Module 1

Introduction to networking and Application Layer

MODULE-I

Introduction to networks: Network hardware, Network software, Reference models.

Application Layer: Principles of Network Applications: Network Application Architectures, Processes Communicating, Transport Services Available to Applications, Transport Services Provided by the Internet, Application-Layer Protocols. The Web and HTTP: Overview of HTTP, Non-persistent and Persistent Connections, HTTP Message Format, User-Server Interaction: Cookies, Web Caching, The Conditional GET, File Transfer: FTP Commands & Replies, DNS; The Internet's Directory Service: Services Provided by DNS, Overview of How DNS Works, DNS Records and Messages

The Introduction to Networking (TSO)

Understanding the Building Blocks

Theory session outcome

- Understanding the fundamentals of networks
- Familiarity with network components
- Understanding network protocols
- Understanding the concept of The concept OSI model

What is a Network?

- A system of interconnected computers and other devices that share resources and communicate with each other.

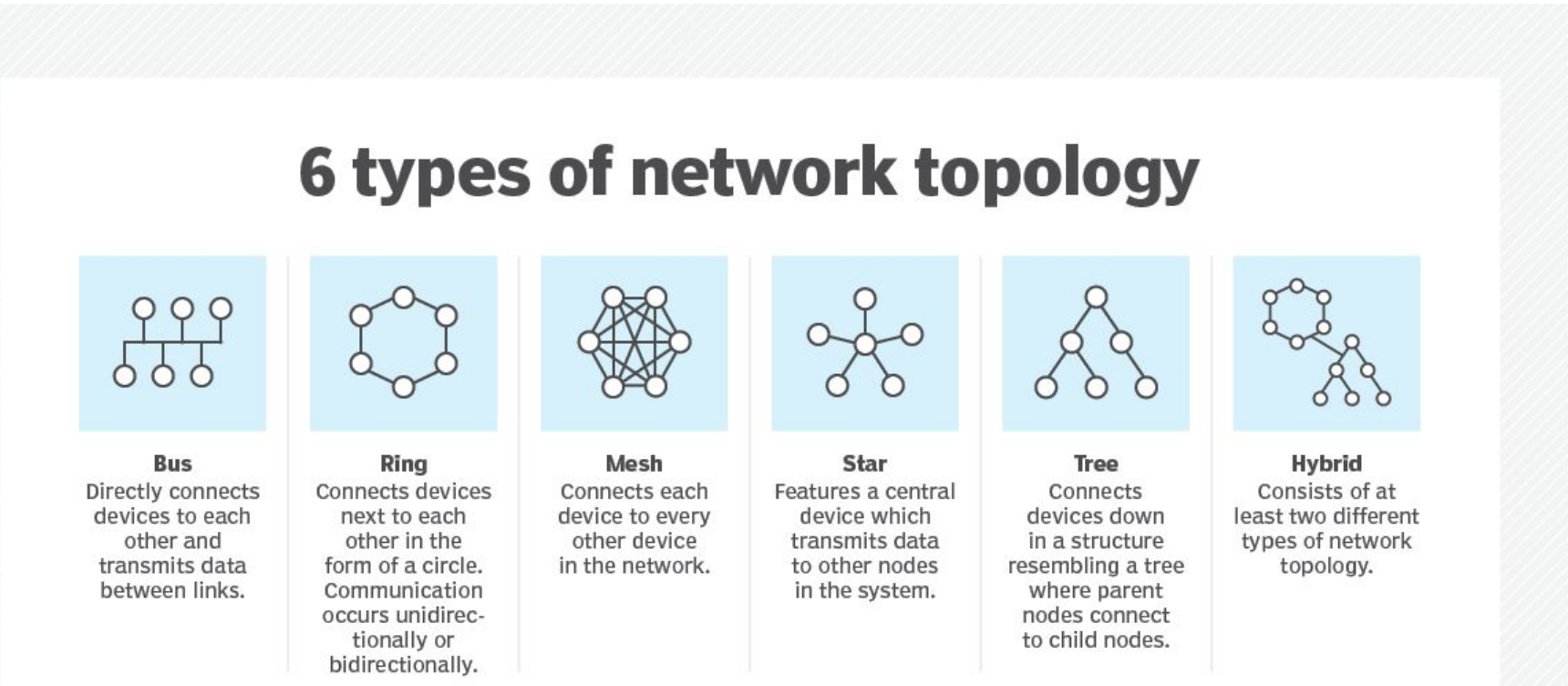
Types of Networks

Local Area Network (LAN):
Connects devices within a limited geographical area (e.g., office, school).

