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COMPUTER NETWORKS

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UNBI

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1. Introduction

- Communication is the process of exchanging information.
- This process can include verbal, nonverbal, written, digital, and other forms of interaction.
- Computer networks are the foundation of modern communications and enable much in the digital age.
- Computer networks represent a system of interconnected devices that share various resources such as data, applications, etc.

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2. Internet

- Known as the *network of all networks*
- 1969. godine kreirana je eksperimentalna mreža ARPANET
- Two very important protocols for transferring packets over the Internet are:
  - TCP
  - IP
- In the early 1990s, Tim Berners-Lee introduced the World Wide Web (WWW).

2. Internet

- The Internet is an indispensable technology in today's world, and it is a system of interconnected computer networks.
- Various private, public, business, academic, etc. networks are connected via the Internet by means of various electronic and telecommunication equipment.
- The Internet has entered all spheres of human life, and today a large number of jobs are done and solved exclusively via the Internet.

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3. Network types

- There are different types of computer networks, and the most well-known of them include the following networks:
- Local Area Network (LAN),
- Wide Area Network (WAN),
- Metropolitan Area Network (MAN),
- Personal Area Network (PAN),
- Campus Area Network (CAN),
- Storage Area Network (SAN),
- Virtual Private Network (VPN).

3. Network types

- A LAN network is used in smaller geographic areas, such as within a single home, an apartment building, an office building, or a campus. It is the most common type of network that most users encounter on a daily basis.
- A WAN network represents a network at the level of a larger geographical area, such as a network within a country or continent. It essentially connects smaller LANs over longer distances.

- A MAN network covers a geographical area, most often within a single city. In other words, it is used to connect LAN networks within a single city.

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3. Network types

- A PAN network refers to a network that operates over a small area, typically a few meters. Often, this network refers to devices that are tied to a single person.

- A CAN network refers to a network that connects different buildings within a campus. It is often used within a university.

- A SAN network refers to a network for connecting data storage devices.

- A VPN network refers to a private network that is used to establish a secure and encrypted connection over a less secure connection, such as the internet.

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4. The concept of protocol

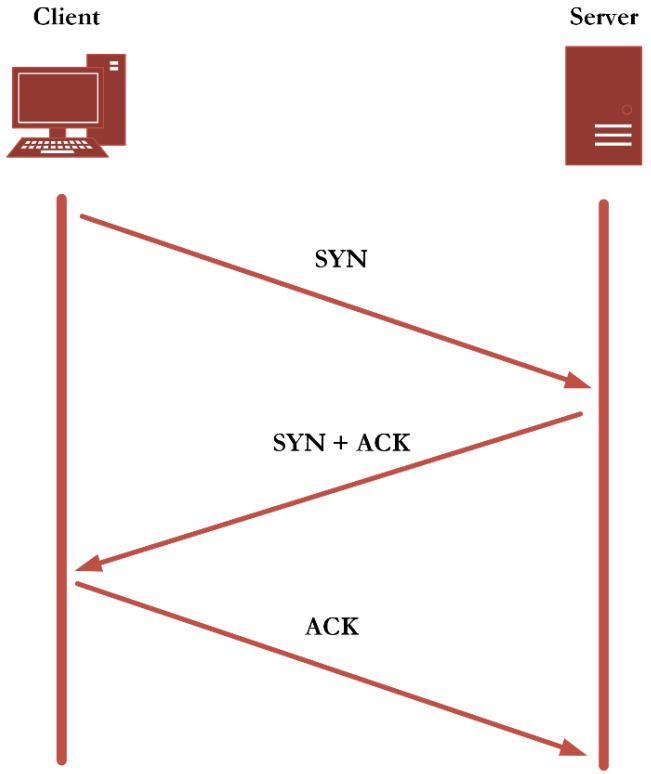
- A protocol is a set of rules that defines and manages elements of communication between different devices on a network.
- With the help of protocols, all elements related to data exchange are defined - from packets to addressing methods.
- Some of the known protocols are:
- Transmission Control Protocol (TCP),
- User Datagram Protocol (UDP),
- Hypertext Transfer Protocol (HTTP),
- Internet Protocol (IP).

