Layered Task

In layered architecture of Network Model, one whole network process is divided into small tasks. Each small task is then assigned to a particular layer which works dedicatedly to process the task only. Every layer does only specific work.

OSI Model

Open System Interconnect is an open standard for all communication systems. OSI model is established by International Standard Organization (ISO). This model has seven layers:

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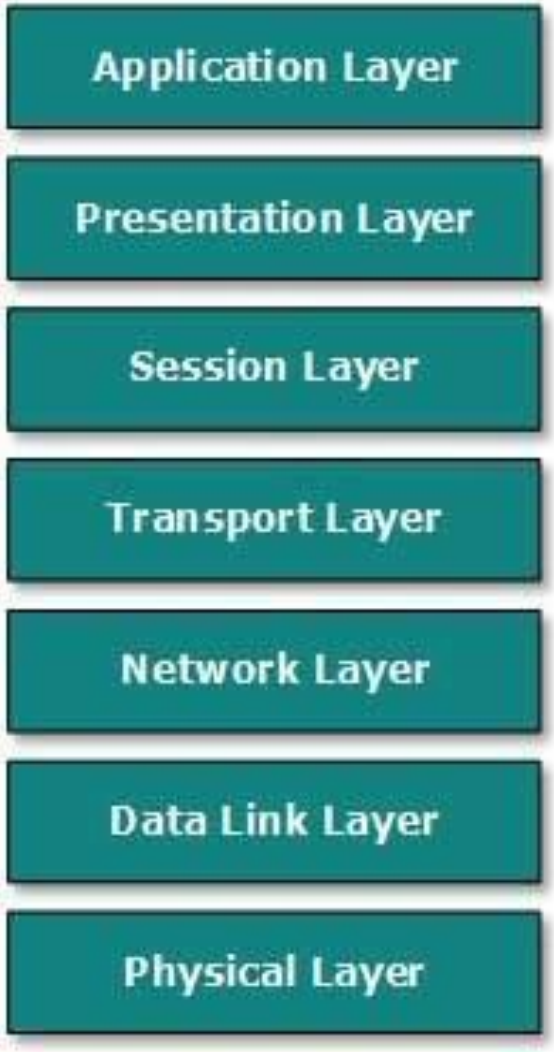

TCP/IP Model

The main work of TCP/IP is to transfer the data of a computer from one device to another. The main condition of this process is to make data reliable and accurate so that the receiver will receive the same information which is sent by the sender. To ensure that, each message reaches its final destination accurately, the TCP/IP model divides its data into packets and combines them at the other end, which helps in maintaining the accuracy of the data while transferring from one end to another end.

The TCP/IP layers are:

1. **Application Layer**
2. **Transport Layer(TCP/UDP)**
3. **Network/Internet Layer(IP)**
4. **Data Link Layer (MAC)**
5. **Physical Layer**

NOTE

The only layers that are not in TCP/IP model is **Presentation Layer** and **Session Layer**
The rest are a bit similar

Lets look at functions of each layer

1. Physical Layer Introduction

The lowest layer of the OSI reference model is the physical layer. It is responsible for the actual physical connection between the devices. The physical layer contains information in the form of **bits.** It is responsible for transmitting individual bits from one node to the next. When receiving data, this layer will get the signal received and convert it into 0s and 1s and send them to the Data Link layer, which will put the frame back together.

The functions of the physical layer are as follows:

1. **Bit synchronization:** The physical layer provides the synchronization of the bits by providing a clock. This clock controls both sender and receiver thus providing synchronization at bit level.
2. **Bit rate control:** The Physical layer also defines the transmission rate i.e. the number of bits sent per second.
3. **Physical topologies:** Physical layer specifies the way in which the different, devices/nodes are arranged in a network i.e. bus, star, or mesh topology.
4. **Transmission mode:** Physical layer also defines the way in which the data flows between the two connected devices. The various transmission modes possible are Simplex, half-duplex and full-duplex.

* Hub, Repeater, Modem, Cables are Physical Layer devices.

2. Data Link Layer (DLL) (Layer 2)

- The data link layer is responsible for the node-to-node delivery of the message. The main function of this layer is to make sure data transfer is error-free from one node to another, over the physical layer. When a packet arrives in a network, it is the responsibility of DLL to transmit it to the Host using its MAC address.

