

## How the Web Works

### Introduction

The internet, as we know it today with online gaming, e-commerce, and social media, was not the original intention when it was created. The language used to build web pages, HTML, has been continuously updated to accommodate new functionalities.

### Web Browsers

- Definition: A software application used on your home computer to request and view web pages.
- Examples: Mozilla Firefox, Google Chrome, Internet Explorer, Apple Safari.
- Market Share (as of the video):
  - Google Chrome: Almost half the market.
  - Mozilla Firefox: Previously popular, now overtaken by Chrome.
  - Internet Explorer: Less than 15% of web users.

### Requesting a Web Page

You can request a web page in several ways:

- Typing a known address into the browser's address bar.
- Clicking a link on another web page.
- Searching for a page using a search engine (e.g., Google).

### The Journey of a Request

1. Browser to ISP: Your web browser sends the request to your Internet Service Provider (ISP).
2. ISP to the Web: The ISP acts as your gateway to the internet, forwarding the request.
3. Servers: Web pages are stored on computers called servers. A server is any internet-connected computer running server software that can receive requests and send back web pages and their resources.
4. Internet as a Network: The internet is a network connecting all these servers. Requests travel from server to server until they reach their destination.

### Server Response

1. Finding Resources: When a server receives your request, it locates all the necessary resources (HTML files, images, etc.) for the requested page.
2. Sending Resources Back: The server sends these resources back to your web browser.
3. Server-to-Server Transfer: Again, these resources are passed from server to server until they reach their destination.

### Bandwidth

- Definition: Refers to the speed at which information can be sent or received across the internet.
- Impact on Loading Speed: Smaller files can be sent more quickly, resulting in faster web page loading.
- Compression: Images and video are particularly bandwidth-intensive and often need to be compressed to be viewable online efficiently.

### Assembling the Web Page

1. **Browser Interpretation:** Once your web browser receives the resources, it follows the HTML instructions.
2. **Content Assembly:** The browser pieces together images and content to assemble the final web page for you to view.
3. **Browser Differences:** Not all browsers interpret HTML instructions perfectly, which can lead to variations in how a web page appears.
4. **Web Standards:** The Worldwide Web Consortium (W3C) develops web standards to promote consistency across different browsers.

## The Web Is Not The Net

### Introduction to the Internet and the World Wide Web

The Internet and the World Wide Web (WWW) are often used interchangeably, but they represent different concepts. The Internet is a global network of interconnected computers that communicate using standardized protocols. The World Wide Web, on the other hand, is a collection of information that is accessed via the Internet through web browsers.

### Historical Context

- **First Message Over the Internet:** The first message sent over the Internet occurred on October 29, 1969. Leonard Kleinrock and his team at UCLA attempted to send the word "login" to Stanford University. The system crashed after sending the letters "L" and "O".
- **Origin of the Term "Internet":** The term "Internetwork" was first coined in 1974 and was later shortened to "Internet".
- **Tim Berners-Lee and the Web:** In March 1989, Tim Berners-Lee proposed a system to organize information through hypertext links, leading to the creation of the World Wide Web.

### Key Differences Between the Internet and the Web

- **Internet:**
  - A network of networks that connects computers globally.
  - It operates on various protocols to facilitate communication.
- **World Wide Web:**
  - A system of interlinked hypertext documents accessed via the Internet.
  - It allows for nonlinear navigation through linked content.

### The Concept of Hypertext

- Hypertext is a method of organizing and presenting text in a nonlinear way, allowing users to navigate through linked documents.
- The integration of hypertext with the Internet by Tim Berners-Lee created a web that transformed how information is shared and consumed.

### The Evolution of the Web

- **First Website:** The first website, created by Tim Berners-Lee, was `info.cern.ch`, which served as a demonstration of the World Wide Web.

- **Web Metaphor:** The web is often referred to with maritime metaphors, such as "surfing the web," and is likened to an ocean of information that is vast, interconnected, and sometimes dangerous.

### Web Traffic and Content

- **Proportion of Adult Content:** A significant portion of Internet traffic is attributed to adult content, but exact numbers can vary.
- **Web Ecosystem:** The web hosts a diverse range of content, and while some may argue that much of it is superficial, it reflects the multifaceted nature of human expression.

### Exploration of the Deep Web

- **Deep Web vs. Surface Web:** The Deep Web consists of content that is not indexed by traditional search engines, accounting for approximately 80% of the entire web, including databases, private sites, and pages behind paywalls.

### Impact of the Web on Society

- **Screenagers:** A term coined by Douglas Rushkoff to describe a generation that interacts with screens not just passively, but actively, shaping their identities and narratives through online engagement.
- **Interactive Narratives:** The web allows for storytelling and content creation that differ from traditional linear narratives, fostering creativity and expression among users.

