



## Open Systems Interconnection (OSI) Model

- The Open Systems Interconnection (OSI) model is a prescription of characterizing and standardizing the functions of a communications system in terms of abstraction layers.
- Similar communication functions are grouped into logical layers.
- A layer serves the layer above it and is served by the layer below it.























## Internet Protocol – 4 Layers

#### 1. Link layer:

 Contains communication technologies for a local network.

#### 2. Internet layer (IP):

Connects local networks, thus establishing internetworking.

#### 3. Transport layer:

- Handles host-to-host communication.

#### 4. Application layer:

- Contains all protocols for specific data communications services on a process-to-process level.
- It focuses more on network services, APIs, utilities, and operating system environments.























## Overview

- Open Systems Interconnection (OSI)
- The Internet
- Internet Protocol (TCP/IP Protocol)
- Ethernet History
- Ethernet
  - Frame structure
  - Physical layer
  - MAC











# Types of Ethernet Cables

| Cable type | Max speed | <u>Max Length</u> | Operating<br>Frequency |
|------------|-----------|-------------------|------------------------|
| CAT5       | 100 Mbps  | 100 m             | 100 MHz                |
| CAT5e      | 1 Gbps    | 100 m             | 100 MHz                |
| CAT6       | 10 Gbps   | 50 m              | 250 MHz                |
| CAT6a      | 10 Gbps   | 100 m             | 500 MHz                |

### All backwards-compatible

CAT7 in the works, 40Gbps and 100Gbps





|                    | RJ-45 Color Code |                                    | de  |   |
|--------------------|------------------|------------------------------------|---|---|
| Cable<br>Structure | T-56<br>12       | 8B Standard<br>2 3 4 5 6 7 8       | Pin #1<br>RJ-45<br>Male Plug                | T-568A Standard<br>12345678                 |
|                    | Pin<br>#         | Ethernet<br>10BASE-T<br>100BASE-TX | EIA/TIA 568A                                | EIA/TIA 568B or<br>AT&T 258A                |
|                    | 1                | Transmit +                         | White with green<br>strip                   | White with orange<br>stripe                 |
|                    | 2                | Transmit -                         | Green with white<br>stripe or solid green   | Orange with white<br>stripe or solid orange |
|                    | 3                | Receive +                          | White with orange<br>stripe                 | White with green<br>stripe                  |
|                    | 4                | N/A                                | Blue with white stripe<br>or solid blue     | Blue with white stripe<br>or solid blue     |
|                    | 5                | N/A                                | White with blue stripe                      | White with blue<br>stripe                   |
|                    | 6                | Receive -                          | Orange with white<br>stripe or solid orange | Green with white<br>stripe or solid         |
|                    | 7                | N/A                                | White with brown strip or solid brown       | White with brown<br>strip or solid brown    |
|                    | 8                | N/A                                | Brown with white<br>stripe or solid brown.  | Brown with white<br>stripe or solid brown.  |











| 00d006269c00<br>00087423ccab<br>0800 | Destination MAC address (router)<br>Source MAC address (desktop)<br>Type = IP packet |
|--------------------------------------|--|
| 45                                   | IPv4, 5 word (20-byte) header  |
| 00                                   | Normal service   |
| 0028                                 | Total length = 40 bytes  |
| c31c                                 | Identification (unique)  |
| 4000                                 | "Don't Fragment"   |
| 4006                                 | hops to live   |
| 06                                   | TCP protocol   |
| 3ff1                                 | Header checksum (one's complement)   |
| 803b1372                             | Source IP 128.59.19.114 (desktop)  |
| 40ec6329                             | Destination IP 64.236.99.41  |

| IP Header Checksum Computation  |                            |  |  |  |  |
|---|----------------------------|--|--|--|--|
| One's complement addition on 16-bit elements<br>16-bit carry out becomes carry in<br>Computed on elements of IP header: |                            |  |  |  |  |
| Computing   | Checking                   |  |  |  |  |
| 4500  | 4500                       |  |  |  |  |
| 0028  | 0028                       |  |  |  |  |
| c31c  | c31c                       |  |  |  |  |
| 4000  | 4000                       |  |  |  |  |
| 4006  | 4006                       |  |  |  |  |
| 0000 ← checksum hole  | 3ff1 ← checksum            |  |  |  |  |
| 803b  | 803b                       |  |  |  |  |
| 1372  | 1372                       |  |  |  |  |
| 40ec  | 40ec                       |  |  |  |  |
| +6329   | +6329                      |  |  |  |  |
| 2c00c (two's complement)  | 2fffd (two's complement)   |  |  |  |  |
| c00e (one's complement)   | 0000 (one's complement—OK) |  |  |  |  |
| 3ff1 (inverted)   | •                          |  |  |  |  |







## MAC Addresses vs. IP Addresses

- MAC address
  - It's just a manufacturer code and a serial number
  - There's no structure to it beyond that, and so no way to route packets efficiently
  - MAC address is used purely to address machines on a local network segment
- IP address
  - Introduced to address machines outside a network segment
  - IP addresses have an inherent hierarchy with the use of subnet masks, etc., allowing large networks to be addressed in a block for efficient routing





