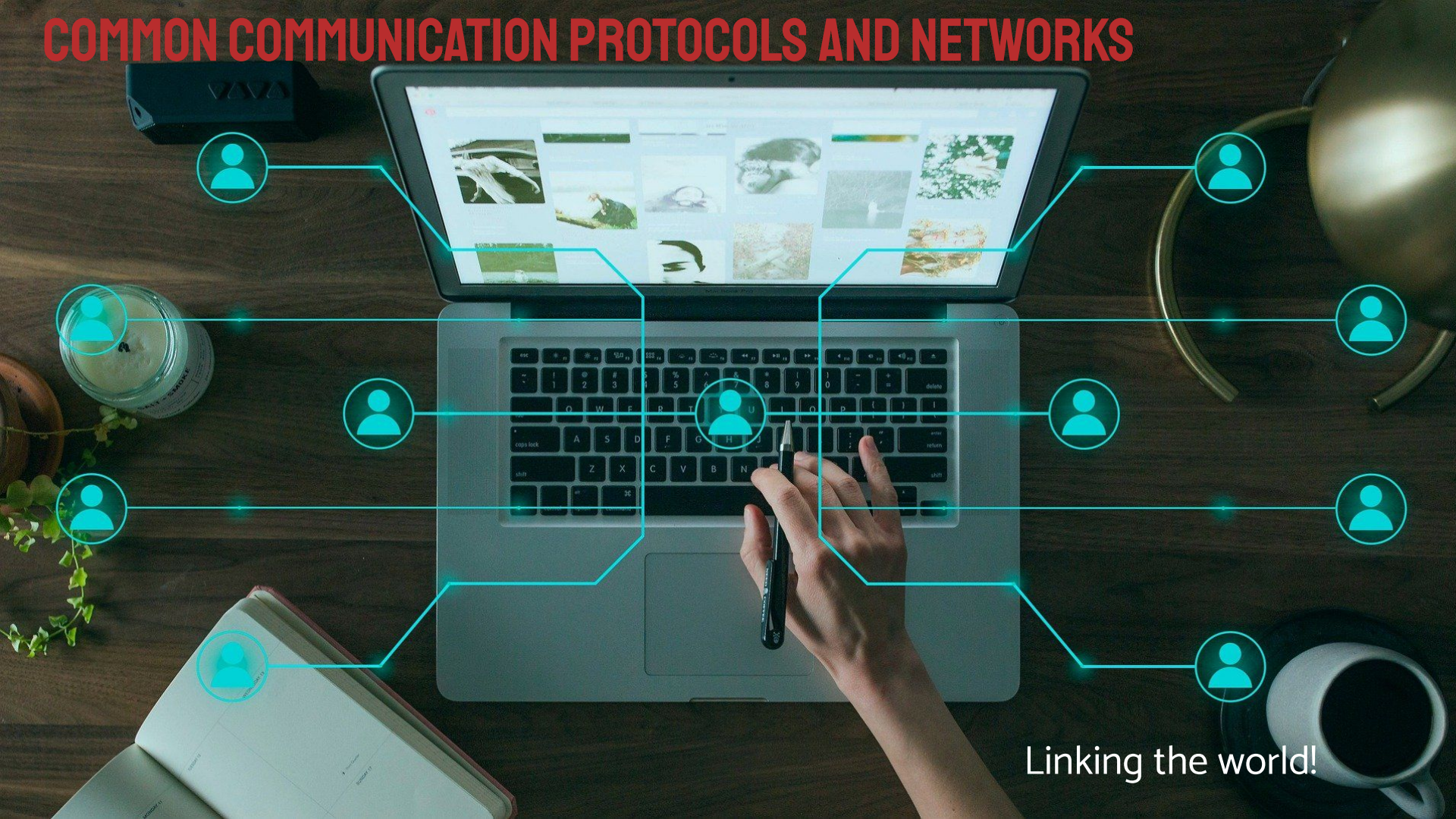
COMMON COMMUNICATION PROTOCOLS AND NETWORKS



Linking the world!

WHAT WE WILL LEARN

TCP/IP STACK

IP NETWORKING

DNS

WIRELESS TECHNOLOGIES

WiFi, Bluetooth, NFC

DIFFERENCE BETWEEN:

"A NETWORK"

A group of connected computers, locally or distributed over separate locations.

AN "INTRANET"

An internal, private network of computers that can communicate with each other, access the web and external services, but is protected from access by other computers outside of the network.

"THE INTERNET"

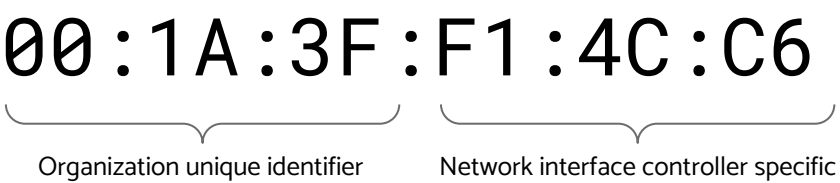
The network of computers connected to each other around the world via a global T-Cabling system, global gateways called DNS servers, and ISPs (Internet Service Providers).

MAC ADDRESS: Media Access Control Address

A MAC is a hexadecimal code that every electronic device that has a network interface possesses and uses to identify itself. Unlike an IP address that can be assigned and reassigned to a device, a MAC address is Unique to a device and immutable (unchangeable once assigned).

As can be seen below, a MAC address has two component parts each consisting of three hexadecimal code pairs. The first three code pairs identify the Organisation that manufactured the device, the next three, are specific to the NIC (network Interface Controller) which provides access for communications with other devices across a network and over the Internet.

Media **A**ccess **C**ontrol Address



IP ADDRESS: INTERNET PROTOCOL ADDRESS

An IP address, unlike a MAC address, is assigned as a kind of pointer to a device or a service on a device . For example your computer will have a local IP address of 127.0.0.1. This is the same on all computers and is known as a Localhost address. It's used when you are setting up a web-server or service on a computer to direct it to run on that computer and not an external computer.

There are two main definitions of IP addresses, private and public. Private IP addresses are those that are private to an internal network or a computer that no one outside of that network can see, whilst a public IP address is publicly visible..

For example, the following terminal command will ping fathat.org to see if it is live and identify its public IP address

```
Ping fathat.org
```

This command will come back with:

```
PING fathat.org (192.64.119.64):56 data bytes
```

It will then wait to receive responses from fathat.org. You can see the IP address of fathat.org in brackets.