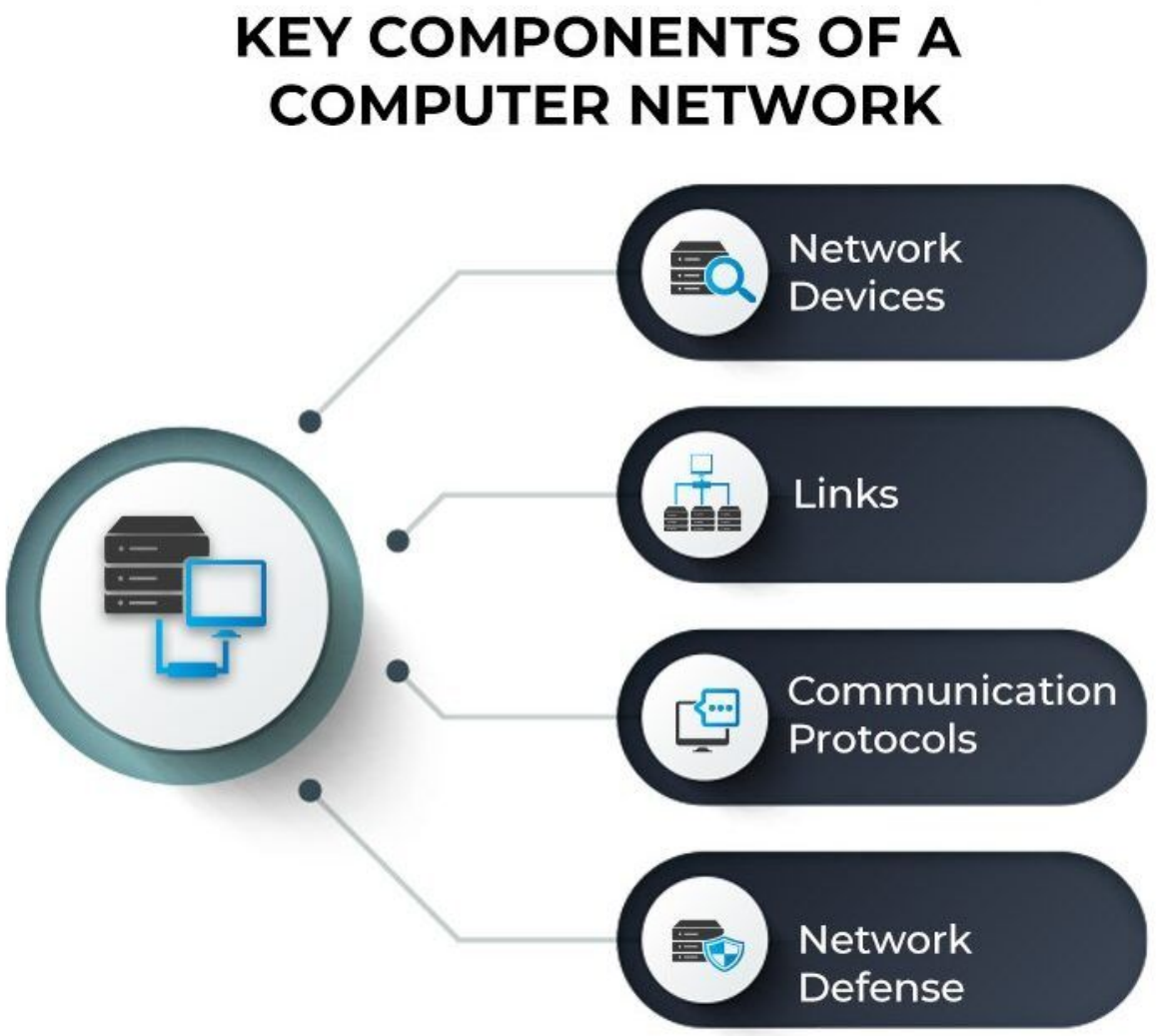
- **Wide Area Network (WAN):** Connects devices over a large geographical area (e.g., cities, countries).

