

# Campus Networking Best Practices

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# The Next Two Days

- Day 1
  - Morning
    - Layer 2 Network Architecture
    - Layer 3 Network Architecture
  - Afternoon
    - Layer 0 Structured Cabling Systems
    - Network Management Overview
- Day 2
  - Morning
    - Wireless LAN Strawman Proposal
    - Help Desk and Trouble Ticketing
  - Afternoon
    - Open Engineering Discussions



# Why is This Stuff Important

- Need a plan
  - The campus network is foundation that you build RENs on.
  - How else will you know where to make investments?
  - Must have a plan to get Public IP address space



# Campus Networking Best Practices

## Session 1: Layer 2

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# Campus Network Rules

- Build Separate Core and Edge Networks
- Minimize number of network devices in any path
- Use standard solutions for common situations
- Provide services near the core
- Separate border routers from core
- Provide opportunities to firewall and shape network traffic



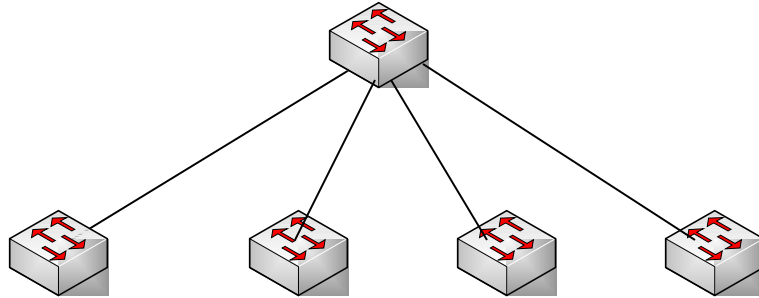
# Core versus Edge

- Core network is the “core” of your network
  - Needs to have reliable power and air conditioning
  - May have multiple cores
  - Always route in the core
- Edge is toward the edges of your network
  - Provide service inside of individual buildings to individual computers
  - Always switch at the edge

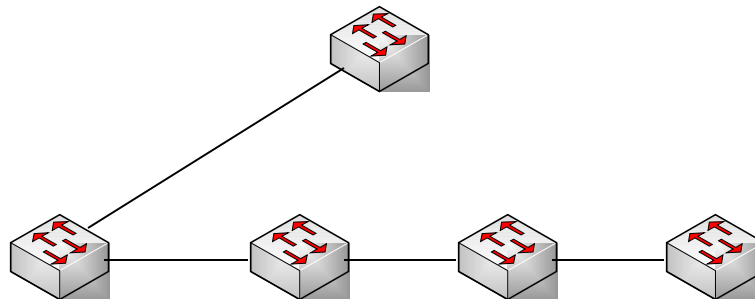


# Minimize Number of Network Devices in the Path

- Build star networks



- Not daisy chained networks



# Edge Networks (Layer 2 LANs)

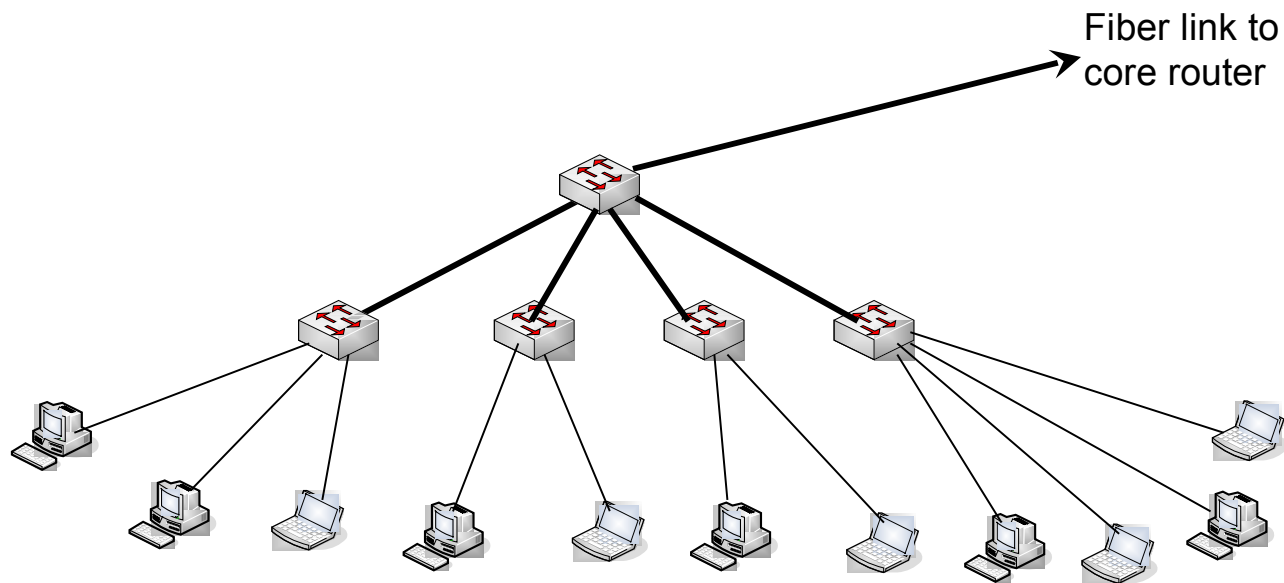
- Provides Service to end users
- Each of these networks will be an IP subnet
- Plan for no more than 250 Computers at maximum
- Should be one of these for every reasonable sized building
- This network should only be switched
- **Always buy switches that are managed – no unmanaged switches!**





