

Objectives

- Basic Ethernet operations
- Repeater, hub, bridge operations
- Ethernet switch operation

Introduction

- A LAN needs:
 - Connectivity between devices
 - A set of rules controlling communication
- eg : Ethernet : [is a set of standards
that define rules for things such as
(Frame Format) & (Communication)]

Ethernet Components: Network Segment

• Ethernet standards include:

- 1) Physical layer Characteristics
- 2) Access to Network
- 3) Frame Format

Note :

- Network segment: A group of network devices that compete with each other for access to the wire.

e.g. Physical wire.

~ How do end-user devices connect to the network segments?

↳ Using a network-Interface

Controller (NICs) and ethernet cabling - or wireless NIC

↳ Ethernet operates at layers 1 & 2

(Layer 1: Physical // Layer 2: Data Link)

- Ethernet Components: CSMA/CD

↳ How do devices know when it
is their turn to send data?

↳ Access to the physical wire or
segment is controlled by a
(Media Access Control) MAC protocol

→ Ethernet uses Carrier Sense

Multiple Access with Collisions

detection CSMA/CD) as its

MAC protocol

Half-Duplex Communication

The CSMA/CD protocol allows a network device to either transmit data or receive data, but not both simultaneously.

• Half-Duplex: Data transmission provides for communication in both directions, but only one direction at a time.

• Full-Duplex: Communication sends and receives data at the same time.

Collision Domains

→ When one device on a network segment is transmitting data, other

Devices cannot transmit data

Collision detection is CD part of CSMA/CD

Ethernet Components: Ethernet Frames

→ How do devices know which data is for them?

How data is encapsulated?

When a device needs to send data the NIC encapsulates it into an Ethernet frame

Ethernet II frame:

This field is the only that differs between Ethernet II & 802.3 is Length of frame.

Destination Layer 2 Address	Source Layer 2 Address	Type		Data	Checksum
		*	...		

* Type: identifies which Layer 3 protocol is being transported in the Ethernet frame.
e.g. IP, AppleTalk.

Preamble & Start Delimiter:

(eg)

7 bytes : Preamble

1 byte : Start Delimiter

8 bytes.

Note :

- 802.3 associated with Ethernet

(eg)

- 802.3 : CSMA/CD

- 802.5 : Token ring tech.

- 802.2 : A method of supporting alternative Layer 3 protocols

- 802.11 : wireless standard.



802.11 month: 2 (Feb)
↓
year: 1990

Ethernet II frame fields

→ How data is encapsulated?

When a device needs to send data
the NIC encapsulates it into an
Ethernet frame.

→ Each NIC has a unique Layer 2
address that is assigned by its
manufacturer.

The manufacturer burns this address

into a PROM chip on the NIC

- * The NIC uses this address as the source address in a frame.
- * For the destination address, it uses the address that is burned into the NIC on the receiving device.

Other names for a Layer 2 address:

- Hardware address
- Physical address
- MAC address *

* MAC addresses

A MAC address is a 48 bit (6 byte) address that uniquely identifies

a device's NIC.



* Multicast address begin with 01

* Broadcast: begin with FF.

00:90:69 - 0f:ea:4b.

Identifies the manufacturer from: (OUI)

Identifies the unique NIC.

Types of MAC Addresses

- When one device sends data to one other device, it uses an individual or unicast address
- If a device needs to send the same data to every device on the network, it uses a broadcast destination MAC

address

- If a device needs to send the same data to a group of devices on the same network, it must use a group address or multicast MAC address.

Network Devices : Repeater

Repeater : A simple hardware device, regenerating electrical signals, connected via Ethernet cables

Rules Governing LAN deployment :

• 5 - 4 - 3 Rule

- 5 segments

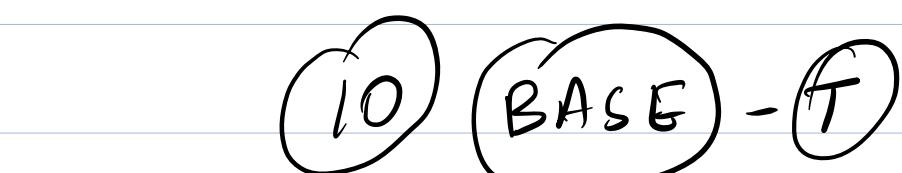
- 4 repeaters

- 3 populated segments

- 2 link-segments

- 1 collision domain.

