Computer Networks

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Overview on computer network

What is a computer network?

Overview on computer network

- A **computer network** consist of two or more computers connected together and **sharing data.**
- they can be connected using network devices like **a Hub , a Switch or a Router**

Overview on computer network: The HUB

- The **Hub** is a **non intelligent device** used to connect computers(host, system, server) together.
- It has no way of knowing where to route the traffic.
- That is why, when the Hub receives a message, it broadcast it to all its ports (ie to all the devices connected)

Overview on computer network: The Switch

- The **switch** is a connectivity device as well for computers and devices.
- It has a built-in os that enables it to know every device in the network using their IP and their MAC addresses.
- It is considered to be an **Intelligent Hub**

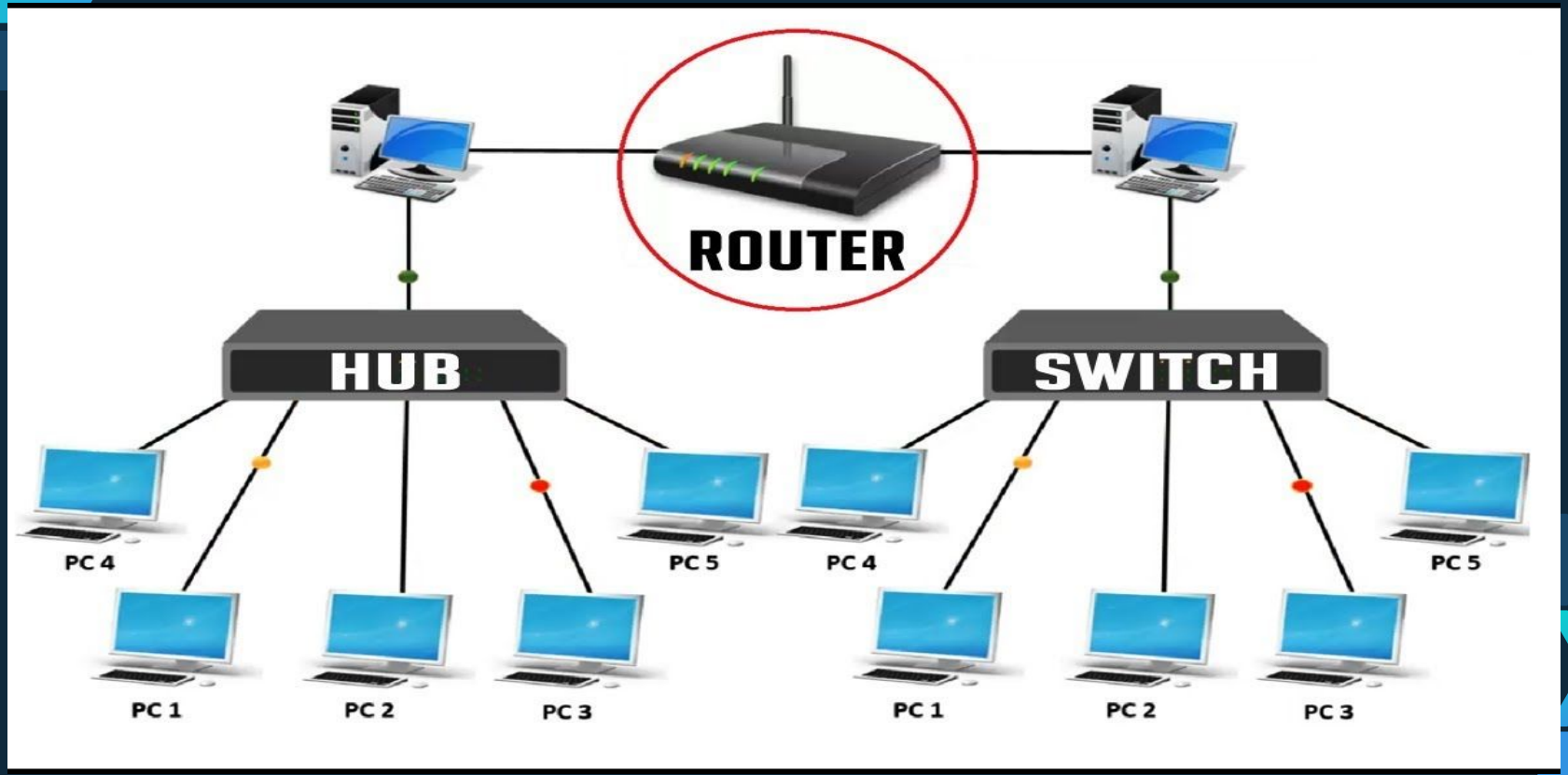
NB: MAC stand for **Media Access Controller**, it is a unique identification given to a computer device by the manufacturer.

