Module 1:
INTRODUCTION

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Overview

- Internet Basics
- World wide web and its evolution
- E-mail, Telnet and FTP
- E-commerce & Cloud Computing,
- Video conferencing
- Internet service providers
- IP Address
- URL
- Domain Name Servers
- Web Browsers, Search Engine
- Web Server vs Application Server.

Web based Information System

- Disseminating all kind of Information to
  - anybody, anytime, anywhere or
    - to all, always, all over world
- 24/7 availability creates high impact in all fields
- Online teaching and learning,
- Virtual office,
- Marketing, selling, getting customer reviews,
- e-banking, payment portals,
- e-shopping
- ticket reservations,
- e hospitals etc.

Website Current Trends and Needs

- **Websites - Types**
    Customized websites (Amazon ,Flipkart, based on search)
    Personalized / Portfolio websites (profile, Behance)
    Interactive websites (Games, Designing product eg Cyclemen)
    Navigational websites (Google Map, Google earth, Open Streetview)
    Regional Language (Tamil, Telugu, Hindi…)
    Content Websites (news, blogs, articles
    Social Media Websites (Facebook, Instagram, Twitter)
    Educational Websites (Coursera, NPTEL, Khan Academy)
    Chatbot – Open AI Website (ChatGPT, DALL-E, Siri, Codex, DeepSeek)

- Platforms – Desktop, Phone, Tablets
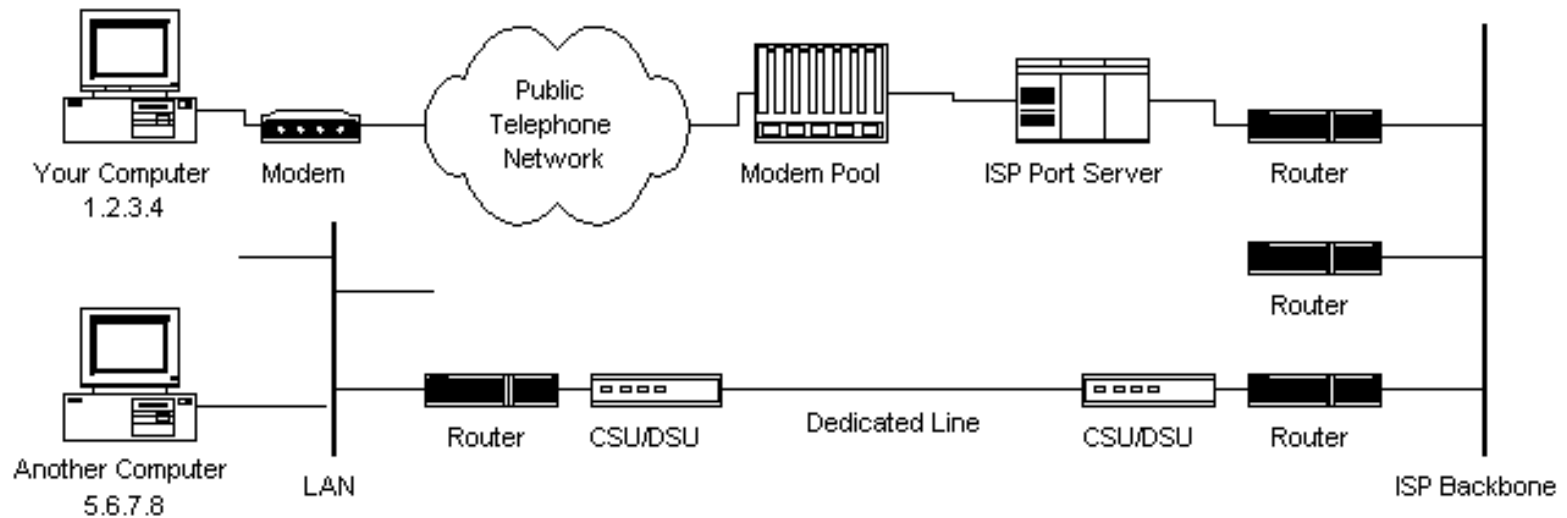- **Browsers** – Google Chrome, Internet Explorer, Mozila, Safari etc

Internet

- **Internet - hardware parts**

  Computers, Laptops, Mobiles through wired or wireless connections.

