

What happens when you type “youtube.com” into the web browser?

Every day we look something up on the internet. But what actually happens when we type in a web address like “www.youtube.com” into our browser and hit enter? How does our browser work behind the scenes to magically locate the website, connect to the website, then load that website in our browser? The whole thing happens so quickly these days, we rarely have time to think about it. And when we try to learn how our browser works, we see sentences like, “the url’s domain name is used to query the dns resolver associated with its specified domain ending,” and our brain immediately hits the eject button. The explanations are dense, unapproachable, and give no entry point to the average person.

The good news is that searching the web is a lot more straightforward than software engineers make it out to be. The power of modern computers lies in simplifying complexity. This means that users only need to know how to use the computer, not what the computer is actually doing in the background to make that happen. When you drive a car, you only need to focus on driving. You put your foot on the accelerator and turn the steering wheel. This makes technology easier to adopt (think of how quickly people took up the iPhone). But ironically, this seamless use also makes the inner workings of the internet harder to understand. The actual technical stuff is tucked behind the curtain like the Wizard of Oz.

But not knowing becomes scary when everything is online, when social media is the town square, and corporations and governments can dictate how we shop, work, and socialize online. If we don’t know what’s going on behind the scenes when we use the internet, then we as users are powerless to decide what the internet should look like.

Now is a good time to pop off the “hood” and get your arms a little dirty. No one likes being at the mercy of a shady mechanic. In four steps, we will outline how your web browser has been working this whole time:

In brief, your browser first looks up the website's address. Second, it connects to the website's server. Third, it requests the web page from the website's server. Finally, it displays the web page on your screen.

Here's how that happens, in detail:

Step 1: Looking up the web address.

Before your browser can connect to a website such as "youtube.com," it needs to be able to find it. The browser finds a website's location by asking a DNS server. DNS stands for a Domain Name Server. A DNS server receives a web address (such as "youtube.com"), and returns the website's actual digital address, called an IP address. IP address stands for Internet Protocol. It is a numerical address that is assigned to every device connected to a computer network.

To illustrate this, think of looking up a website's location like looking up someone's name in a phone book. The DNS server is the phone book. The web address is the name of the person you are looking up in the phone book. The IP address is like the phone number you find under their name that lets you get in contact with them.

A DNS server turns a human-friendly web address into a machine-friendly IP address. The address of a website, such as "youtube.com," is known as its URL (Uniform Resource Locator). URLs are user-friendly – they are easy to remember, easy to read, and easy to type. In the background, however, the browser must convert the URL address ("youtube.com") into a numbered address called an IP address (172.217.19.164). An IP address tells your browser exactly where a website is located on the internet. To convert a URL into an IP address, your browser sends the URL to a DNS server. The DNS server then sends back the URL's corresponding IP address.

With that overview in mind, let's go through each step in more detail. When you type the website's URL into the browser and hit enter, your search request travels from your computer, over Wi-Fi or Ethernet, and into your router. The router then passes your search request from your house to your Internet Service Provider (ISP).

To speed up this process, your Internet service provider stores the IP addresses of commonly searched websites. If the website you are looking up has been recently searched, your ISP can quickly look up the web address and send back its corresponding IP address. Now, your browser has the website's IP address, and therefore, knows how to get in touch with it.

However, sometimes the website you are looking up has not been recently searched by anyone. If this is the case, your ISP needs to request this information from a DNS server. Remember, a DNS server turns a human-friendly web address into a machine-friendly IP address. The catch? There are many different DNS servers, with each handling a different list of websites. This is where the root DNS server comes in.

The root DNS server acts like a dispatcher for other DNS servers. To go back to our phone book metaphor, you send the root DNS server the name of the person you want to get in contact with, then the root DNS server tells you which phone book to look them up in.

How does this work in practice? Your ISP messages the root DNS server. The root DNS server reads the URL, then tells your ISP which DNS server contains that website's IP address. The ISP then gets in touch with that specific DNS server. Once your ISP receives the website's IP address, it sends it back to your browser.

Using DNS servers to lookup web URLs provides a couple advantages. For one, DNS servers allow a website to have multiple IP addresses. This speeds up a user's connection to a website. This is because the DNS server can send the user the IP address of the server closest to them. In addition, DNS servers allow websites to more easily perform maintenance on their servers. Servers can be added or removed without the user ever noticing.

Did you know?

There are actually multiple root DNS servers. Thirteen global non-profits collaborate to run these root DNS servers. The biggest and most important of these is [ICANN](#), which is responsible for managing, maintaining, and setting the global standard for DNS servers. Each non-profit operates its own root DNS server. These non-profits then allow private companies such as GoDaddy to sell people the

exclusive right to a specific web addresses. This model helps ensure that the internet remains decentralized while still being able to inter-operate.