Overview on computer network: The Router

- The **Router** is used to connect computers together
- It also enables connectivity between networks.

NB: These networks devices can be **wired** or **wireless**

Example of network



You can make more research on network devices to better understand and know how they function in sharing data on a network

Let's move to another concept in computer network: The OSI model

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The OSI model

What is this model? Why was it put in place?

The OSI model

- Before the 70's, computers and devices could communicate with each other **only if they came from the same manufacturer**

Example: Hp computers could not communicate with an IBM computer or even an IBM printer.

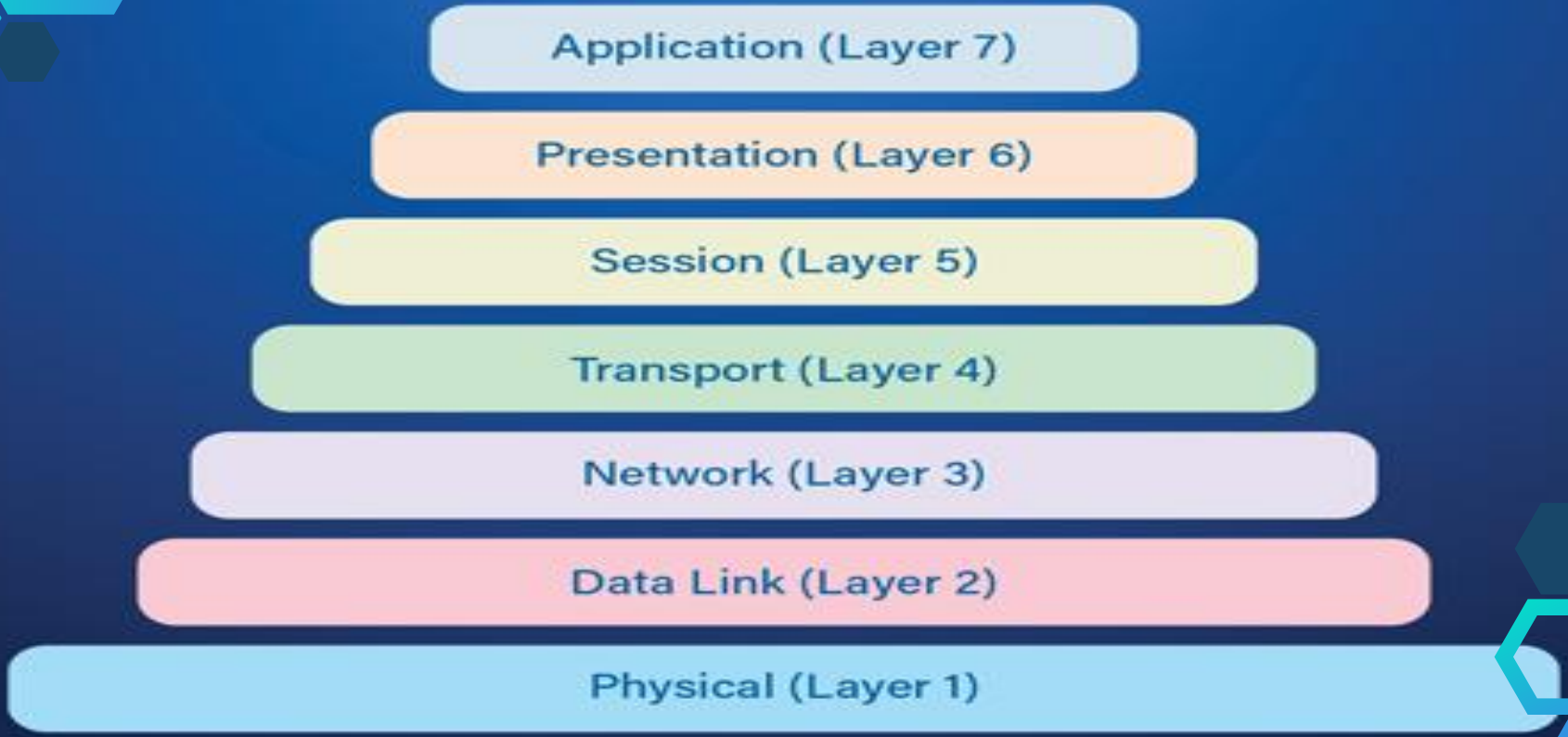
- It was a commercial politic to keep clients buying only their products
- But that was causing a lot of issues to consumers (companies)
- So the **World Organization of Standard** decided to solve that problem
- They created a standard that each manufactured computer device would obey to communicate with others: **The OSI model was born!**

