

Internet Explained



SoftUni Team
Technical Trainers



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#csharp-web

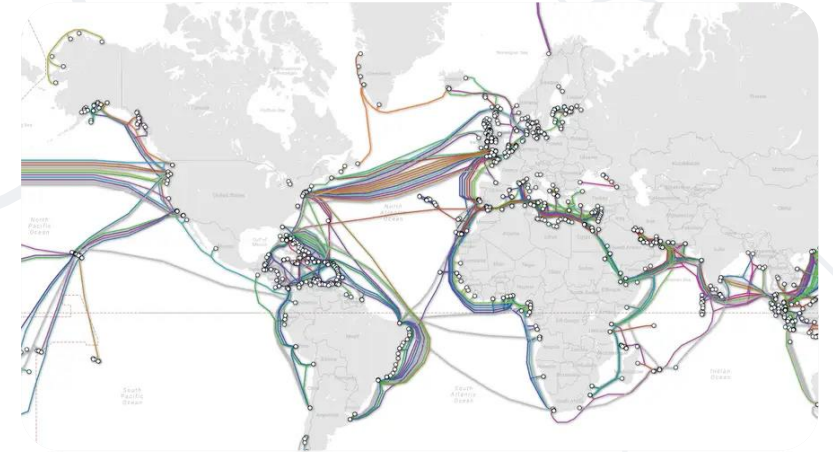


Introduction to Internet

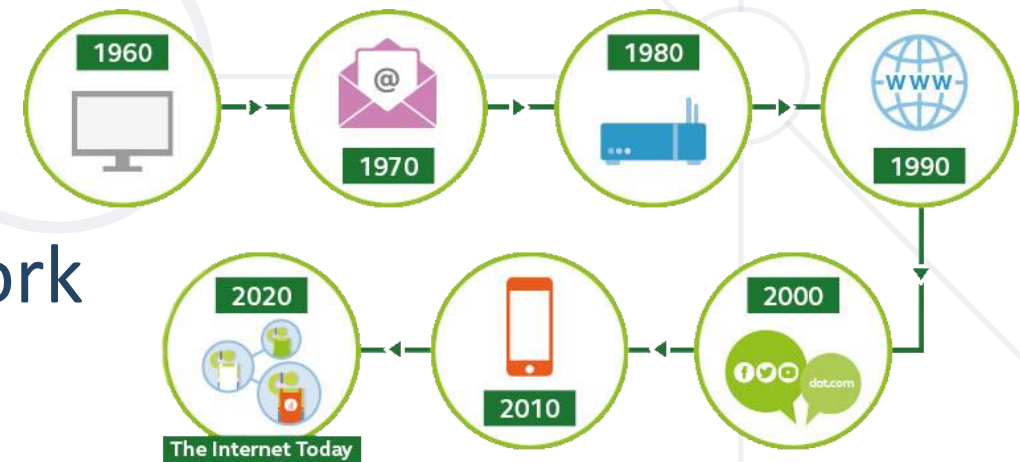
An Introduction to the Internet

What is the Internet?

- **Vast network** that connects billions of devices together all over the globe
 - Through **fiber optics, copper, satellites** or **cell phone network**
- We get indirectly **connected** though **ISPs** (Internet Service Providers)



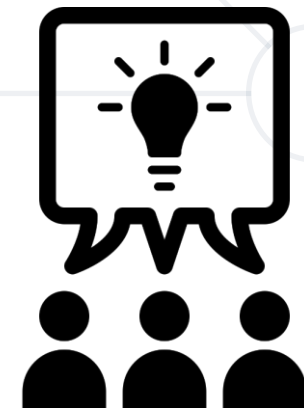
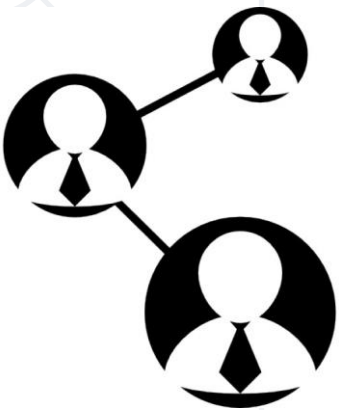
- Begins with the development of electronic computers in the 1950s
- Packet switching networks were developed in the late 1960
- The internet protocol was developed in the 1970s
- In the 1980s at CERN Tim Berners-Lee created the World Wide Web – the first website, linking hypertext documents into an information system, accessible from any node on the network



What is a Network?

- **Network** == a group of **two or more devices** that can communicate
- It is comprised of a number of **different computer systems** connected by **physical and/or wireless** connections
- The scale can range from **a single PC sharing** out basic peripherals to **massive data centers** located around the World, to the Internet itself

- **The internet** is made of hundreds of thousands of **networks** and billions of computers and devices connected physically
- These different systems **connect to each other, communicate with each other** and **work together** because of standards for how data is sent





How Does the Internet Work?

Web Server Work Model



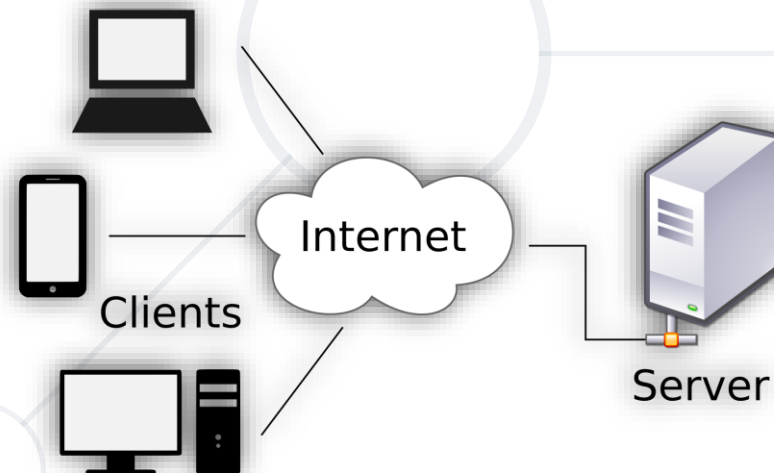
Important Definitions

- To understand how **the Internet works**, first we need to get acquainted with a few definitions
- **What is?**
 - Server and Client
 - Network Protocol
 - Packets
 - TCP vs UDP



Servers and Clients

- All of the machines on the Internet are either **servers** or **clients**
 - **Servers** are the machines that provide services to other machines
 - **Clients** are the machines that are used to connect to those services