IP ADDRESS: INTERNET PROTOCOL ADDRESS

IP addresses come in two main flavours, IPv4 and IPv6, although there is an IPv5 in between, developed for video streaming, but not recognised as a standard as are the latter two.

As you just saw previously IPv4 address consist of a dot separated set of 4 X upto 3 DECIMAL digits blocks.

Below is the fathat.org IPv4 address in dotted decimal notation: 4 bytes (each 8 bits)

192.	64.	119.	64
11000000	01000000	01110111	01000000

The issue with IPv4 addresses is that the requirement for more and more ip addresses for all the devices on the planet is rapidly exhausting the possible pool of addresses. There is a maximum possible 4,294,967,296 possible combinations that can be achieved using the numerical structure of IPv4.

The maximum IP address is 255.255.255.255: That provides 2^32 possibilities of IP addresses for IPv4. And considering that a huge 16 million of these addresses are allocated to the Localhost, i.e. we have 16 million ways to address localhost, starting from 127.0.0.1, 127.0.0.2 and up to 127.255.255.254, that number is not as big as it looks.

IP ADDRESS: INTERNET PROTOCOL ADDRESS

IPv6 addresses the limitations of IPv4 by expanding the possible range of IP addresses. The IPv6 address space is 128-bits (2^{128}) in size, containing 340,282,366,920,938,463,463,374,607,431,768,211,456 IPv6 addresses. That's a lot of addresses.

Unlike IPv4 addresses that are written with decimal notation, IPv6 addresses use hexadecimal notation.

The IPv6 address below contains eight groups of four hexadecimal digits. Each group is separated by a colon(:).

2001:4860:4860:0000:0000:0000:0000:8888

The above address is an expanded IPv6 form of one of Google DNS servers. You can also compress the IPv6 and use that form. The above IPv6 address compresses to:

2001:4860:4860::8888

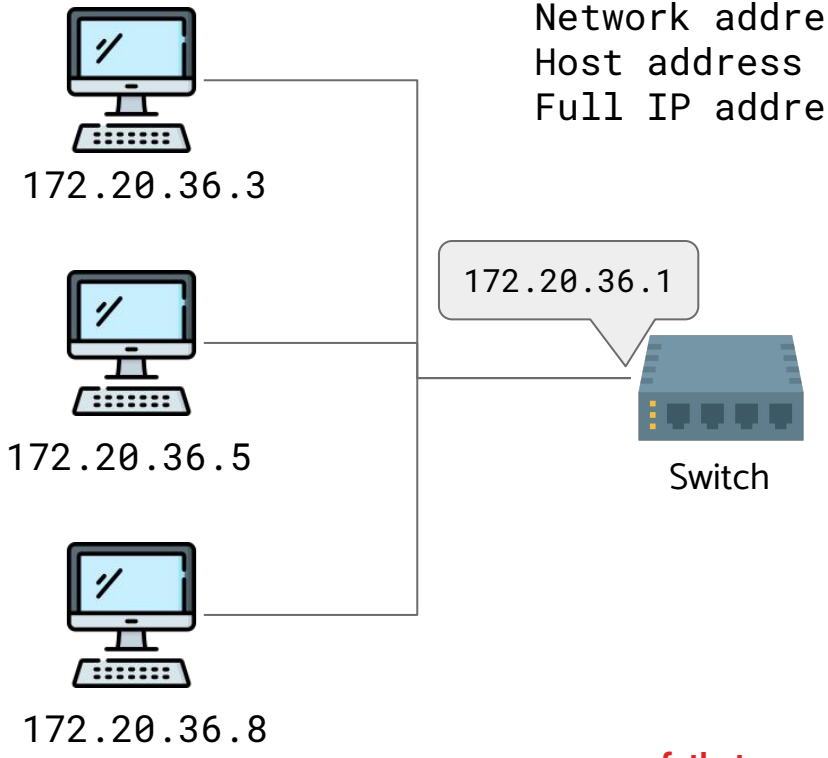
For more on this see https://dnschecker.org/ipv6-compress.php

IP ADDRESS VS MAC ADDRESS

- Every network device has a unique MAC address, whether it is connected to a network or not. It does not change.
- Every device when connected to a network is given an IP address. It may be fixed or dynamic (can change).
- For example, think of VIN numbers on cars and plate numbers. A VIN number is like a MAC address, and a plate number is like an IP address. When a car is made it is given a VIN number. When it is registered to go into traffic, it is given a plate number.

LOCAL AREA NETWORK AND SWITCHES

```
Subnet mask    : 255.255.255.0
Network address: 172.20 .36 .0
Host address   : 0   .0  .0  .5
Full IP address: 172.20 .36 .5
```



Dynamic Host Configuration Protocol (DHCP)
Automatically assigns each computer in local network an IP address

