

Networking Basics

Week 03

CISCO Chapter 5 - Ethernet

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Reference

- Cisco Chapter 5

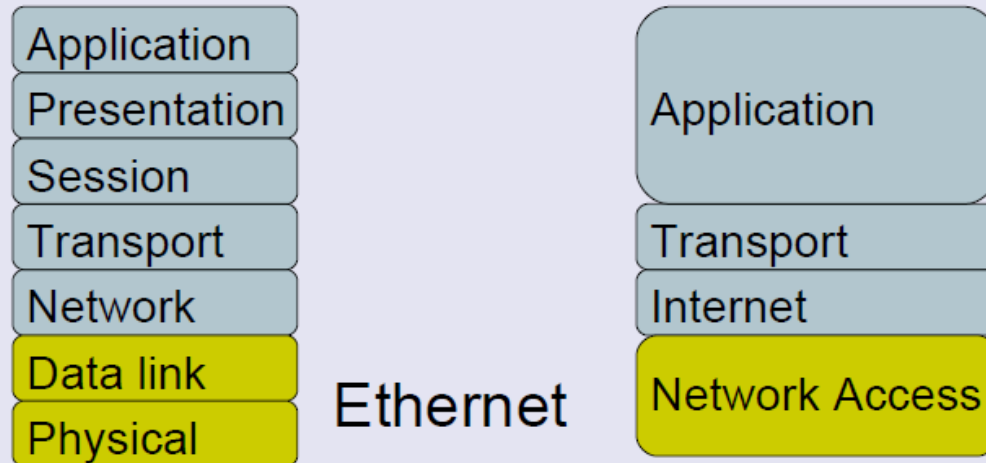
Chapter 5 Learning Outcomes

- Describe the function and characteristics of the media access control method used by the Ethernet protocol
- Describe the Physical and Data Link features of Ethernet
- Describe the anatomy of a MAC address
- Describe Unicast, multicast and broadcast
- Describe a collision and a collision domain
- Compare and contrast Ethernet hubs and switches
- Explain the basic operation of a switch
- Explain the switch MAC address table (aka CAM)
- Explain Address Resolution Protocol
- Describe ARP issues

Ethernet

Ethernet

- OSI model layers 1 (physical) and 2 (data link)
- TCP/IP model Network Access layer



Ethernet

Ethernet

- The most common LAN technology
- Different media (copper cable, optical fibre)
- Different bandwidths (10, 100Mbps, Gbps, +)
- Same addressing scheme
- Same basic frame format

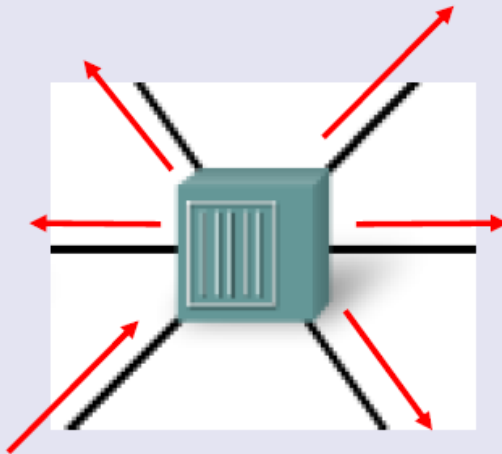
Ethernet

Hubs and switches

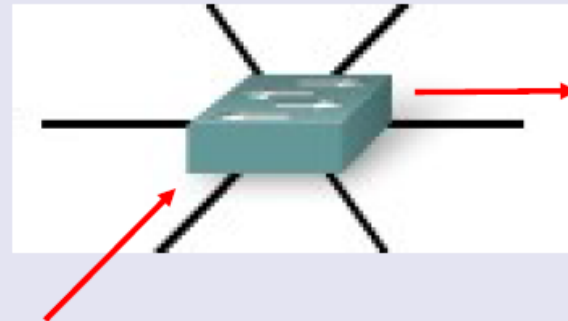
- “Legacy Ethernet”, 10Base5, 10Base2 or 10BaseT with hubs is designed to work with collisions, when devices transmit at the same time. Collisions are managed by CSMA/CD.
- Performance is poor if there is a lot of traffic and therefore a lot of collisions.
- Collisions can be avoided by using switches and full duplex operation.

Ethernet

Hubs and switches



Hub forwards frames through all ports except incoming port.