4. The concept of protocol

- A TCP is a transport protocol. The purpose of this protocol is to reliably deliver data between a source and a destination, or between different devices on a network.
- The main characteristic of this protocol is that it is connection-oriented, which means that before sending a packet, a connection is established and maintained between different devices on the network, that is, between the client and the server.
- The original message, which is sent from the source to the destination, is divided into packets and transmitted over the network. The TCP protocol is a reliable protocol that ensures reliable packet delivery.

4. The concept of protocol

- The aforementioned protocol works on the principle of a three-way handshake, which is shown in the following figure.



4. The concept of protocol

- The triple handshake works as follows. A device (client) that wants to establish a connection with another device (server) sends a SYN (Synchronize) packet.
- In addition, it sends the sequence number (Sequence Number) that will be used for the data.
- The other device (server) responds with SYN and ACK (Acknowledgment), which means that it agrees with the establishment of the connection. Also, the sequence number that will be used for the data is sent here.
- In addition, a thank you is sent for the serial number of the client. After that, the client sends an ACK packet and thanks the server for the serial number.

4. The concept of protocol

- The UDP protocol is a transport protocol just like TCP. In this case, it is a connectionless protocol, which means that a connection is not established, as with the TCP protocol.
- It is an unreliable protocol and does not guarantee secure data delivery, but it is faster than the TCP protocol and is used in cases where delivery speed is more important than reliability.
- The above makes the UDP protocol suitable for real-time applications and is therefore suitable for real-time audio and video transmission (conferences, seminars, etc.), playing video games, etc.

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4. The concept of protocol

- The HTTP protocol is a protocol used to communicate with the server through a web browser, such as e.g. Google Chrome, Mozilla Firefox, Microsoft Edge, etc.
- This protocol is used to transfer hypertext documents, such as e.g. HTTP (HyperText Markup Language) document.
- Through this protocol, the client and server communicate by exchanging messages.
- There are two types of messages in this case, namely Request and Response.

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4. The concept of protocol

Different versions of the HTTP protocol have been used throughout history.

- The first version is known as HTTP/0.9,
- HTTP/1.0 and HTTP/1.1.
  - Version HTTP/1.1 has been used for the longest time, since 1997.
  - HTTP/2 was introduced in 2015.
  - In 2022, the HTTP/3 version was also introduced.
- It is also important to mention that there is an HTTPS (English HTTP Secure) protocol. It is a secure version of the HTTP protocol that uses the SSL/TLS (Secure Sockets Layer/Transport Layer Security) protocol.

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4. The concept of protocol

The IP protocol is one of the most important protocols that is responsible for assigning unique IP addresses to each device and routing packets from the source to the destination.

The specified protocol defines the packet format and addressing system. There are two versions of the IP protocol, namely:

- IPv4 i
- IPv6.
- The key difference between the mentioned two versions of the protocol is that IPv4 uses 32-bit IP addresses while IPv6 uses 128-bit addresses.

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4. The concept of protocol

- When it comes to IP addresses, they can be Public and Private.
- The IPv4 protocol IP address is 32-bit, and consists of four numbers separated by a period.
- The mentioned four numbers can be in the range from 0 to 255, where one number is called an Octet.
- A Public IP address is obtained from an Internet Service Provider (ISP), while a Private IP address is used within a private network.
- The Private IP address is set manually by the system administrator or assigned automatically by the router using the DHCP (Dynamic Host Configuration Protocol) protocol.

