

Chapter 7 – Ethernet LAN Switching Concepts

Hubs : Created one single collision domain, and bandwidth is shared in a 10 BASE T network with a Hub.

Bridges : reduced the number of collision occurred in a network, by segmenting the collision domains, and bridges add bandwidth to the network.

Switches (benefits of using switches) : Creates separate collision domain on each of its interfaces, it can support full duplex if only one device is connected to an interface. Switches multiply amount of available bandwidth in the network.

Ethernet MAC address...

Unicast Addresses: MAC address that identifies a single LAN interface card

Broadcast Addresses: A frame sent with a destination address of broadcast address (FFFF.FFFF.FFFF) implies that all devices on the LAN should receive and process the frame.

Multicast Addresses: Multicast MAC addresses are used to allow dynamic subset of devices on a LAN to communicate.

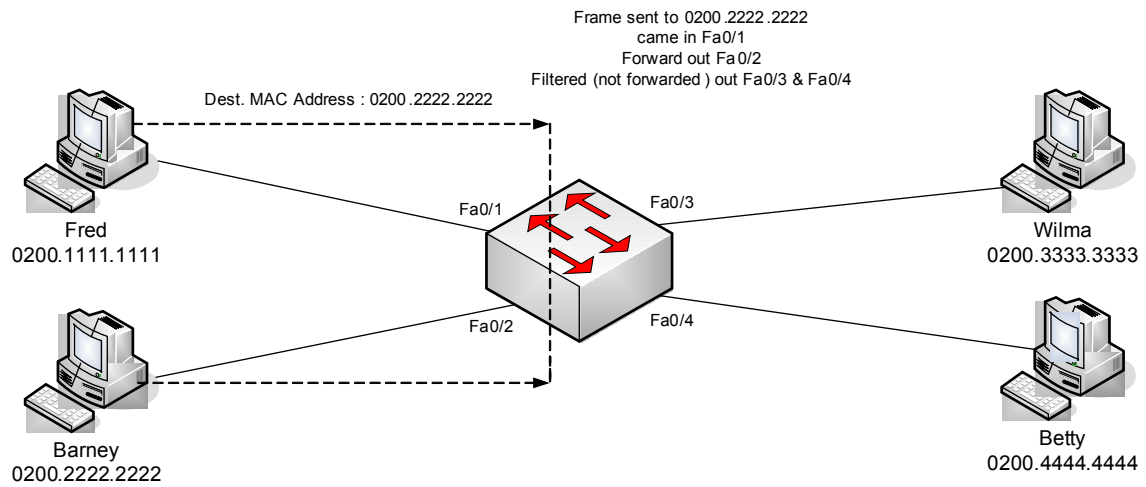
IP multicast over Ethernet uses MAC address in the format 0100.5exx.xxxx where a value between 00.0000 to 7f.ffff can be used for the second half.

Primary functions of a Switch...

1. Deciding when to forward a frame or when to filter (not forward) a frame based on the destination MAC address.
2. Learning MAC address by examining the source MAC address of each frame received
3. Creating a (layer 2) loop free environment with other switches by using Spanning Tree Protocol (STP)

Sample switch forwarding and filtering decision.

(Fred forwards a frame to Barney)