Network Protocol

- **Network Protocol** == a set of rules and standards, that allow communication between network devices
- Network protocols include **mechanisms** for devices to **identify** and make **connections** with each other
- Examples for standard network protocols
 - TCP, QUIC, UDP, IP, ARP
 - HTTP, FTP, TFTP, SMTP, SSH





Packets

Sending and Receiving Data

Packets (1)

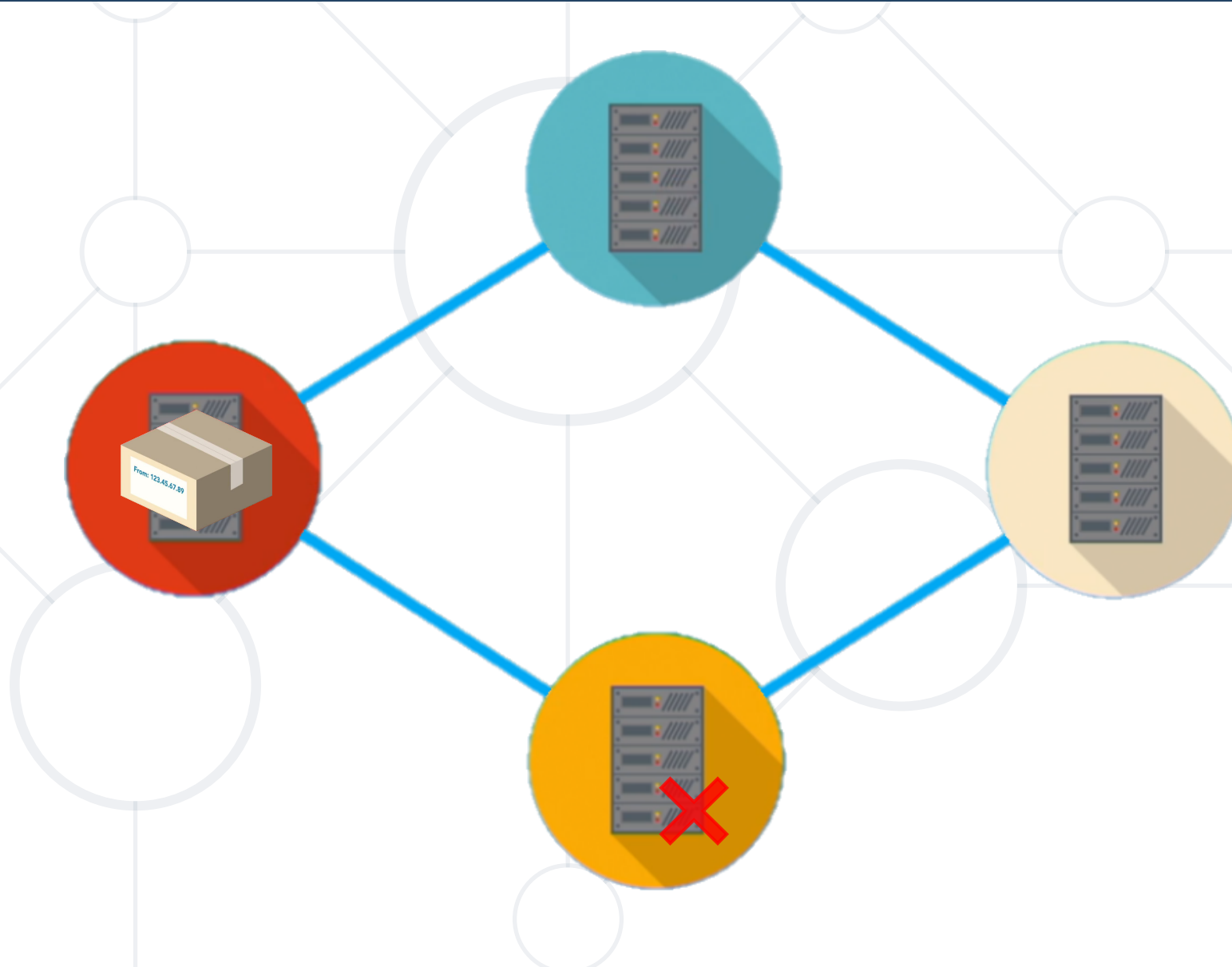
- Everything that is created on a computer is translated into digital data using **bits**
- Bits need to have a way to be transmitted over the internet
- Every message, file or stream of data is broken down into small chunks, called **packets**
- When packets are sent on the internet, they usually travel the network together
- But they might have to take a different route to get to the destination



- Each packet contains some **important information** inside of it, called a **header**
 - Where it came from
 - Where is it going
 - How long it is
 - This is how the packet is known to be complete
 - All the packets in the message are the same size
 - How many packets there are in the overall message



Traveling of the Packets in the Network



A background network diagram consisting of several light gray circles of varying sizes connected by thin gray lines. The circles are arranged in a way that suggests a network topology, with some circles acting as hubs and others as peripheral nodes. The lines connect the circles in a non-uniform, web-like pattern.

216.58.214.46
www.google.com

Internet Protocol

IPv4, IPv6 and DNS

Internet Protocol

- One of the most important protocols used in Internet communication is the **Internet Protocol (IP)**
- All the devices on the Internet have **addresses**
- They are called **IP Addresses**
- The IP address is **unique** to each computer or a device at the edge of the network



IP Address

- An **IP Address** has many parts, organized in a hierarchy

192.168.14.120

Subnetworks

Device address

- This version of IP Addressing is called **IPv4**
 - Provides more than 4 billion **32 bits** unique addresses



IPv4

- **IPv4** == sequence of four, three-digit numbers separated by a period
 - Each number can be a number from 0 to 255
 - **IPv4** is not enough for all network devices connected to the internet
- In 1995, a new version of the internet protocol was created, it's called **IPv6**



IP address classes

Class	Address range	Supports
Class A	1.0.0.1 to 126.255.255.254	Supports 16 million hosts on each of 127 networks.
Class B	128.1.0.1 to 191.255.255.254	Supports 65,000 hosts on each of 16,000 networks.
Class C	192.0.1.1 to 223.255.254.254	Supports 254 hosts on each of 2 million networks.
Class D	224.0.0.0 to 239.255.255.255	Reserved for multicast groups.
Class E	240.0.0.0 to 254.255.255.254	Reserved for future use, or research and development purposes.