Ethernet Cabling:



transmission speed

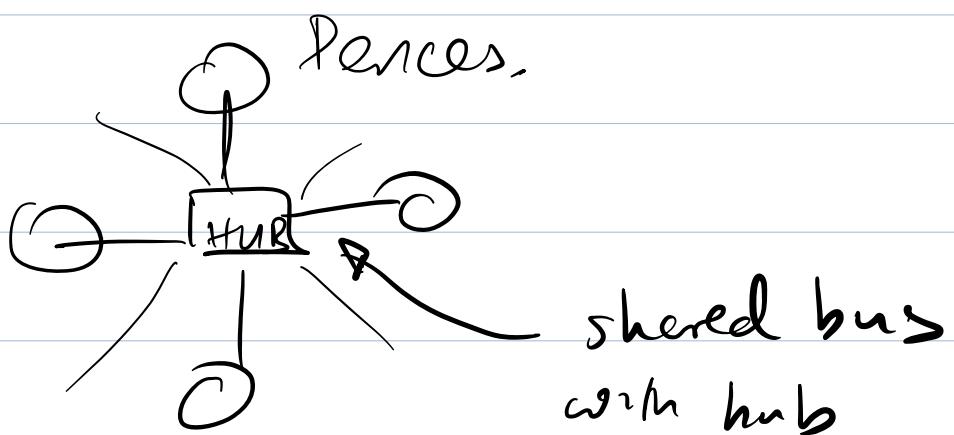


↳ Twisted pairs of unshielded but insulated wires.

Baseband (only Ethernet signalling is carried on the wires)

Ethernet Network Devices: Hub

-Star Configuration with Hub



* no filtering

* Not intelligent network device

(does not look MAC address.)

Ethernet devices: Bridge

Reminder: The grows of ethernet

Devices that compete with each other for access \rightarrow collision domain / network segment.

* A Bridge connects 2 or more physical segments (hubs) to form a larger network segment.

\therefore each side becomes a unique network segment.

[network segmentation]

\therefore collision # \downarrow

Bridge Operations (1)

- Ethernet Bridges have 3 basic functions.

- 1) Forwarding frames
- 2) Learning MAC addresses
- 3) Controlling traffic.

(source addresses only!)

- Builds a MAC address table.

↳ When the bridge receives a frame with a destination MAC address in its MAC address table, it can forward or drop it selectively, reducing overall network traffic.

* Bridges never change the destination or source MAC address. They simply look at the destination MAC address to make their decisions.

Network Speeds

- Network Bandwidth:

- Also known as the data transfer rate or bit rate.
- The amount of data that can be sent from one point to another in a given time period., usually one second.
- Is expressed in bits of data per second. (bps)
- The maximum capacity of a network connection.

- Network Throughput

- The actual amount of data that can be sent over a network in a given period of time.

* Converting Megabits per second (Mbps) to Bytes per second (Bps)

$$\frac{(\text{Mbps} \times 1 \times 10^6)}{8} = \text{Bps}$$

Remember: file sizes are measured in
megabytes

connection speeds measured in
Megabits

* Cables

Ethernet cable

* VOICE : B.I.U.F

- Ethernet Receive: ORANGE
- Auxiliary: BROWN
- Ethernet Transmit: GREEN

Straight-Through and Cross-Over Ethernet Cables

- A straight-through Ethernet cable connects an end-user device to a network device. When the end-user device sends data on its transmit pair of wires, the network device receives the data on its receive pins.

- A crossover Ethernet cable.

connects two end-user devices.
The crossed wires within the cable allows the transmit wires on the sending computer to connect to the receive circuitry on the receiving computer.

Switches:

- Layer 2 device
 - Each port creates a separate collision domain.
 - Forward traffic & builds a MAC address table
 - - Can have few ports or hundreds
- Difference between bridges

* Because both sides of the

connection will receive data from only a single network device, packets will not get corrupted, by multiple stations transmitting simultaneously

- Full-duplex data transmission
- Each port is dedicated to a single device; bandwidth is not shared.
- Virtual LANs are possible

(provide a way to break a single LAN to separate LANs on the same switch)

Limitations of Switches :

- Susceptible to network loops
- Might not improve performance with multicast and broadcast traffic
- might not be able to interconnect geographically dispersed networks.

* Pointers: avoid these issues.
- operate at Layer 3: Network Layer

- Wireless LAN Architecture.

3 Types:

- Autonomous
- centralized.

* Distributed.

- Autonomous WLAN Architecture

LoFat Access Point (or Fat API)
performs all 802.11 functions

- Centralized WLAN Architecture.

(Switched WLAN System)

- Thin Access Points (or Thin APs),
are managed by the access point
controller

* The access point controller can
be physically secured.

* The thin APs do not store

any configuration data or admin user credentials.

- * The access point controller can also provide functionality such as:
[processor inside]
 - Security and access control
 - VLAN management and manipulation.
 - User roaming between access points.

Distributed WLAN Architectures.