LAN AND AND NETWORK ADDRESS

```
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```

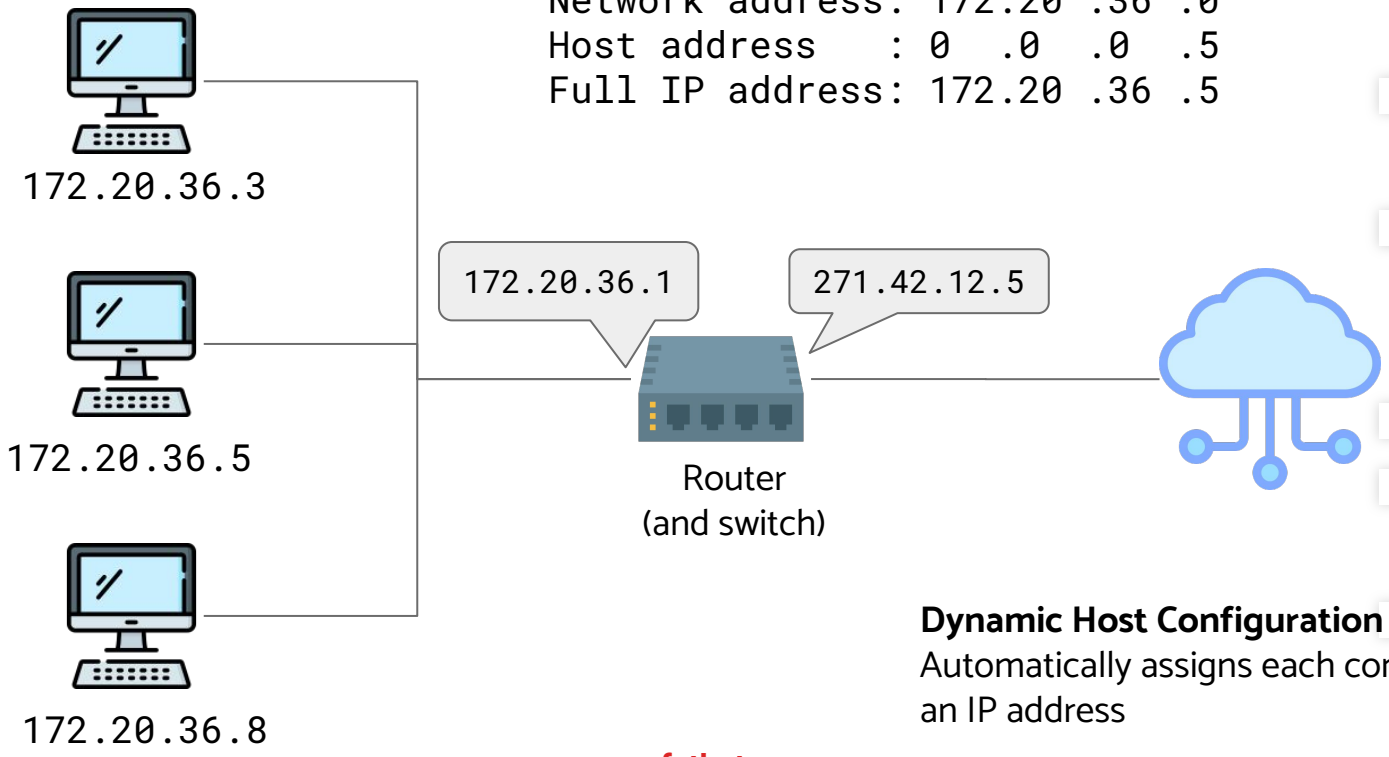

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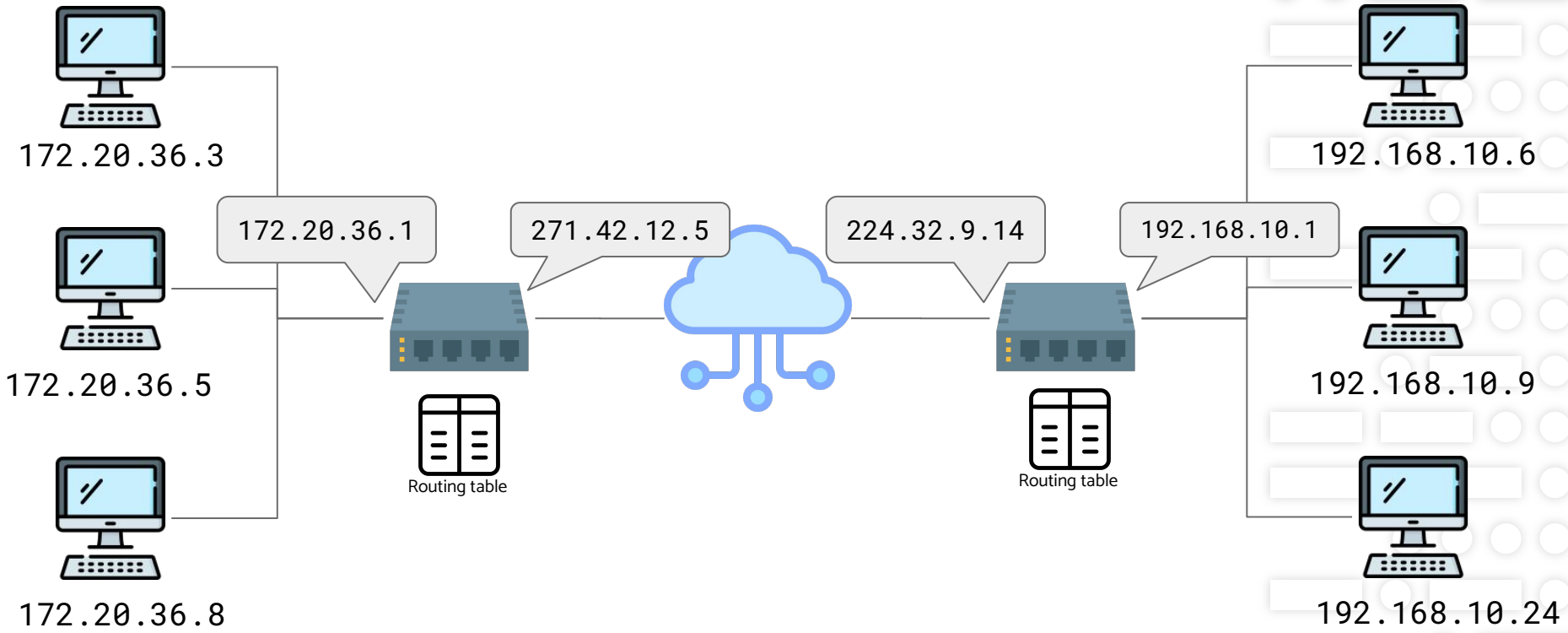
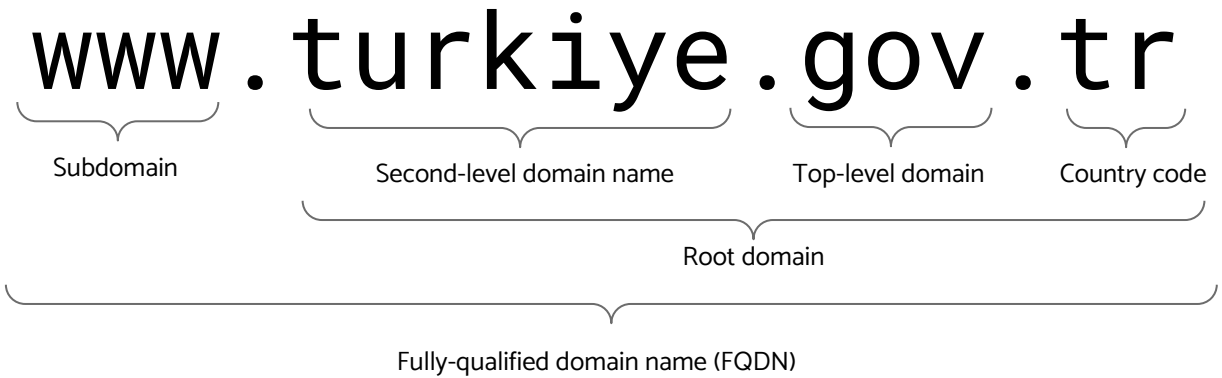
IP ROUTING


172.20.36.3
172.20.36.5
172.20.36.8
172.20.36.1
271.42.12.5
224.32.9.14
192.168.10.1
Routing table
Routing table
192.168.10.6
192.168.10.9
192.168.10.24

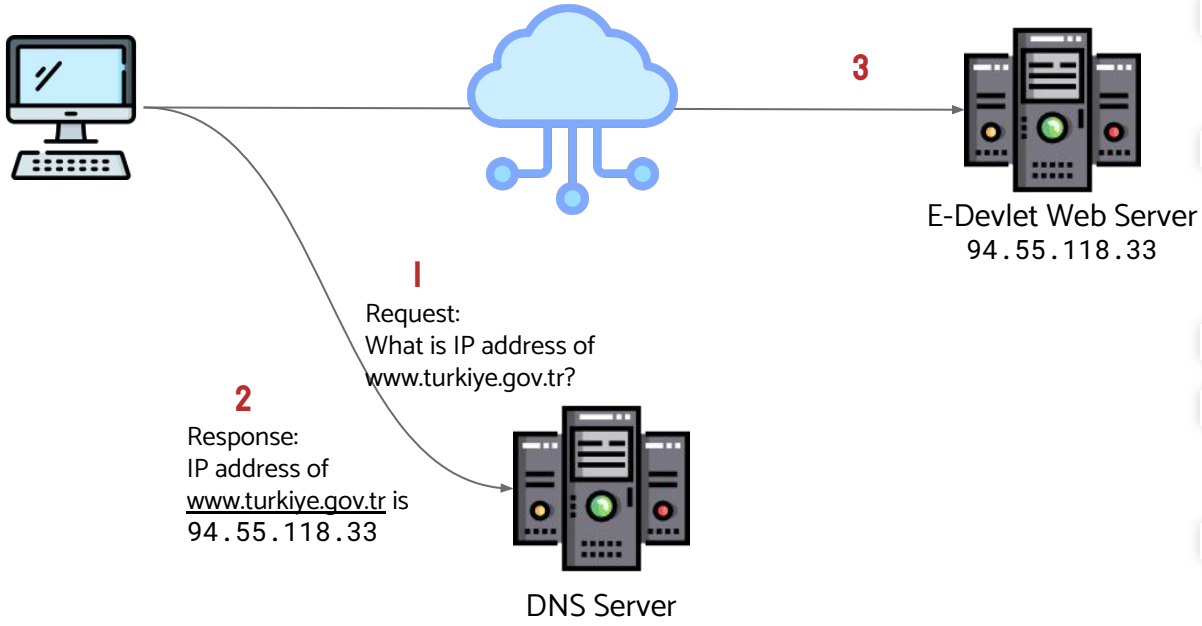
DOMAIN NAMES

A Domain name is an **alias (nickname)** for an IP address



DOMAIN NAME SYSTEM (DNS)

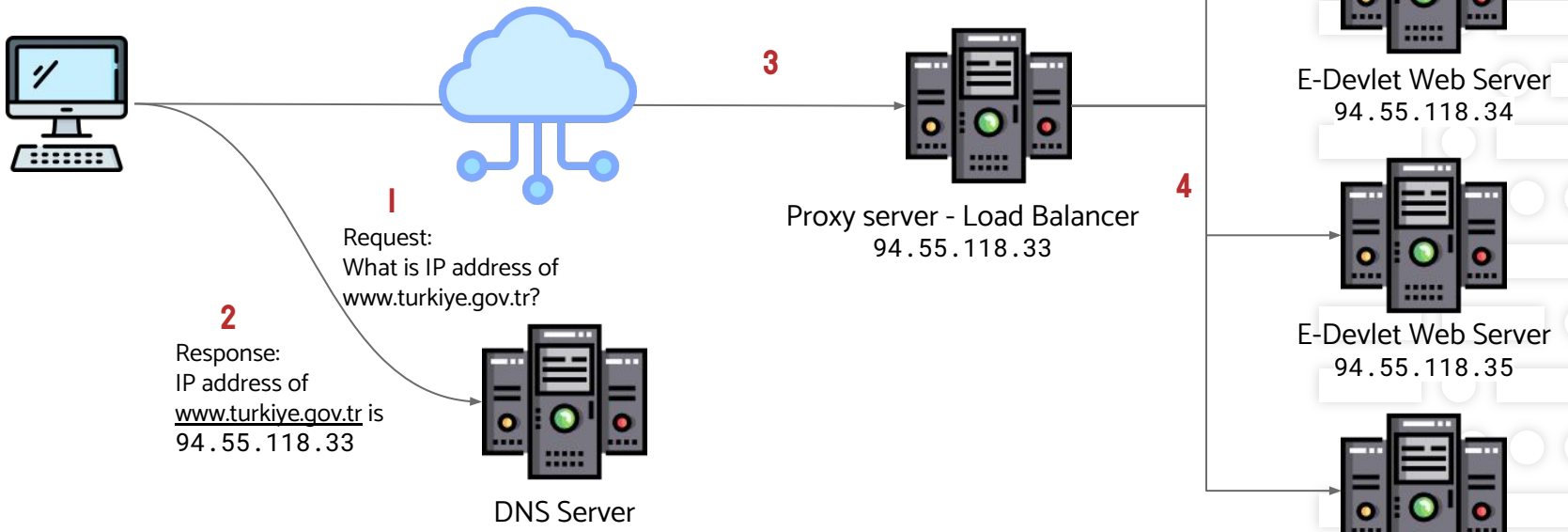
The **Domain Name System** (**DNS**) is the hierarchical and decentralized naming system used to identify computers, services, and other resources reachable through the Internet or other Internet Protocol (IP) networks. The resource records contained in the DNS associate domain names with other