OSI = Open System Interconnect

The OSI model

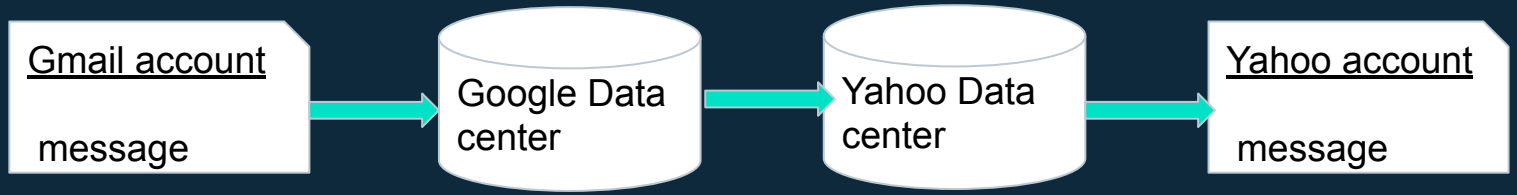
- **The OSI model is a standard for communication between computers**
- It is a very popular concept in networking because **it defines connectivity between any two computer devices.**
- It is made up of **seven (7) layers: Application (L7), Presentation (L6), Session (L5), Transport (L4), Network (L3), Data link (L2), Physical (L1)**
- Each layer plays a specific role in the whole process

