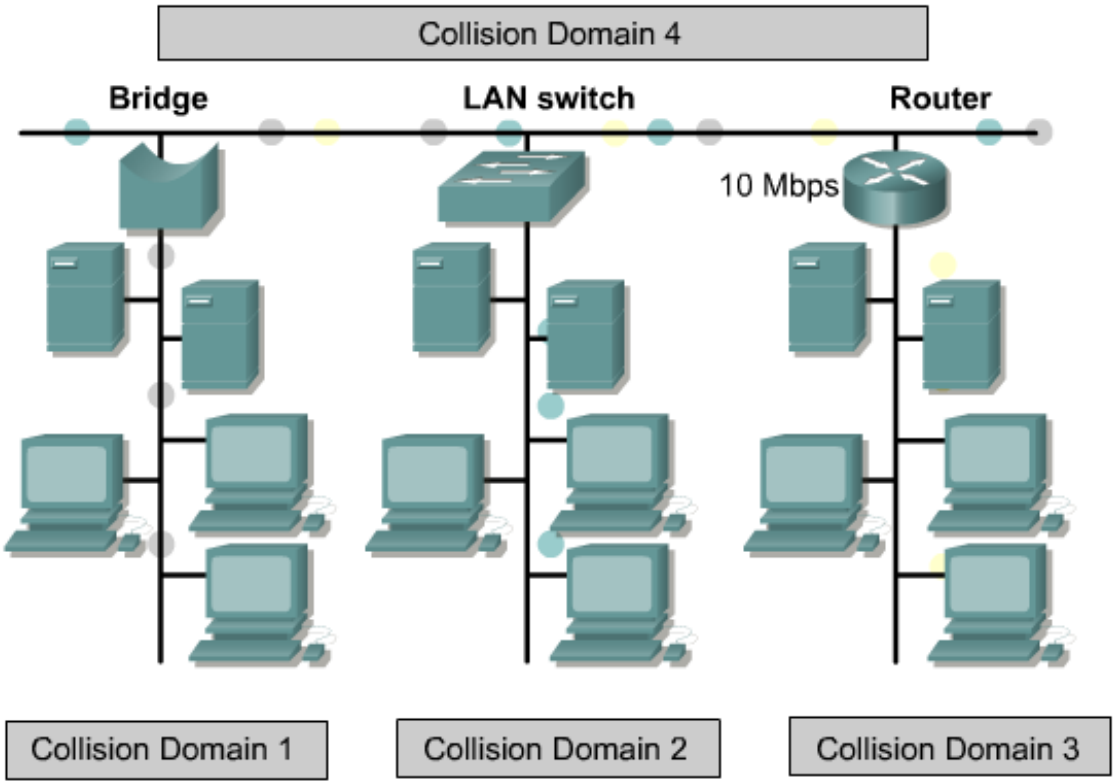
- **Performance of a shared-medium Ethernet/802.3 LANs is negatively affected by factors such as the following:**
  - **The broadcast delivery nature of Ethernet.**
  - **Carrier sense multiple access collision detect (CSMA/CD) access method allows only one host to transmit at a time.**
  - **Multimedia applications with higher bandwidth demand such as video and the Internet.**
  - **The latency of additional devices added by the extension of LANs by using repeaters.**
  - **The distance added by using Layer 1 repeaters.**

CSMA/CD



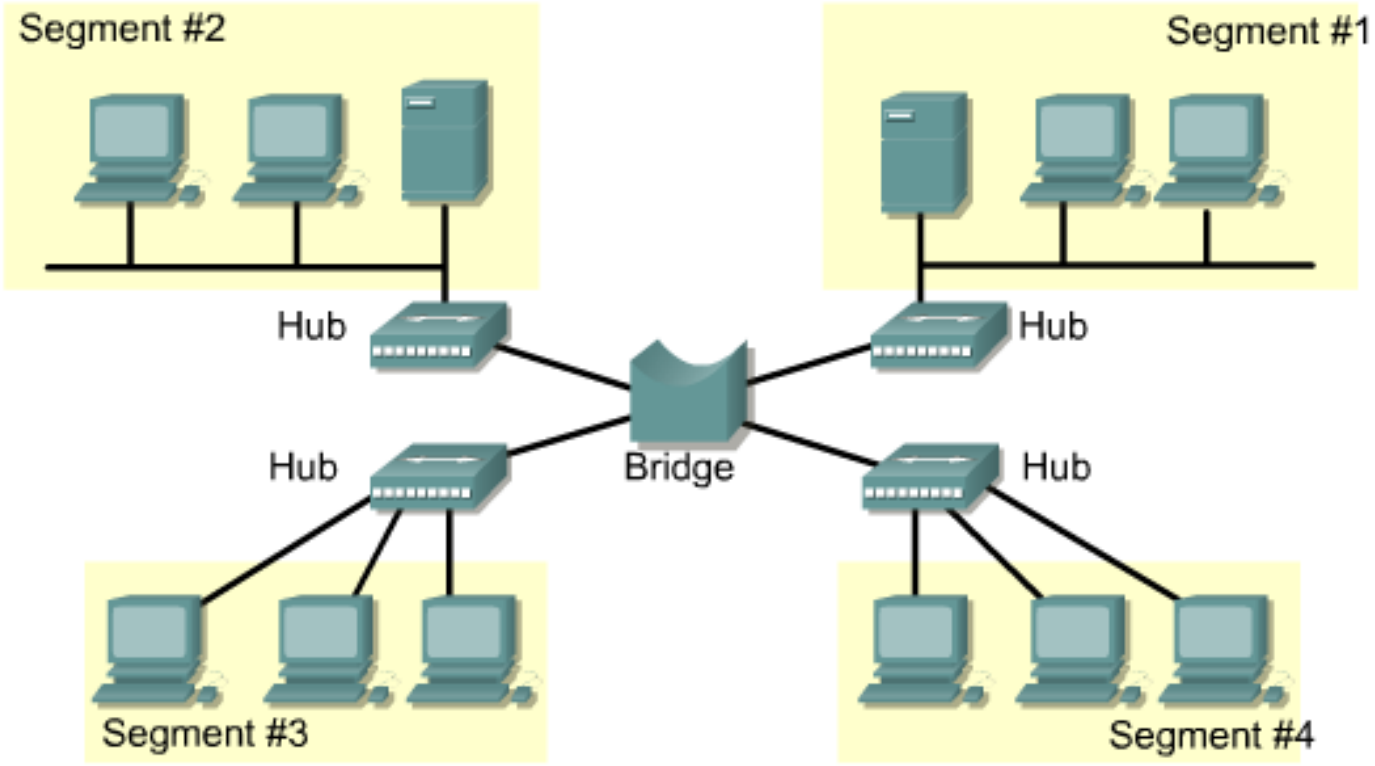
https://en.wikipedia.org/wiki/Carrier-sense_multiple_access_with_collision_detection#/media/File:CSMACD-Algorithm.svg

LAN Segmentation



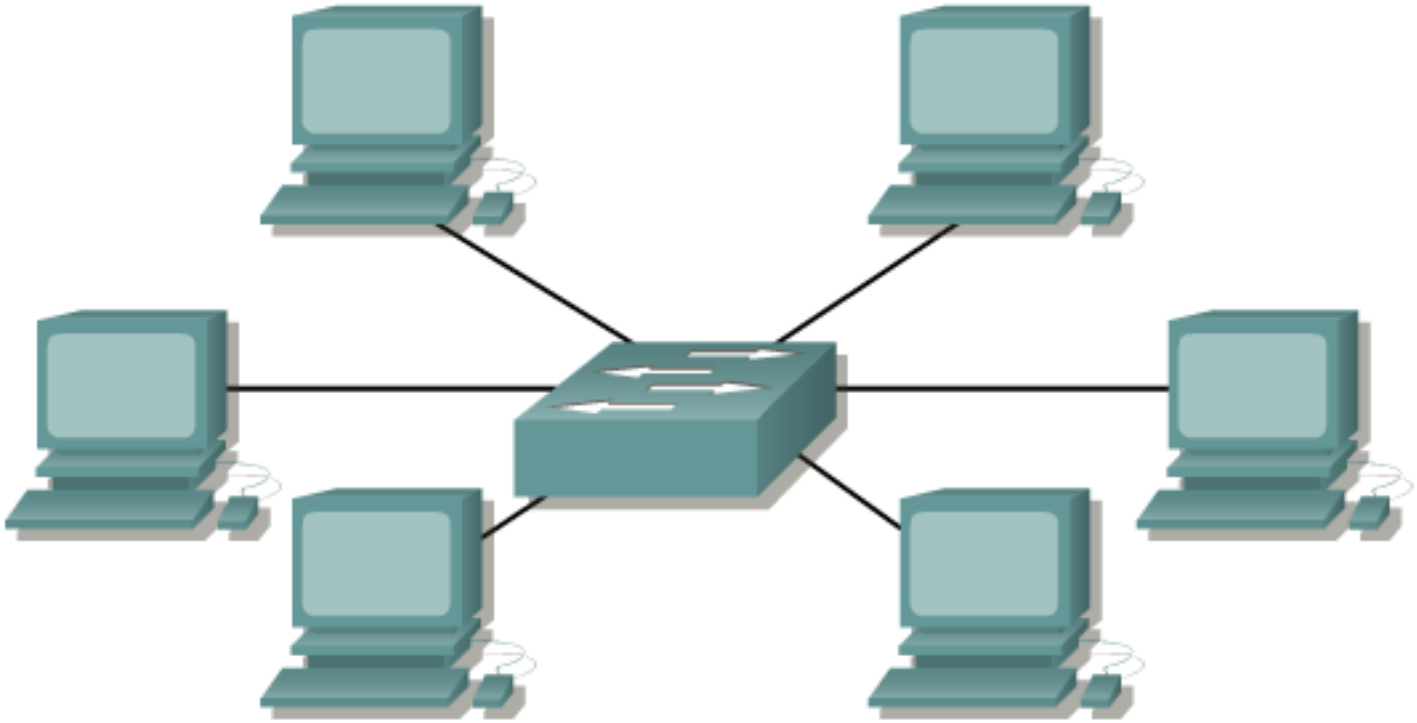
Segmentation allows network congestion to be significantly reduced within each segment.