What Is CIDR (Classless Inter-Domain Routing)

- Classless Inter-Domain Routing == IP addressing scheme that improves the allocation of IP addresses
- It replaces the old system based on classes A, B and C
- This scheme also helped greatly **extend the life of IPv4** as well as slow the growth of routing tables

IPv4 Private Address Space and Filtering

CIDR	IP address range	Class
10.0. 0.0/8	10.0. 0.0 – 10.255. 255.255	A
172.16. 0.0/12	172.16. 0.0 – 172.31. 255.255	B
192.168. 0.0/16	192.168. 0.0 – 192.168. 255.255	C

IPv6

- **IPV6** uses **128 bits** – 340 undecillion unique addresses
 - That's more than the atoms on the surface of the Earth
- These **128** bits are organized into eight 16-bit sections
- Each 16 bit block is converted to hexadecimal and it's separated with a colon
- Full IPV6 address
 - **3FFE:F200:0234:AB00:0123:4567:8901:ABCD**
- The **leading zeros** in **IPv6** can usually be left out



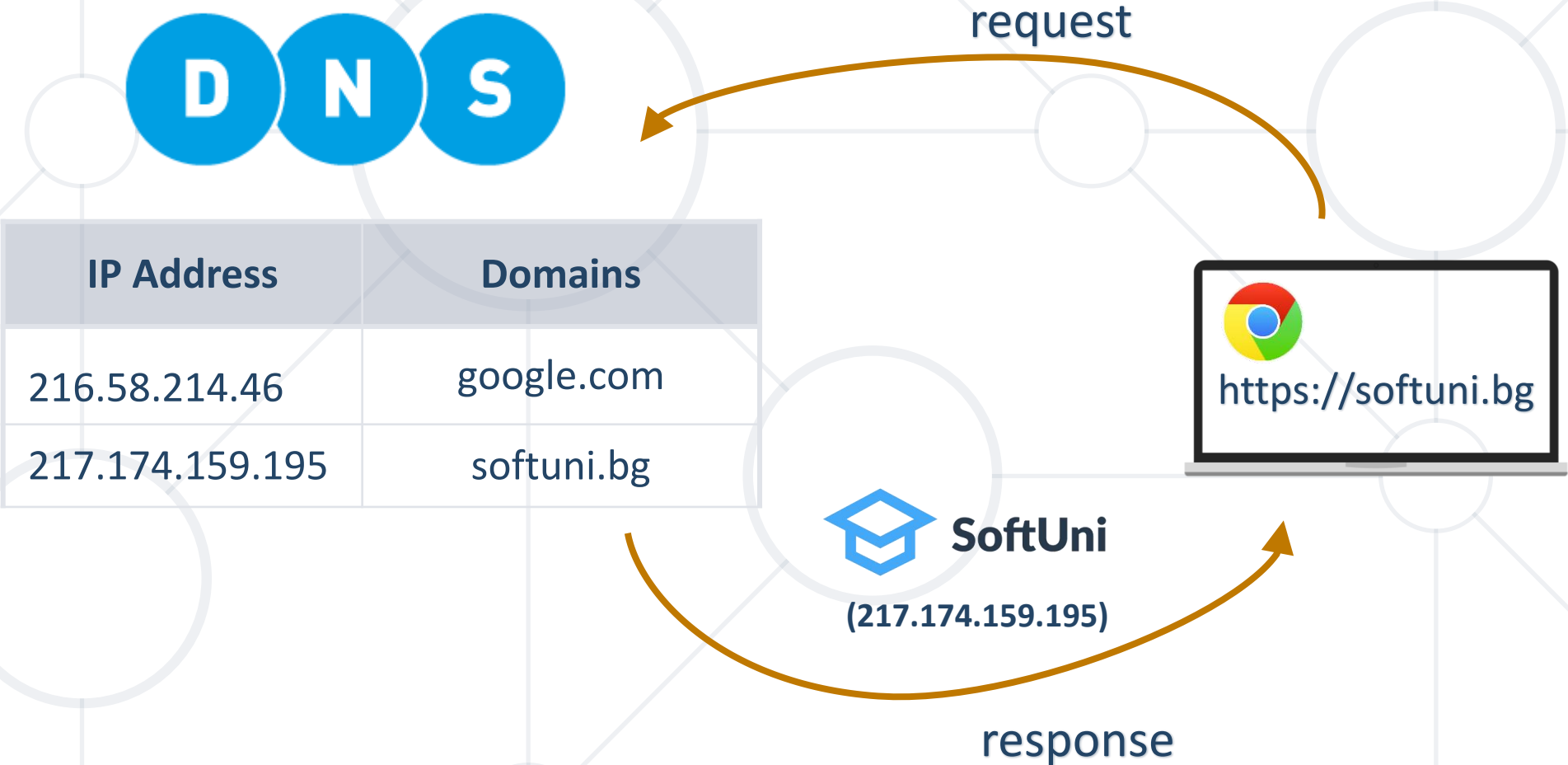
What is a DNS?

`www.softuni.bg`

Domain name

- The **domain name** is a human way to access IP addresses for devices and websites around the world
- It is a sequence of phrases that **map** to a giant **Internet-wide database** of **IP addresses**
- When a domain name is entered in the browser, a request is made to something called a **DNS (Domain Name Server)**
- This server holds a cache of tons of domain names, and their matching IP addresses





A background network diagram consisting of a grid of light gray lines intersecting at various points. Some of these intersections are marked with small, empty light gray circles. A larger, solid dark blue circle is centered in the upper half of the image, containing the text 'TCP' in white.

TCP

Reliability and TCP

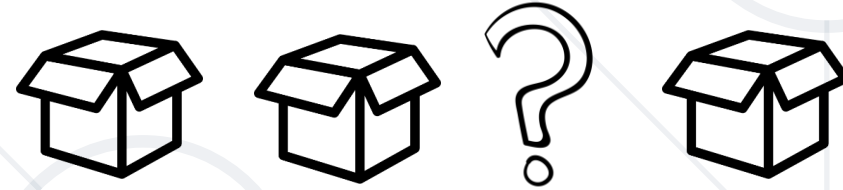
- When packets are transmitted from one location to another, they can take different paths
- When they get to the destination, they are unorganized and sometimes not complete
- So the message needs to be audited and reviewed in order to put it together in the right way
- The **Transmission Control Protocol** or **TCP** does exactly that

Transmission Control Protocol - TCP (1)

- **TCP** uses a process, where it looks at **all the packets** in a message and **checks them**
- Using the header information in each packet, it knows
 - How many there are
 - How large they should be
 - In which order the packets should be in
- Using this checklist, it is able to rearrange the packets