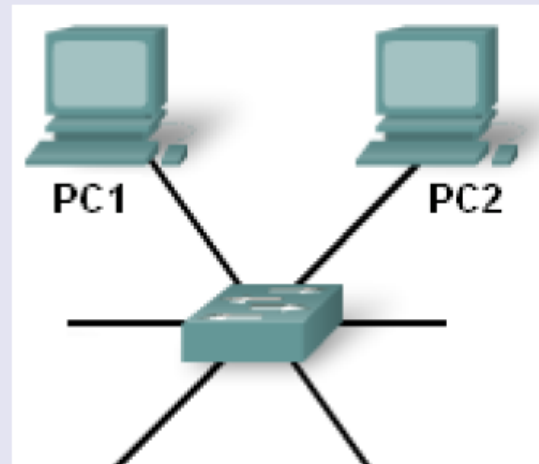


Switch forwards frames only to the destination once the address is known.

Ethernet

Full duplex

- Two way traffic
- PC can transmit and receive at the same time
- Not on shared medium – must have dedicated link from switch
- No collisions





Ethernet

LAN, MAN, WAN

- Ethernet was developed for local area networks confined to a single building or group of buildings on one site.
- Using fibre optics and Gigabit speeds, Ethernet can be used for Metropolitan Area Networks – throughout a town or city.
- Ethernet can even be used over larger areas so the distinction between LAN and WAN is no longer clear.

Ethernet

Ethernet MAC address

- A unique identification for a device (or NIC).
- Burned into the ROM but copied to RAM.
- First 3 bytes identify the manufacturer (Organizationally Unique Identifier)
- A device reads the destination MAC address to see if it should process the frame.
- A switch reads the destination MAC address to see where it should forward the frame.



Ethernet

Writing a MAC address

- The 12 hex digits are written in different ways
- 00-05-9A-3C-78-00
- 00:05:9A:3C:78:00
- 0005.9A3C.7800
- This is the same address
- 00-05-9A is the manufacturer's ID assigned by IEEE
- 3C-78-00 is assigned by the manufacturer

OUI Registry

- <http://standards-oui.ieee.org/oui.txt>
- Examples:
 - 00-10-57 (hex) Rebel.com, Inc.
 - 0C-A4-02 (hex) Alcatel Lucent IPD

Ethernet

On a long journey...

- The packet header with IP addresses is created by the source host and stays the same throughout the journey.
- The frame header is stripped off and replaced by each router, so the MAC addresses are different for every step of the journey. If parts of the journey are not over Ethernet then there will be a different addressing system – not MAC.

Ethernet

Unicast, multicast, broadcast

- Unicast: a message sent to one particular host. It must contain the destination host's IP address and MAC address.
- Broadcast: message for all hosts on a network. "Host" part of IP address is all binary 1s. E.g. 192.168.1.**255** MAC address is all binary 1s, FF:FF:FF:FF:FF:FF in hex.
- Multicast: message for a group of devices. IP address 224.0.0.0 to 239.255.255.255

Ethernet

- CSMA/CD
 - Media Access Control method for Ethernet
 - Low overhead
 - First come first served
 - No one has priority for sending, even after a collision!

Ethernet

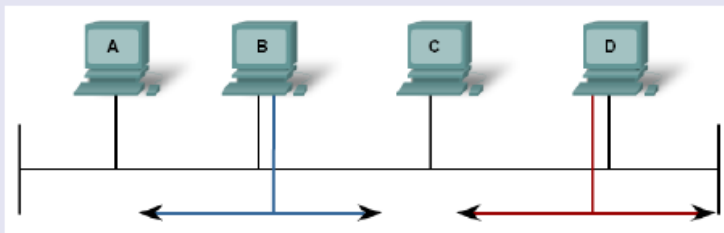
CSMA/CD

- **Carrier Sense:** 'Listen' to see if there are signals on the cable
- **Multiple Access:** Hosts share the same cable and all have access to it
- **Collision Detection:** Detect and manage any collisions of signals when they occur
- This is the 'first come, first served' method of letting hosts put signals on the medium