# Edge Networks

- Make every network look like this:

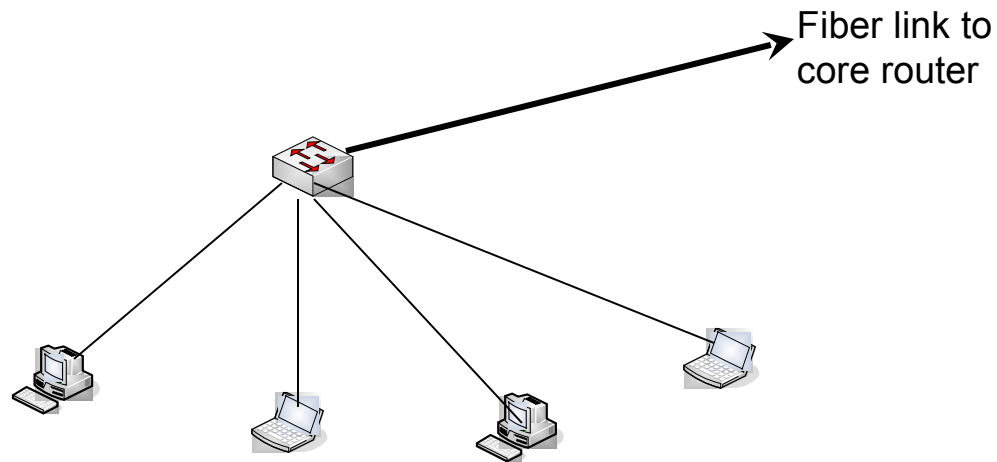


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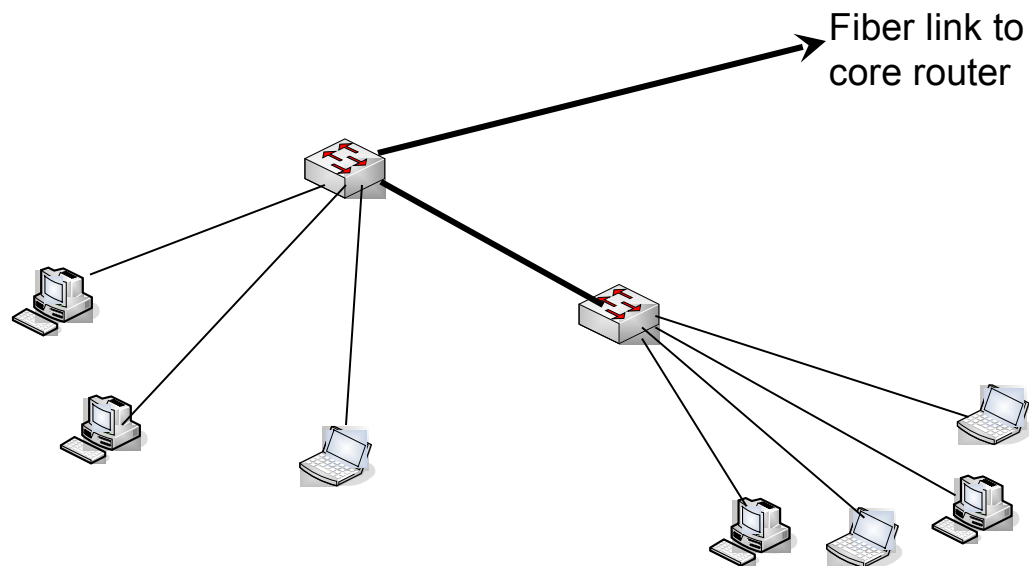
# Edge Networks Continued

- Build Edge network incrementally as you have demand and money
- Start Small:



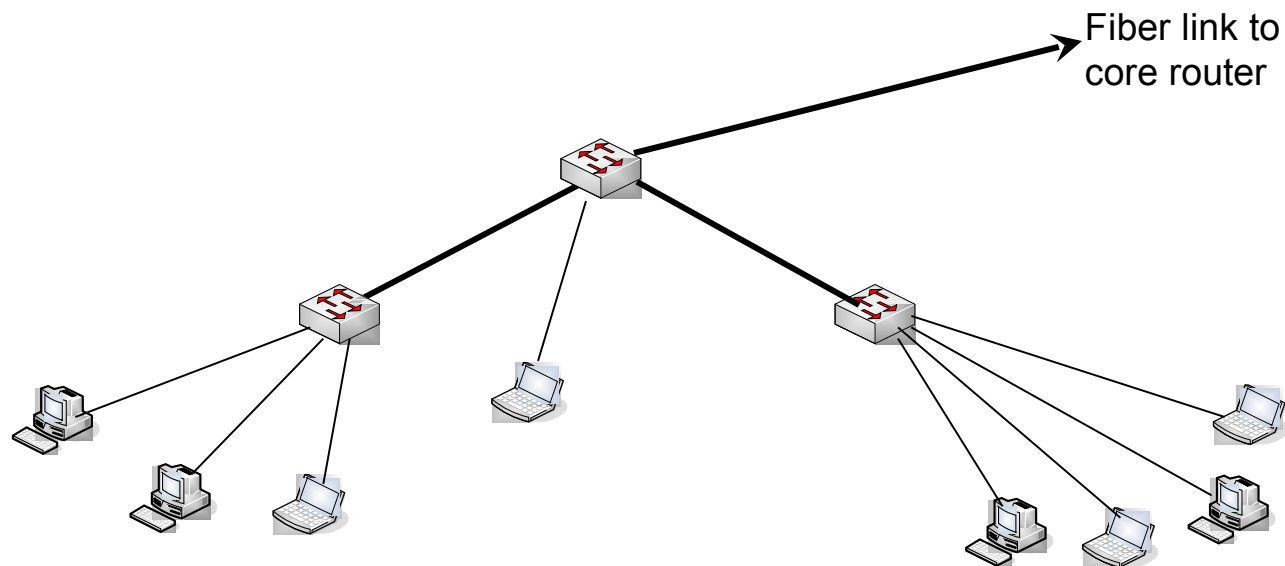
# Edge Networks Continued

- Then as you need to add machines to the network, add a switch to get this:



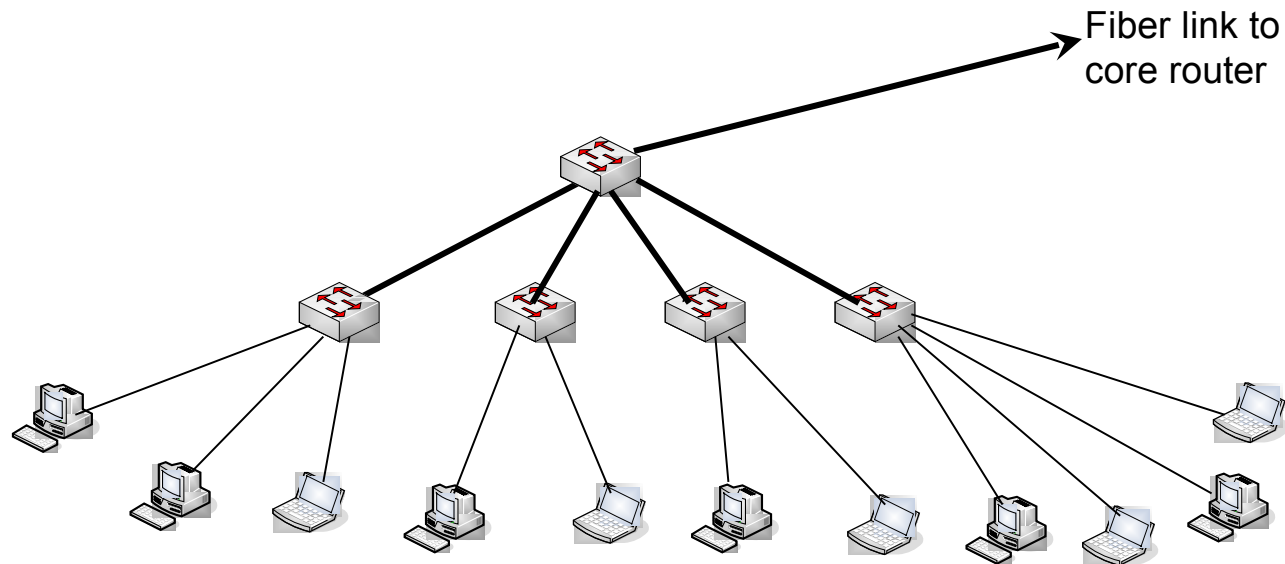
# Edge Networks Continued

- And keep adding switches to get to the final configuration



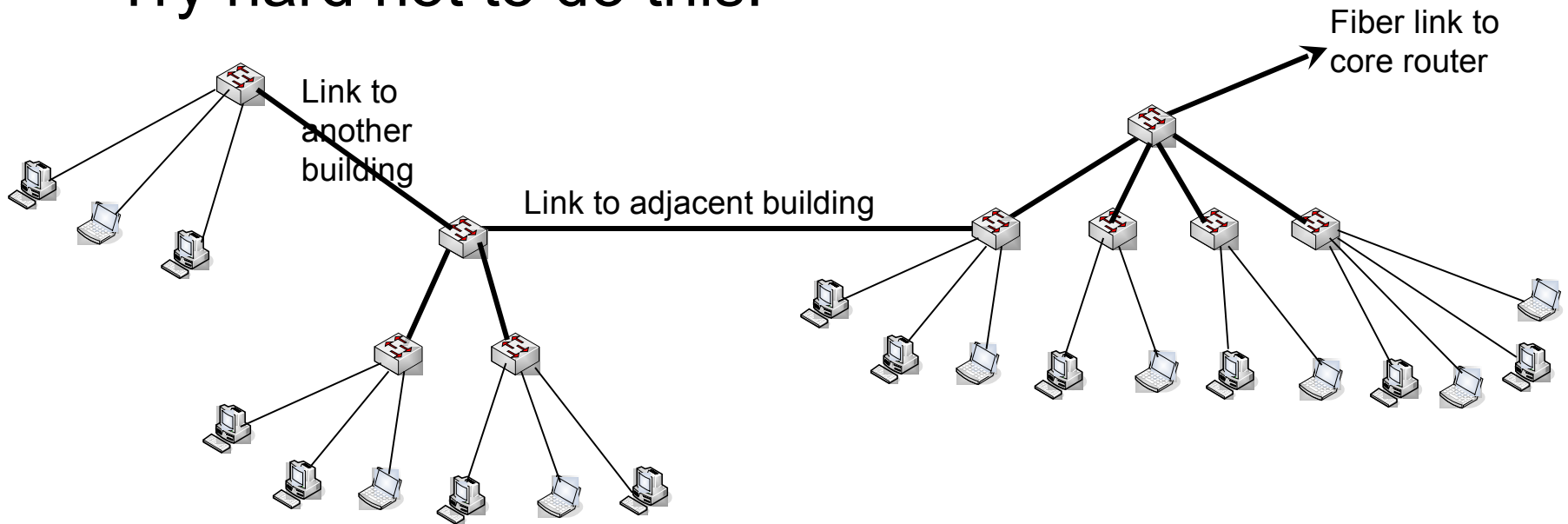
# Edge Networks Continued

- And keep adding switches to get to the final configuration



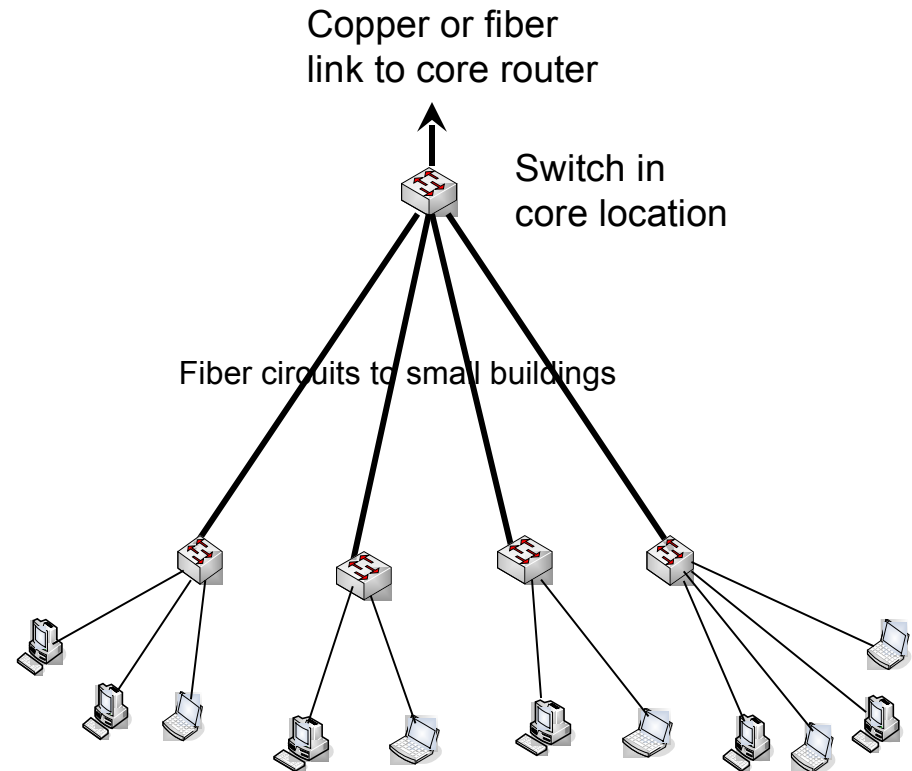
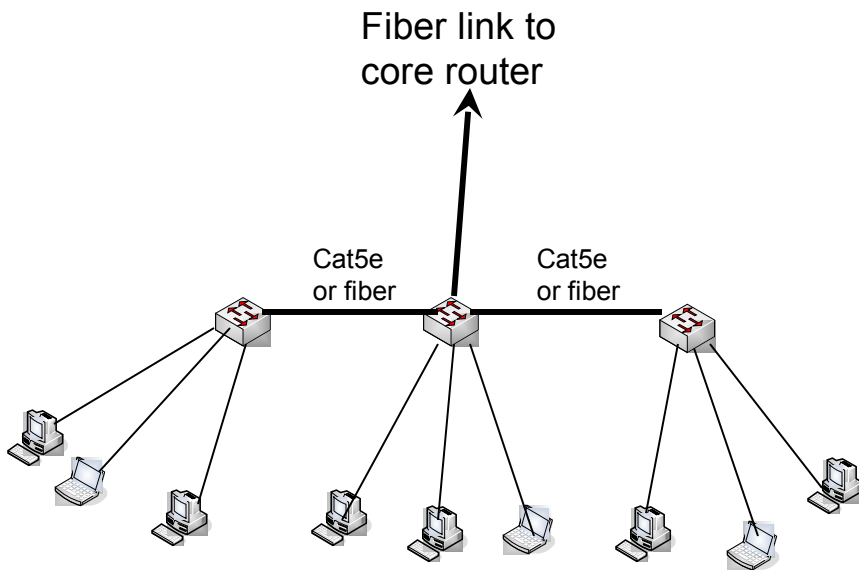
# Edge Networks Continued