- If it finds that a packet doesn't match the expected characteristic, it is discarded
- **TCP verifies** that all the packets are
 - In the right order
 - Free of any issues
- After that it **certifies the data** and the packets are **merged** together to recreate the **original** file that was on the sender's device

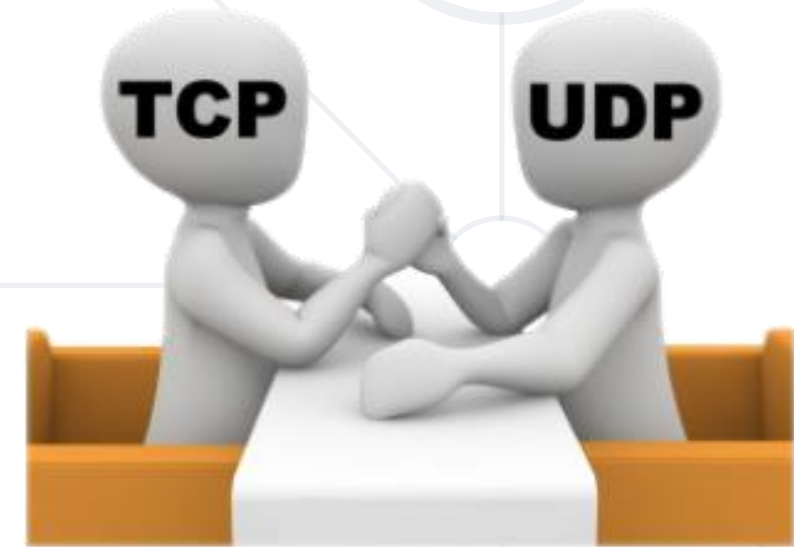


User Datagram Protocol

- UDP does not establish a session and it does not guarantee data delivery
- It is known as the **"fire-and-forget" protocol**
 - It sends data and it doesn't really care if the data is received at the other end

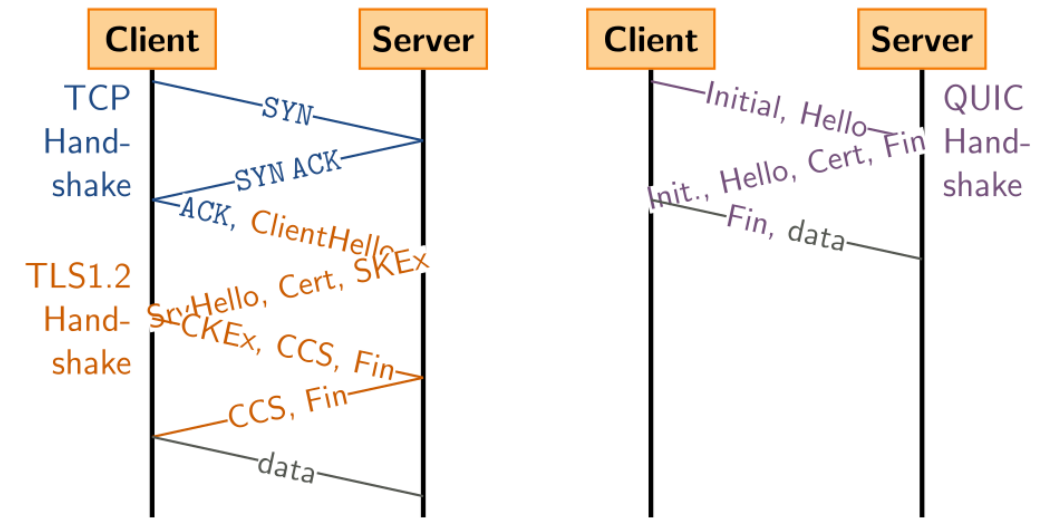


- **TCP** places **reliability** in a higher priority than speed or latency
- For instances where reliability isn't as important, but **speed** is, **UDP** is used
- UDP doesn't do excessive reliability checks, but it can send information at a faster rate
- TCP is the foundation of how a majority of data is transmitted over networks



QUIC Protocol

- **QUIC** == new transport protocol designed for **mobile-heavy** Internet usage
- Uses **UDP** as its basis, not TCP
- Packets are encrypted **individually**
- Exchange of supported protocols is a part of the initial **handshake process**