4. The concept of protocol

- IP addresses can be Static and Dynamic.
- A Static IP address is obtained by the ISP upon request, is tied to the user for a longer period, and is usually used when some services are provided via the Internet (eg some web application that is hosted on a private server).
- A dynamic IP address is assigned automatically to each user by the ISP and is tied to the user for a specific short period of time.
- The user's private IP address can be seen if, for example, within the Windows operating system, in the command window (Command Prompt, CMD), or in Windows PowerShell, type the command ipconfig or ipconfig /all.

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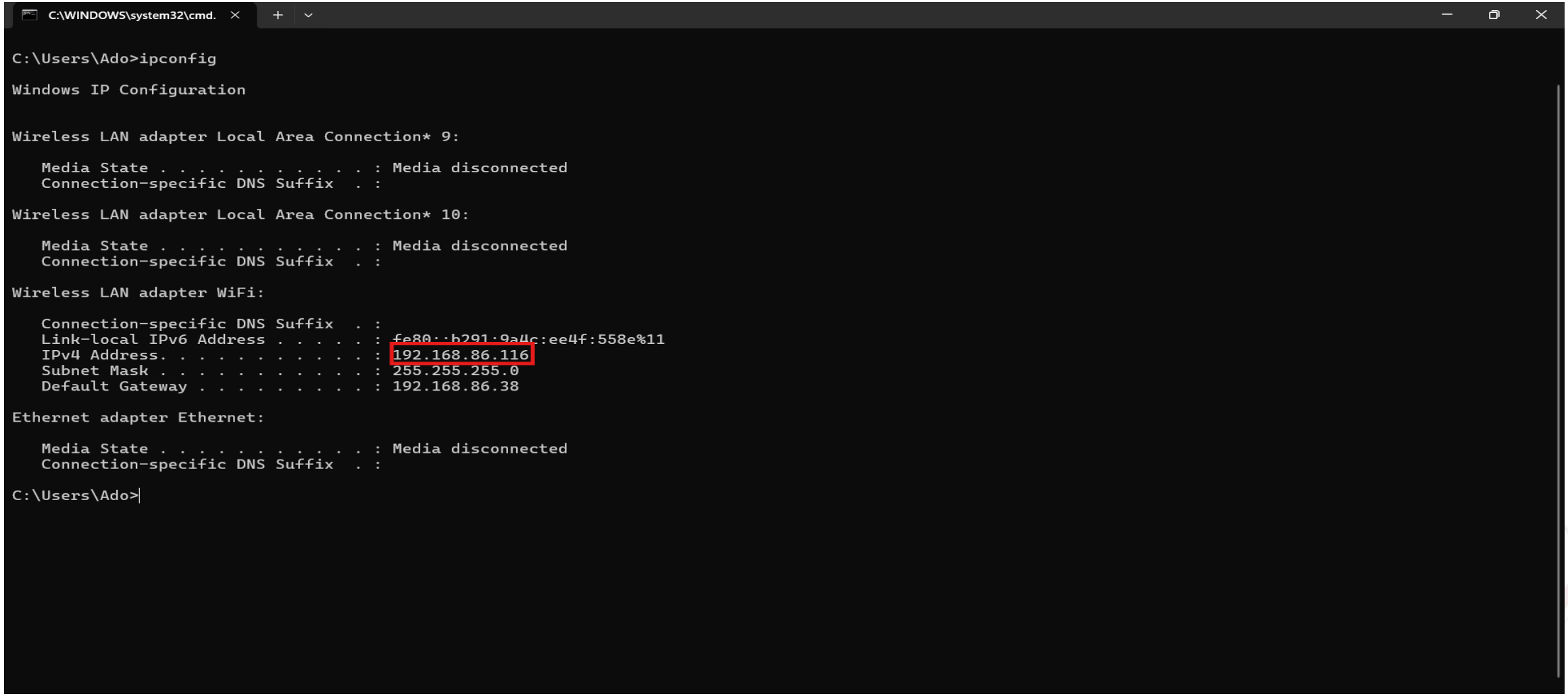
4. The concept of protocol