The internet as we know it today depends on the hard work of non-profits such as ICANN, IEEE, and IETF. They work tirelessly to maintain code, standards, and infrastructure. Without them, the internet wouldn't work!

Step 2: Establishing a connection to the server.

Using the IP address acquired in step 1, your browser can now locate YouTube's web server. Next, your browser needs to establish a stable connection with this server.

To establish a connection, your browser needs to first initiate contact with the server. Your browser does this by messaging YouTube's web server. Your browser addresses the message to the server's IP address. This message does two things. First, it tells the server that your browser would like to initiate contact. Second, it allows the browser and server to agree ahead of time what to do if a message is lost in transit. Messages get lost all the time, either because a router is broken, the network is congested, or the data gets corrupted in transit. For this reason, the browser and server need to agree ahead of time what to do if a message does get lost. Otherwise, communication between the browser and the server can fall apart.

Whenever two computers communicate over the internet, they use different protocols to send and receive data. To establish a connection with the server, your browser uses a protocol called TCP (Transmission Control Protocol).

Think of TCP like the post system. TCP handles the act of communicating. It sends messages, reads messages, and maintains a stable connection. By establishing a TCP connection, your browser can use other communication protocols to focus solely on transmitting data. If TCP is the post system, these other communication protocols are the messages being sent in the mail.

Did you know?

Having one protocol handle communication, while another protocol handles content, is called “separation of concerns.” Separation of concerns allows each protocol to split up the complicated work of communicating over the internet. That way, each protocol can focus on doing one thing well. Without separation of concerns, there would be no internet!

Step 3: Retrieving the web page.

Now that a stable connection has been established, your browser can finally retrieve YouTube’s web page. If the previous step was about setting up the postal service, this step is about using that service to deliver a message to YouTube’s servers. In this case, your browser sends a message requesting the web page from YouTube’s server.

A web page is stored as a series of documents (we will go into further detail in step 4). These documents tell the browser what the website’s content is (e.g. text, buttons, search bars), as well as how to format this content. In order to retrieve the web page, your browser must make a new type of request to the server called an HTTP request.

HTTP is *the* communication protocol for communicating with websites and other web services. HTTP communications are sent over the TCP connection established in step 2. This separation of concerns means that HTTP can focus on providing web content, while the underlying TCP connection can focus on maintaining a strong connection.

Once received, YouTube’s server will attempt to respond to your HTTP request by gathering all the documents necessary to display YouTube’s home page. YouTube’s server will then attempt to send back the requested web page as a series of files, as well as a status code indicating whether it was successful.

Sometimes the server succeeds in responding to your request, other times it fails. The server can fail for a variety of reasons, such as faulty code or missing files. If this happens, the server will instead send back an error status code with no web page. You might be familiar with the most common error message: “404 – not found.” When your web browser displays a 404 message, that means your browser was able to communicate with the server, but the server was unable to find the web page you requested.

Step 4: Displaying the web page.

Using the files received in step 3, your browser can finally display YouTube's homepage. The browser does this by translating these files into a graphic display. Typically, a web page is made up of three main types of files: HTML, CSS, and JavaScript. All of these documents play a different role in building the web page.

You might already be familiar with HTML (Hypertext Markup Language). HTML describes a website's content, as well as how that content is structured. Think of it like the blueprint of a house. HTML contains elements such as the text, headings, tables, and search bar.

CSS is the style guide that tells the browser how to style the website's content. Think of it like the decorations in a house. CSS contains the colors, margins, and font size for the website.

Finally, JavaScript is a programming language that makes the website more interactive. Think of it like the plumbing and electricity in a house – without it, the sink or appliances wouldn't work! JavaScript handles automation, animations, and user interaction.

JavaScript runs locally on your device. Without JavaScript, your browser would first need to message the server before updating your web page. You wouldn't be able to seamlessly hover over a drop-down menu or select different t-shirt colors in an online store without having to reload the entire web page.

In conclusion:

Hopefully, this helps you appreciate how incredible and complicated the internet is. By forgoing unnecessary technical details, this explanation helps you understand what exactly happens when you look up a website.

To recap, whenever you type "youtube.com" into your browser and hit enter, your browser 1. looks up the website's address using a DNS server, 2. connects to the website using TCP, 3. retrieves the web page from the server in the form of files, and 4. displays the web page on your screen.

It is amazing that all of this happens in a matter of seconds, especially when considering that this process can span across countries. The internet is a culmination of centuries of research in math, engineering, and material science. What's more, the amount of collaboration required to make it work is staggering.

Understanding how the internet works is empowering. You are engaging with a deeply complex system, but a system that is capable of being understood. Ironically, knowing how it works imbues the whole thing with a true sense of wonder.