The 7 Layers of OSI

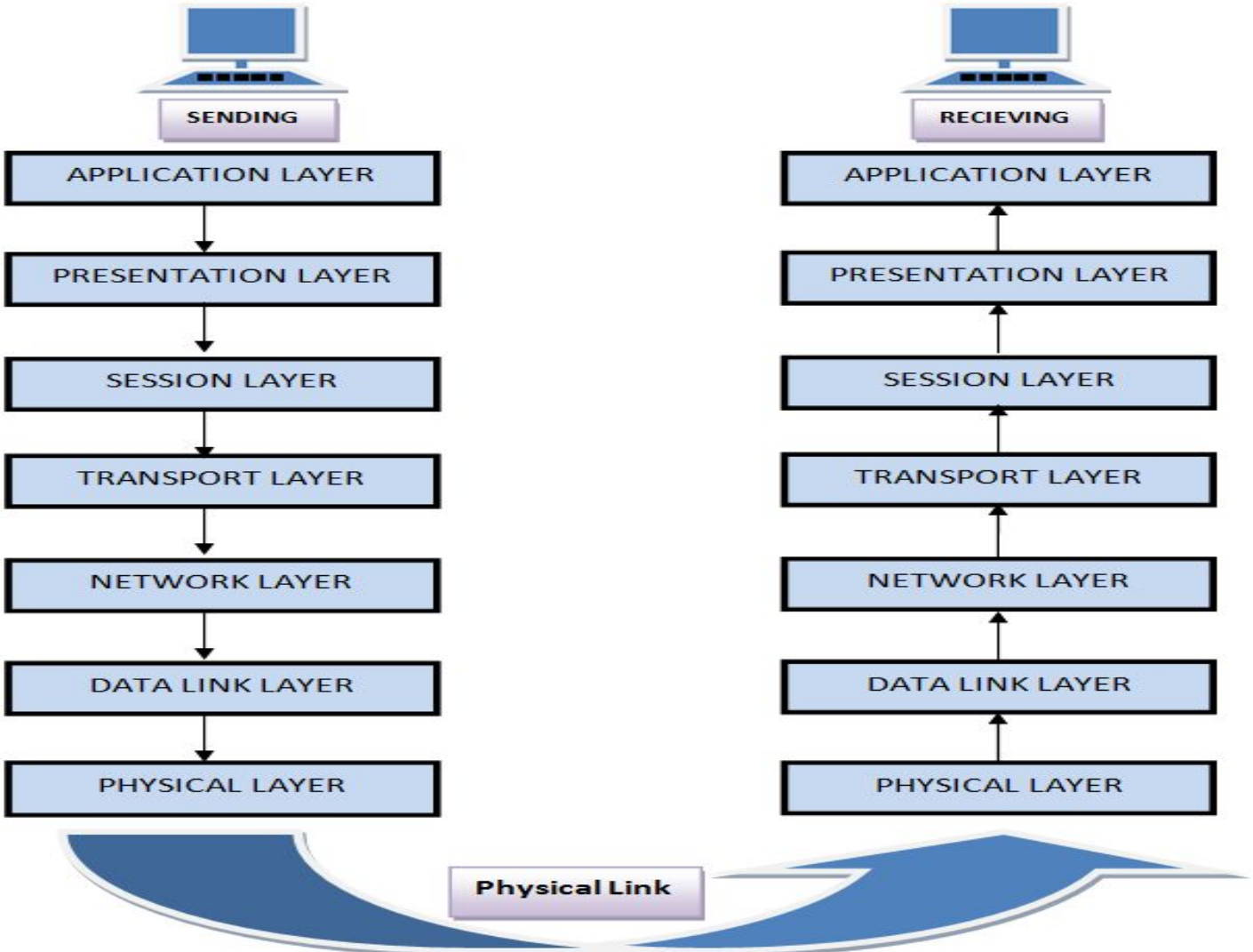


The OSI model

- Have you ever thought of how an email is sent from your **Gmail account** on your computer, to the **Yahoo account** of a friend on his own computer ?



- This diagram may seem simple but, for the message to leave your computer to reach your friend's computer, **it goes through all the seven layers of the OSI model**


SENDING
APPLICATION LAYER
PRESENTATION LAYER
SESSION LAYER
TRANSPORT LAYER
NETWORK LAYER
DATA LINK LAYER
PHYSICAL LAYER
RECIEVING
APPLICATION LAYER
PRESENTATION LAYER
SESSION LAYER
TRANSPORT LAYER
NETWORK LAYER
DATA LINK LAYER
PHYSICAL LAYER
Physical Link

*The **OSI model** is a very popular concept that every IT professional must understand. Not necessarily for an interview, but for general knowledge in networking and computer connectivity*

Now let's stop on a specific layer to explain the difference between TCP and UDP: **Transport Layer (L4)**

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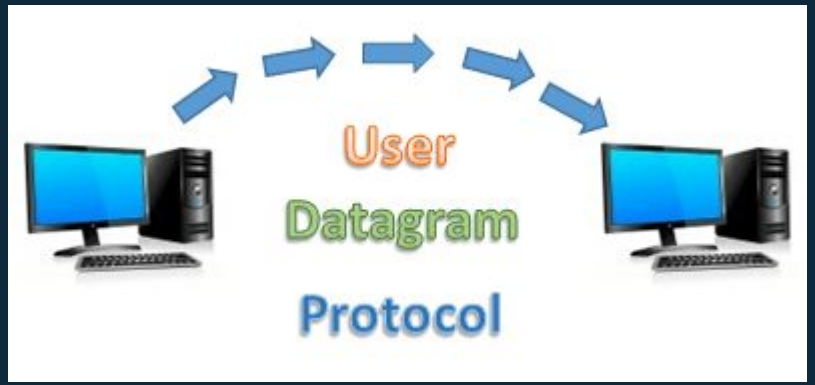
Difference between TCP and UDP Protocols

The Transport Layer (L4)