### The Future of the Web

- **Continuous Exploration:** As of now, Google receives around 500 million search queries daily that have never been asked before. This highlights the dynamic nature of the web and the potential for new discoveries.
- **Metaphors of Exploration:** The design of suits for ocean exploration inspired the development of technologies for space exploration, showcasing human ingenuity in navigating new frontiers.

### Conclusion

The World Wide Web has transformed communication, information sharing, and expression. It is essential to understand the distinction between the web and the Internet, as well as the historical developments that led to the current state of digital communication. As users engage more deeply with the web, its impact on society will continue to evolve, presenting both challenges and opportunities for the future.

### The Internet

#### What is the Internet?

The internet is described as a distributed packet-switched network. It's a system that has evolved over time, much like everyday inventions such as the ballpoint pen, the flush toilet, or the zipper.

#### Origins of the Internet

- **Early Concepts:** The foundations of the internet can be traced back to the early 1970s with the work of Vint Cerf and Bob Kahn.
- **ARPANET:** This was a precursor to the internet, an experiment funded by the U.S. Department of Defense. ARPANET stood for Advanced Research Projects Agency Network.

- **Packet Switching:** A key concept that emerged from research, particularly by Paul Baran, was the idea of breaking messages into small "blocks" or packets. These packets could then be sent as quickly as possible in multiple directions through a "mesh network." This design was intended to create a communication system that could potentially survive a nuclear attack.
- **Nationwide Experimental Network:** The ARPANET project successfully developed into a nationwide experimental packet network.

### Who is in Charge of the Internet?

The internet is not controlled by a single person or organization. The honest answer is that "nobody" is in charge, or perhaps "everybody" is.

- **Distributed Nature:** The internet is composed of a vast number of independently operated networks.
- **No Central Control:** There is no central authority dictating how data packets are routed, where networks are built, or which networks connect to each other.
- **Business Decisions:** Decisions about network interconnection and expansion are made independently by the operators of these networks, often driven by business considerations.
- **Motivation for Connectivity:** The operators are motivated to ensure end-to-end connectivity across the entire network. The primary utility of the internet lies in its ability to allow any device to communicate with any other device, similar to how any telephone can connect to any other telephone globally.

### The Power of Sharing Information

The internet facilitates the sharing of information, which is a powerful motivator. This concept is fundamental to how scientific progress is made.

- **New Applications:** The internet provides a platform for people to develop new applications, such as mobile apps.
- **Infrastructure Growth:** Individuals can contribute to the expansion of the internet's infrastructure, extending access to those who currently lack it.
- **Everyday Use:** The internet is an integral part of daily life, and understanding its workings can enhance its use.

### Key Concepts

- **Packet Switching:** A method of transmitting data by breaking it into small packets that travel independently across the network and are reassembled at the destination.
- **Distributed Network:** A network where control and data are spread across multiple nodes rather than being concentrated in a central location.
- **Mesh Network:** A network topology where each node is connected to every other node, providing multiple paths for data transmission.

## The Internet: Packets, Routing, and Reliability

### Introduction to the Internet

The internet is a vast network of interconnected computers and networks that allows information to be shared globally. It's not a single, direct connection between users, but rather a complex system that enables data to travel through various paths and devices.

## How Information Travels: Packets

### The Concept of Packets

Instead of sending large chunks of data as a single unit, information on the internet is broken down into smaller pieces called packets. This is analogous to how a large item, like a space shuttle, would need to be disassembled into smaller parts for transport.

### Packet Contents

Each packet contains:

- The data itself (a portion of the larger message, image, song, etc.)
- The internet address of the sender (where it came from)
- The internet address of the recipient (where it's going)

### Breaking Down Large Data

When you send or receive large amounts of data (e.g., an image made of millions of bits), your computer breaks it down into thousands of smaller packets. This allows for more efficient and flexible transmission.

### Routing: Directing the Packets

#### The Role of Routers

Routers are specialized computers on the internet that act as traffic managers. They guide packets along the best available paths toward their destination.

#### Dynamic Routing

- Packets do not follow a fixed path.
- The path a packet takes can change during its journey, similar to how a car might take a different route due to traffic.
- Routers maintain information about multiple possible paths for sending packets.

### Choosing the "Cheapest" Path

Routers select the "cheapest" available path for each packet based on the destination IP address. "Cheapest" doesn't refer to monetary cost but rather to factors like:

- Transmission time
- Network congestion
- Non-technical factors (e.g., politics, relationships between companies)

### Fault Tolerance and Redundancy

The ability of routers to choose different paths for packets makes the internet fault tolerant. This means the network can continue to send data even if some paths or devices fail. The more routers we add, the more reliable the internet becomes due to increased redundancy.

## Reliability: Ensuring Data Delivery

### The Need for Reliability

Even with dynamic routing, it's crucial to ensure that all the packets arrive at their destination correctly and in the right order so that the original data can be reconstructed.