LAN Segmentation with Bridges



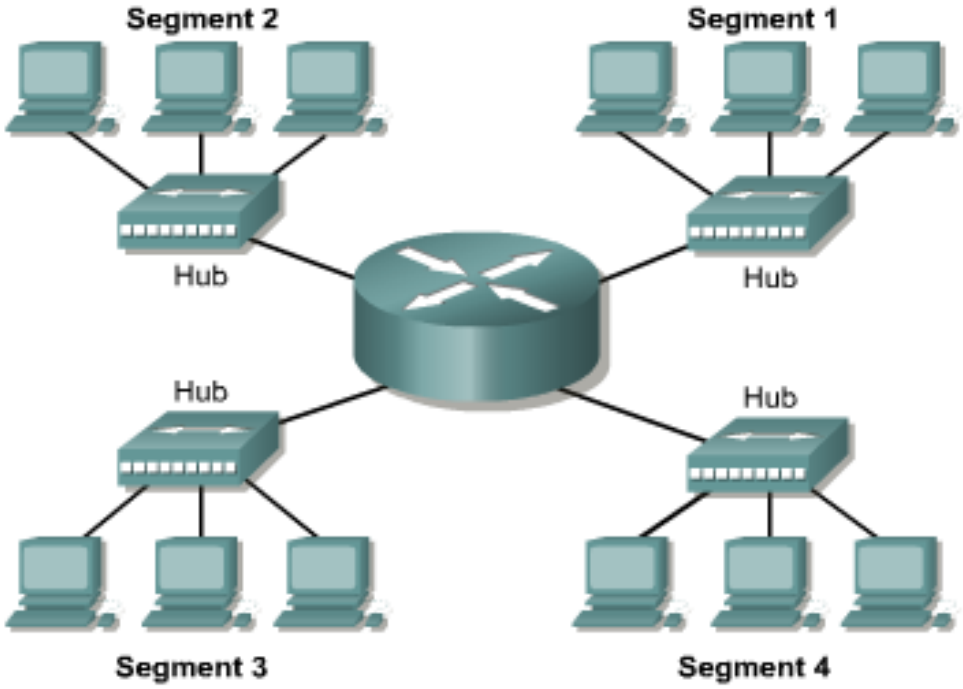
- Segmentation provides fewer users per segment
- Bridges store, then forward frames based on Layer 2 addresses
- Layer 3 Protocol-independent
- Increase latency on the network

LAN Segmentation with Switches



- A switch eliminates the impact of collisions through microsegmentation
- Low latency and high frame-forwarding rates at each interface port
- Works with existing 802.3(CSMA/CD) compliant network interface cards and cabling

LAN Segmentation with Routers

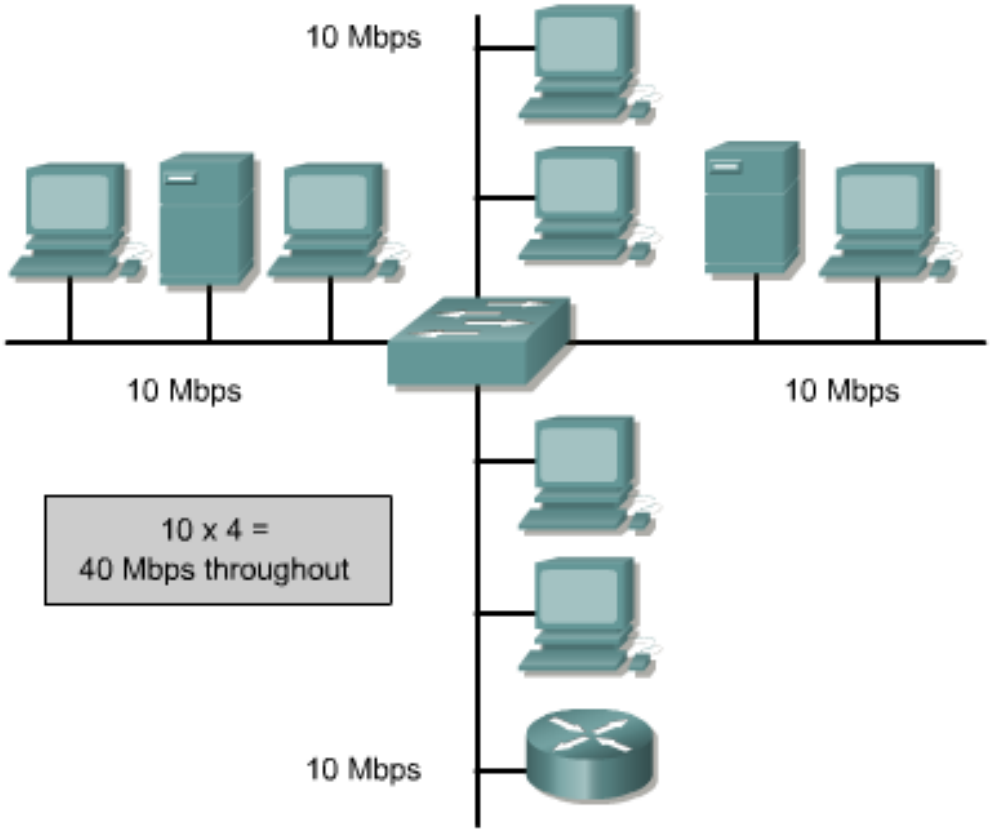


- More manageable, greater functionality, multiple active paths
- Smaller broadcast domains
- Operates at Layer 3

Special Topic 開放選擇 (iLearn 學生回饋區)

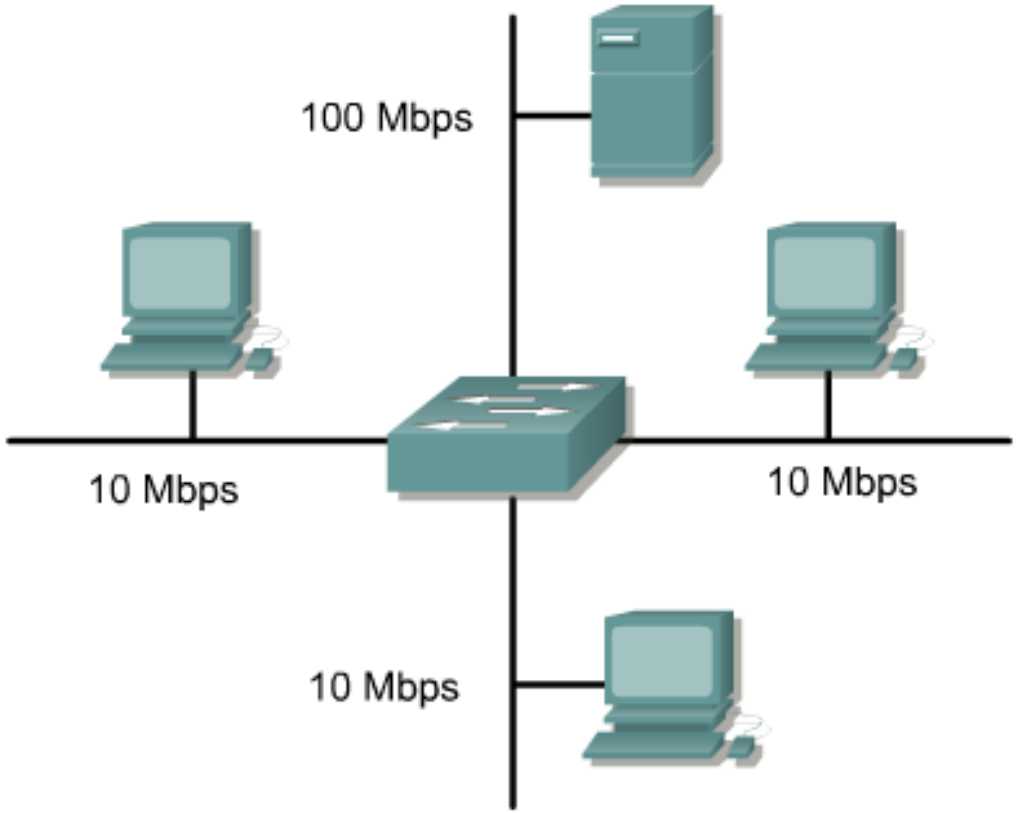
Mixed Reality	Brain-Computer Interface	Immersive Technology	Virtual Assistants	Augmented Analytics
Digital Twins	Quantum Computing	Exoskeleton	Volumetric Display	Internet of Behaviors
Smart Spaces	Smart Dust	Smart Fabrics	4D Printing	Anywhere Operations
Empowered Edge	Edge AI	AI PaaS	Flying Autonomous Vehicles	Autonomous Driving Level 5

Symmetric Switching



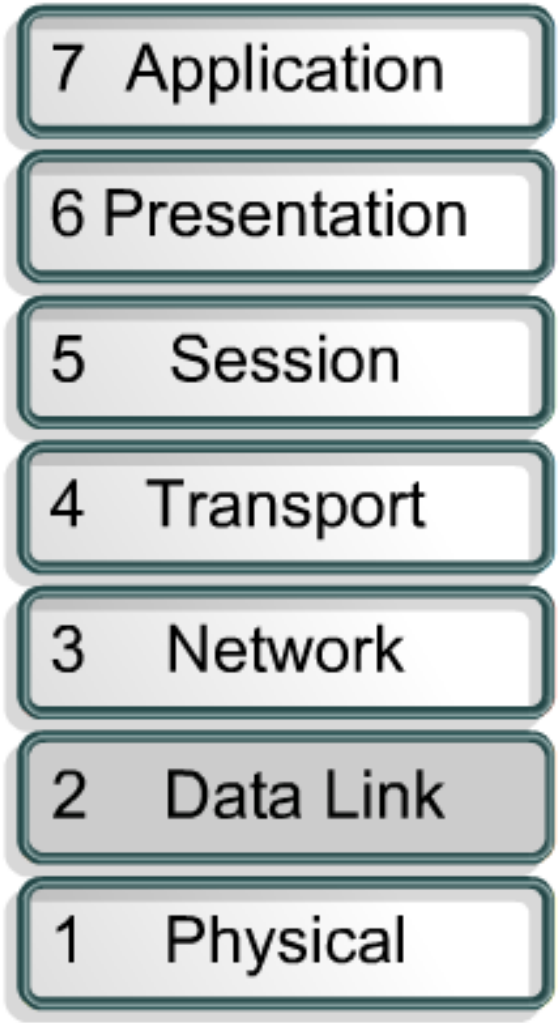
- Provides switching between like bandwidths (10/10 or 100/100 Mbps)
- Multiple simultaneous conversations increase throughput

Asymmetric Switching

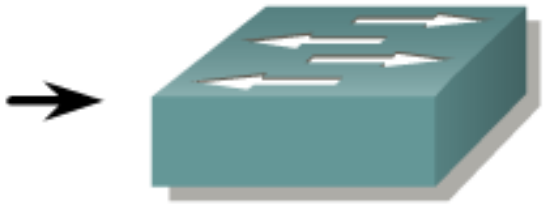


- Provides switching between unlike bandwidths (10/100 Mbps)
- Requires the switch to use memory buffering

Functions of Ethernet Switches



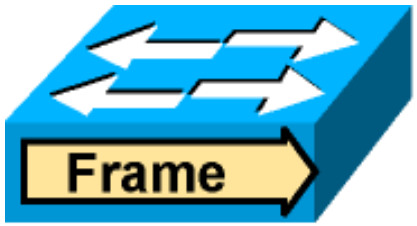
- Hardware-based bridging
- Wire-speed performance
- High-speed scalability
- Low latency
- MAC address
- Low cost