UDP: User Datagram Protocol



UDP protocol

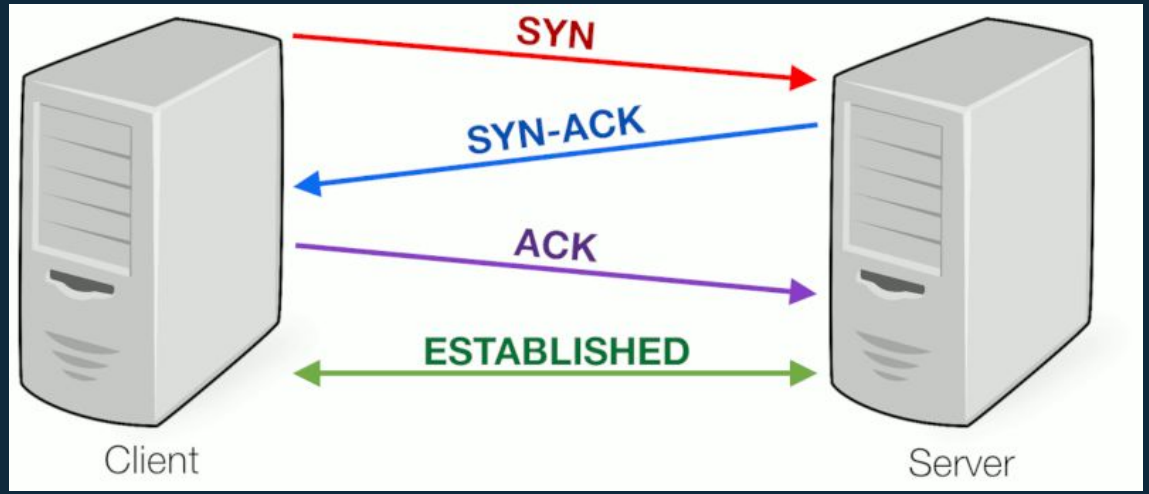
There are many protocols that can be used in the transport layer but **TCP** and **UDP** are the most used ones.

- **UDP(User Datagram Protocol)** is a “**non connection oriented**” protocol
- It speeds up transmissions by enabling the transfer of data without an agreement provided by the receiving party.
- The communication here is **unidirectional**

UDP protocol

- UDP is **simple but fast**
- It's often used for **time-sensitive applications** where speed is more important than accuracy:
  - real-time video streaming,
  - voice over Internet Protocol ,
  - video or audio playback
  - etc.
- UDP doesn’t check if all the packets reach their destination. **It does not resend missing packets.**

TCP: Transmissions Control Protocol



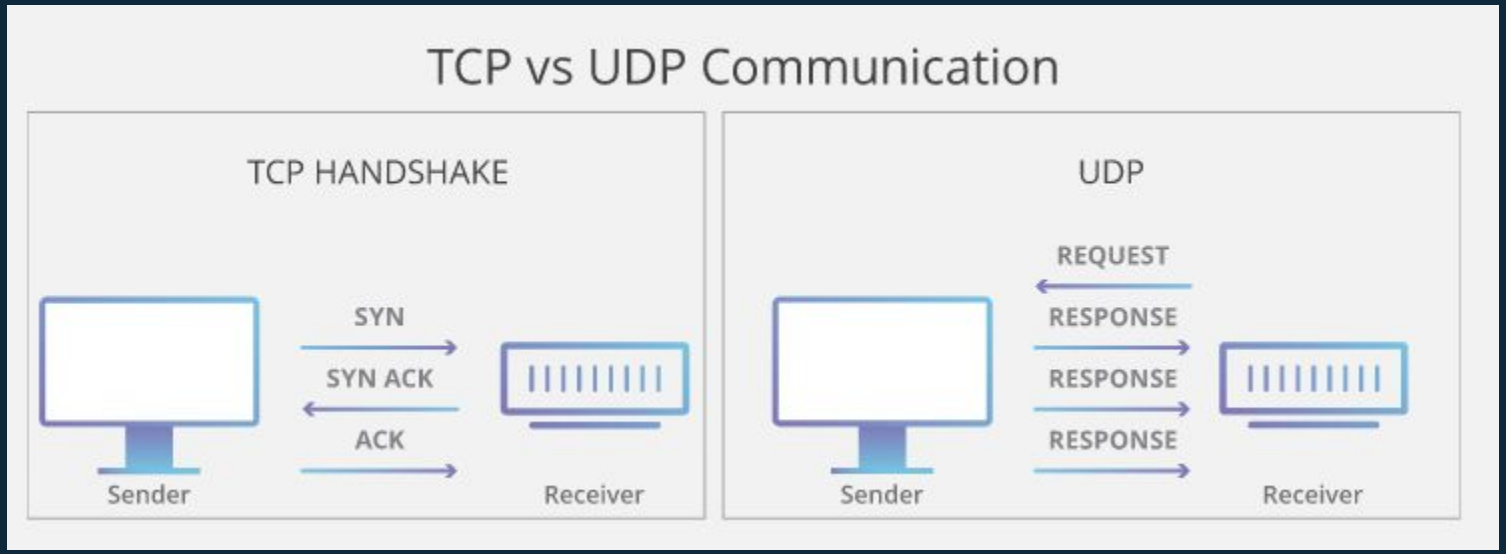
TCP protocol

- **TCP (Transmission Control Protocol)** is a “**connection oriented**” protocol.
- It is very **secure, reliable** and **redundant**
- It has a **3 ways handshake check** before establishing the connection
  - Synchronization: SYN,
  - Synchronization Acknowledgement: SYN-ACK,
  - Acknowledgement: ACK