- Wireless Mesh System
(environments where cabling is not possible)

" us military in field operation

(repeated to neighbour nodes)

802.11 Group of Standards:

Physical Layer

↳ The 802.11 group is responsible for standards at layer 1 (physical layer) and a part of layer 2 called the media access control sub-layer

- At Physical Layer:

802.11 defines a variety of wireless connection types:

Or -

- Indoor : 100m ↓ Increases
- Outdoor : 500 ↓

* IEEE 802.11 (First WiFi standard)

Speeds : 5.5 - 11 Mbps

Modulation :

- FHSS : Frequency-hopping spread spectrum modulation

- DSSS : Direct sequence spread spectrum modulation



Used to control interference



- At {Layer 2: Data Link Layer}

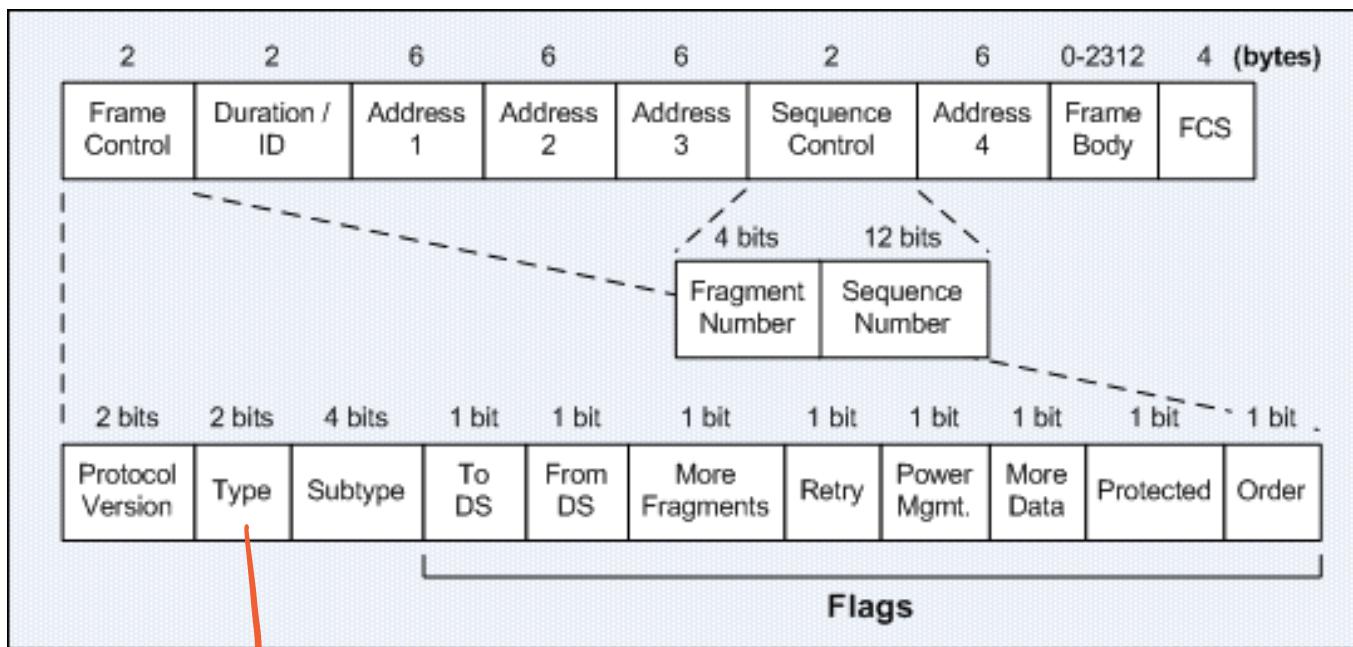
- 802.11 standards at this layer covers:

- Carrier sense Multiple Access and collision Avoidance (CSMA/CA)
- Virtual collision detection
- Asynchronous data transfers.
- Security (access control, authentication and encryption)
- Roaming between access points
- Power saving
- Quality of service

* Ethernet II Format vs.

Generic 802.11 Format.

↳ Greenfield Preamble & legacy Preamble



Types:

- Data

- Regular data being transmitted.
- Certain types of special messages intended for the access points.

- Control

- Request to send , clear to send , acknowledgement.

- Management .

- Beacons sent by access points to advertise the wireless network.

- Probes sent by a client looking for a particular wireless network

- Finding an Access Point (WLAN)

- Passive scanning

- Active scanning

↓ sends an (association)
frame to access point.

↓
responds with
association ID (accepting)

Roaming → Reassociation!
(Lost connection to →
Previous access point)

Handling collisions,

• Virtual collision Detection Method.

Frame Control Settings:

• RTS threshold: Specifies the

size of frame above which the request to send / clear to send mechanism must be used!

- Retry counters

- Short: For frames smaller than the RTS threshold
- Long: For frames larger than the RTS threshold.

- Fragmentation threshold:

Specifies what size of packets should be split into fragments.

- Fragment lifetime:

Fragments are discarded when this expires.

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