Transmitting Frames

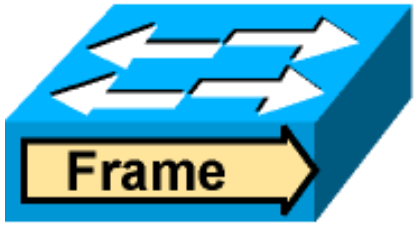
Cut-Through

- Switch checks destination address and immediately begins forwarding frame



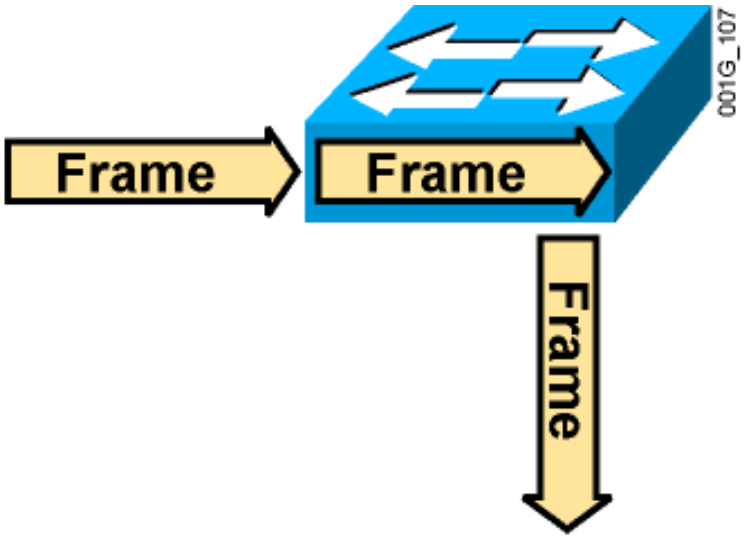
Fragment-Free

- Switch checks the first 64 bytes, then immediately begins forwarding frame

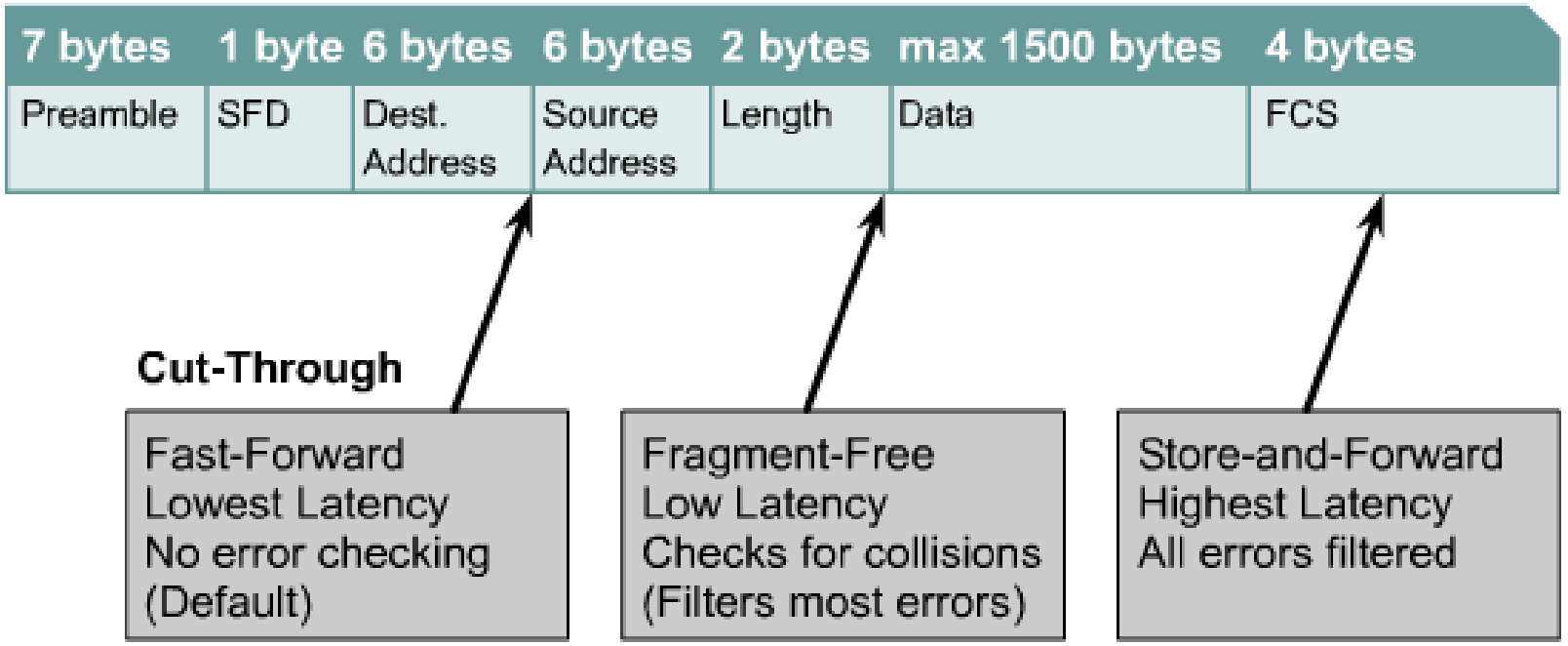


Store and Forward

- Complete frame is received and checked before forwarding

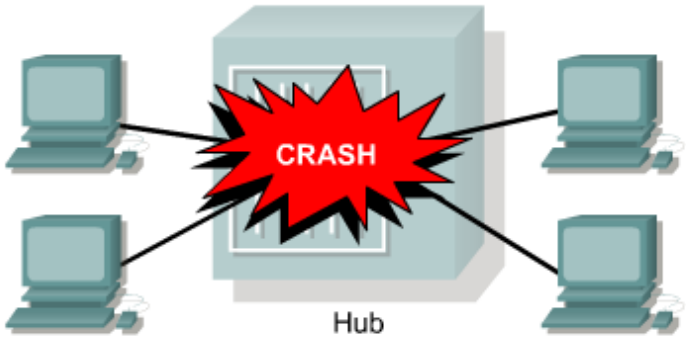


Frame Transmission Modes



Switches and Collision Domains

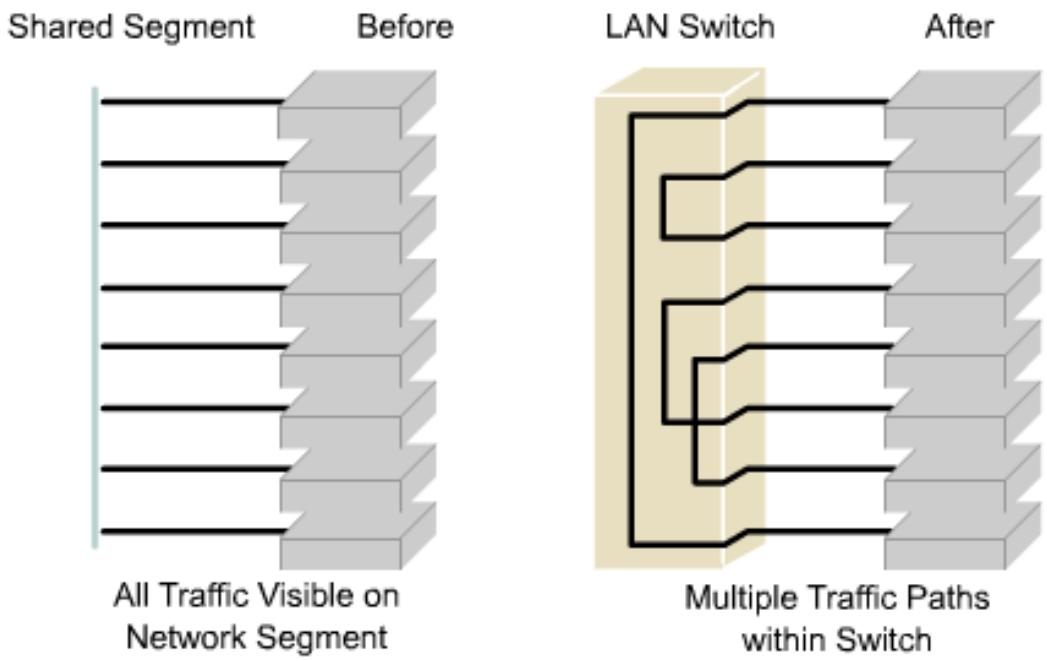
- "I could have walked to Finance by now."
- "I knew I should have stayed home."
- "File transfers take forever."
- "I'm waiting all the time."



- Sluggish network response
- Increasing user complaints

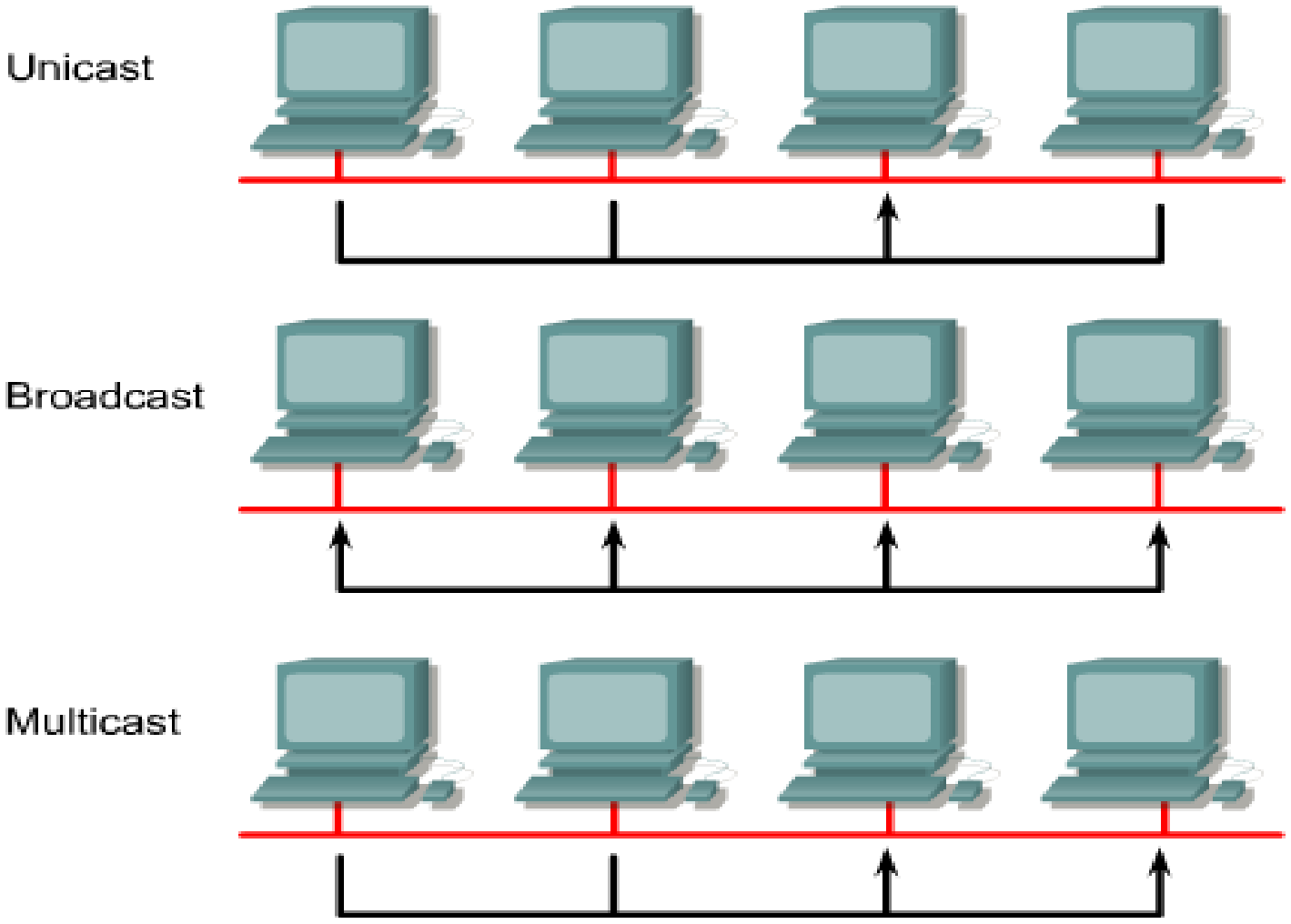
The network area where frames originate and collide is called the collision domain. All shared media environments are collision domains.