- **Metropolitan Area Network (MAN):** Connects devices within a city or metropolitan area.

Network Topology



Network Components



Network Devices

- Network devices or nodes are computing devices that need to be linked in the network. Some network devices include:
- **Computers, mobiles, and other consumer devices**: These are end devices that users directly and frequently access. For example, an email originates from the mailing application on a laptop or mobile phone.
- **Servers**: These are application or storage servers where the main computation and data storage occur. All requests for specific tasks or data come to the servers.
- **Routers**: Routing is the process of selecting the network path through which the data packets traverse. Routers are devices that forward these packets between networks to ultimately reach the destination. They add efficiency to large networks.
- **Switches**: Repeaters are to networks what transformers are to electricity grids—they are electronic devices that receive network signals and clean or strengthen them. Hubs are repeaters with multiple ports in them. They pass on the data to whichever ports are available. Bridges are smarter hubs that only pass the data to the destination port. A switch is a multi-port bridge. Multiple data cables can be plugged into switches to enable communication with multiple network devices.
- **Gateways**: Gateways are hardware devices that act as ‘gates’ between two distinct networks. They can be firewalls, routers, or servers.

Links

- Links are the transmission media which can be of two types:
- **Wired:** Examples of wired technologies used in networks include coaxial cables, phone lines, twisted-pair cabling, and optical fibers. Optical fibers carry pulses of light to represent data.
- **Wireless**: Network connections can also be established through radio or other electromagnetic signals. This kind of transmission is called ‘wireless’.
  - The most common examples of wireless links include communication satellites, cellular networks, and radio and technology spread spectrums. Wireless LANs use spectrum technology to establish connections within a small area.

Communication protocols

- A communication protocol is a set of rules followed by all nodes involved in the information transfer. Some common protocols include the internet protocol suite (TCP/IP), IEEE 802, Ethernet, wireless LAN, and cellular standards. TCP/IP is a conceptual model that standardizes communication in a modern network. It suggests four functional layers of these communication links:
- Network access layer: This layer defines how the data is physically transferred. It includes how hardware sends data bits through physical wires or fibers.
- Internet layer: This layer is responsible for packaging the data into understandable packets and allowing it to be sent and received.
- Transport layer: This layer enables devices to maintain a conversation by ensuring the connection is valid and stable.
- Application layer: This layer defines how high-level applications can access the network to initiate data transfer.

Most of the modern internet structure is based on the TCP/IP model, though there are still strong influences of the similar but seven-layered open systems interconnection (OSI) model.

IEEE802 is a family of IEEE standards that deals with local area networks (LAN) and metropolitan area networks (MAN). Wireless LAN is the most well-known member of the IEEE 802 family and is more widely known as WLAN or Wi-Fis.

Network Défense

- While nodes, links, and protocols form the foundation of a network, a modern network cannot exist without its defenses. Security is critical when unprecedented amounts of data are generated, moved, and processed across networks.
- A few examples of network defense tools include firewall, intrusion detection systems (IDS), intrusion prevention systems (IPS), network access control (NAC), content filters, proxy servers, anti-DDoS devices, and load balancers.

Network Hardware

- Network Interface Card (NIC): A hardware component that enables a device to connect to a network.