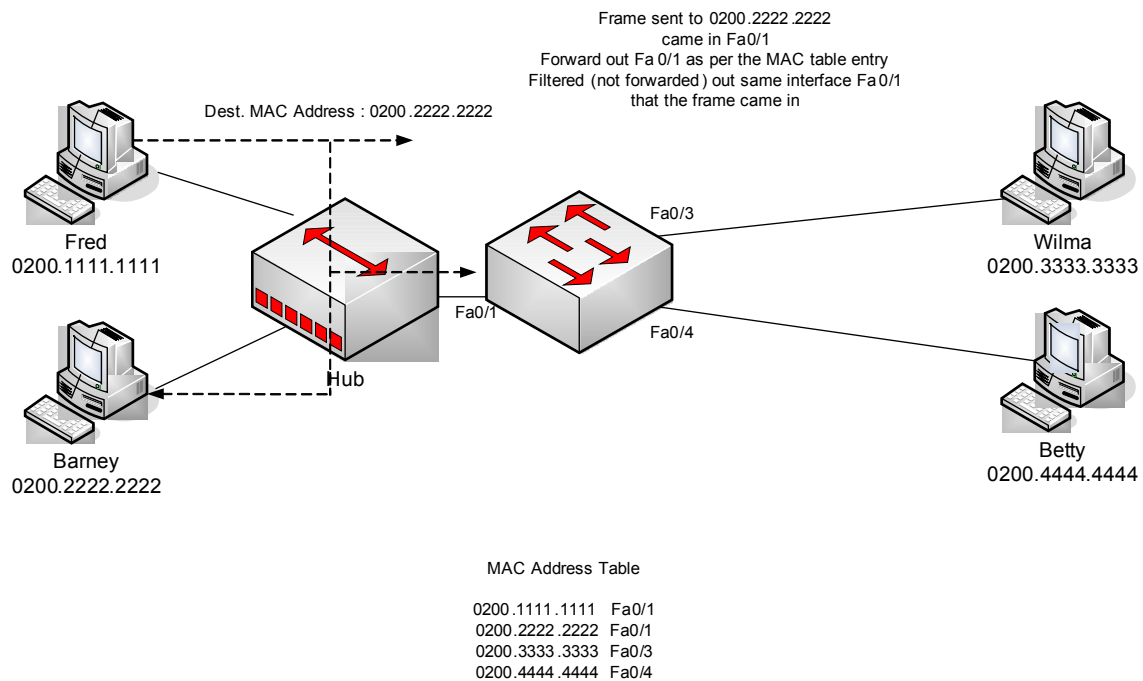
MAC Address Table

0200.1111.1111	Fa0/1
0200.2222.2222	Fa0/2
0200.3333.3333	Fa0/3
0200.4444.4444	Fa0/4

MAC address table is also called, Switching Table, Bridging Table or Content Addressable Memory.

Sample switch filtering decision.

Note that the hub simply regenerates the electrical signals out each interface, so the hub forwards the electrical signal send by Fred to both Barney and the switch, The switch decides to filter out (not forward) the frame noting that the MAC address table interface for destination address 0200.2222.2222 (Fa0/1) is the same as the incoming interface.



How switch learn MAC address: Switches populate the MAC table by listening to the frame, it adds the source MAC address and the interface it came from if an entry is not already there in the MAC address table.

Flooding Frames: When a switch receives a frame with a destination address that is not in its MAC address table, it forwards out all the interface except the one it came from.

Switches keeps a timer for each entry in the MAC address table, called inactivity timer. Switch sets the timer to 0 for new entries, and resets it to zero each time it receives a frame from a MAC address, this counter counts upwards, so at any point in time if the

switch memory runs out switch know which is the oldest inactive entry in the MAC address table and it deletes it to free up memory.

Spanning Tree Protocol (STP): STP prevents loops by blocking some interfaces (ports) from forwarding frames, so that only one active logical path exists in a physically redundant network between two LANs. In STP a port can have one of two states Blocking (cannot send and receive) and Forwarding (can send and receive).

Internal Processing on Cisco Switches

Store and Forward Processing : In this type of processing a switch must receive the entire frame before it starts forwarding the first bits of the frame.

Cut through processing : With this type of processing a switch starts forwarding the frame as soon as possible without waiting an entire frame to be received. This is possible because the destination MAC address come in early in the Ethernet header, even though this can reduce latency, it may cause erroneous frames to be forwarded as the FCS is placed at the end of the frame and switch can't determine the forwarded frame was in error.

Fragment free processing : works very much similar to cut through processing, but it try to reduces the number of errored frames that it forwards.

Switching Method	Description
Store-and-Forward	The switch fully receive all bits in the frame (store) before forwarding the frame. This allows the switch to check the FCS before forwarding the frame.
Cut-through	The switch forward the frame as soon as it can. This reduces latency but does not allow the switch to discard the frame that fails the FCS check.
Fragment-free	The switch forwards a frame after receiving first 64 bytes of the frame, thereby avoiding forwarding of frames that were errored due to collision.

LAN Switching Summary

LAN switches provide many additional features compared to Lan hubs and bridges, In particular LAN switches provide the following benefits:-

- Switch port connected to a single device micro-segments the LAN, providing dedicated bandwidth to that device
- Switches allow multiple simultaneous conversations between devices on different ports

- Switch ports connected to a single device supports full duplex, in effect doubling the available bandwidth to the device.
- Switches support rate adaptation, which means devices using different Ethernet speeds can communicate through the switch (hubs cannot).

Switches use Layer 2 logic, examining the Ethernet data link header to choose how to process frames. In particular switches makes decisions to forward and filter frames, learn MAC addresses, and use STP to avoid loops as follows...

Step 1. Switches forward frame based on destination address

- a) If the destination address is a broadcast, multicast, or unknown destination unicast (address not found in the MAC table), then the switch floods the frame, sends out all the other ports except the port it was received.
- b) If the destination address is a known unicast address
 1. If the outgoing interface listed in the MAC table is different to the interface it came from, switch forwards the frame out the outgoing interface.
 2. If the outgoing interface listed in the MAC table is same as the interface it came from, switch filters the frame, or simply ignore the frame without forwarding it.