forms of information. These are most commonly used to map human-friendly domain names to the numerical IP addresses computers need to locate services and devices using the underlying network protocols, but have been extended over time to perform many other functions as well. The Domain Name System has been an essential component of the functionality of the Internet since 1985



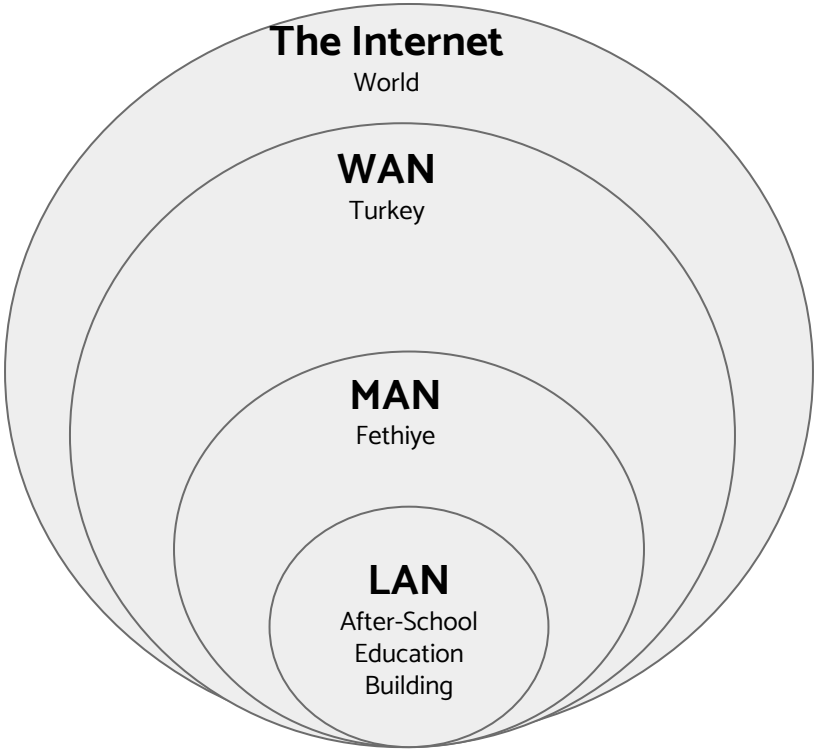
PROXIES AND LOAD BALANCING

From Wikipedia:

A **proxy server** is a server that acts as an intermediary between a client requesting a resource and the server providing that resource.[1] A **load balancing** refers to the process of distributing a set of tasks over a set of resources (computing units), with the aim of making their overall processing more efficient. Load balancing can optimize the response time and avoid unevenly overloading some compute nodes while other compute nodes are left idle