Microsegmentation of the Network



A switch employs “microsegmentation” to reduce the collision domain on a LAN. The switch does this by creating dedicated network segments, or point-to-point connections.

Three Methods of Communication

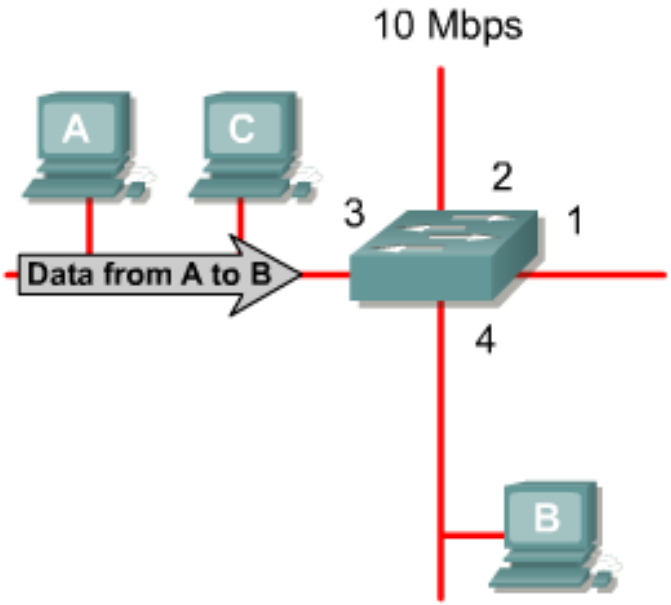


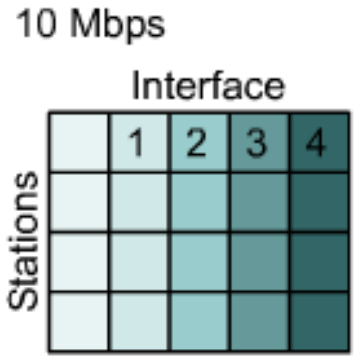
Switches and Broadcast Domains

- **Broadcasting is when one transmitter tries to reach all the receivers in the network. The server station sends out one message, and everyone on that segment receives the message.**

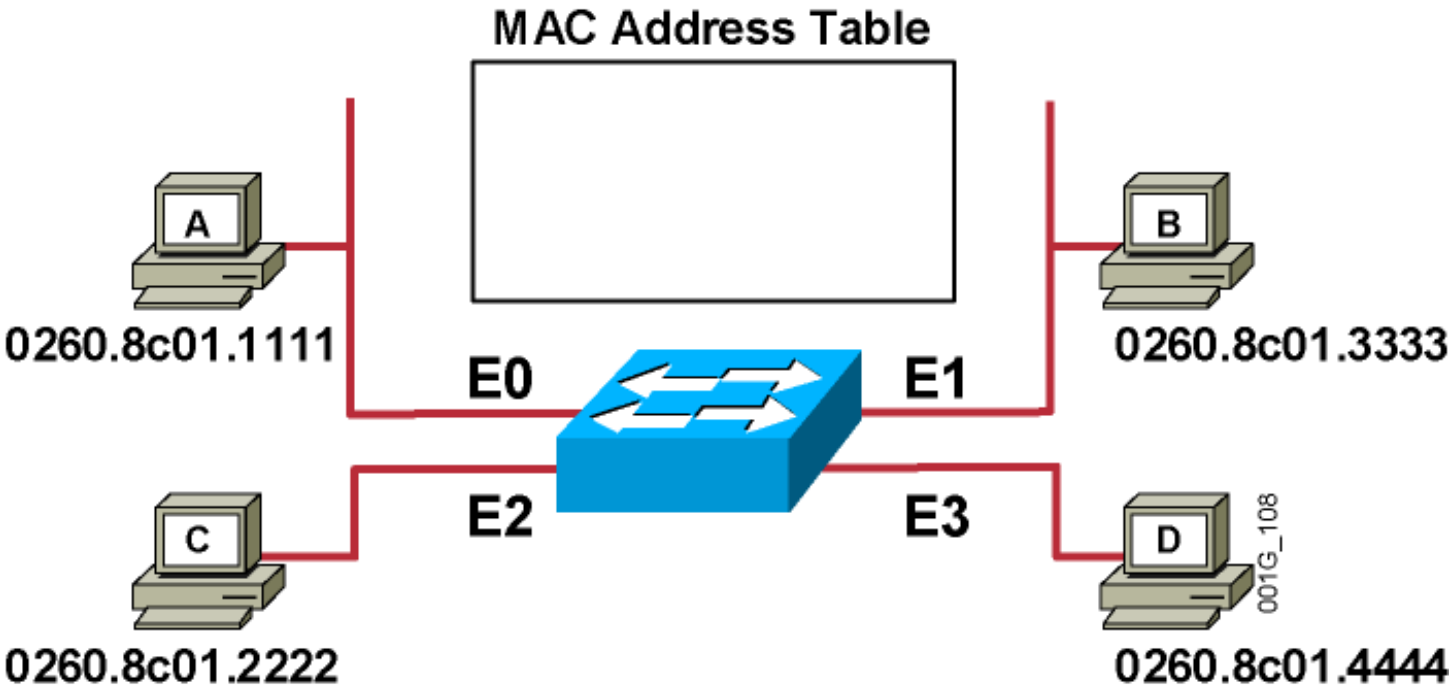
LAN Switch Operation

- Forward packets based on forwarding table
  - Forwards based on the MAC (Layer 2) address
- Operates at OSI Layer 2
- Learns a station's location by examining source address
  - Sends out all ports when destination address is broadcast, multicast, or unknown address
  - Forwards when destination is located on different interface