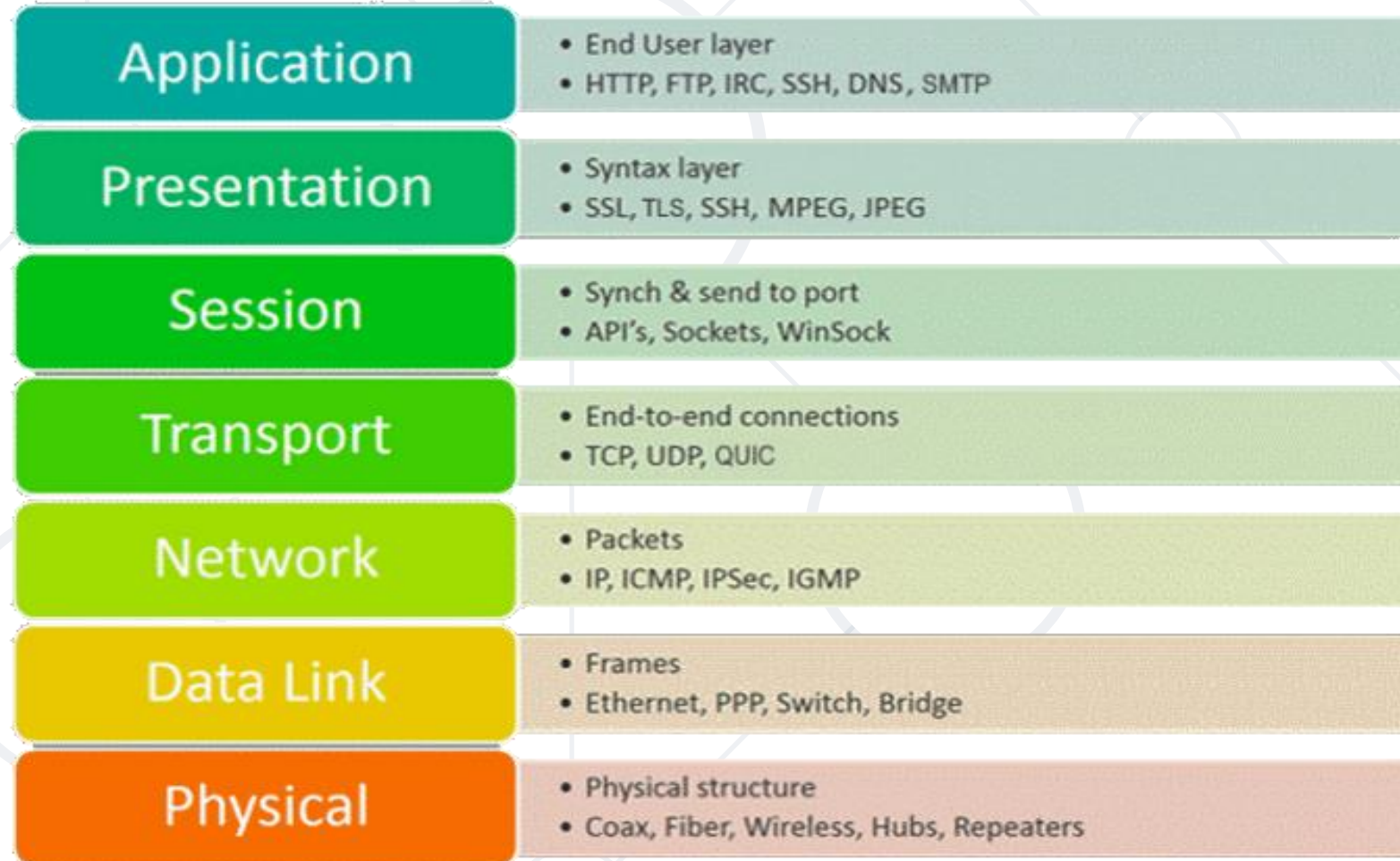


The OSI Model

What is the OSI Model?

- **OSI** model stands for **O**pen **S**ystem **I**nterconnect
- It consists of **7 layers**
 - Each layer serves the layer above it and in return, is served by the layer below it
- Understanding each layer of the model helps us with
 - **Troubleshooting**
 - **Communicating** better with technical and non-technical individuals about any system





Application Layer – 7

- Only layer that **directly interacts** with the **user**
- Software applications, e.g., **web browsers** and **e-mail clients**, rely directly on its protocols
- Protocol examples
 - DNS, FTP, HTTP, SMTP, POP3, IMAP
- Most **important** layer for **software engineers**

```
GET /doc/test.html HTTP/1.1
Host: www.test101.com
Accept: image/gif, image/jpeg, */*
Accept-Language: en-us
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/4.0
Content-Length: 35

bookId=12345&author=Tan+Ah+Teck
```