4. The concept of protocol

- DNS is used to translate domain names (eg www.unbi.ba) into IP addresses (eg 184.222.37.17). It is also called the Internet directory. The existence of DNS eliminates the need to remember IP addresses because users access various information via domain names.
- The FTP protocol is a protocol used to transfer documents between devices on the network, that is, between a client and a server. The FTP protocol is used today to transfer text documents, images, videos, etc.
- Mail protocols are responsible for the successful exchange of electronic mail.
- Three basic protocols are used:
  - POP (Post Office Protocol),
  - IMAP (Internet Message Access Protocol) and
  - SMTP (Simple Mail Transfer Protocol).
- The first two protocols are used for receiving, while the SMTP protocol is used for delivering.

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5. ISO/OSI and TCP/IP model

- The ISO/OSI (International Organization for Standardization/Open Systems Interconnection) model is a conceptual framework used to understand and implement various network protocols.

- It is about a systematic approach to networks and system networking, and the elements of communication are designed so that everything is divided into seven layers.

5. ISO/OSI and TCP/IP model

The layers of the OSI model are:

- Application Layer – provides network services to applications,
- Presentation Layer – encryption, i.e. data encryption, translation of different data formats,
- Session Layer – session management,
- Transport Layer – enables data transfer,
- Network Layer – routing data packets through the network,
- Data Link Layer – node-to-node communication management,
- Physical Layer – responsible for the physical elements of communication.

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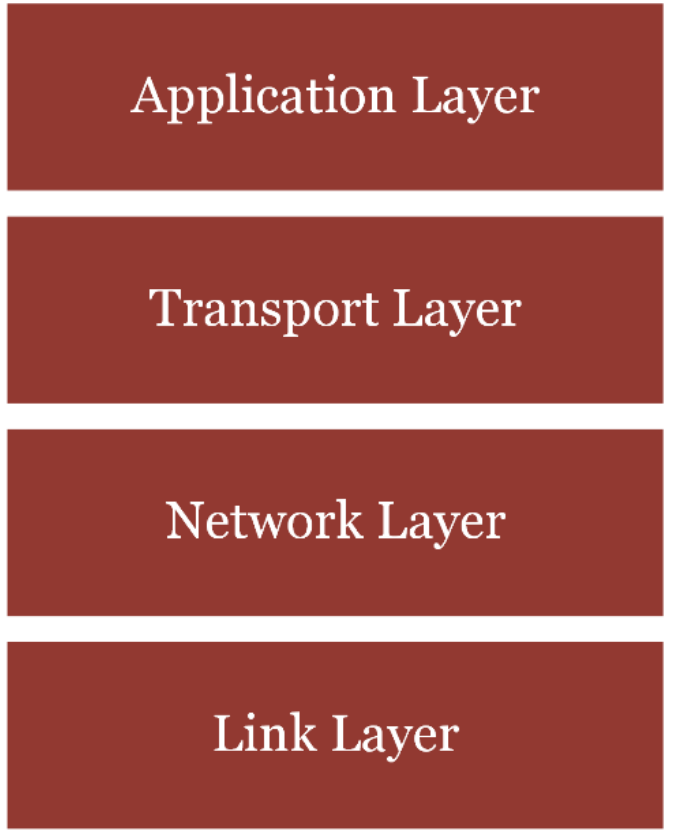
5. ISO/OSI and TCP/IP model

The TCP/IP model represents a key framework that defines all elements related to communication and data exchange between different devices on a network.