TCP protocol

- To know when a packet get lost in order to resend it, the **TCP puts a mark on each packet.**
- Data get transferred completely, and **missing packets are resend** until they reach the destination
- It is used by many internet applications, including the
  - World Wide Web (WWW),
  - email,
  - data transfer,
  - peer-to-peer file sharing etc.

TCP vs UDP summary



TCP vs UDP summary

TCP	UDP
TCP is **connection Oriented protocol** (a connection need to be established before data is transmitted)	UDP is **Connectionless protocol** (no connection needs to be established. The packets are sent directly over the network)
Data transfer takes more time (time for establishing connection and then for removing the connection)	**Data transfer is faster** (no need to establish the connection, no need to remove it)
Data transfer is reliable (Acknowledgement based)	**Data transfer is non-reliable** (sender does no know, for sure, if the packet has actually reached the receiver or not).

TCP vs UDP summary

TCP	UDP
Header Size of a **TCP packet is bigger**	Header size of a **UDP packet is smaller**
TCP does the **error checking**	UDP **does not have an option for Error checking**.
Packets are ordered (i.e they are received in the same order as they are sent).	**Packets are not ordered** (i.e they are received in any order. There might be some missing packets)
Application layer protocols like HTTP, FTP, Telnet, etc. uses TCP to transmit data	UDP is used by protocols like VoIP, DHCP, SNMP, video conferencing etc.

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The notion of IP address version 4

How are IP addresses build?

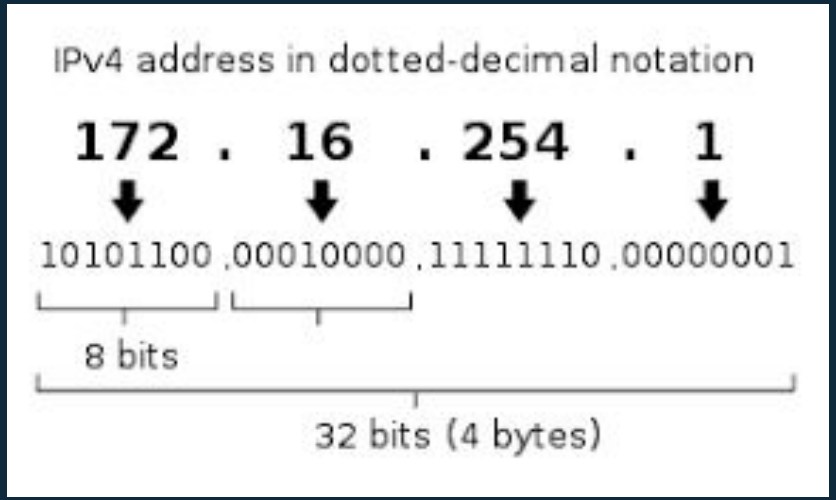
IP: Internet Protocol

IP address V4

- An **IP address** is a unique number assign to a device on a specific network.
- It is made up of **4 differents numbers** separated by dots (.) ie **a.b.c.d**
- Each number represents an **octet** (a set of 8 bits)
- Thus, It is a **32 bits number** (4 packets of 8 bits) used to identify the device on the network
- Some bits are **ON (1)** while others are **OFF(0)**

IP address V4

Example:



IP address classes

How to determine the class of an IP address

IP address V4: Classes

- There are **five (5) classes of IP addresses**: **A, B, C, D** and **E**
- Classes D and E are reserved for **multicasting and research**. So we will focus on the classes A, B and C

Classes	Range of the first octet (a.)	Subnet mask	Example
A	1 - 126	255.0.0.0	10.0.0.1
B	128 - 191	255.255.0.0	191.10.2.65
C	192 - 223	255.255.255.0	192.168.0.1

IP address V4: Classes

- If you are given and **IP address** without the **subnet mask**, and asked to determine its class, you just need to check **the range of the first octet of the address** (that is the number a)

Example:

Question: What is the class of the **IP address 192.168.1.45** ?