Request Line

Request Headers

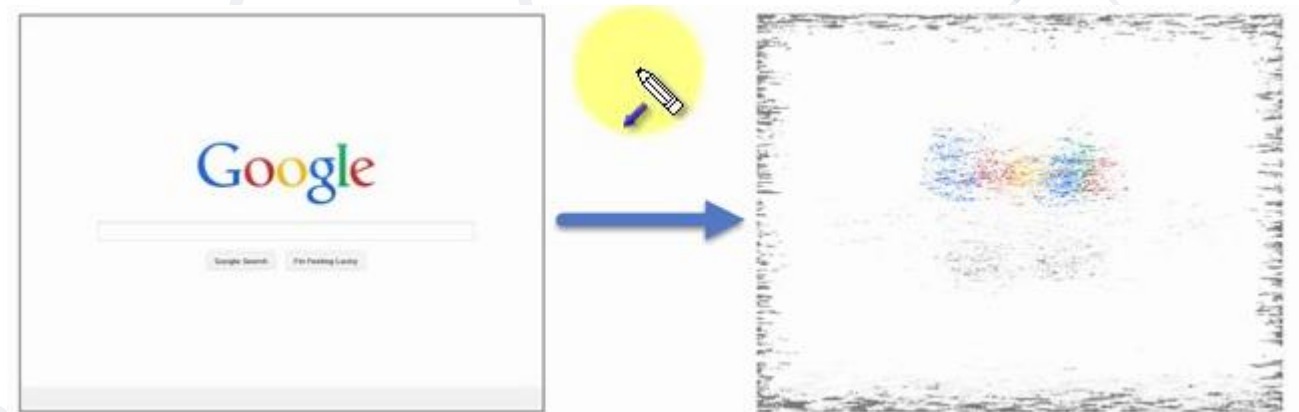
Request
Message
Header

A blank line separates header & body

Request Message Body

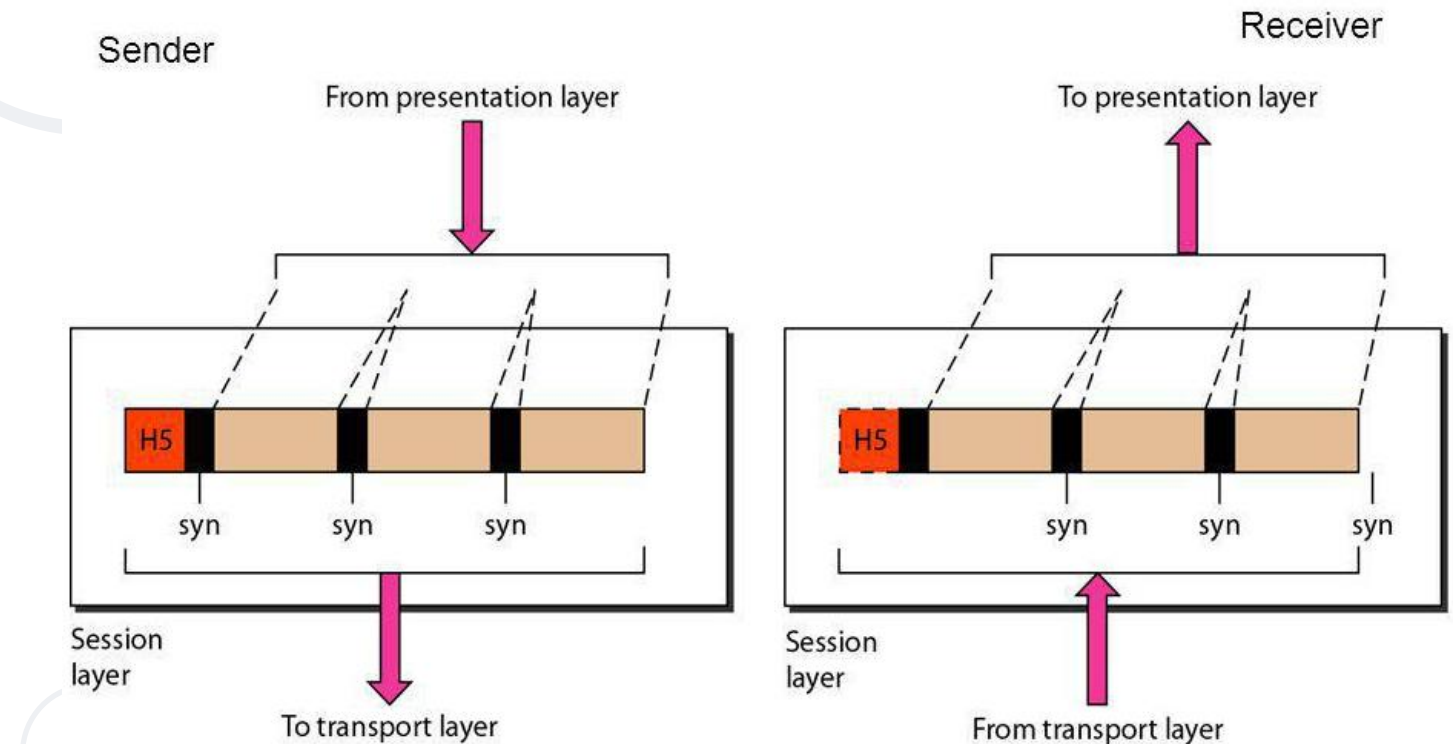
Presentation Layer – 6

- This layer is a part of an operating system (OS)
- **Converts** incoming and outgoing **data** from one presentation format to another
- Responsible for **translation**, **encryption**, and **compression** of **data**
- Protocol examples
 - SSL, TLS



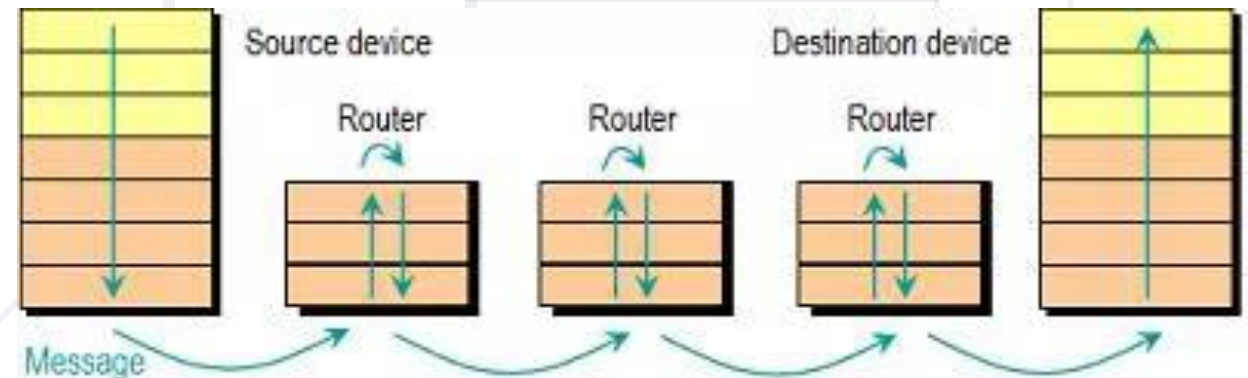
Session Layer – 5

- Controls the **dialogues** (connections) between computers
- Establishes, manages and terminates **connections** between the local and remote application
- Its services include **authentication** and **reconnection** after an interruption
- Protocol examples
 - RPC, PPTP



- Responsible for end-to-end communication over a network
- Transfers data, splitting it into pieces (**segments**)
- Provides logical communication between application processes
- Responsible for the management of error correction, providing quality and reliability to the end user
- Important concept for web devs – **port number**
- Protocol examples – **TCP, QUIC, UDP**

- Transfers **packets** from one node to another
- Responds to service requests from the transport layer and issues service requests to the data link layer
- Protocol examples
 - **IP, IPv6, IPSec, ICMP, IGMP**
- Important concept for web devs – **IP address**