It is made of four layers, namely:

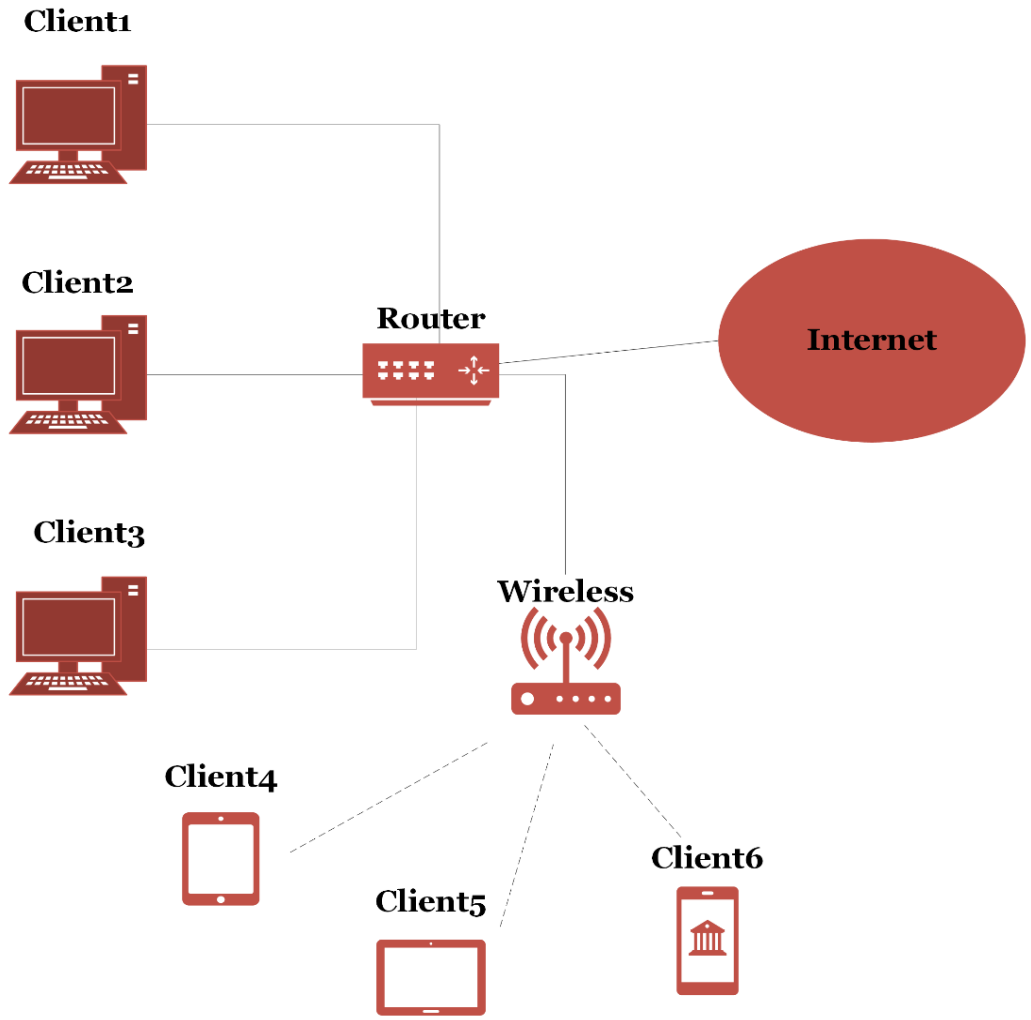
- Application Layer,
- Transport Layer,
- Network Layer or often Internet Layer,
- Link Layer or often Network Access, Network Interface).



6. LAN network

- A LAN network is a network in a smaller geographical area, such as in a home, apartment building, or office building, etc.

- An illustration of a LAN network is shown in the figure.



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6. LAN network

A LAN network can be divided into:

- Wired LAN – Ethernet cables are used to connect devices,
- Wireless LAN, WLAN – where devices connect wirelessly.

The most famous topologies in the LAN network are:

- Star Topology,
- Bus Topology,
- Ring Topology,
- Mesh Topology.

