What is TCP/IP and How does it Work?

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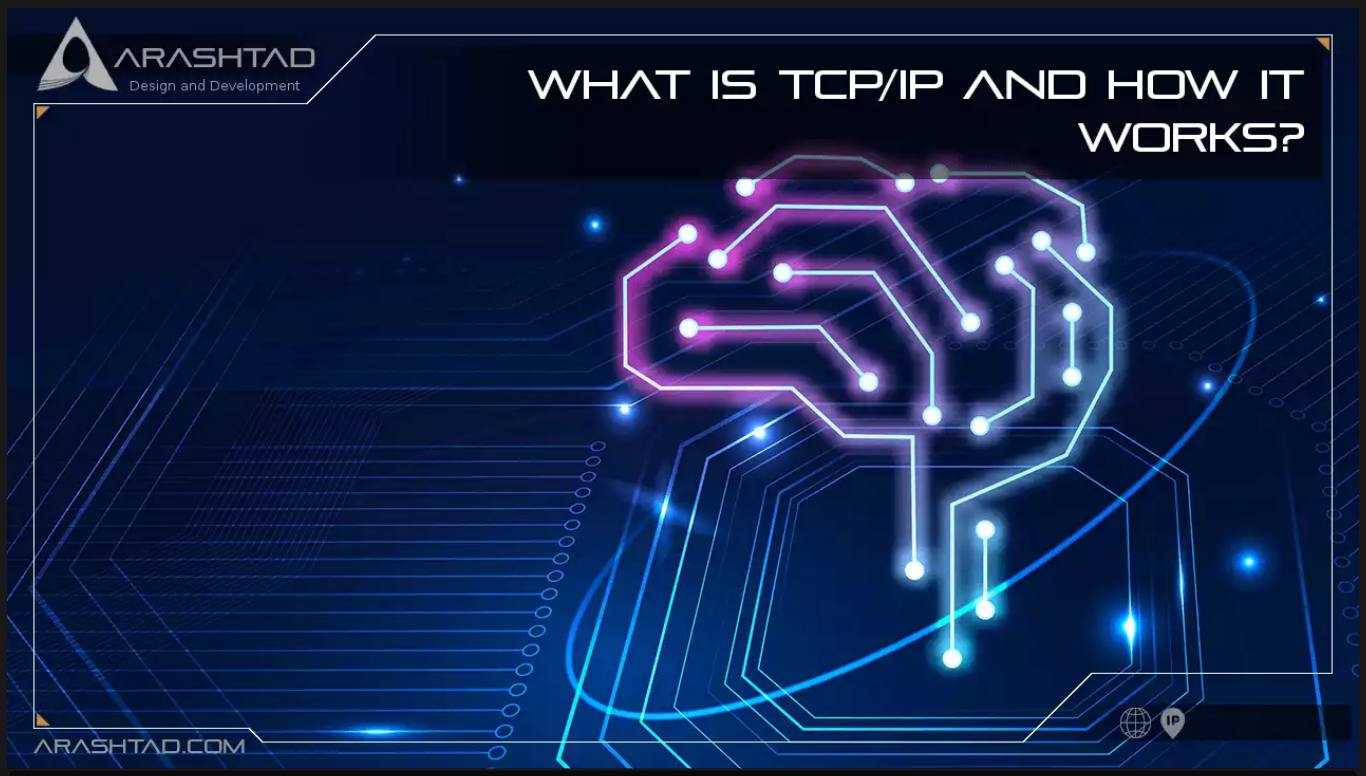

TCP/IP which is the acronym for Transmission Control Protocol/Internet Protocol is a set of standardized rules that allow computers or network devices to communicate with each other. This communication can either be on the internet or on a private network like an intranet. The TCP/IP protocol suite functions as an abstraction layer between internet applications and the routing and switching fabric.

TCP/IP functionality

TCP/IP determines how data should be exchanged on the internet by providing end-to-end communications that specify how it should be broken into packets, addressed, transmitted, routed, and received at the destination. TCP/IP is designed to make networks reliable so that data cannot be easily hacked. It also has the ability to recover automatically from the failure of any device on the network.

TCP which stands for Transmission Control Protocol has its own specific function in the IP suite. TCP defines how applications can create channels of communication across a network. It also manages how a message is assembled into

smaller packets before they are then transmitted over the internet and reassembled in the right order at the destination address.

IP or Internet Protocol is another important protocol of the IP suite and it defines how to address and route each packet to make sure it reaches the right destination. Each gateway computer on the network checks this IP address to determine where to forward the message.

Common TCP/IP protocols include the following:

1. HTTP (Hypertext Transfer Protocol) handles the communication between a web server and a web browser.
2. HTTPS (Hypertext Transfer Protocol Secure) handles secure communication between a web server and a web browser.
3. FTP (File Transfer Protocol) handles the transmission of files between computers.

How does TCP/IP work?

TCP/IP uses the client-server model of communication, meaning that a service is provided for a user or machine (a client), like sending a webpage, by another computer (a server) in the network. The TCP/IP suite of protocols is classified as stateless, which means each client request is considered new because it is unrelated to previous requests. Being stateless frees up network paths so they can be used continuously.
On the other hand, the transport layer itself is stateful. It transmits a single message, and its connection remains in place until all the packets in a message have been received and reassembled at the destination. The TCP/IP model differs slightly from the Open Systems Interconnection (OSI) networking model designed after it. The OSI reference model has seven layers and defines how applications can communicate over a network.

The 4 layers of the TCP/IP model

The TCP/IP functionality consists of four layers. Each of these layers has specific functionality and protocol. These layers include:

1. The application layer provides applications with standardized data exchange. Its protocols include HTTP, FTP, Post Office Protocol 3, Simple Mail Transfer Protocol, and Simple Network Management Protocol. At the application layer, the payload is the actual application data.