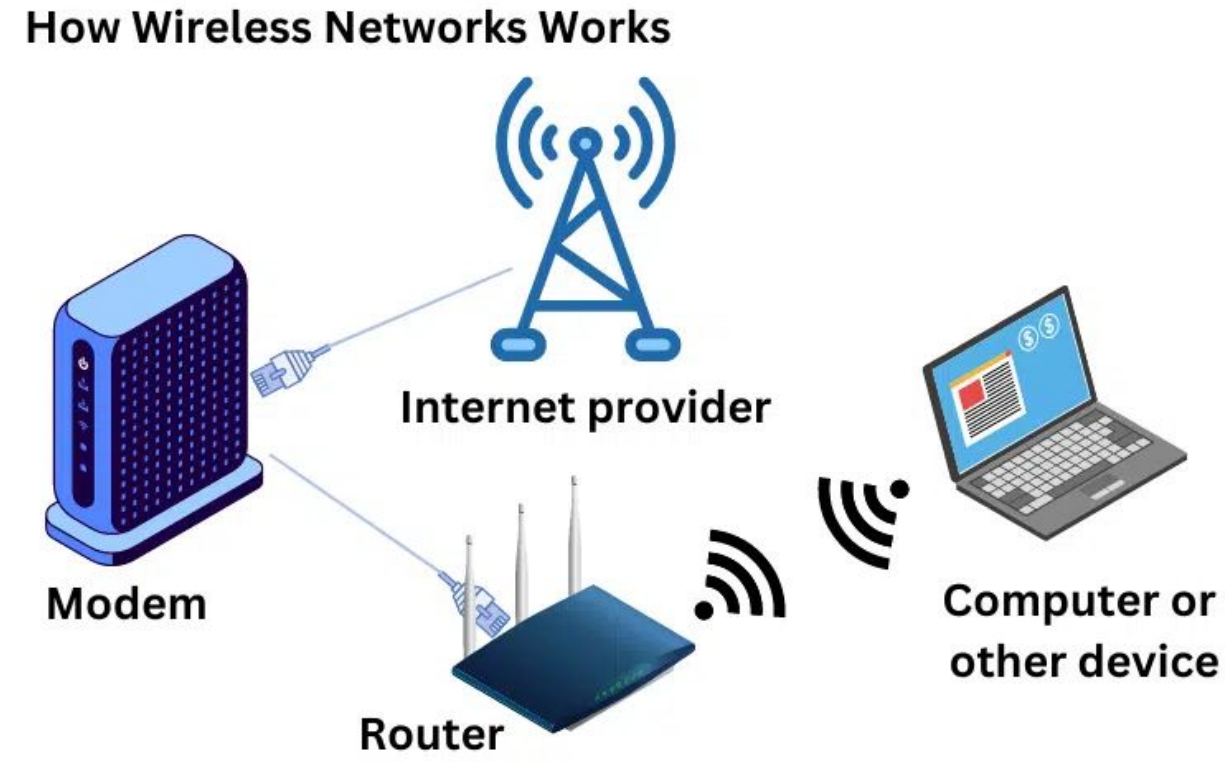
- Cables

Unshielded Twisted Pair (UTP)

Shielded Twisted Pair (STP)

Coaxial cable Fiber optic cable

Wireless Networking



Network Software

- Operating Systems
- Network functionality: File sharing
- Printing
- Remote access
- Examples: Windows, macOS, Linux

Network Protocols

- **Definition:** Rules that govern communication between devices on a network.
- **Examples:**
- TCP/IP
- HTTP
- FTP
- SMTP

Protocol Hierarchies

- Networks are organized as a stack of layers or levels, each one built upon the other.
- The number of layers, the name of each layer, the contents of each layer, and the function of each layer differ from network to network.
- The purpose of each layer is to offer certain services to the higher layers

The entities comprising the corresponding layers on different machines are called peers.

