THE TCP/IP MODEL

# ABSTRACT

This R&D document explains the TCP/IP Model, which describes the guidelines for implementing computer protocol. The report studies the layered structure, working mechanisms, functionality and protocol operations in networking scenarios. The document also compares TCP/IP with the OSI model in a few chosen aspects.

# OBJECTIVE

* To understand how each layer of the TCP/IP model works.
* To show how different layers send and receive data and use encapsulation or decapsulation.
* To find where the real-world protocols (such as TCP, IP, HTTP, DNS, etc.) are mapped to each TCP/IP layer .
* To investigate how packet delivery works with the use of network models.

# INTRODUCTION

In the 1970s, the **Defense Advanced Research Project Agency (DARPA)** created the TCP/IP model which is a protocol suite employed in interconnecting the network devices. The seven-layer OSI model is different from the TCP/IP model. It is a four-layer model with each layer handling different functionality for data communication. End-to-end data transmission is offered by it and is the foundation for all internet communications.

The model makes it possible to manage networking by separating it into simple layers:-

Application

Transport

Internet

Network Access

Encapsulation is used by each layer which then adds applicable headers to data before sending it down the stack which then provides reliable, interoperable communication.

# Layer wise Functional Analysis:

# **Layer 4 - Application Layer**

On the TCP/IP model, the Application Layer is the topmost layer, which lets applications and network services communicate. It hosts high-level protocols like HTTP, FTP, SMTP, and DNS that deal with the ways email, file transfers, and browsing the web are done on the network. It also takes care of data representation and encoding to ensure there is compatibility between different systems.

Working:

* The person starts an application such as a web browser or email client.
* A data request generated by application such as an HTTP GET to access a webpage.
* The Layer selects the suited protocol such as HTTP, FTP, SMTP.
* Handling the requests as allowed by the protocol.
* The data is formatted into a proper structure for transmission.
* Services such as DNS will change a domain name into an IP address.
* After formatting, the data is given to the Transport Layer to be transmitted further.
* Upon getting data, the Application Layer translates it and displays it to the user application.

Functionality of application layer:

* Applications permit users to interact with the network.
* The system offers essential (HTTP, FTP, SMTP, DNS, and DHCP) protocols.
* Uses different formats and encodes the data so that it can be delivered and interpreted properly.
* Handles the user session management and also resolves domain name.

Example:

* The web address e.g.,www.example.com is entered by a user into Chrome.
* HTTP is used by the browser (Application Layer) to create the GET /index.html.
* DNS takes www.example.com and resolves it into an IP address.
* The request for an HTTP is made to the web server’s IP address.

## **Layer 3 - Transport Layer**

It is the responsibility of the Transport Layer to ensure a quicker and smooth transfer of data across a network. It handles segmentation, keeping an ordered sequence, checking for errors, and controlling the flow of data to make sure there isn’t any problem during communication.

Working:

* Let source and destination devices connect with each other (by implementing TCP three-way handshake).
* Large data of segments is divided into small packets so that it can be sent over a network.
* Allows data to reach the required application by giving it the right port number.
* Prevents traffic jams by using the sliding window mechanism.
* Checks all incoming data to make sure errors are being noticed.
* Resends packets that are missing or damaged when required.
* Resembles the segments of data to form the original message in the proper order.

Functionality of Transport layer:

* Channels data to the right application with the help of port numbers.
* Deals with segmentation, sequence ordering, and resembling of data packets.
* TCP provides connection oriented ,reliable and faster delivery and UDP provides connectionless delivery without any guarantee.
* Uses data flow management to ensure that the speed of transmitting data remains under control.
* Check for errors if any and repeat transmission of the data to improve its accuracy.

Example:

* Prior to transmission, TCP creates a new connection by carrying out a 3-way handshake i.e., SYN → SYN-ACK → ACK.
* Data (for example, a file) is segmented into smaller parts.
* Every segment of data is transmitted in order and is acknowledged.
* If an error appears or some packets are lost, retransmission of data is performed.

## **Layer 2- Internet Layer**

It is the responsibility of the Internet Layer to handle the logical addresses, the process of routing, and delivery of packets over different networks. It makes sure that data is carried from the source host to the destination host by selecting the best paths in linked networks.

Working:

* The Transport Layer passes the segmented data to the Layer 2 i.e internet layer.
* Encapsulation is performed by the internet layer and segments are encapsulated into packets.
* The source and destination of every packet get their own IP addresses through this layer.
* The network finds out the most efficient way to reach the destination through routing protocols.
* The router sends the packet to the next host on the way to the destination.
* If the size of the packet is bigger than the permitted limits for the next network segment, it is fragmented.
* Fragmented packets got reassembled on the receiving end.

Functionality of Internet Layer:

* Make use ofIPv4 and IPv6 IP addresses to perform logical addressing.
* Facilitates the flowing of packets from one network to another.
* Transfer the packet to the next correct node in the network.
* IP, ICMP, ARP, and IGMP are the chief protocols it uses.

Example:

* The Transport Layer uses source and destination port numbers and generates a packet.
* In the Internet Layer, headers are put on the packets with the source and destination IP addresses.
* The packet is transferred from the source network to the destination network by means of routers.
* If the packet size is bigger than MTU (Maximum Transmission Unit), it then git fragmented and reassembled at the receiving end.

## **Layer 1 - Network Access Layer**

The Network Access Layer makes up the lowest level of the TCP/IP model. It manages physical moving data over local networks and defines the framing, addressing and transmitting of bits on Ethernet or Wi-Fi hardware. It unites the OSI Data Link and Physical Layers to handle device access as well as signal transmission.

Working:

* The Internet layer passes packets to the network access layer.
* Encapsulation is performed by encapsulating packets from the network layer into frames.
* Adds CRC method or any other error detection code to check and maintain the accuracy of transmission.
* Frames are turned into electrical, optical, or radio signals to be physically sent.
* Signals are sent in the physical medium by cables, fiber optics, or wireless sources.
* At the receiving end, it extracts the frames, reviews them for any issues, and delivers them to the next part of the network.

Functionality of Network access:

* Looks after framing, MAC addresses, and checks errors (belonging to Data Link).
* Hardware is managed to gain access to the transmission medium.
* Takes care of transforming the input data into output signals needed by the medium (Handles turning data into signals the medium needs).
* Manages the need of physical specifications such as the kinds of cables, connectors, and interfaces.

Example:

* A new frame is formed by using a destination MAC and an error-checking code (usually CRC).
* The information is changed into electrical signals and then delivered to the router using an Ethernet cable.
* On the other side, after receiving the signal, the device restores the frame and double-checks if there are errors.