Introduction to Ethernet

In this lesson, we give a quick introduction to Ethernet.

Introduction

Ethernet was designed in the 1970s at the Palo Alto Research Center. The first prototype used a coaxial cable as the shared medium and 3 Mbps of bandwidth.

First Official Ethernet Specification

Ethernet was improved during the late 1970s and in the 1980s, Digital Equipment, Intel and Xerox published the first official Ethernet specification.

Important Parameters

This specification defines several important parameters for Ethernet networks.

1. The first decision was to **standardize the commercial Ethernet at 10 Mbps**.

2. The second decision was the **duration of the slot time**. In Ethernet, a

long slot time enables networks to span a long distance but forces the host to use a larger minimum frame size. The compromise was a **slot time of** 51.2 **microseconds**, which corresponds to a minimum frame size of 64 bytes.

3. The third decision was the **frame format**. The experimental 3 Mbps Ethernet network built at Xerox used short frames containing 8 bit source and destination address fields. Up to 554 bytes of payload using 8 bit addresses was suitable for an experimental network, but it was clearly too small for commercial deployments. Hence, they came up with 48 bit source and destination address fields and up to 1500 bytes of payload.

Changes Recommended by First Official Specification

The initial Ethernet specification recommended **three important changes** compared to the networking technologies that were available at that time.

1. The first change was to require each host attached to an Ethernet network to have a globally unique data link layer address. Until then, data link layer addresses were manually configured on each host.

2. The second change introduced by Ethernet was to encode each address as a 48 bit field. 48 bit addresses were huge compared to the networking technologies available in the 1980s, but the huge address space had several advantages, including the ability to allocate large blocks of addresses to manufacturers. Eventually, other LAN technologies opted for 48 bit addresses as well.

3. The third change introduced by Ethernet was the definition of broadcast and multicast addresses. The need for multicast Ethernet was foreseen. Thanks to the size of the addressing space, it was possible to reserve a large block of multicast addresses for each manufacturer.
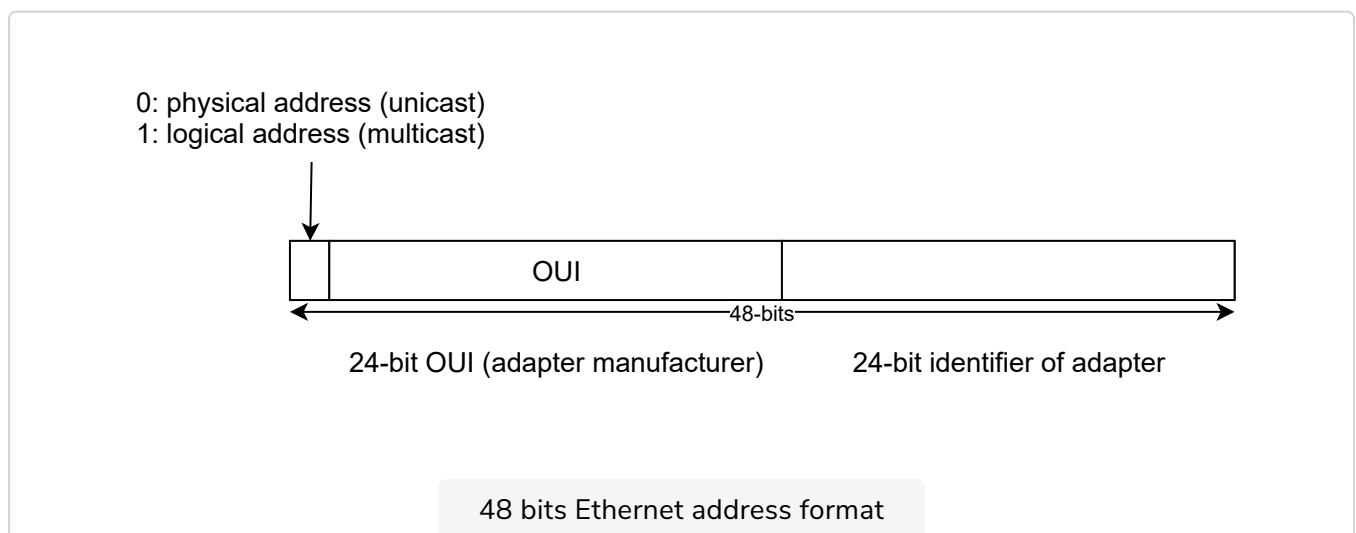
> 📝 **Note: Unicast, Multicast, & Broadcast**:
>
> - **Unicast** messages are sent to **one host** on the network.
> - **Multicast** messages are sent to **a group of hosts** on the network
> - **Broadcast** messages are sent to **all hosts on the network**.