- Resist the urge to save money by breaking this model and daisy chaining networks or buildings together
- Try hard not to do this:



# Edge Networks Continued

- There are cases where you can serve multiple small buildings with one subnet.
- Do it carefully.
- Two basic models:



# Selected Layer 2 Topics

- Collision versus Broadcast Domain
- VLANs
- ARP – how it works
- DHCP - How it works
- Spanning Tree
- Link Aggregation
- Failure modes
  - 100 Mbs and Gigabit Duplex mismatch





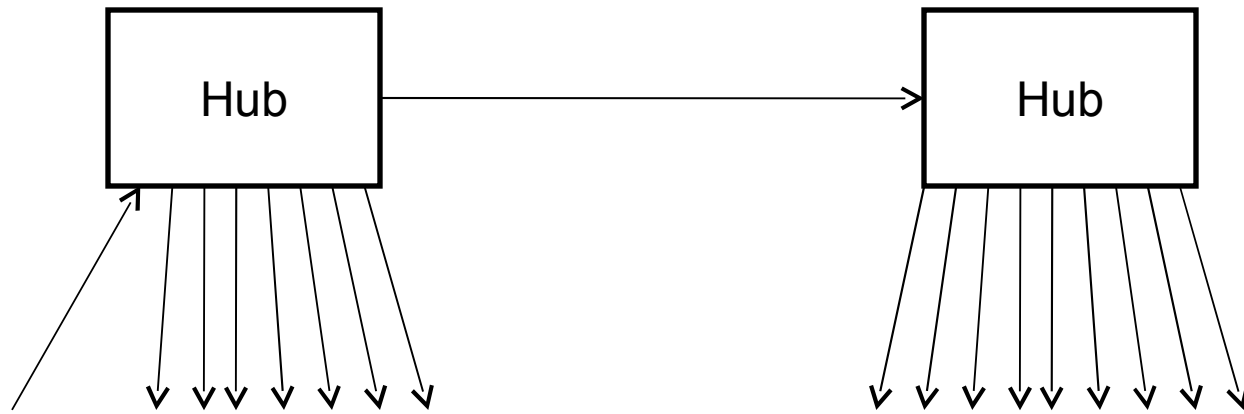
# Collision vs. Broadcast Domain

- Similar issues – affects performance of LAN
- Hubs (Repeaters)
  - Every packet goes to every port, irrespective of destination of packet
  - Every port is half duplex
  - Can only be one packet in transit – two transmitters = Collision