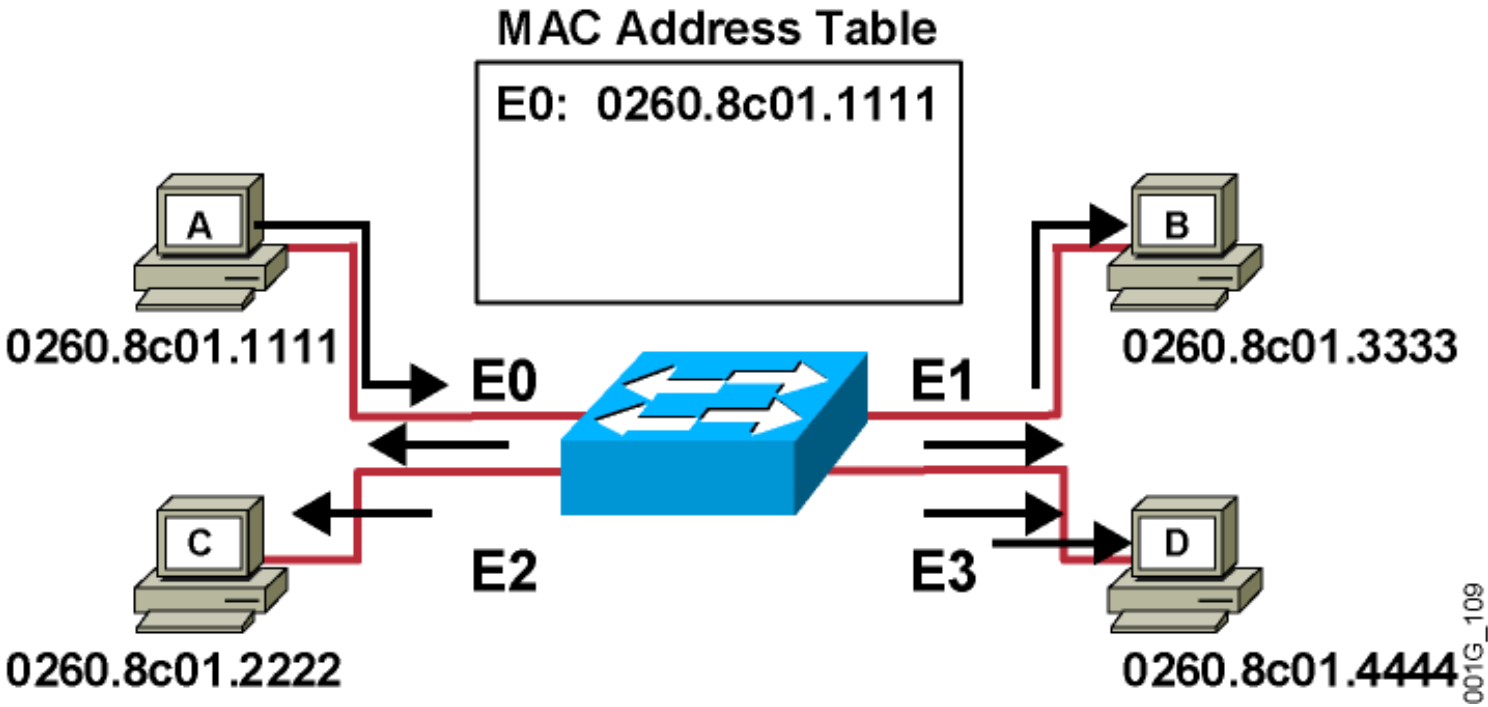


MAC Address Table



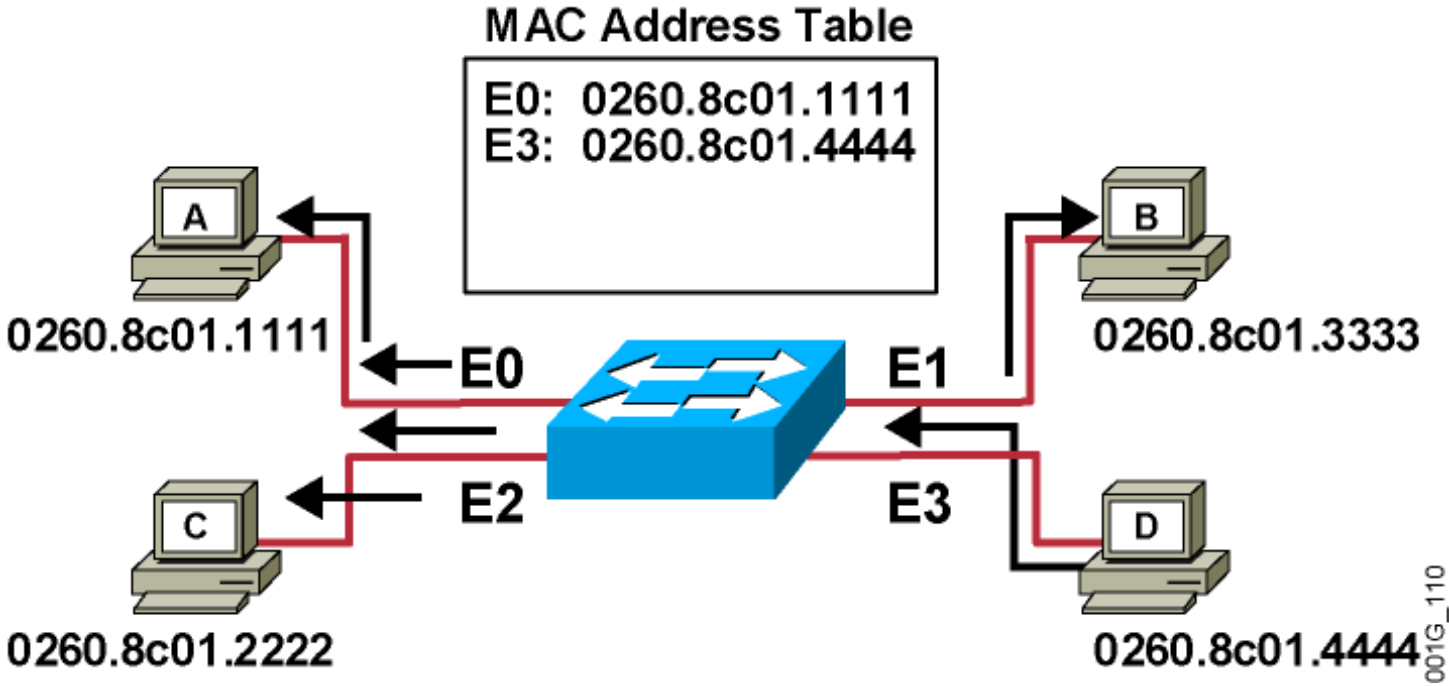
- **The initial MAC address table is empty.**

Learning Addresses



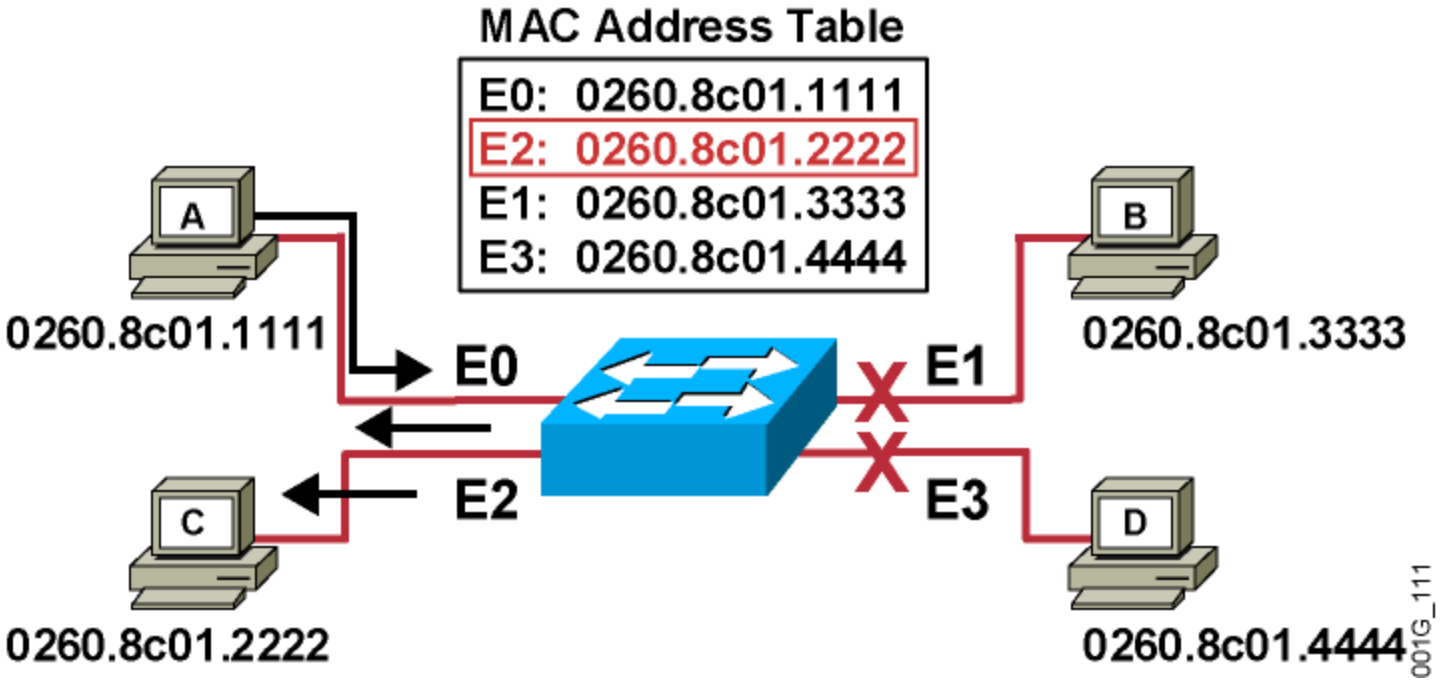
- Station A sends a frame to station C.
- The switch caches the MAC address of station A to port E0 by learning the source address of data frames.
- The frame from station A to station C is flooded out to all ports except port E0 (unknown unicasts are flooded).

Learning Addresses (Cont.)



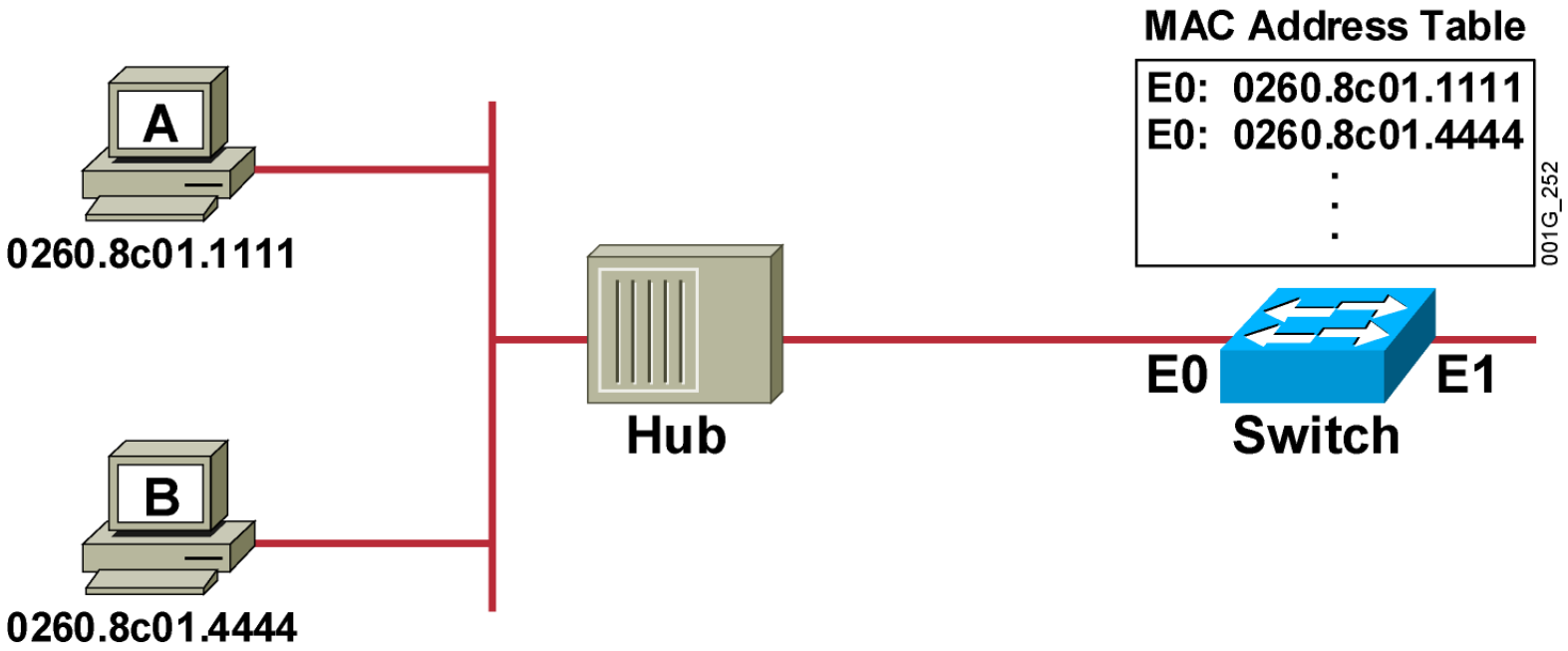
- Station D sends a frame to station C.
- The switch caches the MAC address of station D to port E3 by learning the source address of data frames.
- The frame from station D to station C is flooded out to all ports except port E3 (unknown unicasts are flooded).