Step 2. Switches uses the following logic to learn MAC address table entries

- a) For each received frame, examine the source MAC address and the interface from which the frame was received
- b) If they are not already in the table, add the address and interface, setting the inactivity timer to 0
- c) If it is already in the table, reset the inactivity timer to zero.

Step 3. Switches use STP to prevent loops by causing some interfaces to block, meaning that they do not send or receive frames.

LAN Design Considerations

Collision Domain : A collision domain is a set of LAN interfaces whose frames could collide with each other.

A broadcast domain is a set of devices where when one device sends a broadcast all other devices receive a copy of the broadcast. A switch floods broadcast and multicast out all ports, so a switch creates a single broadcast domain.

A collision domain is a set of network interface cards (NIC) for which a frame sent by on NIC could collide with a frame sent by another NIC in the same collision domain.

A broadcast domain is a set of NICs for which broadcast frame sent by one NIC is received by all other NICs in the same broadcast domain.

Switches are much preferred option in a network as it micro segments collision domain, and devices does not have to share the bandwidth.

A very large network with multiple switches creates a single broadcast domain, this could be split into multiple broadcast domains using a router.

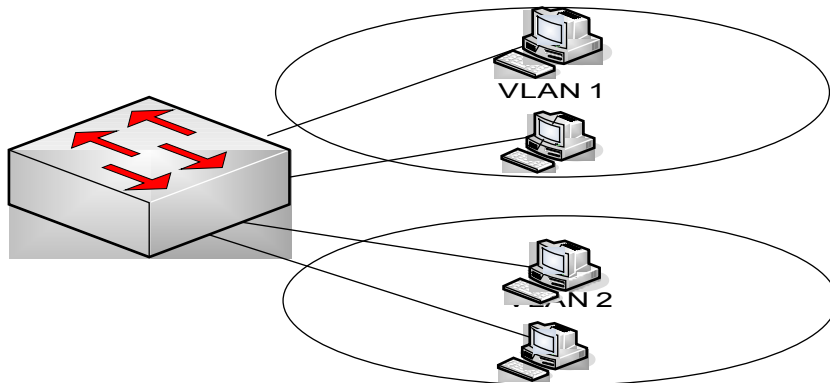
Benefits of segments Ethernet Devices using Hubs, Switches and Routers
(LAN design features in comparison with hubs, switches and routers)

Feature	Hub	Switch	Router
Greater cabling distance are allowed	Yes	Yes	Yes
Creates multiple collision domains	No	Yes	Yes
Increases bandwidth	No	Yes	Yes
Creates multiple broadcast domain	No	No	Yes

Virtual LAN (VLAN)

Without VLAN a switch considers all its interfaces to be in the same broadcast domain. With VLAN a switch can put some interfaces to a broadcast domain and some into another broadcast domain based on some simple configurations.

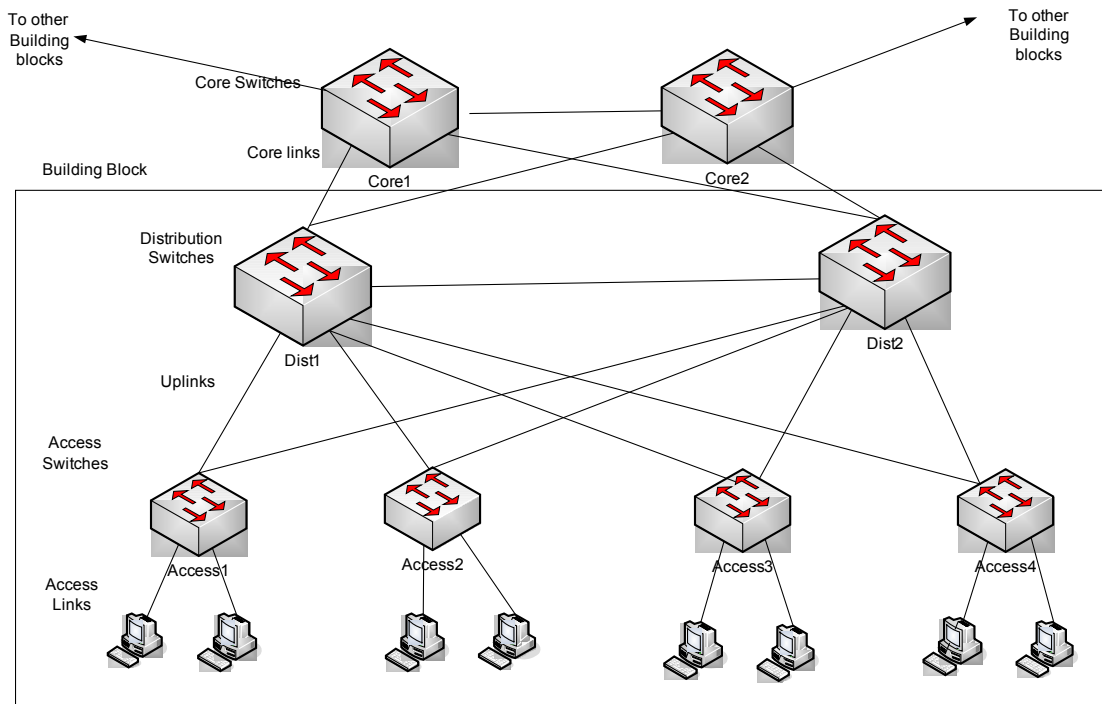
Sample network with two VLANS using one Switch