# Collision vs. Broadcast Domain

- Hubs/Repeaters

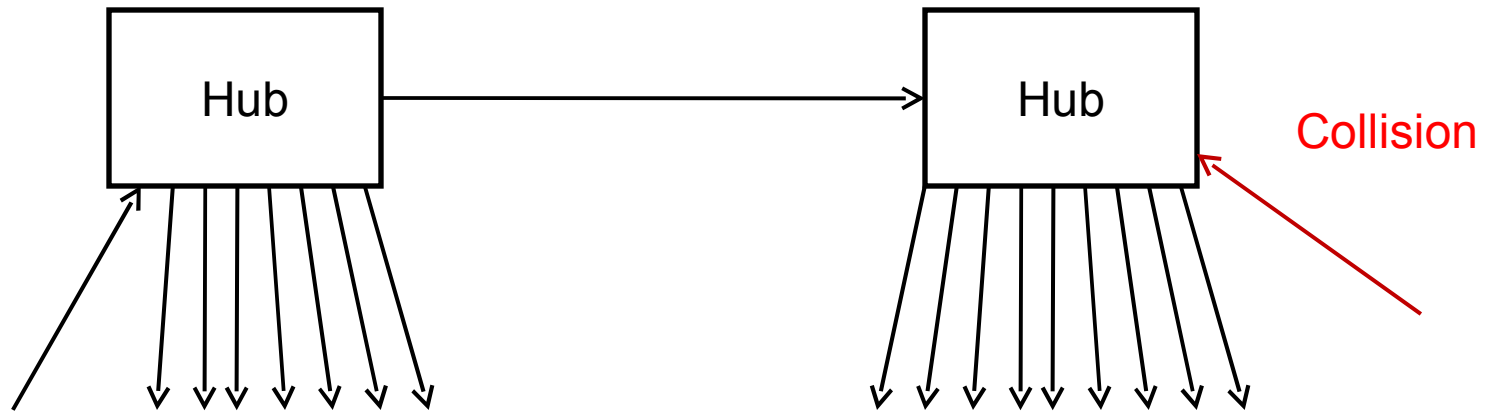


- Only One Packet at a time
- Every packet (even unicast) goes to every port



# Collision vs. Broadcast Domain

- Hubs/Repeaters



Two Transmitters = Collision



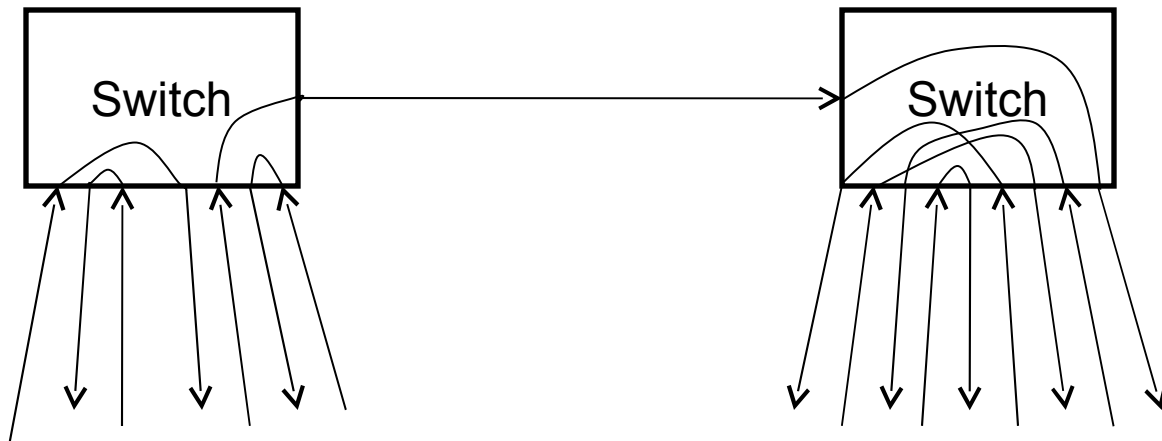
# Collision vs. Broadcast Domain

- Switches
  - Switches learn where hosts are eavesdropping on traffic and building a forwarding table
  - Switches forward packets to correct port
  - Can only be many packets in transit
  - Broadcasts must go to all ports



# Collision vs. Broadcast Domain

- Switches

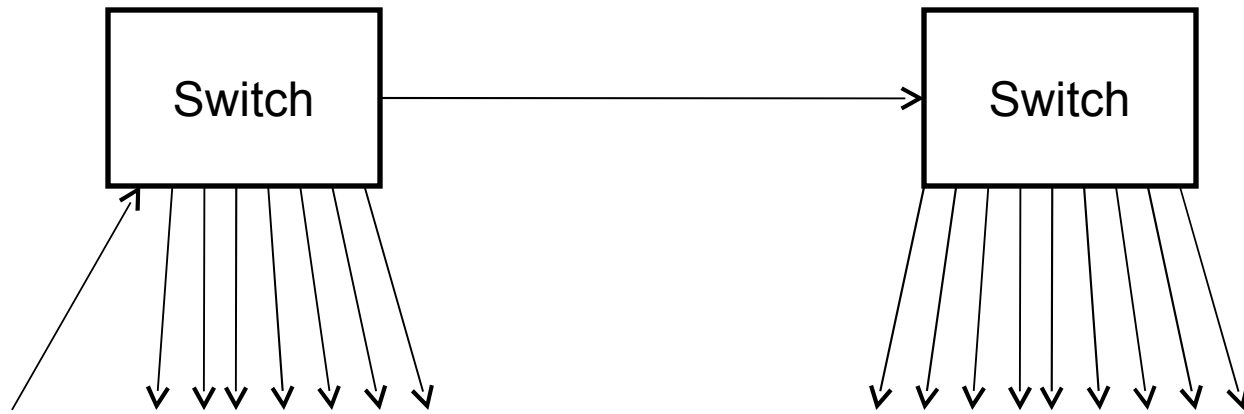


- Many packets can be in flight – store and forward
- Unicast Packets go to intended destination



# Collision vs. Broadcast Domain

- Switches

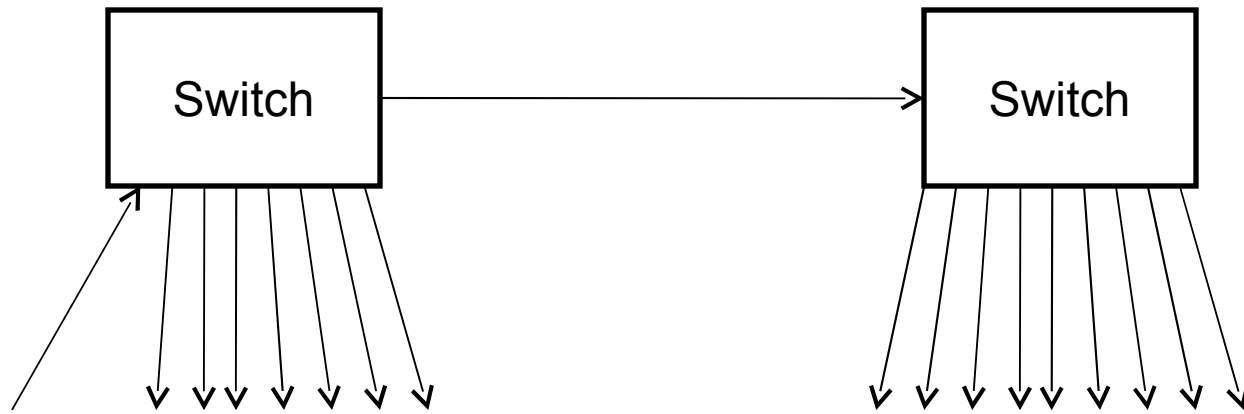


- Broadcasts go to all ports (notice this looks like the hubs picture some slides ago)