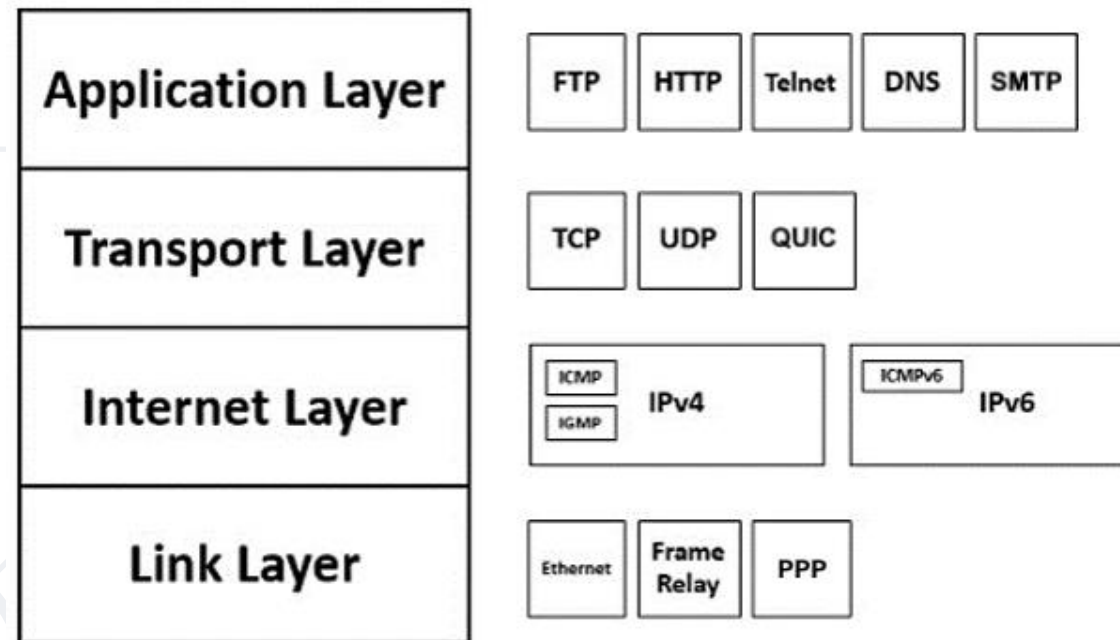
Data Link Layer – 2

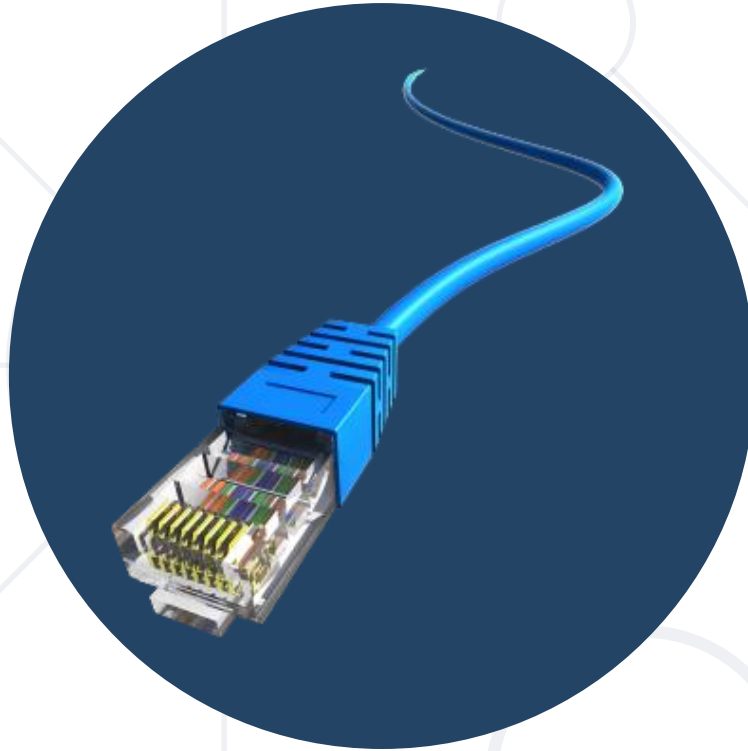
- Provides **node-to-node data transfer**
- The data transferred is split into packets – **frames**
- It **detects** and possibly **corrects** errors that may occur in the **physical layer**
- Divides into two sublayers
 - **Medium access control (MAC)** layer – controlling how devices in a network gain access to a medium and permission to transmit data
 - **Logical link control (LLC)** layer – identifying and encapsulating network layer protocols, controls error checking and frame synchronization
- Example protocols – **ATM, Ethernet, MAC**



- It is responsible for the physical connection between two or more parties
- Converts the **binary** from the upper layers into **signals, transmits** them over local media (electrical, light, or radio signals)
- Examples
 - **Ethernet**
 - **USB**
 - **Bluetooth**
 - **802.11a/b/g/n**







Network Hardware

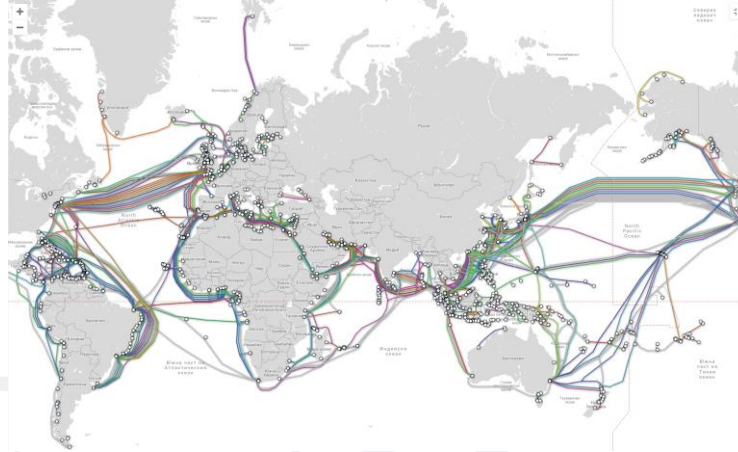
Basic Hardware Components

Network Hardware

- Basic Hardware Components
 - Cables
 - Routers
 - Repeaters, Hubs and Switches
 - Bridges
 - Gateways
 - Network Interface Cards



- Network cables – the **transmission media** to transfer data from one device to another



- Router – **connecting device** that transfers data packets between different computer networks (operates on level 3 of OSI)



- **Repeaters, hubs and switches connect** network **devices** together so that they can function as a single segment
 - **Repeater** – **receives** a **signal** and regenerates it before re-transmitting, so that it can travel longer distances
 - **Hub** – multiport **repeater** (operates on level 1 of the OSI model)
 - **Switch** – **receives data** from a port, uses packet switching to resolve the destination device and forwards the data to the particular destination (operates on level 2 of the OSI model)

■ Bridge

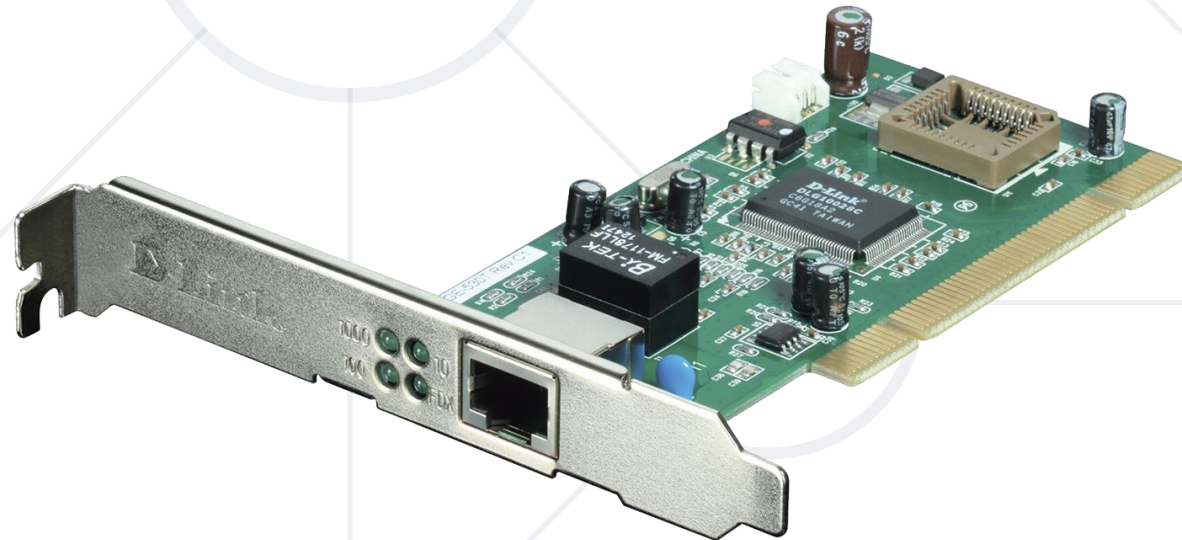
- Connects two separate but **similar** Ethernet network segments
- Forwards packets from the source network to the destined network (operates on level 2 of OSI)