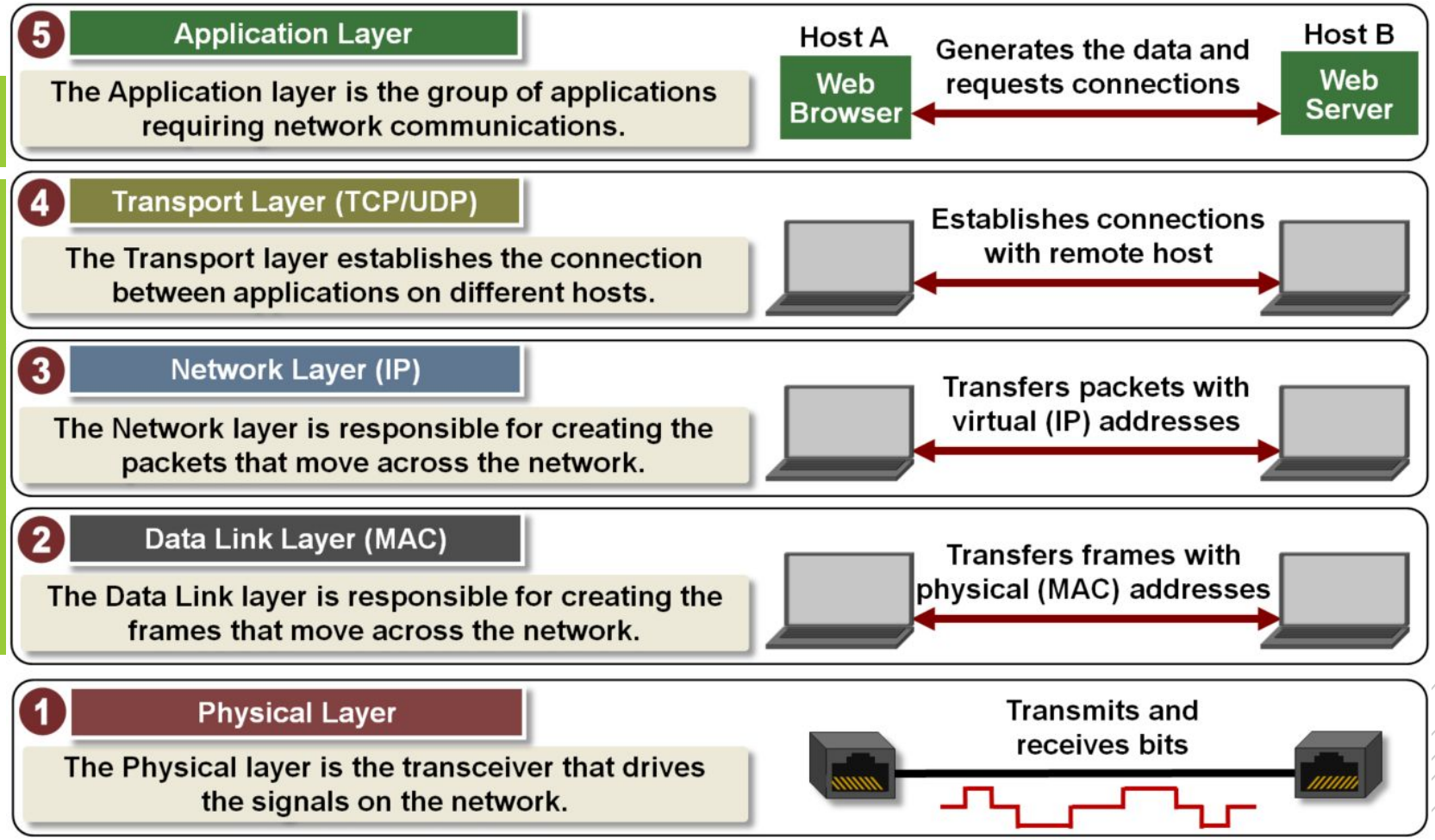
The peers may be processes, hardware devices, or even human beings.

 No data are directly transferred from layer n on one machine to layer n on another machine. Each layer passes data and control information to the layer immediately below it, until the lowest layer is reached.

 Below layer 1 is the physical medium through which actual communication occurs.

 A set of layers and protocols is called a network architecture. A list of protocols used by a certain system, one protocol per layer, is called a protocol stack