- **Data Link Layer is divided into two sub-layers:**
- **1. Logical Link Control (LLC)**
- **2. Media Access Control (MAC)**

Logical Link Control (LLC)

- It deals with protocols, flow-control, and error control

Media Access Control (MAC)

- The packet received from the Network layer is further divided into frames depending on the frame size of NIC(Network Interface Card). DLL also encapsulates Sender and Receiver's MAC address in the header.
- The Receiver's MAC address is obtained by placing an ARP(Address Resolution Protocol) request onto the wire asking "Who has that IP address?" and the destination host will reply with its MAC address.

The functions of the Data Link layer are :

- **Framing:** Framing is a function of the data link layer. It provides a way for a sender to transmit a set of bits that are meaningful to the receiver. This can be accomplished by attaching special bit patterns to the beginning and end of the frame.
- **Physical addressing:** After creating frames, the Data link layer adds physical addresses (MAC address) of the sender and/or receiver in the header of each frame.
- **Error control:** Data link layer provides the mechanism of error control in which it detects and retransmits damaged or lost frames.
- **Flow Control:** The data rate must be constant on both sides else the data may get corrupted thus, flow control coordinates the amount of data that can be sent before receiving acknowledgement.
- **Access control:** When a single communication channel is shared by multiple devices, the MAC sub-layer of the data link layer helps to determine which device has control over the channel at a given time.

* *Packet in Data Link layer is referred to as* ***Frame.***

** Data Link layer is handled by the NIC (Network Interface Card) and device drivers of host machines.

*** Switch & Bridge are Data Link Layer devices.

CSMA/CD (Carrier Sense Multiple Access/ Collision Detection)

- **Carrier sense multiple access** with Collision Detection (CSMA/CD) is a **network protocol** for carrier transmission that operates in the Medium Access Control (MAC) layer. It senses or listens whether the shared channel for transmission is busy or not, and defers transmissions until the channel is free. The **collision detection** technology detects collisions by sensing transmissions from other stations. On detection of a collision, the station stops transmitting, sends a jam signal, and then waits for a random time interval before retransmission
- **Collision detection in CSMA/CD involves the following features:**
- **Carrier sense:** Before transmitting data, a device listens to the network to check if the transmission medium is free. If the medium is busy, the device waits until it becomes free before transmitting data.
- **Multiple Access:** In a CSMA/CD network, multiple devices share the same transmission medium. Each device has equal access to the medium, and any device can transmit data when the medium is free.

- **Collision detection:** If two or more devices transmit data simultaneously, a collision occurs. When a device detects a collision, it immediately stops transmitting and sends a jam signal to inform all other devices on the network of the collision. The devices then wait for a random time before attempting to transmit again, to reduce the chances of another collision.
- **Backoff algorithm:** In CSMA/CD, a backoff algorithm is used to determine when a device can retransmit data after a collision. The algorithm uses a random delay before a device retransmits data, to reduce the likelihood of another collision occurring.
- **Minimum frame size:** CSMA/CD requires a minimum frame size to ensure that all devices have enough time to detect a collision before the transmission ends. If a frame is too short, a device may not detect a collision and continue transmitting, leading to data corruption on the network.

Advantages of CSMA/CD:

- **Simple and widely used:** CSMA/CD is a widely used protocol for Ethernet networks, and its simplicity makes it easy to implement and use.
  Fairness: In a CSMA/CD network, all devices have equal access to the transmission medium, which ensures fairness in data transmission.
  Efficiency: CSMA/CD allows for efficient use of the transmission medium by preventing unnecessary collisions and reducing network congestion.

Disadvantages of CSMA/CD:

- **Limited scalability:** CSMA/CD has limitations in terms of scalability, and it may not be suitable for large networks with a high number of devices.
  Vulnerability to collisions: While CSMA/CD can detect collisions, it cannot prevent them from occurring. Collisions can lead to data corruption, retransmission delays, and reduced network performance.
  Inefficient use of bandwidth: CSMA/CD uses a random backoff algorithm that can result in inefficient use of network bandwidth if a device continually experiences collisions.
  Susceptibility to security attacks: CSMA/CD does not provide any security features, and the protocol is vulnerable to security attacks such as packet sniffing and spoofing.

3. Network Layer (Layer 3) :

- The network layer works for the transmission of data from one host to the other located in different networks. It also takes care of packet routing i.e. selection of the shortest path to transmit the packet, from the number of routes available. The sender & receiver's IP addresses are placed in the header by the network layer.

