**Network Protocols (TCP/IP, UDP, HTTP, FTP) and how they work**

## Introduction

You ever wonder how the Internet work, or how one computer communicates with another computer, you log in to a website through a web browser and you requested some information, how does the browser communicate with the website server and get that information (data) displayed to your screen, it’s through the internet protocol, communication protocol is one of the fundamentals of backend engineering, Transmission Control Procol / Internet Protocol (TCP/IP) plays a crucial role in communication protocols.

## TCP/IP

Transmission Control Protocol / Internet Protocol is a set of standardized rules allowing computers to communicate on a network like the Internet. To still feel like this is strange let me explain this to you like 7 years old, TCP/IP is like a set of rules that help computers talk to each other over the internet. It ensures messages get sent correctly, like putting addresses on letters and using routers to deliver them. The TCP/IP protocols suite consists of several protocols that work together to enable communication across networks. some of the important ones are:

* Internet Protocol (IP)
* Transmission Control Protocol (TCP)
* User Datagram Protocol (UDP)
* Domain Name System (DNS)
* File Transfer Protocol (FTP)
* Simple Mail Transfer Protocol (SMTP)
* Hypertext Transfer Protocol (HTTP)

Now let’s get into details with each and every one of the listed protocols.

## Internet Protocol (IP)

Internet protocol is a core suite of TCP/IP, its major function is to provide the addressing and routing mechanisms necessary for the delivery of data packets across networks. what does this mean? in simple terms, it’s just like phone numbers for computers. Every computer connected to the internet has its own unique IP address, just like how each person has their own phone number. These IP addresses are a series of numbers that help the computers find each other and send messages. When you want to send a message or a picture to someone on the internet, your computer breaks it into smaller pieces called packets. Each packet is like a little piece of the message. It puts the IP address of the person you want to send it to on each packet, like putting their address on an envelope. The packets then travel across the internet and go through different routers, which are like post offices. These routers read the IP address on each packet and figure out where to send it next until it reaches the right computer.

When the packets arrive at the other computer, they are put back together in the right order, like assembling a puzzle. Then the computer can read the message or show the picture you sent. IP also helps with important things like making sure the packets get to the right place and can be put back together correctly. It helps prevent the packets from getting lost or mixed up along the way.

## Transmission Control Protocol (TCP)

TCP Is a communication standard that enables application programs and computing devices to exchange messages over a network. It is designed to send packets across the internet and ensure the successful delivery of data and messages over networks. So what does this mean? Let's say you have some packages with different labels and patterns and you want to get them delivered to a friend in another city, TCP is that magical system that helps make sure all the packages get to your friend safely and in the right order. When you send the packages, TCP breaks them into smaller parts called packets. Each packet is like a small box with some of the packages inside. It puts a number on each packet, like a sticker, so your friend knows the order they should be opened it. Then, TCP sends these packets one by one, like a long line queue of people with each person carrying the packages. As each packet arrives, your friend’s computer says, “I got it!” and sends a message back to your computer to say it arrived safely. If the message doesn’t come back, your computer knows something went wrong, and it sends that packet again, like sending another person to carry the box. Once all the packets arrive at your friend’s computer, TCP helps put them back together in the right order, just like your friend opening the packages in the order in which they are labeled. This way, your friend gets all the packages exactly as you sent them.

So, TCP is like a helpful system that breaks your packages into sub-packages of smaller packets, sends them one by one, and makes sure they all arrive safely and in the right order. It’s like having a magical helper that ensures nothing gets lost on the way and your friend gets all the packages you sent them.

## User Datagram Protocol (UDP)

UDP is a communication protocol that is used for time-critical data transmission, it’s a connectionless protocol that offers a simpler, faster, and less reliable delivery mechanism compared to TCP, It is often used for applications that can tolerate some degree of data loss, such as real-time audio and video playback, online gaming, etc.

what does this mean? Imagine you want to play a game of catch with your friend who lives far away. UDP is like a fast and simple way to throw a ball to your friend, but without worrying too much if they catch it or not. When you want to play catch, you throw a ball toward your friend’s house. With UDP, you don’t wait for your friend to catch the ball and throw it back to you. Instead, you keep throwing more balls without waiting. Some of the balls you throw might reach your friend, and they can catch them. But some balls might get lost along the way, or your friend might miss them and they bounce away.