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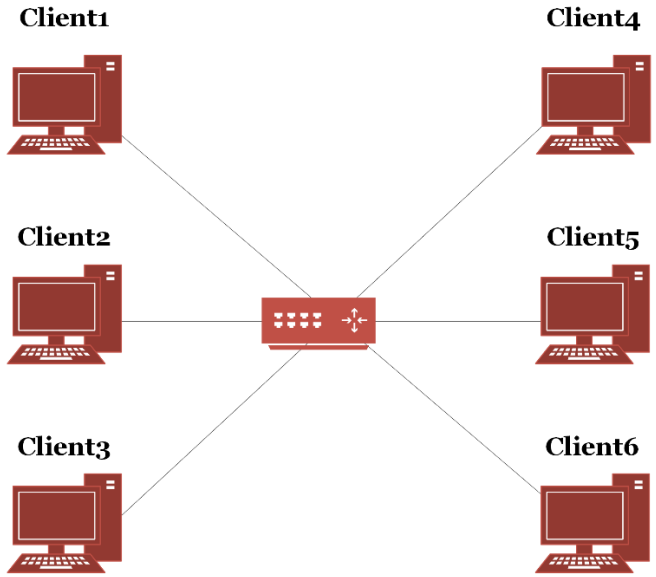
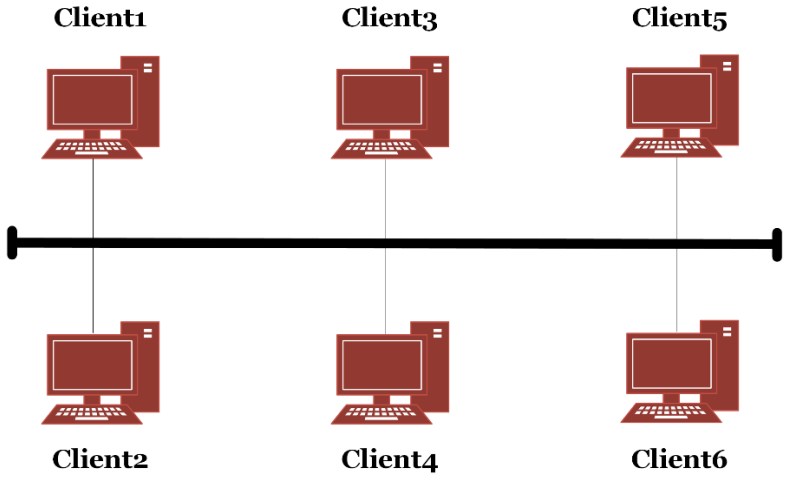
6. LAN network

- In a Star Topology, all devices are connected to a central device (e.g. a switch), where data is forwarded through said device.
- In a Bus Topology, all devices are connected to a central cable called a bus.
- In the Ring Topology, all devices are connected to two neighboring devices, and data travels in a circular fashion.
- In a Mesh Topology, all devices are connected to every device in the network.