Ethernet

Collisions

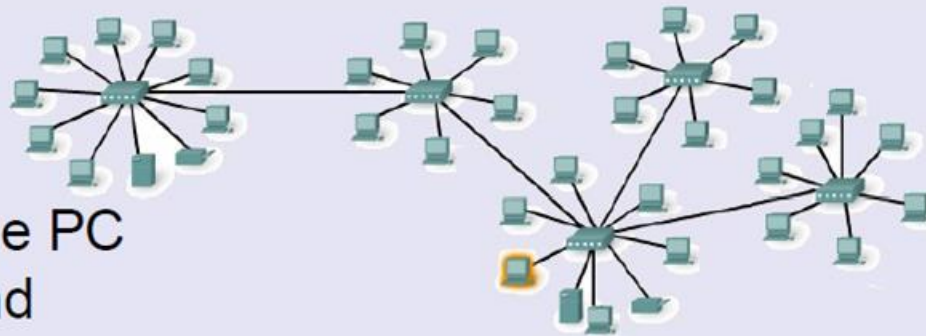
- Ethernet originally used shared coaxial cable.
- If hosts transmit at the same time, there is a collision.
- Later networks used hubs and UTP cable but the medium is still shared and collisions occur.



Ethernet

Hubs and Collision Domains

- Collision domain – area where collisions occur.
- Add more hubs and PCs – collision domain gets bigger, more traffic, more collisions.
- Hosts connected by hubs share bandwidth.



- Only one PC can send

Ethernet

Get rid of collisions

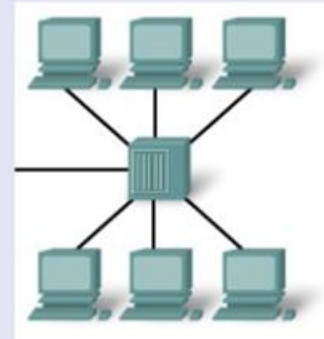
- Replace all hubs with switches.
- Each device has a private cable and gets the full bandwidth.
- Use full duplex on each link.
- No collisions.
- Can use higher bandwidths.

Ethernet

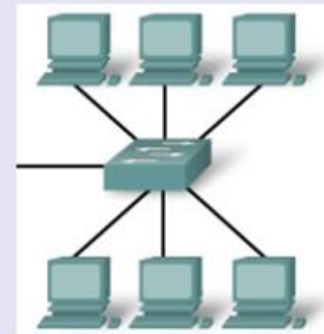
Hub and Switch

- Shared medium
 - Shared bandwidth
 - Collisions
-
- Point to point links
 - Dedicated bandwidth
 - Use full duplex – no collisions

Hub



Switch



Ethernet

- Switch
 - In a LAN where all nodes are connected directly to the switch, the throughput of the network increases dramatically. The three primary reasons for this increase are:
 - Dedicated bandwidth to each port
 - A point to point topology!
 - Full-duplex operation
 - Full duplex implies collision free
 - Collision-free environment

Note that GbE only works in full duplex mode!

FYI - Ethernet

- Switch operations:
 - Selective Forwarding
 - Learning
 - Flooding
 - Aging
 - Filtering

Ethernet

Switching table

- Switch builds a switching table matching its port numbers to the MAC addresses of devices connected to them.
- When a frame arrives, it reads the destination MAC address, looks it up in the table, finds the right port and forwards the frame.

PORT	MAC ADDRESS
1	0A
3	0B
6	0C
9	0D

Ethernet

- Address Resolution Protocol (ARP)
 - ARP allows a device to discover the MAC addresses of same-subnet devices
 - ARP requests ARE NOT routed to other subnets by the router
 - The ARP request is simple:
 - Who has 192.13.34.33? Tell 192.13.34.34

Ethernet

ARP table

- A host wants to send a message.
- It knows the destination IP address and puts it in the packet header.
- It looks in its ARP table and finds the corresponding MAC address.
- It puts the MAC address in the frame header.

Ethernet

Address resolution protocol

- A host wants to send a message.
- It knows the destination IP address.
- The destination MAC address is not in its ARP table.
- Host broadcasts “Calling 192.168.1.7, what is your MAC address?”
- 192.168.1.7 replies “My MAC address is...”
- Host sends message and updates ARP table.

Ethernet

Remote addresses

- Host can see that destination IP address is on another network
- It finds the IP address of the default gateway
- It sends an ARP request for the matching MAC address of the default gateway
- Default gateway router replies and gives its own MAC address
- Host sends message via router and updates ARP table.

Ethernet

- ARP Issues
 - Overhead on the media
 - ARP Broadcast can flood the local media
 - Security
 - Frames can be hijacked by a device pretending to be a given IP address

The End!

Important Note

- Some slides copied from:
 - Cisco Academy Slide set
 - Online Cisco Curriculum