Motivations for using VLANs....

- To create more flexible network design that group by users by department, or by groups that work together, instead of by physical location
- To segment devices into smaller LANs (broadcast domains) to reduce overhead caused to each host in the VLAN
- To reduce workload for STP by limiting a VLAN to a single access switch
- To enforce better security by keeping hosts that work with sensitive data in a separate VLAN
- To separate traffic sent by IP phone from traffic sent by PCs connected to the phones

Campus LAN design terminology listed...



Access : Provides a connection point (access) for end user devices, does not forward frames between two other access switches under normal circumstances.

Distribution : Provides an aggregation point for access switches, forwarding frames between switches, but not connected directly to end user devices.

Core: Aggregates distribution switches in a very large LANs, providing very high forwarding rates.

Ethernet Types, Media and Segment Lengths

Ethernet Type	Media	Maximum segment length
10BASE-T	TIA/EIA CAT3 or better, 2 pair	100 m (328 feet)
100BASE-TX	TIA/EIA CAT5 UTP or better, 2 pair	100 m (328 feet)
1000BASE-FX	62.5/125 micron multimode fiber	400 m (1312.3 feet)
1000BASE-CX	STP (shielded twisted pair)	25m (82 feet)
1000BASE-T	TIA/EIA CAT5e or better, 4 pair	100 m (328 feet)
1000BASE-SX	Multimode fiber	275 m (853 feet) for 62.5 micron fiber 550 m (1804.5 feet) for 50 micron fiber
1000BASE-LX	Multimode fiber	550 m (1804.5 feet) for 50 and 62.5 micron fiber
1000BASE-LX	9 micron single mode fiber	10 km (6.2 miles)

Broadcast domain: A set of devices that receive broadcast frame originated from any device within the set. All devices in the same VLAN are in the same broadcast domain.

Broadcast frame: An Ethernet frame sent with a destination address FFFF.FFFF.FFFF meaning that the frame should be delivered to all hosts in the LAN.

Collision Domain: A set of NICs for which a frame sent by a NIC could result in a collision with a frame sent by any other NIC in the same collision domain.

Cut-through switching: One of the three options of internal processing in some models of the cisco LAN switches in which the frame is forwarded as soon as possible, including forwarding bits of the frame before the whole frame is received.

Flooding : is the process in which Switches forward Broadcast, unknown unicast and multicast (some times) out all the other ports except the port where it came from.

Fragment-free-switching: One of the three processing options on some cisco LAN switches in which first bits of the frame may be forwarded before the entire frame is received, but not until first 64 bytes of the frame are received, in which case in a well designed LAN collision fragments should not occur as a result of this forwarding logic.

Microsegmentation : The process in LAN design by which every switch port connects to a single device creating a separate collision domain per interface.

Segmentation : The process of breaking large amount of data from an application into pieces appropriate in size to be sent thorough the network.

Spanning Tree Protocol (STP): A bridge protocol that uses Spanning Tree Algorithm, allowing switch to dynamically work around loops, in a network topology by creating a spanning tree. Switches exchange Bridge Protocol Data Unit (BPDU) message with other bridges to detect loops, and remove the loops by shutting down the selected bridge interface.

Store-and-forward switching: One of the three processing options in some cisco LAN switches in which Ethernet frame must be completely received before the switch can begin forwarding the first bit of the fame.

Unknown-unicast-frame: An Ethenet frame whose destination MAC address is not listed in the MAC address table of the switch, so the switch must flood the frame.

Virtual LAN : A group of devices connected to one of more switches with the devices grouped in to a single broadcast domain through switch configurations. VLAN allow switch administrators to separate devices connected to switches into separate VLANs without requiring separate physical switches, gaining design advantage of separating traffic without buying additional hardware.

Please go toDo I know this Already –QUIZ. – Chapter 7. :- Page 168.