- **<u>The functions of the Network layer are :</u>**
- **1.Routing:** The network layer protocols determine which route is suitable from source to destination. This function of the network layer is known as routing.
- **2. Logical Addressing:** In order to identify each device on internetwork uniquely, the network layer defines an addressing scheme. The sender & receiver's IP addresses are placed in the header by the network layer. Such an address distinguishes each device uniquely and universally.

Segment in Network layer is referred to as **Packet**.

** Network layer is implemented by networking devices such as routers.

4. Transport Layer (Layer 4) :

- The transport layer provides services to the application layer and takes services from the network layer. The data in the transport layer is referred to as *Segments*. It is responsible for the End to End Delivery of the complete message. The transport layer also provides the acknowledgement of the successful data transmission and re-transmits the data if an error is found.
- **At sender's side:** Transport layer receives the formatted data from the upper layers, performs **Segmentation**, and also implements **Flow & Error control** to ensure proper data transmission. It also adds Source and Destination port numbers in its header and forwards the segmented data to the Network Layer.
- ***Note**: The sender needs to know the port number associated with the receiver's application.*
- Generally, this destination port number is configured, either by default or manually. For example, when a web application makes a request to a web server, it typically uses port number 80, because this is the default port assigned to web applications. Many applications have default ports assigned.

- **At receiver's side:** Transport Layer reads the port number from its header and forwards the Data which it has received to the respective application. It also performs sequencing and reassembling of the segmented data.

- **The functions of the transport layer are as follows:**
- 1. **Segmentation and Reassembly:** This layer accepts the message from the (session) layer, and breaks the message into smaller units. Each of the segments produced has a header associated with it. The transport layer at the destination station reassembles the message.
- 2. **Service Point Addressing:** In order to deliver the message to the correct process, the transport layer header includes a type of address called service point address or port address. Thus by specifying this address, the transport layer makes sure that the message is delivered to the correct process.
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- The services provided by the transport layer :
- **A. Connection-Oriented Service:** It is a three-phase process that includes
- – Connection Establishment
  – Data Transfer
  – Termination / disconnection
- In this type of transmission, the receiving device sends an acknowledgement, back to the source after a packet or group of packets is received. This type of transmission is reliable and secure.
- **B. Connectionless service:** It is a one-phase process and includes Data Transfer. In this type of transmission, the receiver does not acknowledge receipt of a packet. This approach allows for much faster communication between devices. Connection-oriented service is more reliable than connectionless Service.

** Data in the Transport Layer is called as **Segments**.*

*** Transport layer is operated by the Operating System. It is a part of the OS and communicates with the Application Layer by making system calls.*

*Transport Layer is called as **Heart of OSI** model.*

5. Session Layer (Layer 5)

- This layer is responsible for the establishment of connection, maintenance of sessions, authentication, and also ensures security.
- The functions of the session layer are :
- **1. Session establishment, maintenance, and termination:** The layer allows the two processes to establish, use and terminate a connection.
- **2. Synchronization:** This layer allows a process to add checkpoints which are considered synchronization points into the data. These synchronization points help to identify the error so that the data is re-synchronized properly, and ends of the messages are not cut prematurely and data loss is avoided.
- **3. Dialog Controller:** The session layer allows two systems to start communication with each other in half-duplex or full-duplex.

***All the below 3 layers(including Session Layer) are integrated as a single layer in the TCP/IP model as "Application Layer".*

Implementation of these 3 layers is done by the network application itself. These are also known as* ***Upper Layers *or* ***Software Layers****.*

6. Presentation Layer (Layer 6)

- The presentation layer is also called the **Translation layer**. The data from the application layer is extracted here and manipulated as per the required format to transmit over the network.

- **The functions of the presentation layer are :**
- **1. Translation:** For example, ASCII to EBCDIC.
- **2. Encryption/ Decryption:** Data encryption translates the data into another form or code. The encrypted data is known as the ciphertext and the decrypted data is known as plain text. A key value is used for encrypting as well as decrypting data.
- **3. Compression:** Reduces the number of bits that need to be transmitted on the network.

7. Application Layer (Layer 7) :

- At the very top of the OSI Reference Model stack of layers, we find the Application layer which is implemented by the network applications. These applications produce the data, which has to be transferred over the network. This layer also serves as a window for the application services to access the network and for displaying the received information to the user.
- Example: Application – Browsers, Skype Messenger, etc.

- **The functions of the Application layer are :**
- **1. Network Virtual Terminal**
- **2. FTAM-File transfer access and management**
- **3. Mail Services**
- **3. Directory Services**