UDP is like that. It sends small packets of information, like little balls, to your friend’s computer. It doesn’t wait for a response or confirmation. It just keeps sending more and more packets quickly. If some packets get lost or don’t make it to your friend’s computer, UDP doesn’t worry too much. It knows that the important thing is to send the packets as fast as possible and hope that most of them reach your friend. This makes UDP great for things like streaming videos or live chats, where speed is important. Even if some information is missing or not delivered, the show can go on, and you can still see and hear most of what’s happening.

So, UDP is like a quick way of throwing balls at your friend without waiting for them to catch each one. It’s fast and simple, but it doesn’t worry too much if some balls are dropped or missed along the way.

## Domain Name System (DNS)

DNS is a distributed system used to translate human-readable domain names like (medium.com) into IP addresses. The DNS is a critical component of the internet infrastructure and allows users to access websites and other online resources using easy-to-remember domain names rather than numerical IP addresses (do you remember I discussed what an IP is above?).

What does this mean? DNS servers convert URLs and domain names into IP addresses that computers can understand and use. They translate what a user types into a browser into something the machine can use to find a webpage. This process of translation and lookup is called DNS resolution.

The basic process of a DNS resolution follows the steps below

* The user enters a web address or domain name into a browser.
* The browser sends a message, called a recursive DNS query, to the network to find out which IP or network address the domain corresponds to.
* The query goes to a recursive DNS server, which is also called a recursive resolver, and is usually managed by the internet service provider (ISP). If the recursive resolver has the address, it will return the address to the user, and the webpage will load.
* If the recursive DNS server does not have an answer, it will query a series of other servers in the following order: DNS root name servers, top-level domain (TLD) name servers, and authoritative name servers.
* The three server types work together and continue redirecting until they retrieve a DNS record that contains the queried IP address. It sends this information to the recursive DNS server and the webpage the user is looking for loads. DNS root name servers and TLD servers primarily redirect queries and rarely provide the resolution themselves.
* The recursive server stores, or caches, the A record for the domain name, which contains the IP address. The next time it receives a request for that domain name, it can respond directly to the user instead of querying other servers.
* If the query reaches the authoritative server and it cannot find the information, it returns an error message.

Common DNS records include A record, NS record, TXT record, and CNAME record.

## File Transfer Protocol (FTP)

The term file transfer protocol (FTP) simply refers to a process that involves the transfer of files between devices over a network. It provides a standard set of commands for accessing, uploading, and downloading files.

There are different types of FTP, (FTP) anonymous, FTPS (FTP Secure), and others. FTPS (FTP Secure) is an extension of FTP that adds a layer of security through the use of SSL (Secure Sockets Layer) or TLS (Transport Layer Security) encryption. It provides secure file transfer by encrypting the data and ensuring that it cannot be intercepted or tampered with during transit. FTPS is commonly used when data security is a concern. there are still others ones, you can read about them.

## Simple Mail Transfer Protocol (SMTP)

SMTP is like a special language that your mailbox uses to send emails to your friend’s mailbox. It defines how email clients and servers communicate to transmit or exchange messages, and data regardless of their underlying hardware or software.

SMTP is a mail delivery protocol, not a mail retrieval protocol. SMTP is responsible for sending emails from your computer to the recipient’s email server. It’s like the messenger that carries your message from your computer to the destination server. It ensures that your email is delivered to the correct email server based on the recipient’s email address.

On the other hand, to retrieve or receive emails from your email server, you use a different protocol called POP3 (Post Office Protocol version 3) or IMAP (Internet Message Access Protocol). These protocols handle the process of fetching emails from the server and delivering them to your email client or program.

When you want to check your emails, your email client (such as Outlook, Gmail, or Yahoo Mail) connects to the email server using either POP3 or IMAP. POP3 downloads the emails from the server to your device, and usually, it removes the emails from the server after they are downloaded. IMAP, on the other hand, allows you to access your emails on multiple devices while keeping them stored on the server.

## Hypertext Transfer Protocol (HTTP)

This is the most common of all protocols, The Hypertext Transfer Protocol (HTTP) is an application-layer protocol, it’s designed for communication between web browsers and servers and can also be used for other purposes. it runs on top of different layers of the network protocol stack. Below are the listed layers.

1. Application layer:
2. Transport layer
3. Internet layer
4. Link layer etc

Each layer in the HTTP stack performs specific functions that contribute to the overall communication and data transfer process over the Internet. Together, these protocols enable the seamless exchange of information between web browsers and web servers, forming the backbone of the World Wide Web. Also, note we have HTTP and HTTPS, HTTPS is an extension of HTTP that operates over a secure connection. It adds an extra layer of security through the use of SSL (Secure Sockets Layer) or TLS (Transport Layer Security) encryption protocols.