Answer: The first octet is **192**. This number is in the range [192, 223]. Therefore the IP address 192.168.1.45 is from **class C**

IP address: The subnet mask

What is its role?

IP address V4: Subnet Mask

- The **subnet mask** is also a 32 bits number that **defines the class of an IP address**
- It helps to identify the **network portion** (**Net ID**) and the **Host portion** (**Host ID**) of any IP address
- **When you have the subnet, you don't worry about the range of the first octet of the address. The subnet will determine the IP address class.**

Example : Given a network IP address of **10.0.0.3** with the subnet **255.255.0.0**. What is its Class? **Answer: class B.**

Exercice: What is the Class of the IP address 10.0.0.65 subnet 255.255.255.0?

IP address V4: Subnet Mask

- In a network, the **NetID** (network portion) of the IP address does not change for all the devices connected. Only the **HostID**(Host portion) is subject to changes.

NB: You can check your IP address and the ones of each device in your network to confirm that.

To check the IP address of your Windows computer:

- Click on the **Start button** (this is on Windows)
- Type **cmd** in the search bar
- When the command line opens, run the command **ipconfig**

How to determine the number of IP addresses available in a network?

This helps to determine the total number of devices that can be connected on the network

Number of IP address in a network

The total number of available IP addresses depends on the class in which you are. Let's consider the IP address **a.b.c.d**

Class	Subnet mask	Net ID	Host ID	Number of IP addresses	Number of addresses that can be assign
A	255.0.0.0	a.	b.c.d	2^24 = 16 777 216	(2^24) - 2 = 16 777 214
B	255.255.0.0	a.b.	c.d	2^16 = 65 536	(2^16) - 2 = 65 534
C	255.255.255.0	a.b.c.	d	2^8 = 256	(2^8) - 2 = 254

Number of IP address in a network

- In each network we have two reserved **IP addresses**:
  - The first one is the **Network address** itself
  - The second is for the **Broadcast (the Gateway address)**
- That is why, to count the number of devices that can be connected (or the number of assignable addresses), **we remove two**.
- Remember that **the more devices are connected to your network, the more the traffic slows down**.

How to convert an IP address in bits?

This implies the conversion of decimal numbers into binary numbers (bits)

IP Address conversion in bits

To convert an IP address **a.b.c.d** to its representation in bits we convert each octet in binary and represent it on 8 bits

Example: Let's convert **192.168.0.1** in bits

There is a trick with the various powers of 2 that you can use to do this faster.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1

IP Address conversion in bits

Let's first convert **192** in bits using the table with the powers of 2

192 - 128 -64 =0. This means:

Powers	128	64	32	16	8	4	2	1
ON/OFF	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**

Conclusion: **192 ⇔ 1 1 0 0 0 0 0 0**

IP Address conversion in bits

Let's do the same for **168**. We have

168 - 128 - 32 - 8 = 0 => **168 ⇔ 1 0 1 0 1 0 0 0**

Powers	128	64	32	16	8	4	2	1
ON/OFF	**1**	**0**	**1**	**0**	**1**	**0**	**0**	**0**

Naturally **0 ⇔ 0 0 0 0 0 0 0 0** and **1 ⇔ 0 0 0 0 0 0 0 1**

IP Address conversion in bits

Finally, we have:

IP Address conversion in bits

If all the bits in the octet are on we will obtain the number 255. That is

255 - 128 - 64 - 32 - 16 - 8 - 4 - 2 - 1 = 0

255 ⇔ 1 1 1 1 1 1 1 1

Powers	128	64	32	16	8	4	2	1
ON/OFF	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

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The difference between IP address and the MAC address

MAC address VS IP address

IP vs MAC Address

The differences between the IP address and the Mac address can be summarized in the following table:

MAC address	IP address
It is the **physical address of the NIC card**	It is the **logical address of the computer**
It is assigned to the NIC card by the manufacturer	It is assigned to the computer device either manually by the network administrator, or automatically by a DHCP server
MAC address is fixed, **it can't change**	IP address **can change**
Example: D4-BE-D9-8D-46-9A	**Example:** 192.168.0.1

Thanks!

Any questions?

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- **website**: http://utrains.org/
- **Phone:** +1 (302) 689 3440
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