Filtering Frames



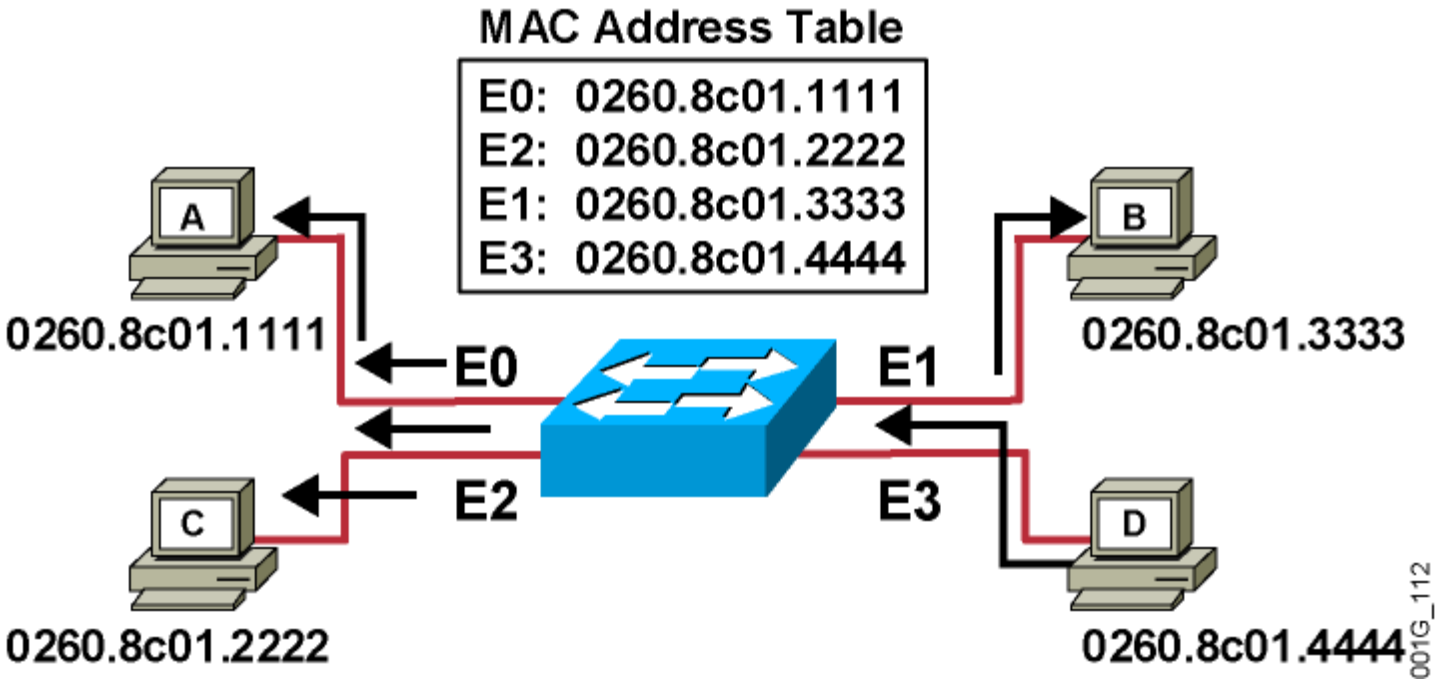
- **Station A sends a frame to station C.**
- **The destination is known; the frame is not flooded.**

Filtering Frames (Cont.)



- Station A sends a frame to station B.
- The switch has the address for station B in the MAC address table.

Broadcast and Multicast Frames



- **Station D sends a broadcast or multicast frame.**
- **Broadcast and multicast frames are flooded to all ports other than the originating port.**

LAN Design Goals

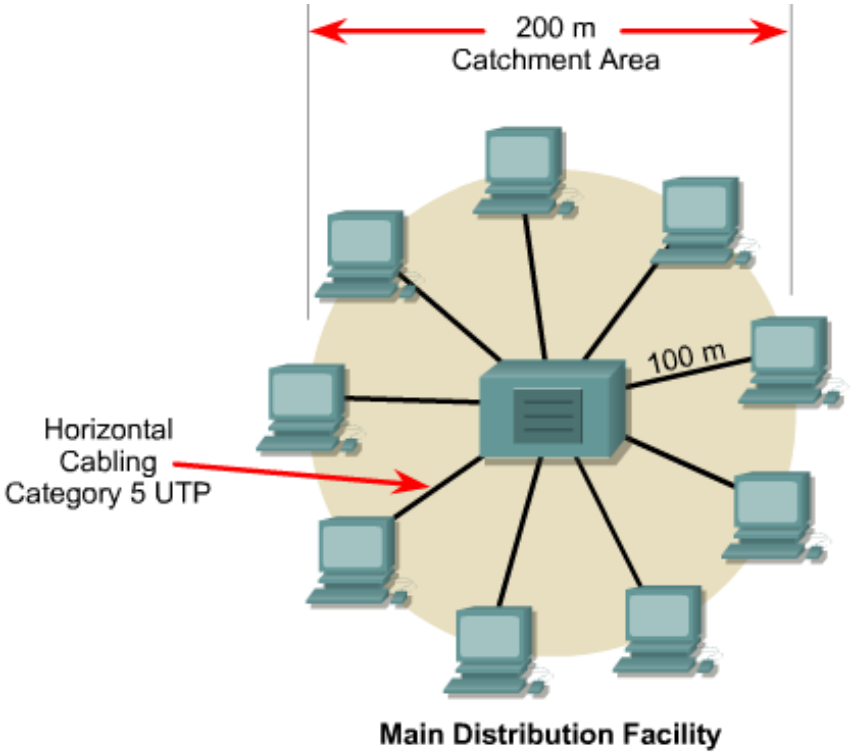
- **Functionality**
- **Scalability**
- **Adaptability**
- **Manageability**

LAN Design Methodology

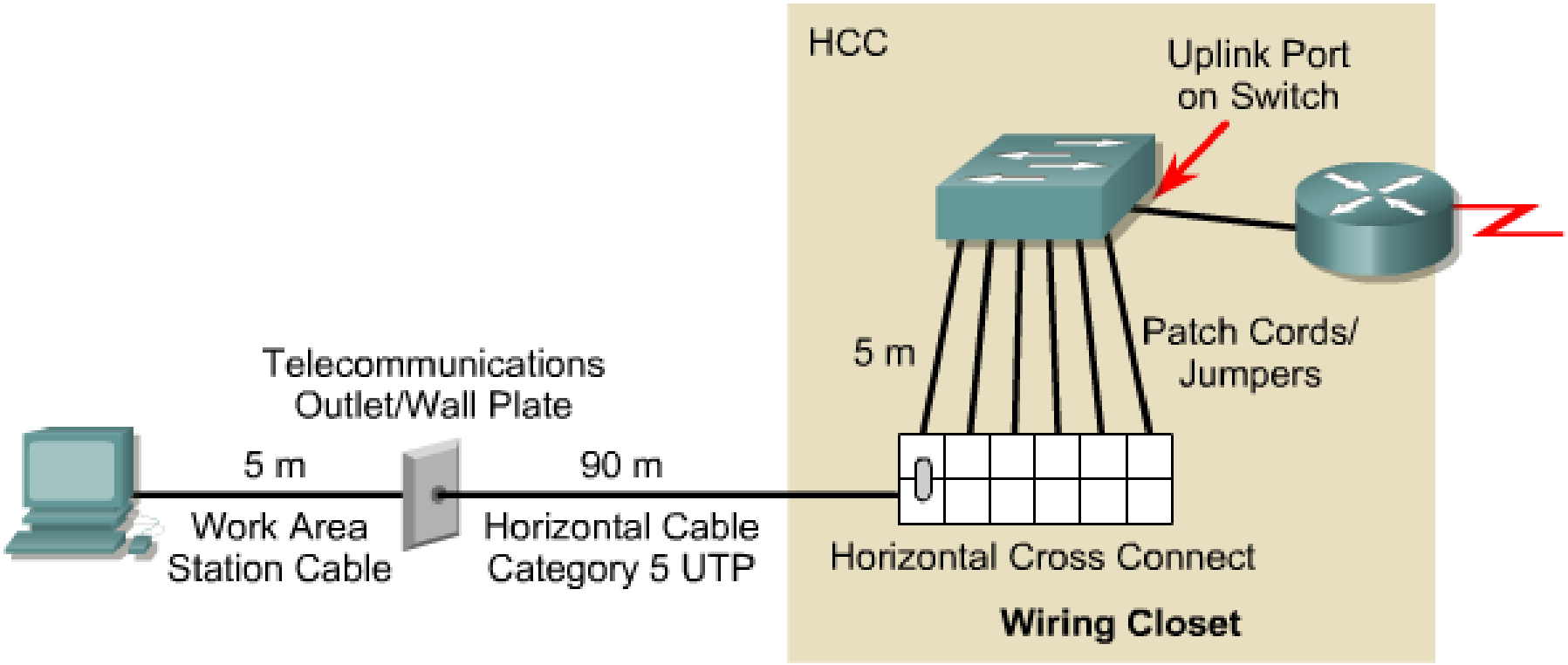
- Gather requirements and expectations
- Analyze requirements and data
- Design the Layer 1, 2, and 3 LAN structure, or topology
- Document the logical and physical network implementation

Layer 1 Design

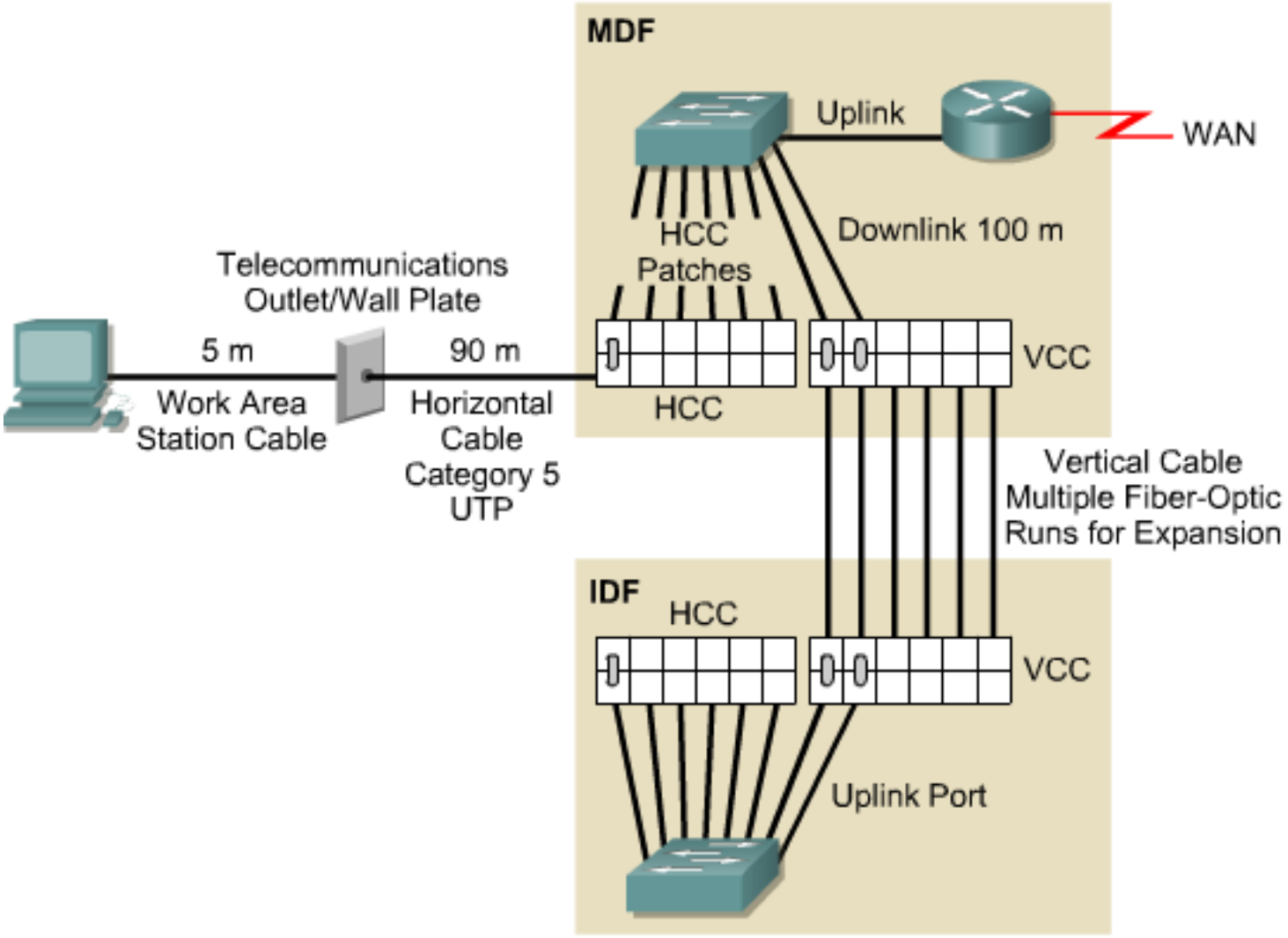
Characteristic	10BASE-T	10BASE-FL	100BASE-TX	100BASE-FX
Data rate	10 Mbps	10 Mbps	100Mbps	100 Mbps
Signaling method	Baseband	Baseband	Baseband	Baseband
Medium type	Category 5 UTP	Fiber-optic	Category 5 UTP	Multi-mode fiber (two strands)
Maximum length	100 meters	2000 meters	100 meters	2000 meters