MAC Addresses

The **data link layer addresses used in Ethernet networks are often called MAC addresses**. They are structured as shown in the figure below.

- The first bit of the address indicates whether the address identifies a network adapter or a multicast group.

- The upper 24 bits are used to encode an **Organization Unique Identifier (OUI)**. This OUI identifies a block of addresses that has been allocated by the secretariat who is responsible for the uniqueness of Ethernet addresses to a manufacturer. For instance, `00000C` belongs to **Cisco Systems Inc.**. Once a manufacturer has received an OUI, it can build and sell products with any of the ~16 million addresses in this block. A manufacturer may obtain more than one OUIs.

0: physical address (unicast)
1: logical address (multicast)

OUI

48-bits

24-bit OUI (adapter manufacturer)   24-bit identifier of adapter

48 bits Ethernet address format

Mac addresses are generally represented as 6 hex numbers separated by colons.

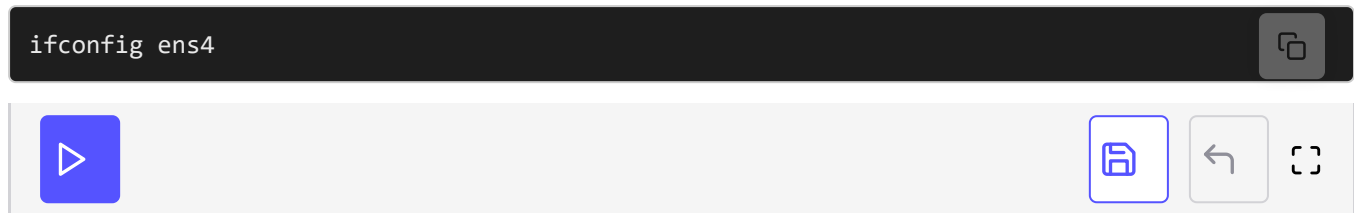## Checking Your MAC Address #

You can run the following command on Unix based systems like Linux and Mac OS to get a list of interfaces available on your system.

```
ifconfig
```

Pick the ethernet interface. Our's is called `ens4`. You can run the following

command to get only your ethernet interface's details.

```
ifconfig ens4
```
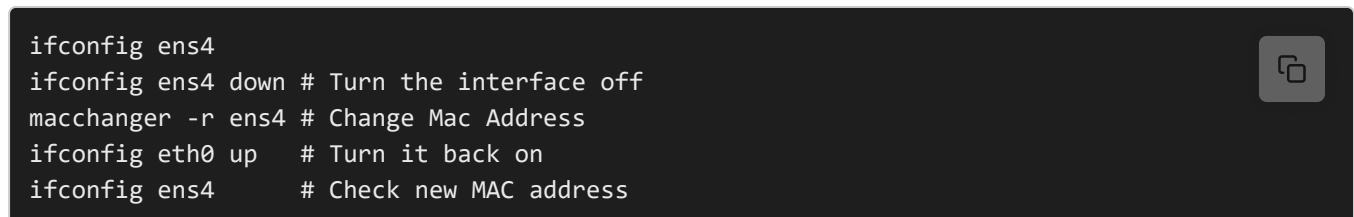
The MAC Address is printed after `HWaddr`. So the output may be as follows:

```
ens4        Link encap:Ethernet  HWaddr 42:01:0a:80:00:31
            inet addr:10.128.0.49  Bcast:10.128.0.49  Mask:255.255.255.255
            inet6 addr: fe80::4001:aff:fe80:31/64 Scope:Link
            UP BROADCAST RUNNING MULTICAST  MTU:1460  Metric:1
            RX packets:484039 errors:0 dropped:0 overruns:0 frame:2374
            TX packets:442202 errors:0 dropped:0 overruns:0 carrier:0
            collisions:0 txqueuelen:1000
            RX bytes:2637134894 (2.6 GB)  TX bytes:73969976 (73.9 MB)
```

So, the MAC Address is `42:01:0a:80:00:31`.

Next, we can use a tool called `macchanger` to change our MAC address.

```
ifconfig ens4
ifconfig ens4 down # Turn the interface off
macchanger -r ens4 # Change Mac Address
ifconfig eth0 up   # Turn it back on
ifconfig ens4      # Check new MAC address
```

Try changing your MAC Address!

Quick Quiz!

1 Which of the following is NOT a valid unicast MAC address?

Now that we have a basic understanding of ethernet, let's look at what an ethernet frame looks like in the next lesson!