2. The transport layer is responsible for maintaining end-to-end communications across the network. TCP handles communications between hosts and provides flow control, multiplexing, and reliability. The transport protocols include TCP and User Datagram Protocol, which are sometimes used instead of TCP for special purposes.

3. The network layer, also called the internet layer, deals with packets and connects independent networks to transport the packets across network boundaries. The network layer protocols are IP and Internet Control Message Protocol, which are used for error reporting.

4. The physical layer, also known as the network interface layer or data link layer, consists of protocols that operate only on a link -- the network component that interconnects nodes or hosts in the network. The protocols in this lowest layer include Ethernet for local area networks and Address Resolution Protocol.

Why is TCP/IP important?

TCP/IP is not controlled by a single company or authority. As a result, the IP suite can be modified easily. Moreover, it is compatible with all operating systems, so it can communicate with any other system. The IP suite is also compatible with all types of computer hardware and networks. Furthermore, TCP/IP is highly scalable and consequently, can determine the most efficient path through the network. It is widely used in current internet architecture.

Uses cases of TCP/IP

TCP/IP use cases vary in so many different ways. This protocol can be used to provide remote login over the network for interactive file transfer to deliver email, to deliver webpages over the network, and to remotely access a server host's file system. In general, it is used to change the form of information at the time of transferring the data over a network from the concrete physical layer to the abstract application layer. It elaborates the basic protocols, or methods of communication, at each layer as data passes through.

Pros and cons of TCP/IP

The advantages of TCP/IP:

1. Helps establish a connection between different types of computers.
2. Works independently of the OS.
3. Supports many routing protocols.
4. Uses a client-server architecture that is highly scalable.
5. Can be operated independently.
6. Supports several routing protocols.
7. Is lightweight and doesn't place unnecessary strain on a network or computer.

The disadvantages of TCP/IP:

1. Is complicated to set up and manage.
2. The transport layer does not guarantee the delivery of packets.
3. Is not easy to replace protocols in TCP/IP.
4. Does not clearly separate the concepts of services, interfaces, and protocols, so it is not suitable for describing new technologies in new networks.
5. Is especially vulnerable to a synchronization attack, which is a type of denial-of-service attack in which a bad actor uses TCP/IP.

Differences between TCP/IP and IP ?

There are numerous differences between TCP/IP and IP. For example, IP is a low-level internet protocol that facilitates data communications over the internet. Its purpose is to deliver packets of data that consist of a header, which contains routing information, such as the source and destination of the data, and the data payload itself.

IP:

IP is limited by the amount of data that it can send. The maximum size of a single IP data packet, which contains both the header and the data, is between 20 and 24 bytes long. This means that longer strings of data must be broken into multiple data packets that must be independently sent and then reorganized into the correct order after they are sent. Since IP is strictly a data send/receive protocol, there is no built-in checking that verifies whether the data packets sent were actually received.

TCP/IP:

In contrast to IP, TCP/IP is a higher-level smart communications protocol that can do more things. TCP/IP still uses IP as a means of transporting data packets, but it also connects computers, applications, webpages, and web servers. TCP understands holistically the entire streams of data that these assets require in order to operate, and it makes sure the entire volume of data needed is sent the first time. TCP also runs checks that ensure the data is delivered.As it does its work, TCP can also control the size and flow rate of data. It ensures that networks are free of any congestion that could block the receipt of data.An example is an application that wants to send a large amount of data over the internet. If the application only used IP, the data would have to be broken into multiple IP packets. This would require multiple requests to send and receive data since IP requests are issued per packet.With TCP, only a single request to send an entire data stream is needed; TCP handles the rest. Unlike IP, TCP can detect problems that arise in IP and request retransmission of any data packets that were lost. TCP can also reorganize packets so they get transmitted in the proper order, and it can minimize network congestion. TCP/IP makes data transfers over the internet easier.

Wrapping Up

In this article, you learned about TCP/IP protocol, its functionality, layers, importance, pros and cons, and difference with IP protocol (which is a lower level network protocol). Of course, there are other high-level models that are newer and work more efficiently than the TCP/IP model like the OSI, but the TCP/IP protocol is more popular and widely adopted among companies and developers. Moreover, the OSI model is not practically used for communication. Rather, it defines how applications can communicate over a network. TCP/IP, on the other hand, is widely used to establish links and network interaction.

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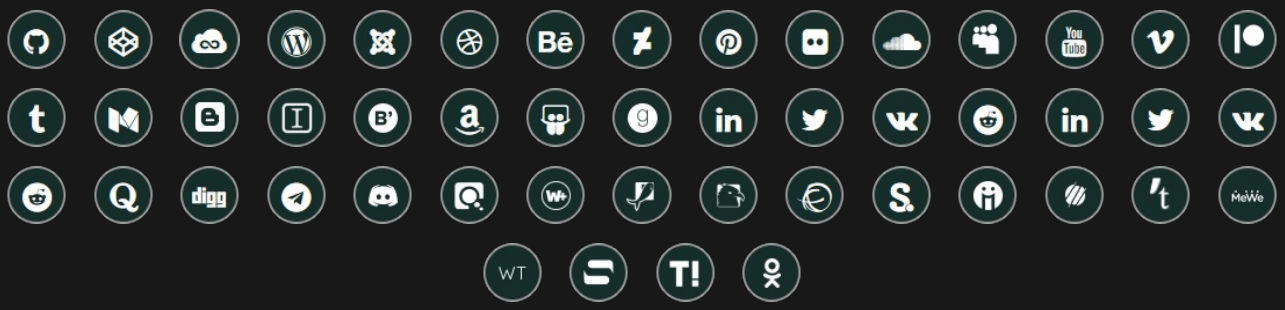

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