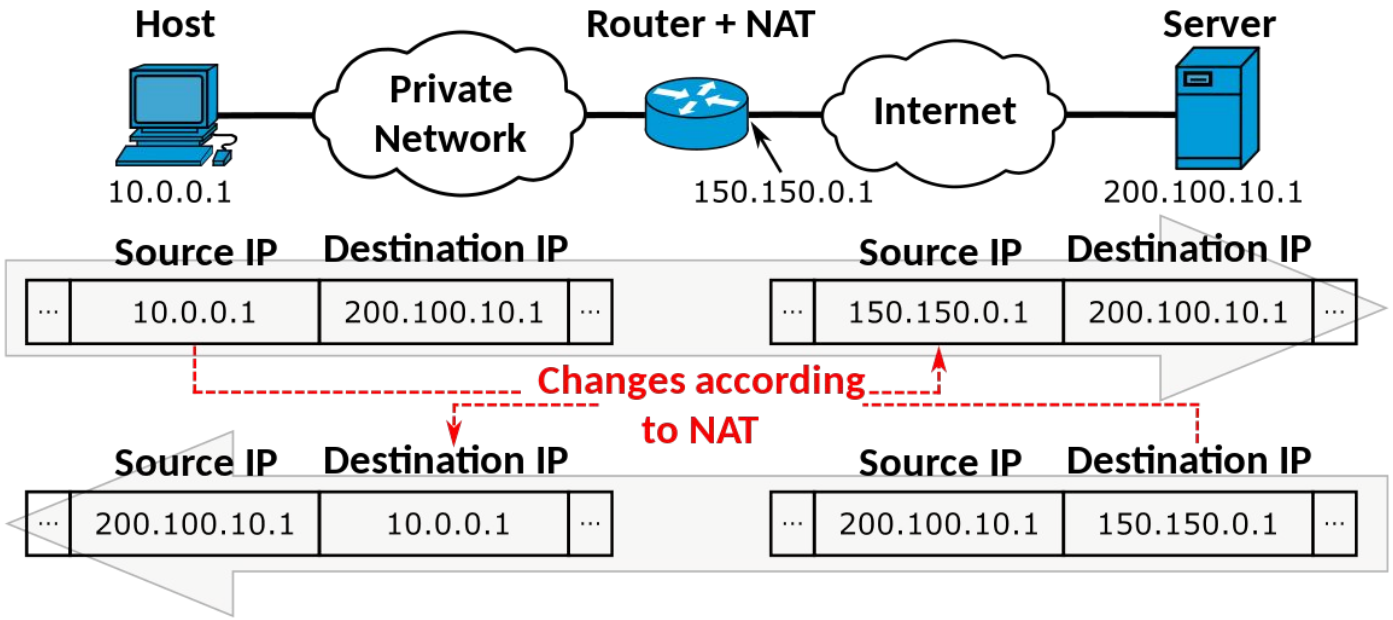


HIERARCHY OF NETWORKS

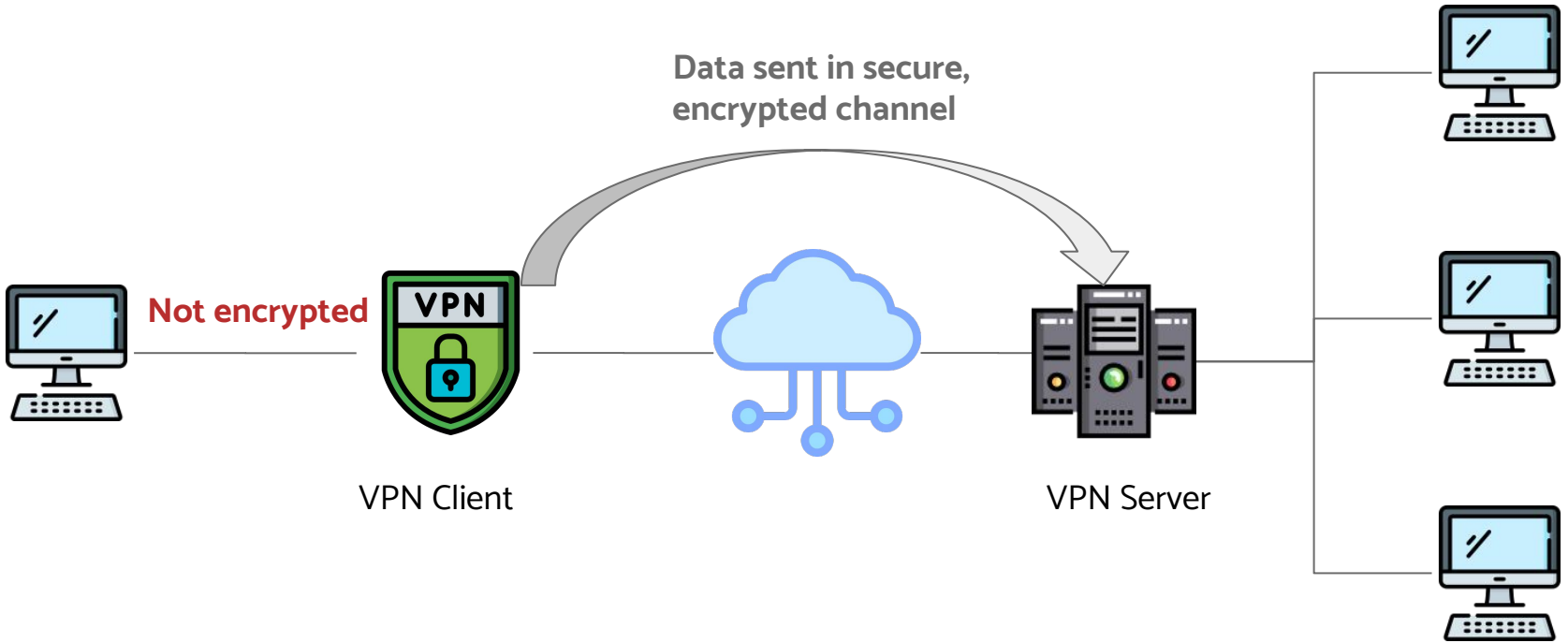


NAT: NETWORK ADDRESS TRANSLATION

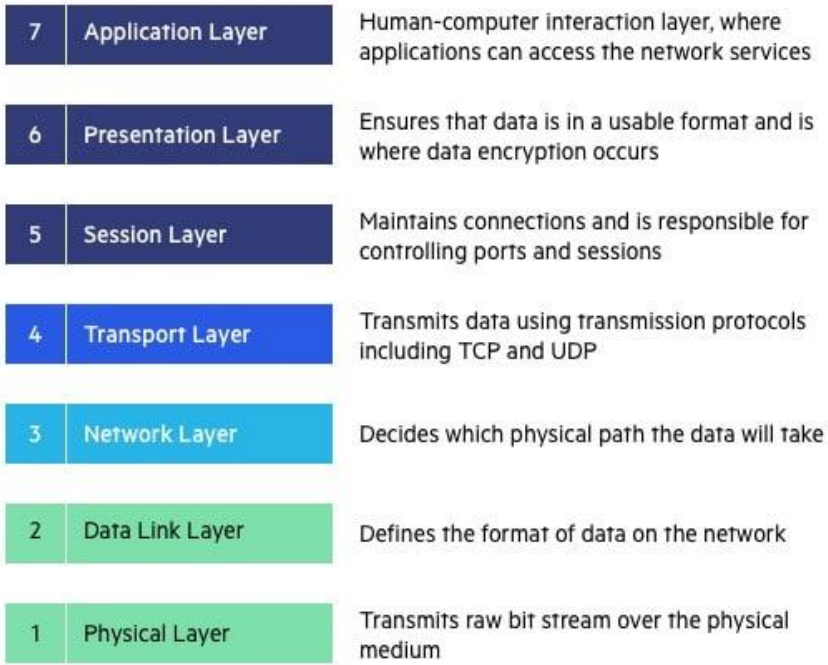
Network address translation is a method of mapping an IP address space into another by modifying network address information in the IP header of packets while they are in transit across a traffic routing device.



VPN: VIRTUAL PRIVATE NETWORK

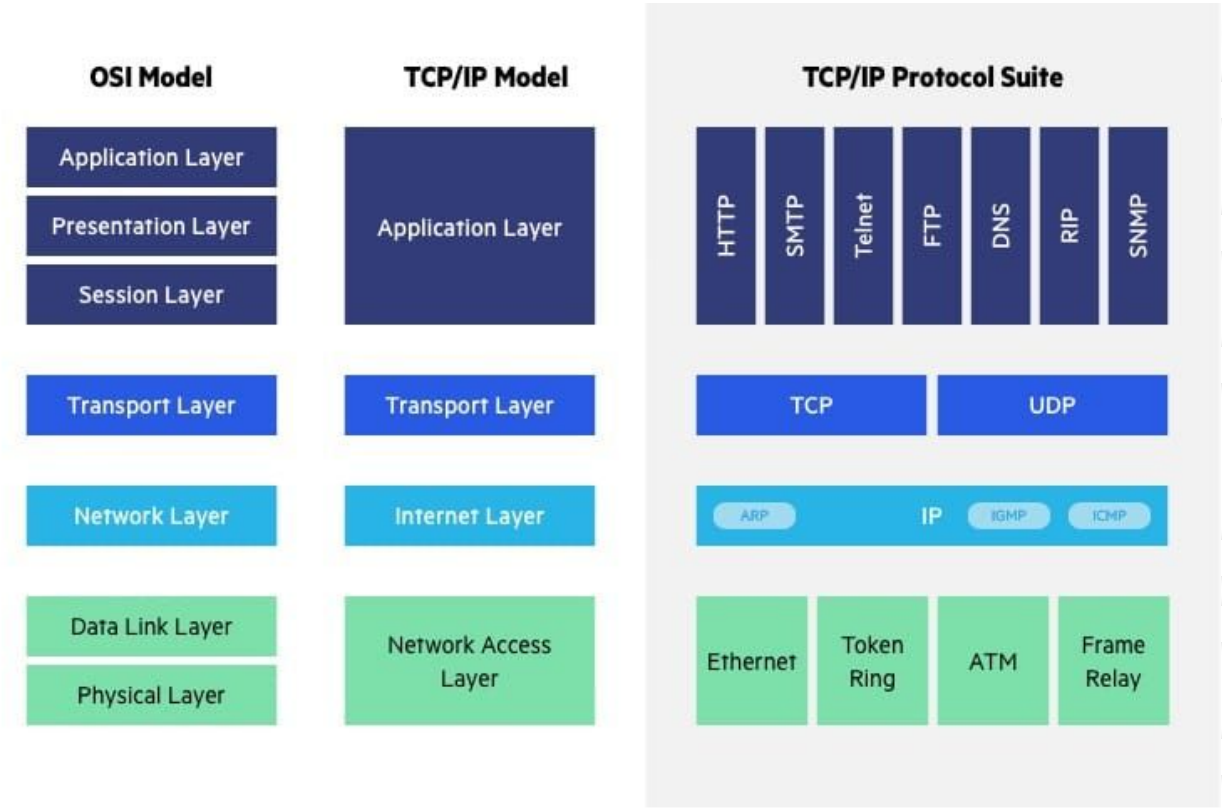


7 LAYERS OF OSI MODEL: Open Systems Interconnection



https://www.imperva.com/learn/application-security/osi-model/

TCP/IP MODEL: Transmission Control Protocol/Internet Protocol



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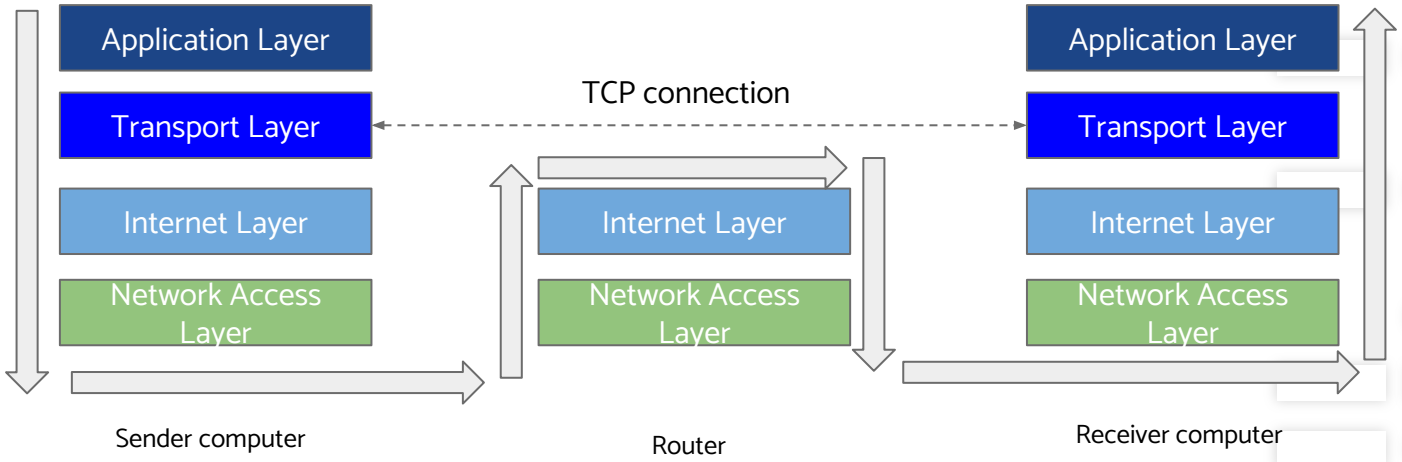
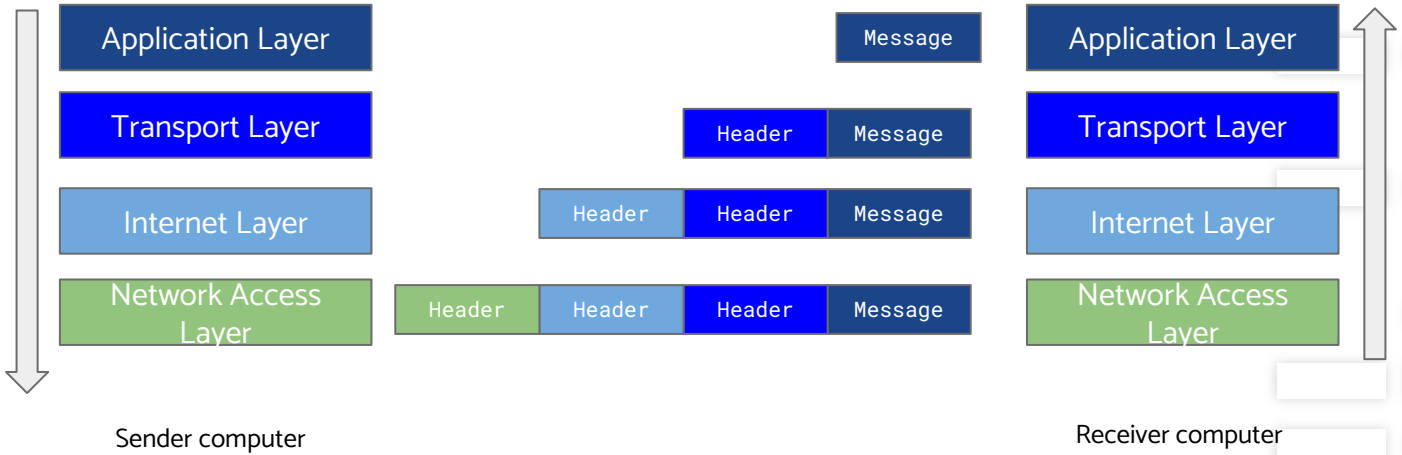
LAYERS OF TCP/IP MODEL



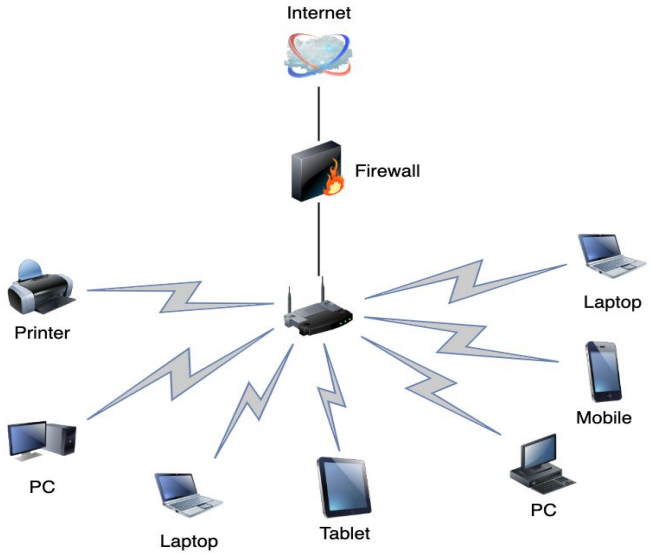
LAYERS OF TCP/IP MODEL



WIRELESS TECHNOLOGY: WIFI