# Collision vs. Broadcast Domain

- Switches



- Switches need to know about multicast



# VLANs

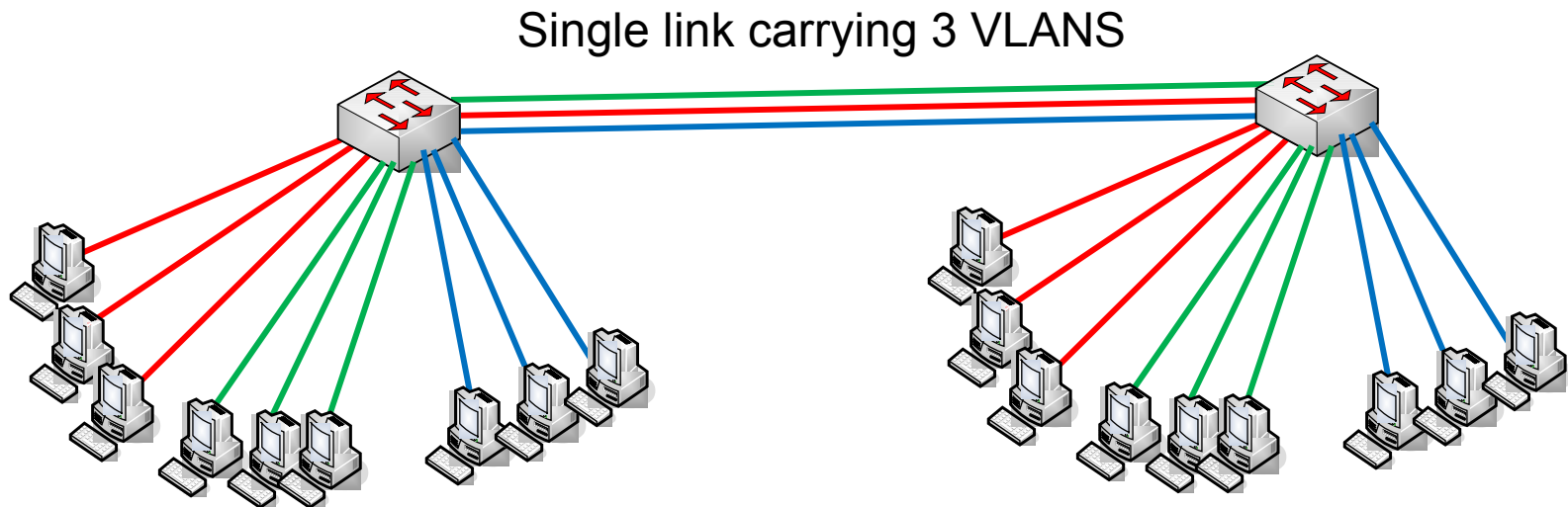
- Virtual LANs – reduce scope of broadcast domain and separate traffic
- Tagging – identifying the VLAN associated with a packet. Ports are configured as Tagged or untagged.
- Trunking – Carrying traffic for multiple VLANs on a single link. Must use tagging.