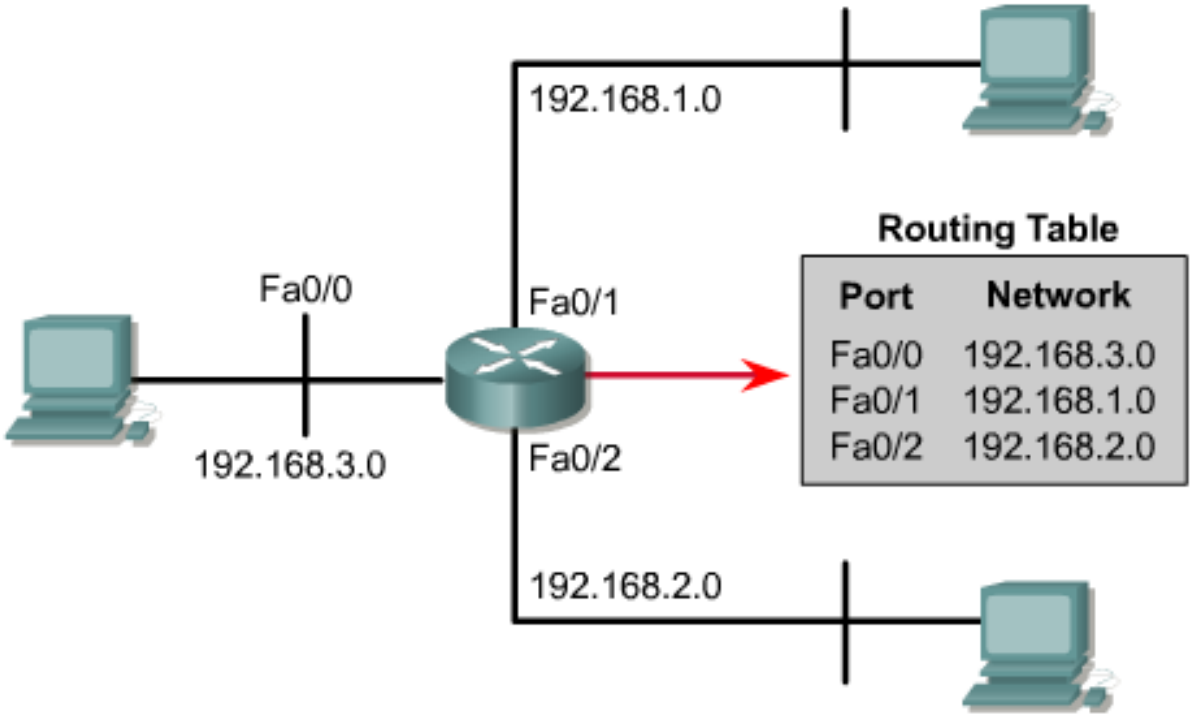
Typical MDF in Star Topology



Extended Star Topology in a Multi-Building Campus

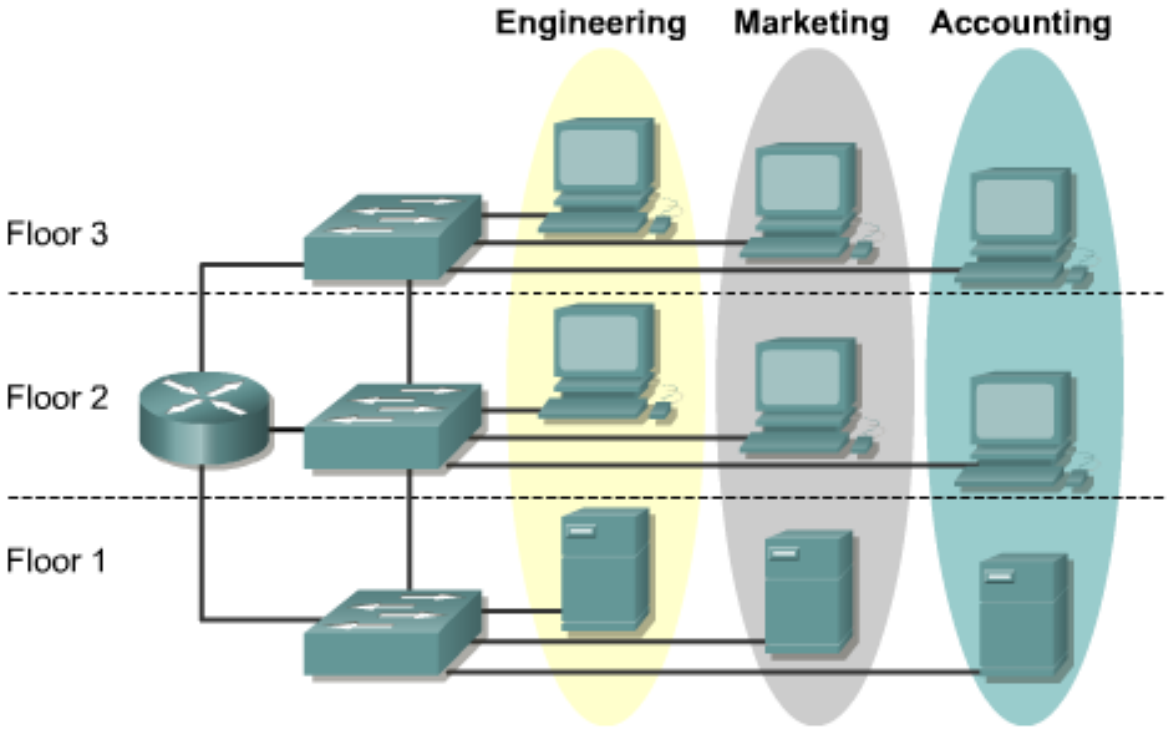


Use Routers to Impose Logical Structure



Routers provide scalability because they serve as firewalls for broadcasts. They can also provide scalability by dividing networks into subnetworks, or subnets, based on Layer 3 addresses.

Setting Up VLAN Implementation



- Group users by department, team, or application
- Provides broadcast containment and security
- Routers provide communication between VLANs

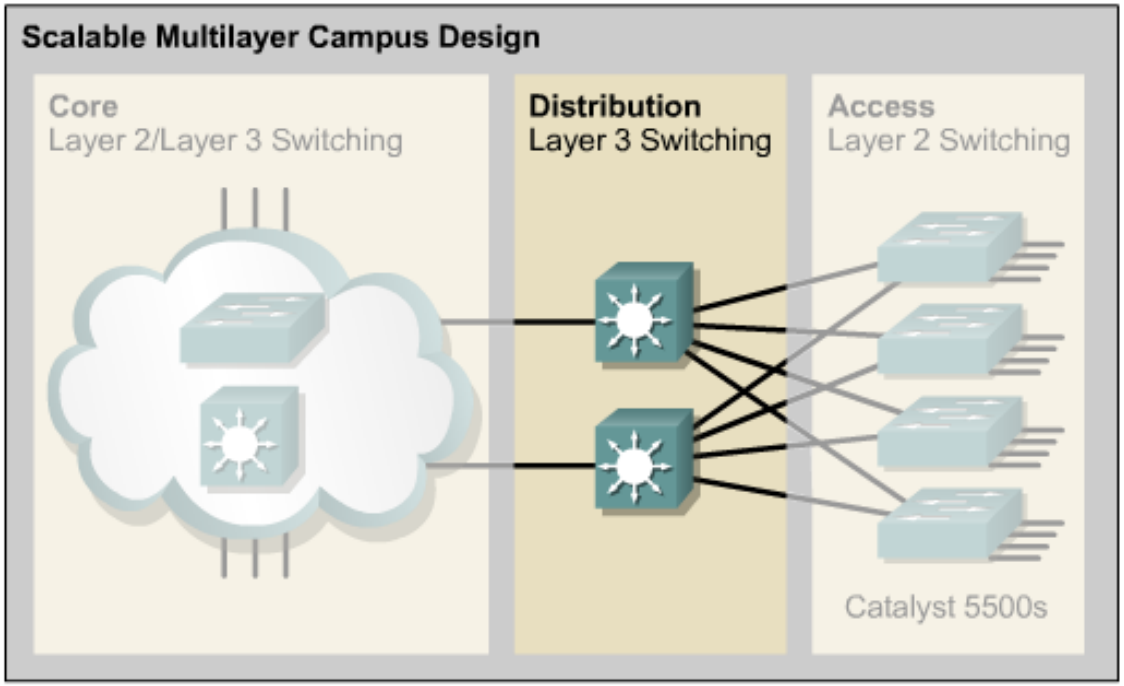
Access Layer

- **Functions of the Access Layer:**
  - **Shared Bandwidth**
  - **Switched Bandwidth**
  - **MAC Layer Bandwidth**
  - **Microsegmentation**

Access Layer Switches

- Catalyst 1900 series
- Catalyst 2820 series
- Catalyst 2950 series
- Catalyst 4000 series
- Catalyst 5000 series

Distribution Layer



- **The distribution layer includes several functions:**
  - **Aggregation of the wiring-closet connections**
  - **Broadcast/multicast domain definition**
  - **VLAN routing**
  - **Security**

