WEEK-01

Cloud Infra and Security

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Task -02

- **Prepare R&D Document on working & functionality of TCP/IP Model**

Introduction:
The TCP/IP model (Transmission Control Protocol/Internet Protocol) is the foundational suite for the Internet and modern networking. Developed by the U.S. Department of Defence in the 1970s, it defines how data should be packetized, addressed, transmitted, routed, and received. It is a more practical model compared to the theoretical OSI model and comprises four abstraction layers.

1. Application Layer

- **Primary Role:**
  Serves as the interface between user-facing applications and the underlying network system.
- **Combines OSI Layers:**
  Integrates the functions of the OSI Application, Presentation, and Session layers.
- **Key Responsibilities:**
  - Initiates communication from software like browsers, mail clients, etc.
  - Formats and prepares data as required.
  - Applies encryption/decryption (e.g., SSL/TLS) when needed.
  - Handles session creation, maintenance, and termination.
- **Common Protocols Used:**
  - **HTTP/HTTPS –** For loading web pages**.**
  - **FTP –** File transfers**.**
  - **SMTP, POP3, IMAP** – Email services.

- **DNS –** Converts domain names to IP addresses.
- **SNMP –** Used for monitoring and managing network devices.

- **Example :**
  When you type a website URL into a browser, the browser initiates an HTTP request at this layer.

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2. Transport Layer

- **Purpose:**
  Manages reliable or efficient communication between source and destination systems.
- **Responsibilities:**
  - Breaks data into segments and reassembles them at the receiver.
  - Manages port numbers to direct traffic to specific services.
  - Implements flow control and congestion management.
  - Ensures either reliability or speed, based on protocol choice.
- **Key Protocols:**
  - **TCP (Transmission Control Protocol):**
    - Connection-oriented
    - Delivers data in sequence and error-free
    - Uses acknowledgments and retransmissions
  - **UDP (User Datagram Protocol):**
    - Connectionless
    - No guarantee of delivery
    - Lightweight and faster for streaming or gaming
- **Example :**
  Sending an email via TCP ensures that every byte of data is reliably delivered and ordered.

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3. Internet Layer

- **Role in the Stack:**
  Handles the logical addressing and routing of packets across interconnected networks.

- **Core Tasks:**
  - Assigns and interprets IP addresses.
  - Chooses optimal routes for data packets.
  - Performs fragmentation of packets for various network types.
- **Major Protocols:**
  - IP (Internet Protocol – IPv4/IPv6): For addressing and routing.
  - ICMP (Internet Control Message Protocol): For error messages and diagnostics (e.g., ping).
  - ARP (Address Resolution Protocol): Maps IP addresses to MAC addresses.
- **Example :**
  When loading a website from a server in another country, this layer decides the best path to reach that server.

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4. Network Access Layer (Link Layer)

- **Primary Focus:**
  Handles the actual transmission of frames over physical media and ensures that data reaches the next device in the path.
- **Responsibilities:**
  - Encapsulates data into frames.
  - Assigns MAC (hardware) addresses for delivery on the same network.
  - Performs error detection through mechanisms like CRC.
  - Interfaces with the physical medium (cables, Wi-Fi signals, etc.).
- **Common Technologies/Protocols:**
  - Ethernet – Wired LAN communication.
  - Wi-Fi (IEEE 802.11) – Wireless LAN.
  - Others: DSL, FDDI, Token Ring

- **Example :**
  Your laptop sends data using its Wi-Fi adapter, which follows IEEE 802.11 to convert data into radio signals.

- **Encapsulation & Decapsulation Flow**
- **Sender's Side (Encapsulation):**
  1. Application Layer adds its header →
  2. Transport Layer adds TCP/UDP segment header →
  3. Internet Layer attaches IP header →
  4. Network Access Layer wraps data in a frame with MAC addresses.
- **Receiver's Side (Decapsulation):**
  The process reverses—each layer removes its respective header until the application data is revealed.

- **Differences with OSI:**

Feature	OSI Model	TCP/IP Model
Number of Layers	7	4
Developed by	ISO	DoD
Design Approach	Theoretical	Practical
Widely Used	Educational/reference	Real-world networks

- **Real-World Applications of TCP/IP Model:**

Layer	Example Use Case
Application	Browsing websites using HTTP/HTTPS
Transport	Reliable file downloads via TCP
Internet	Routing packets using IP addresses across routers
Network Access	LAN communication via Ethernet or Wi-Fi