# VLANs

- Tagging on Trunks – must tag

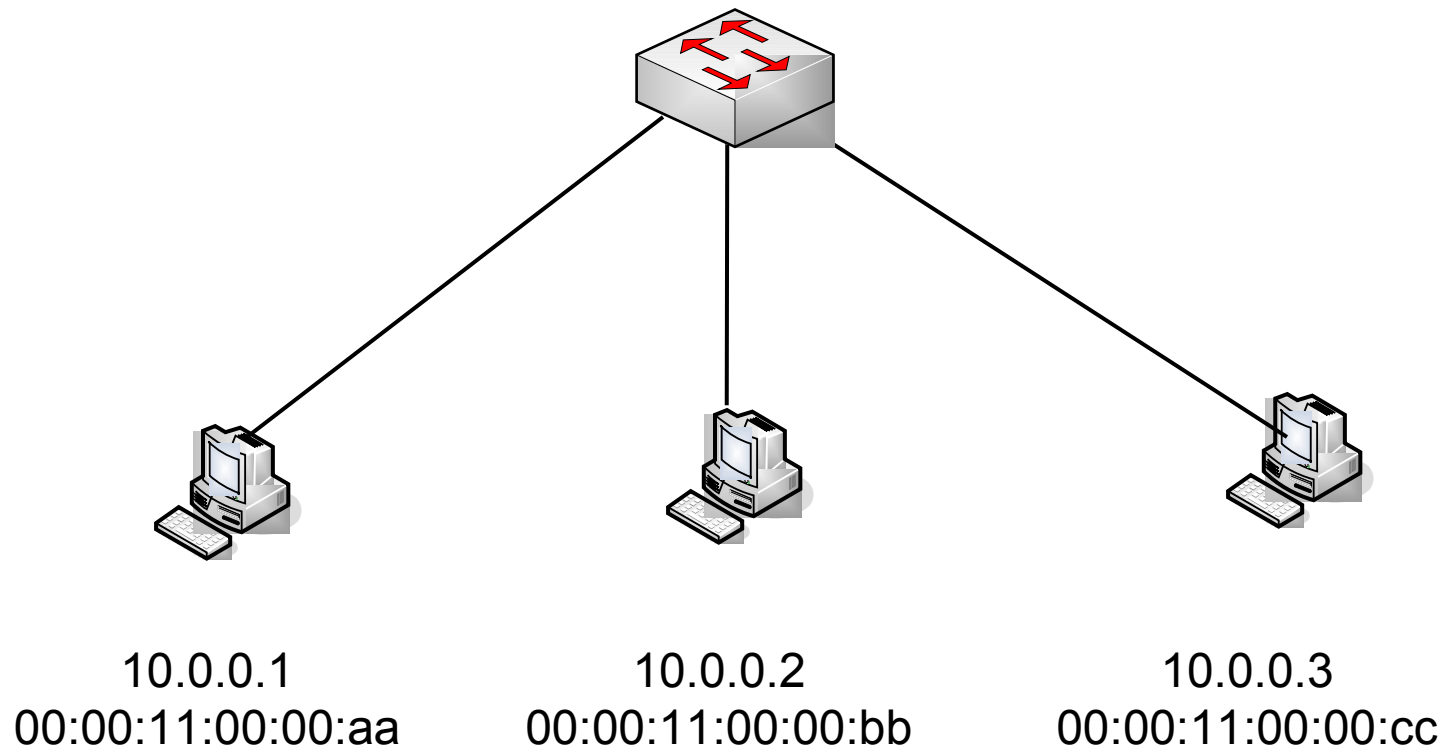


# ARP

- Address Resolution Protocol
- Builds a mapping of IP address to Ethernet Address
- ARP Protocol
  - Broadcast ARP Request (who has this IP?)
  - Owner of IP address in ARP Request issues ARP reply
- Pathology: anyone can issue an ARP reply at any time



# ARP



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# DHCP

- Dynamic Host Configuration Protocol
- Used to assign IP address and provide basic IP configuration to a host.
- Simple protocol
  - Client broadcasts a DHCP Discover
  - Server(s) unicast back a DHCP Offer
  - Client selects an offer and sends back a DHCP Ack to server
- Manage switches can block rogue DHCP



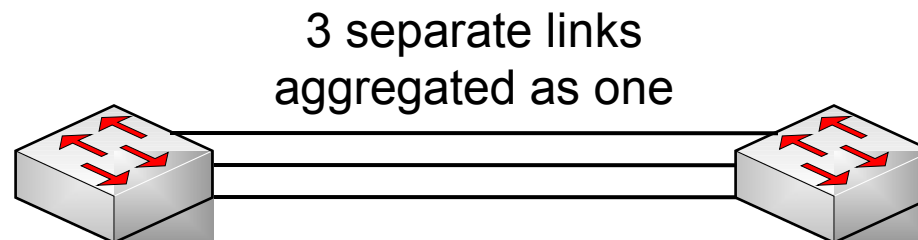
# Spanning Tree

- Eliminates loops in Layer 2 networks
- Several flavors
  - Original Spanning Tree 802.1D
  - Rapid Spanning Tree (RSTP) 802.1w
  - Multiple Spanning Tree (MSTP) 802.1s and 802.1Q-2003
- Modern managed switches can do all of the above



# Link Aggregation

- Bonds multiple channels together to provide more bandwidth
- Issues:
  - Compatibility
  - How traffic is scheduled



# Failure Modes

- Loops in your network
- Rogue DHCP servers
- Duplex mis-match
  - 100Mbs – late collisions and CRC
  - 1000Mbs – can't establish link
- Need managed switches to correct these



# Thanks

## Questions?

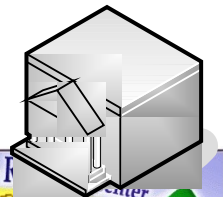
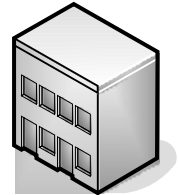
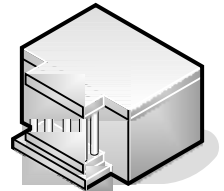
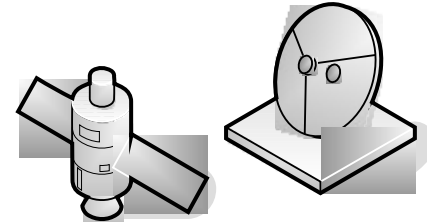
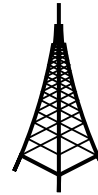
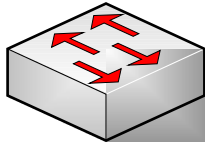
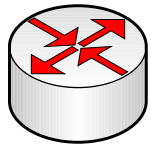


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# Symbols to use for diagrams



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