### Transmission Control Protocol (TCP)

TCP (Transmission Control Protocol) is a fundamental protocol that manages the sending and receiving of data packets to guarantee reliable delivery. It acts like a guaranteed mail service.

### How TCP Works

1. **Segmentation:** When you request data (e.g., a song from Spotify), the sender breaks the data into many packets.
2. **Transmission:** These packets are sent across the internet, potentially taking different routes via routers.
3. **Acknowledgment:** Upon receiving packets, the recipient's TCP layer performs an inventory. It sends back acknowledgments (ACKs) for each packet successfully received.
4. **Verification:**
  - If all packets are received and acknowledged, TCP confirms the delivery.
  - If some packets are missing or incomplete, TCP does not confirm delivery.
5. **Resending:** For any missing or incomplete packets, the sender (e.g., Spotify) will resend them.
6. **Reassembly:** Once TCP verifies the complete delivery of all necessary packets, the data can be reassembled and used (e.g., the song begins to play).

## Scalability of the Internet

The systems that govern packet transmission (routers) and data reliability (TCP) are designed to be scalable. This means they can handle a massive and growing number of devices and users, from a few devices to billions. The principles of fault tolerance and redundancy are key to this scalability, allowing the internet to grow without interrupting service for existing users.

### The Physical and Logical Connections

The internet is physically composed of hundreds of thousands of networks and billions of connected devices. These diverse systems communicate and work together through agreed-upon standards for data transmission. Computing devices and routers play a vital role in guiding these packets to their destinations, where they are reassembled if necessary. This process happens billions of times daily for various activities like sending emails, browsing the web, video chatting, and more.

## The Internet: HTTP & HTML

### Introduction to the Internet and Web Browsing

The internet enables computers worldwide to communicate. Web browsing is a primary way we interact with the internet. This process involves:

1. **Opening a Web Browser:** This is the application used to access web pages (e.g., Chrome, Firefox, Safari).
2. **Typing a Web Address (URL):** A Uniform Resource Locator specifies the exact location of a website.
3. **Requesting Information:** Your computer sends a request to a remote computer called a server.
4. **Receiving Information:** The server responds, sending the requested data back to your computer.

## HTTP: The Language of the Web

HTTP, or HyperText Transfer Protocol, is the fundamental language computers use to request and transfer documents over the internet.

### GET Requests

The most common type of HTTP request is a "GET" request. It's used to ask for a specific document from a server.

- **Format:** GET /document\_name
- **Example:** If you want to load the Tumblr login page, your browser sends a GET /login request to Tumblr's server. This tells the server you want the HTML code for that page.

### POST Requests

POST requests are used when you need to send information to a server, such as when filling out a form or submitting search queries.

- **Process:** Your browser sends data along with the POST request.
- **Example:** When logging into Tumblr, you make a POST request to the login page. This request includes your email address and password. The server processes this data, verifies your identity, and sends back a response, often including a web page confirming your login.

## HTML: Structuring Web Pages

HTML, or Hyper Text Markup Language, is the language used to tell a web browser how to structure and display a web page.

- **Content:** The text content of a web page is directly included in the HTML
- **Formatting:** HTML uses tags to define how content should appear:
  - Making text big and bold.
  - Setting specific fonts.
  - Linking text to other pages.
  - Making text italic.
- **Media:** Images, videos, and other media are often separate files with their own URLs. The browser sends separate HTTP requests for each of these media files.

## Cookies: Remembering Users

Cookies are small pieces of data that websites store on your browser to remember who you are.

- **Function:** A cookie acts like an ID card for a website. It's a unique identifier (often a number) that the website uses to recognize your browser on subsequent visits.
- **Process:** When you log in, the server may send a cookie to your browser. The next time you visit, your browser automatically includes that cookie with its request, allowing the server to identify you.

## Security: SSL/TLS

The internet is largely open, meaning information can be sent in plain text and potentially intercepted. Secure websites use SSL (Secure Sockets Layer) and its successor TLS (Transport Layer Security) to protect communications.

- Purpose: SSL/TLS create a secure, encrypted channel for data transmission, protecting it from snooping and tampering.
- Indicators:
  - You'll see a small lock icon in your browser's address bar.
  - The URL will start with `https://` instead of `http://`.
- Digital Certificates: To establish a secure connection, a website must provide a digital certificate. This is like an official ID card, issued by a trusted certificate authority, that proves the website is legitimate. Your browser verifies this certificate to ensure it's connecting to the correct website.

## Underlying Internet Infrastructure

While HTTP and HTML are what we see on the surface, several layers work beneath to make the internet function:

- TCP/IP: These protocols manage the breaking down of information into small packets for transport and their reassembly at the destination.
- Routers: These devices direct the packets across the network.
- Packets: Information is transmitted in small packets.
- Binary: Packets are ultimately composed of binary code (sequences of 1s and 0s).
- Physical Transmission: This binary data travels through electric wires, fiber optic cables, and wireless networks.