- **Web - software parts**

  Websites connected through URL addresses.

Internet Vs Intranet

INTERNET	INTRANET
Public network	Private network
In internet, there are multiple users.	In intranet, there are limited users.
Internet is unsafe.	Intranet is safe.
Internet provides unlimited information.	Intranet provides limited information.
Unlimited Traffic	Traffic is limited
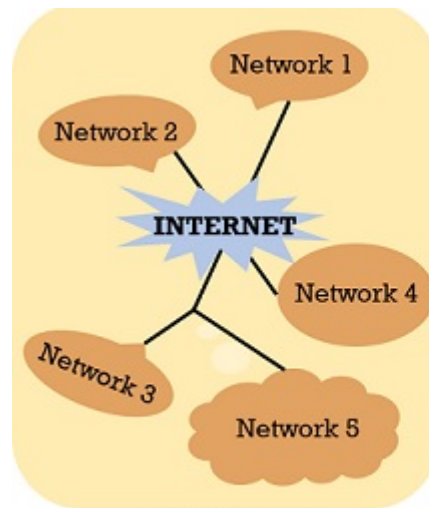
INTERNET   INTRANET

Web vs Internet

Internet	Web
Internet is network of computers	World wide Web is networks of websites
Transfer the contents	Access the information
Layered System of Protocols: 1. Application Layer – Data transfer 2. Transport Layer - Communication 3. Network Layer – Route	To link with the internet, 1. HTML, CSS, Scripting Languages – webpage creation 2. HTTP/HTTPS – Transfer Protocols 3. URL – Address of Resource. 4. Server- Data Storage 5. Client – Web browsers

Network

■All machines will receive short messages, called packets

■Types of Network

– **LAN** - single office/ building / campus.