Distribution Layer Switches

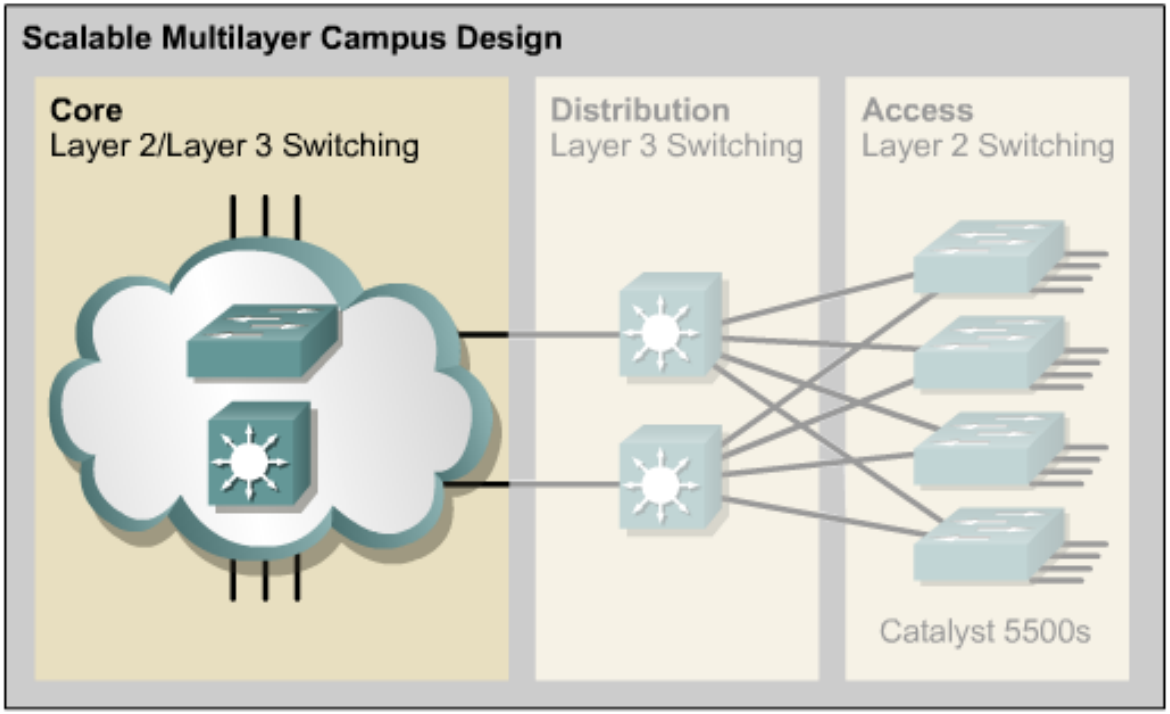
Cisco Catalyst 2926G

<not pictured>

Cisco Catalyst 5000 Family

Cisco Catalyst 6000 Family

Core Layer



The core layer is a high-speed switching backbone. The core layer should be designed to switch packets as fast as possible.

Core Layer Switches

IGX 8400 series

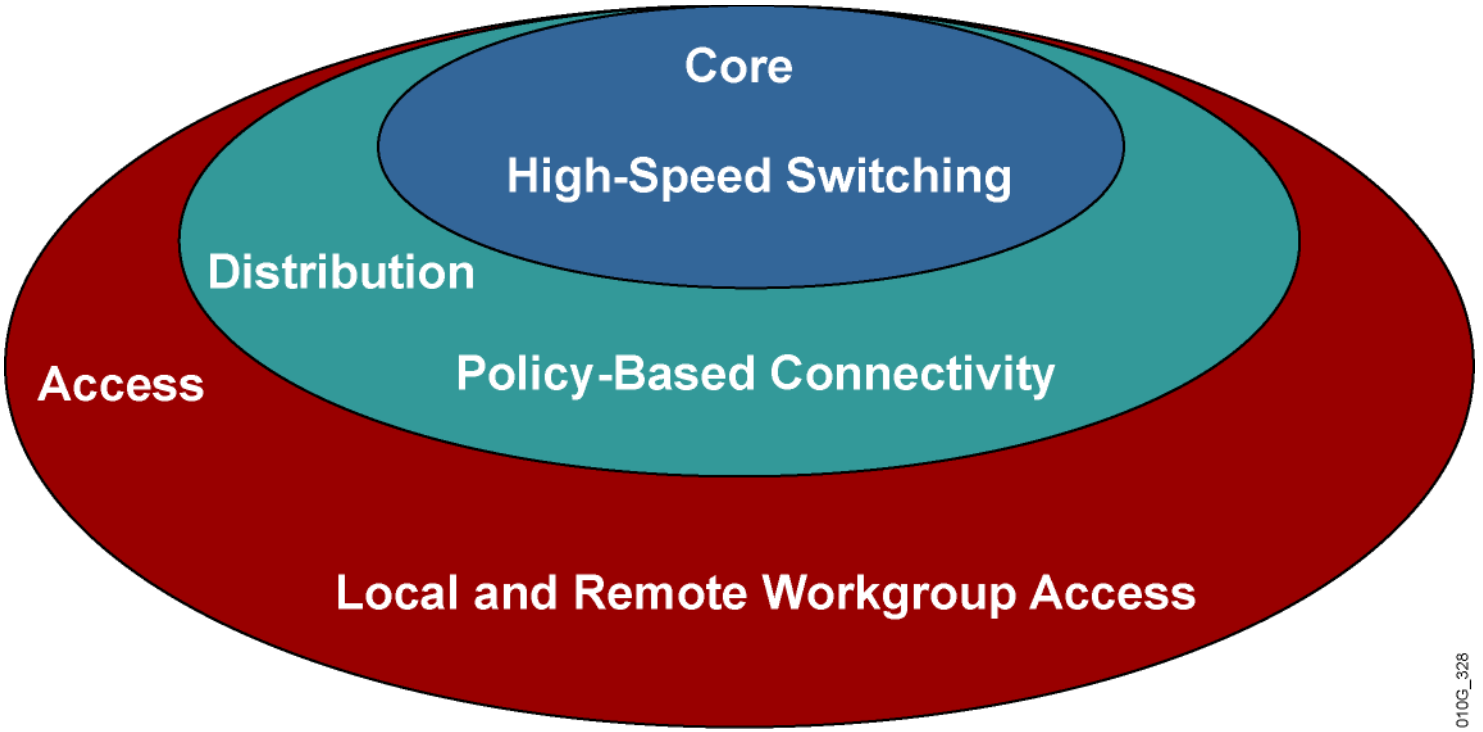
<not pictured>

Catalyst 6500 series

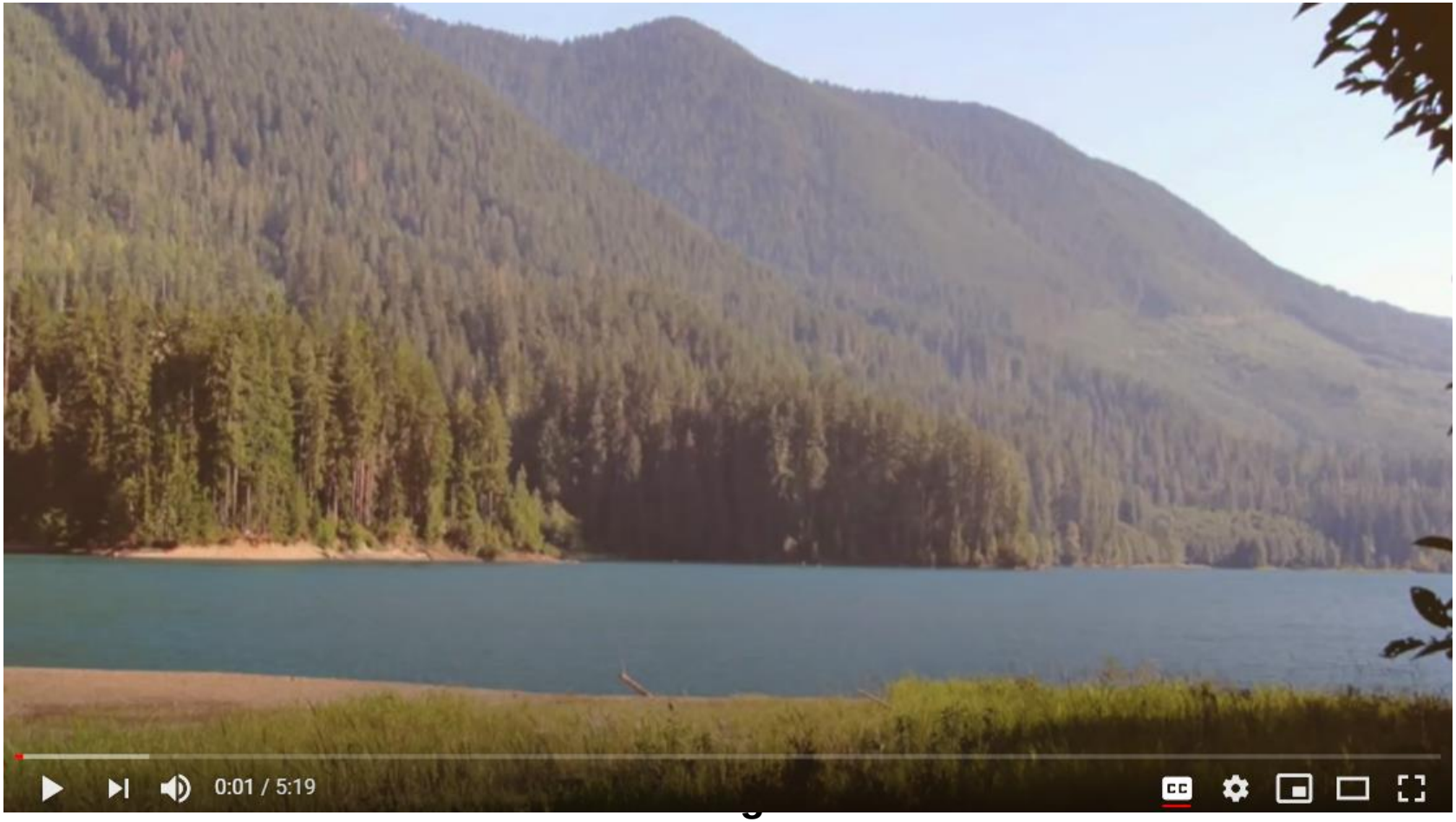
Lightstream 1010

Catalyst 8500 series

Hierarchical Model



GOOGLE Machine Learning



https://www.youtube.com/watch?v=_rdlNNHLYaQ&t=8s

TESLA/ Elon Musk (特斯拉/ 伊隆·馬斯克): The City of the Future

https://www.youtube.com/watch?v=L054Xd97_rk&t=273s