6. LAN network

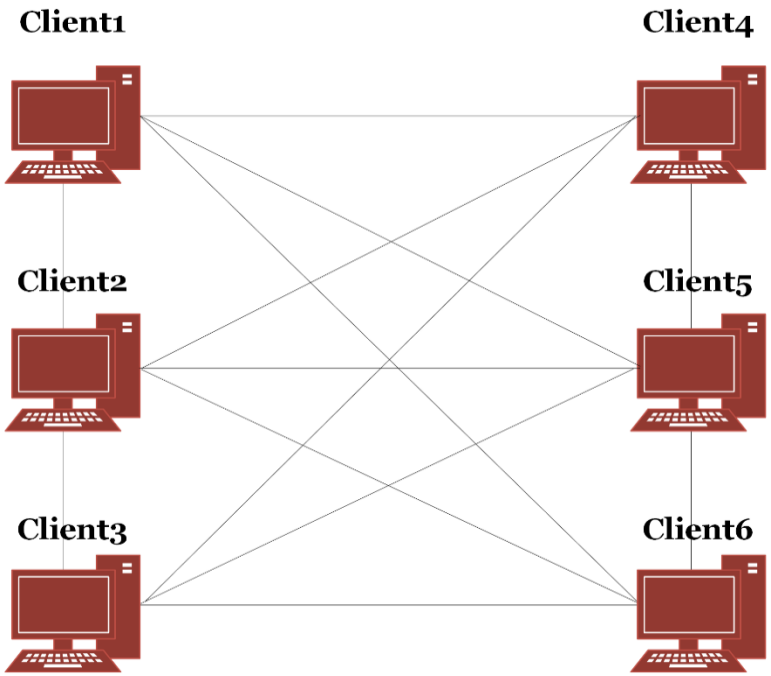


Star Topology

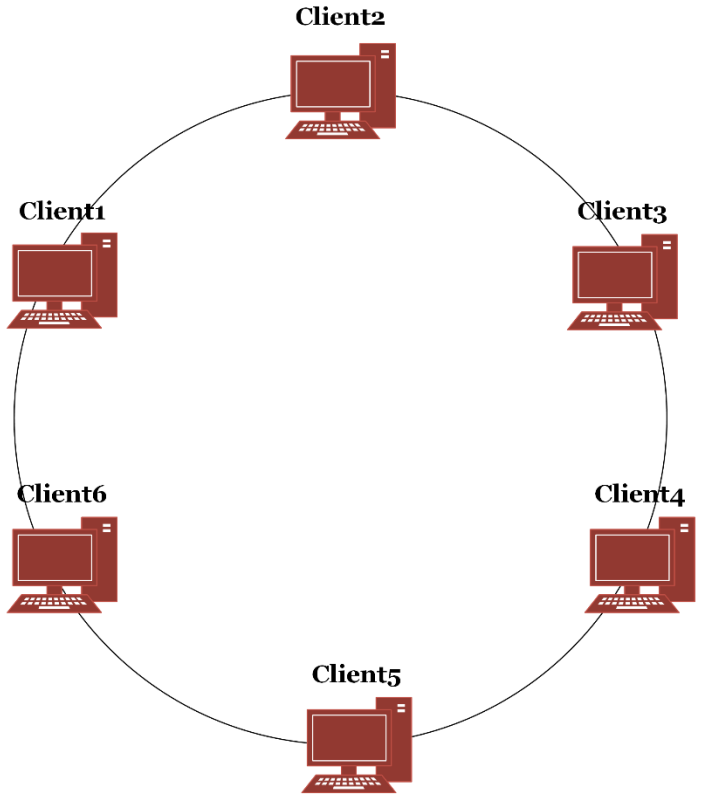


Bus Topology

6. LAN network



Mesh Topology



Star Topology

7. Network equipment

Network equipment is the electronic devices that are necessary for communication between different devices on a network. The most commonly used network devices include:

- Router,
- Switch,
- Access Point,
- Modem,
- Firewall,
- Load Balancer,
- Repeater,
- Network Interface Card,
- Bridge.

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7. Network equipment

- Routers connect different networks and route packets between them.
- A Switch connects devices within a single network. Usually, it is a LAN network.
- An Access Point is a device that allows other devices (e.g. smartphones, tablets, laptops) to connect to a wired network wirelessly. This device is usually connected to the rest of the network via a wire.
- A Modem (Modulator/Demodulator) is used to convert digital signals to analog and vice versa, for the purpose of transmitting signals over a telephone or cable network.
- It is usually provided by an ISP. Some examples are DSL (Digital Subscriber Line) modems and cable modems.

7. Network equipment

- A Firewall is a security device used to monitor incoming and outgoing traffic to a network. In this regard, a firewall operates according to defined security rules for each network.
- A Load Balancer is used to distribute the load across multiple servers. The purpose of this device is to reduce the overload on a particular server by distributing user requests evenly across each server.
- A Repeater is a device used to amplify and retransmit signals. In other words, it extends the reach of the signal.
- A Network Interface Card is the device through which the computer connects to the network.
- A Bridge is used to connect different network segments and filter traffic between them.

WBnet

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Questions & Answers

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