■ Gateway

- Connects networks that work upon **different** protocols
- The entry and the exit point of a network (controls the access to other networks)
- Level 4, 5, 6 or 7 of the OSI model (same as Firewalls)

Network Interface Cards – NIC

- **NIC** – a computer component that connects it to the network
- There are two types of network cards:
 - Internal
 - External





The Future of the Internet

The Future of the Internet

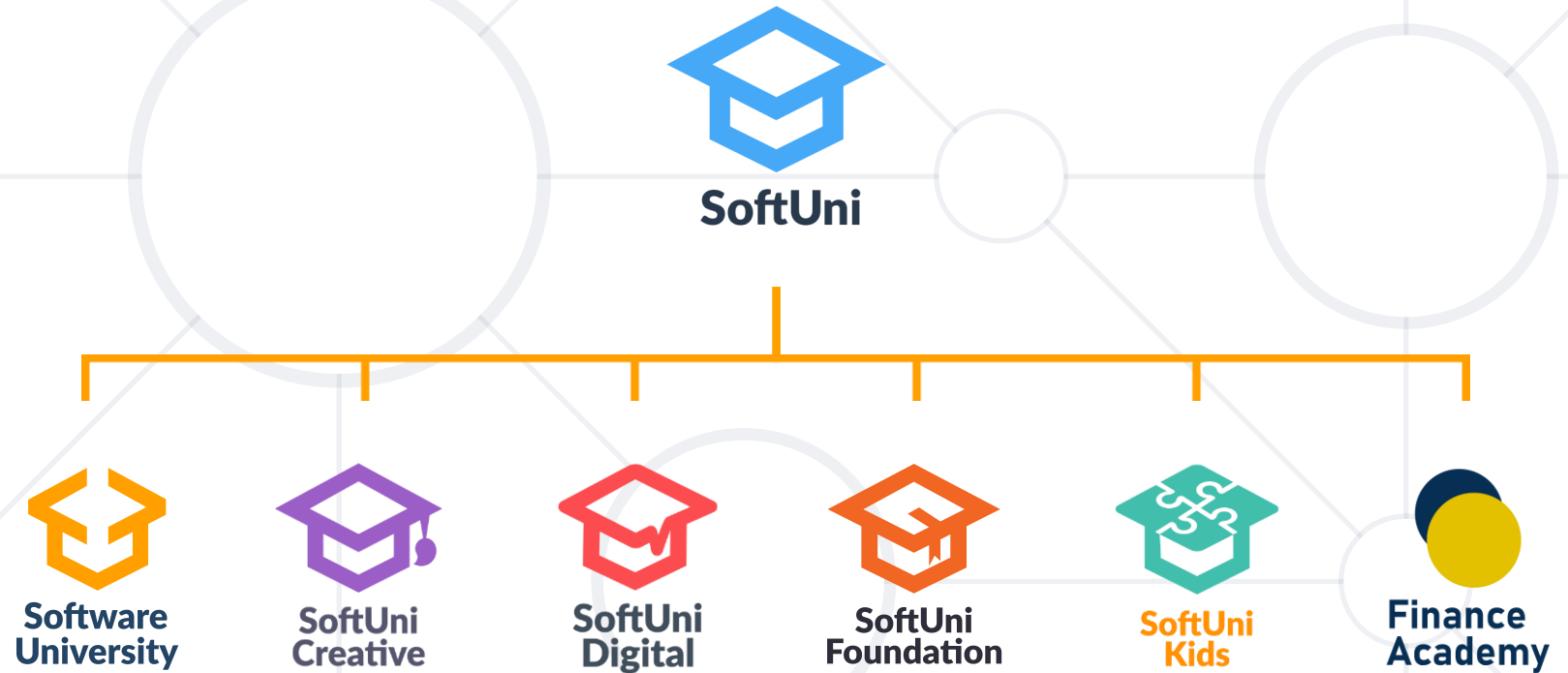
- A typical modern home consists of: PC, Laptop, Tablet, Phones, TV, Security Camera, Air Conditioner, Smart Watch, Printer, Music Player, Light, etc.
- The "**Internet of Things**" will expand
 - Healthcare, agriculture, wearables, manufacturing
 - Smart homes, cars and cities (pollution, parking, energy)
 - In 2030 there will be **50 billion devices** connected to the Internet of Things



- **Internet** and Definitions of Internet
- Sending and Receiving Data
- **OSI** model
 - Layers
- Network **Hardware**
- The Future of the Internet



Questions?



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Решения за твоето утре

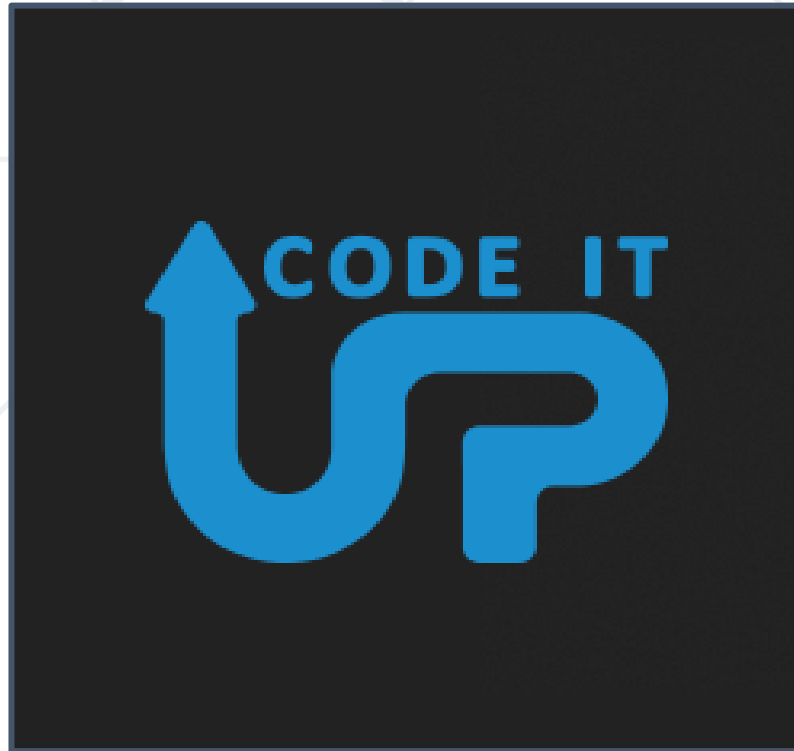


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