A five-layer network

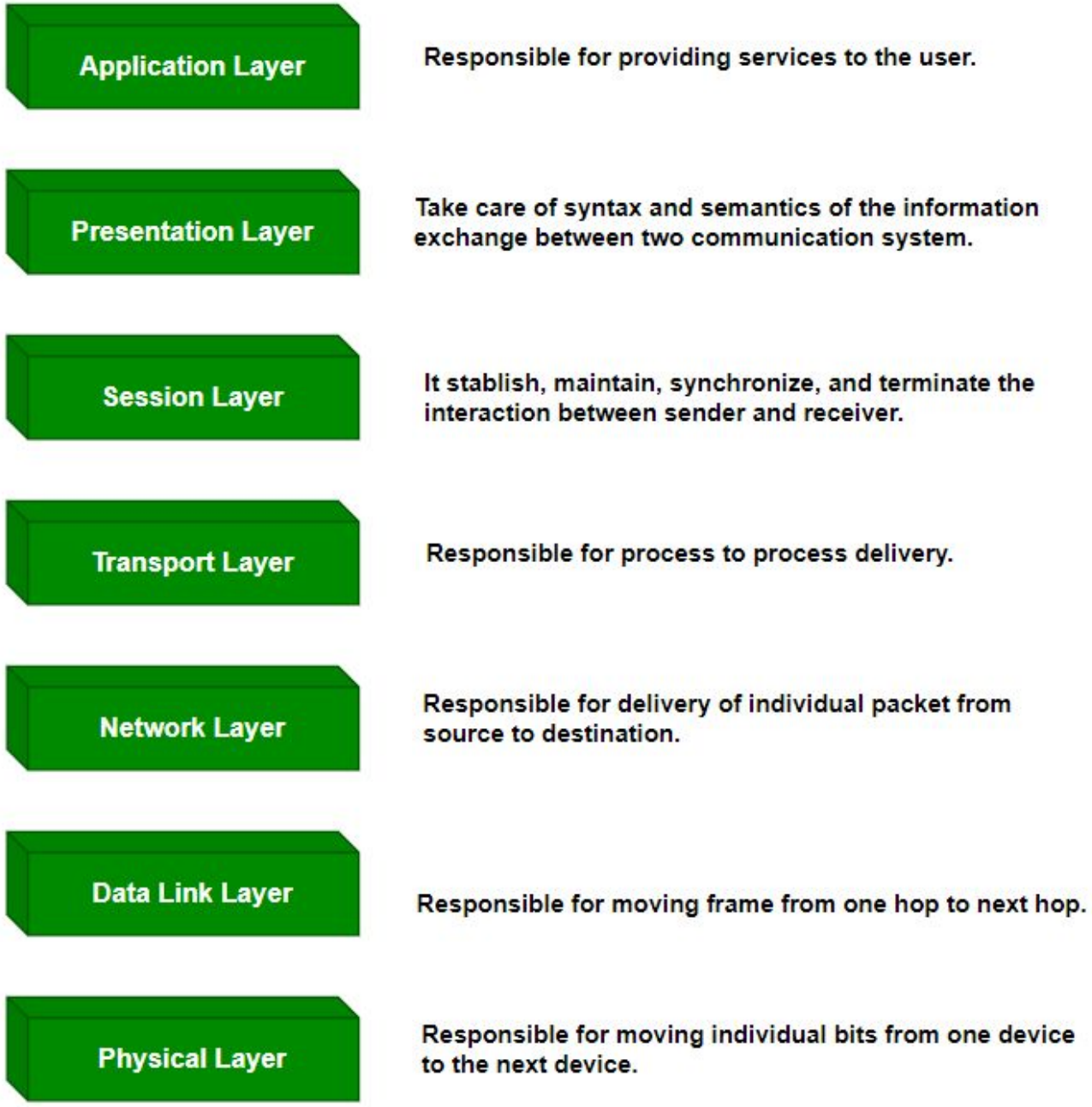


Connection-Oriented and Connectionless Services

- Layers offer two different types of service to the layers above them: connection-oriented and connectionless.
- Connection-oriented service first establishes a connection, uses the connection, and then releases the connection. eg. Telephone system.
- Connectionless service is modelled after the postal system. Each message carries the full destination address, and each one is routed through the system independent of all the others.
- Unreliable connectionless service is called datagram service, which does not return an acknowledgement to the sender.
- In this service the sender transmits a single datagram containing a request; the reply contains the answer.

	Service	Example
Connection -oriented	Reliable Message Stream	Sequence of pages
	Reliable Byte Stream	Remote Login
	Unreliable Connection	Digitized Voice
Connection -less	Unreliable Datagram	Electronic Junk Mail
	Acknowledged Datagram	Registered Mail
	Request-reply	Database Query

The OSI (Open Systems Interconnection)



Data Flow In OSI Model

- Data flows through the OSI model in a step-by-step process:
- Application Layer: Applications create the data.
- Presentation Layer: Data is formatted and encrypted.
- Session Layer: Connections are established and managed.
- Transport Layer: Data is broken into segments for reliable delivery.
- Network Layer : Segments are packaged into packets and routed.
- Data Link Layer: Packets are framed and sent to the next device.
- Physical Layer: Frames are converted into bits and transmitted physically

Let's look at it with an Example:

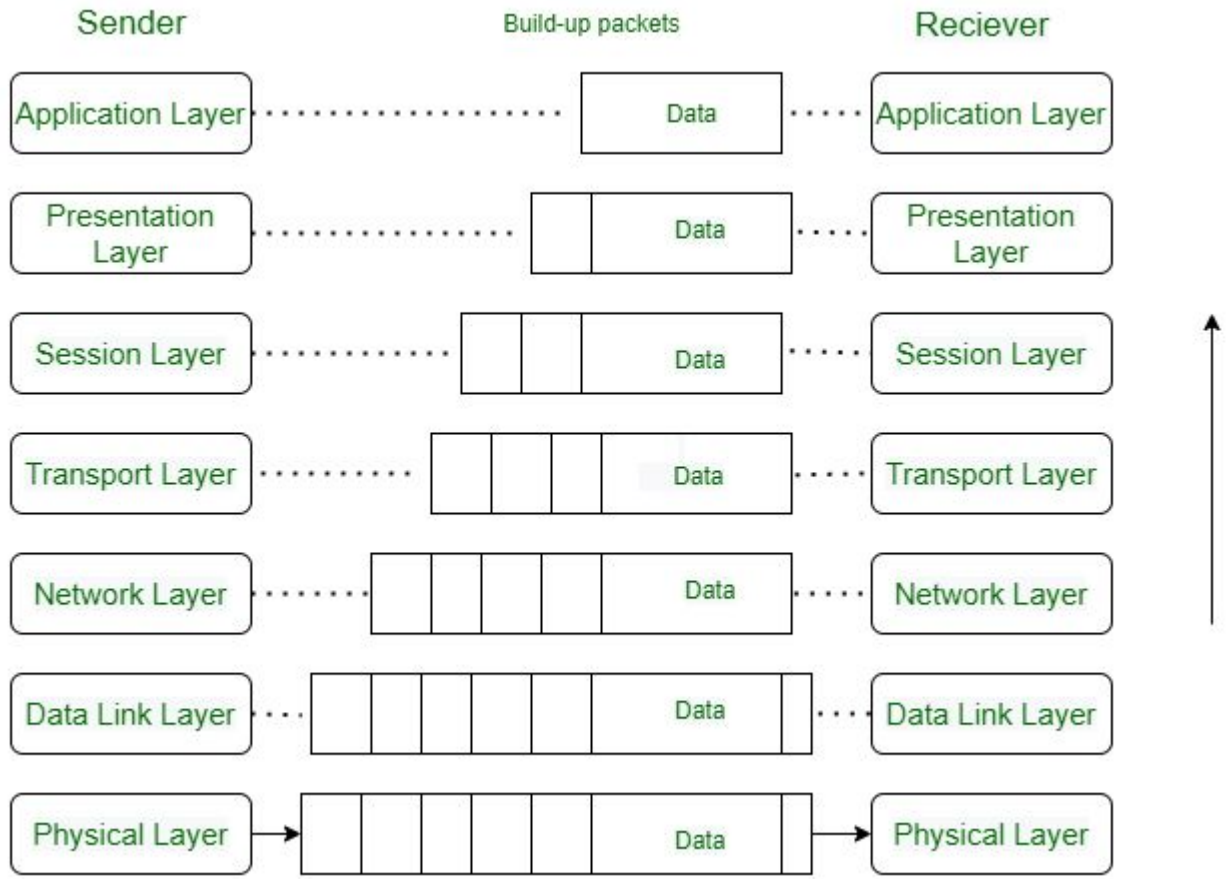
Luffy sends an e-mail to his friend Zoro.

Step 1: Luffy interacts with e-mail application like Gmail , outlook , etc. Writes his email to send. (This happens in Layer 7: Application layer)

Step 2: Mail application prepares for data transmission like encrypting data and formatting it for transmission. (This happens in Layer 6: Presentation Layer)

Step 3: There is a connection established between the sender and receiver on the internet. (This happens in Layer 5: Session Layer)

Step 4: Email data is broken into smaller segments. It adds sequence number and error-checking information to maintain the reliability of the information. (This happens in Layer 4: Transport Layer)



Step 5: Addressing of packets is done in order to find the best route for transfer. (This happens in Layer 3: Network Layer)

Step 6: Data packets are encapsulated into frames, then MAC address is added for local devices and then it checks for error using error detection. (This happens in Layer 2: Data Link Layer)

Step 7: Lastly Frames are transmitted in the form of electrical/ optical signals over a physical network medium like ethernet cable or WiFi.

After the email reaches the receiver i.e. Zoro, the process will reverse and decrypt the e-mail content. At last, the email will be shown on Zoro's email client