Wireless technology is a wire free technology that predominantly uses radio frequencies to enable physically unconnected devices to communicate.

Typically Wireless networks are made up of Transmitters and Receivers controlled by routers and antennas. A typical wireless network looks something like:



WIRELESS TECHNOLOGY: WIFI

Wireless technologies typically work on frequency bands 2.4Ghz and 5Ghz. Each frequency can be further broken down into channels. The higher the frequency, the faster the data transmission and shorter the signal range.

The main differences between these frequency bands are:

1. WiFi coverage
   Coverage is better in the low frequency range, which can better penetrate solid objects
   WiFi signals can be disrupted and weakened by dense materials, even heavily leafed trees.

2. WiFi speed
   The higher frequency 5 GHz band makes up for its shorter range with much faster WiFi speeds than the 2.4 GHz band.

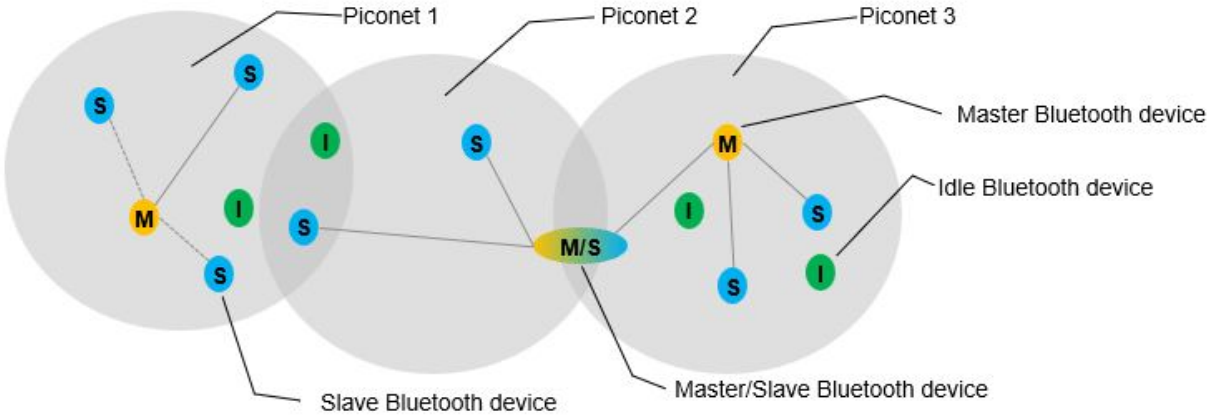
3. Channel interference
   In the 2.4 GHz band, you have the option to choose from 11 WiFi channels, where 3 of which are non-overlapping. In the 5 GHz band, you have the option to choose from 45 WiFi channels, where 24 of which are non-overlapping. Overlapping channels are what lead to network interference.

The newest WiFi standard is 802.11n (WiFi 4) and has been around since 2009. Therefore most devices are capable of using both frequency bands. Which one is chosen depends somewhat on the physical surroundings and the amount of WiFi traffic in the area.

BLUETOOTH TECHNOLOGY

Bluetooth is a short-range wireless technology standard that is used for exchanging data between fixed and mobile devices over short distances using UHF radio waves in the ISM bands, from 2.402 to 2.48 GHz, and building personal area networks. For more click Wikipedia

BLUETOOTH ARCHITECTURE

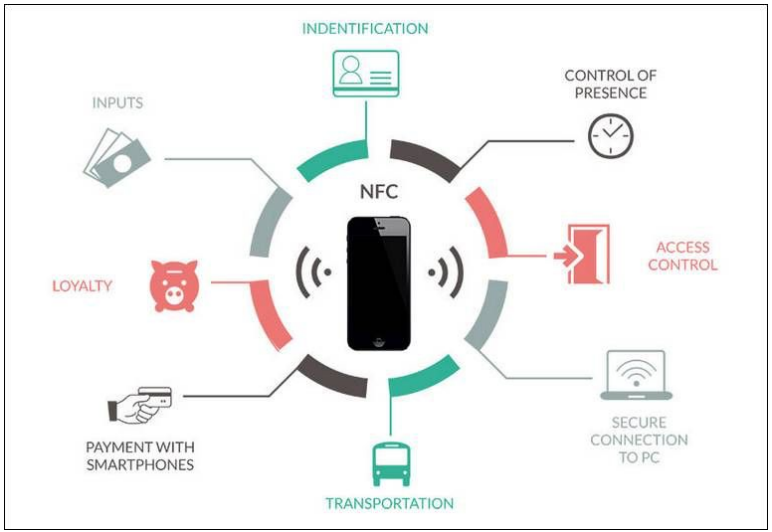


NFC TECHNOLOGY: NEAR FIELD COMMUNICATION

NFC is a wireless data transfer technology that is able to detect and enable other NFC devices in close proximity to communicate without the need for an internet connection.

The tech is evolved from radio frequency identification (RFID). An NFC chip operates as one part of a wireless link. Once it's activated by another chip, small amounts of data between the two devices can be transferred when held a few centimeters apart.

It is widely used for mobile payment, document data transfer, think passports...



RESOURCES

Watch these:

- History of the Internet: https://www.youtube.com/watch?v=o1ezCGjxV3A
- TCP/IP Foundations: https://www.youtube.com/watch?v=XAlNX9KGIXk

Read these:

- https://freecomputerbooks.com/Introduction-to-Networking-How-the-Internet-Works.html#downloadLinks