– **MAN** - entire city / company connects its offices in a city.
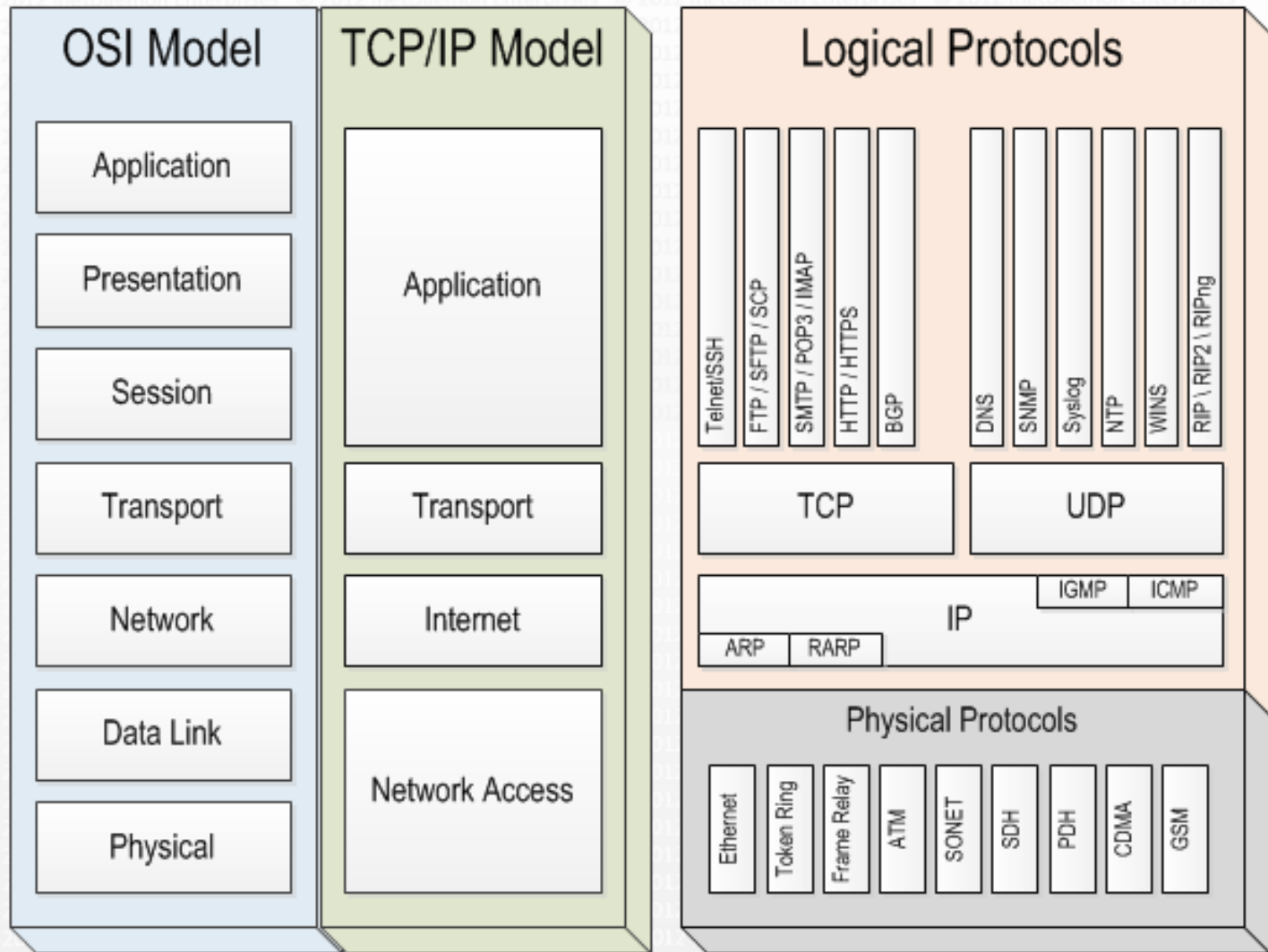
– **WAN** - country / continent /whole world.

Services – Port Numbers

- Common port numbers are 80 (for web pages), 23 (for telnet) and 25 and 110 (for mail)
- Port numbers above 1024 are available for other kinds of communication between our programs
- Common (well known) ports:
  - FTP   21
  - TELNET 23
  - SSH 22
  - SMTP 25
  - HTTP 80
  - DNS – 53
  - NTP 123
  - Finger 79
  - DHCP – 67 & 68
  - POP – 110

Protocols

- In order for computers to communicate with one another, they must agree on a set of rules for who says what, when they say it, and what format they say it in

- This **set of rules** is a protocol

- Different programs can use different protocols

- Protocols may be in ASCII (characters) or in binary

- Some common protocols are HTTP (for web pages), FTP (for file transfer), and SMTP (Simple Mail Transfer Protocol)

NETWORK MODELS

OSI Model	TCP/IP Model	Logical Protocols
Application		
Presentation	Application	
Session		
Transport	Transport	
Network	Internet	
Data Link	Network Access	
Physical		

Logical Protocols:

Telnet/SSH, FTP / SFTP / SCP, SMTP / POP3 / IMAP, HTTP / HTTPS, BGP — TCP

DNS, SNMP, Syslog, NTP, WINS, RIP \ RIP2 \ RIPng — UDP

IGMP, ICMP, IP

ARP, RARP

Physical Protocols:

Ethernet, Token Ring, Frame Relay, ATM, SONET, SDH, PDH, CDMA, GSM

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Application Layer Protocols	Usage
HTTP: Hyper Text Transport Protocol	Transfer web pages
HTTPS: Hyper Text Transport Protocol Secure	
DNS: Domain Name System	Translates website names to IP addresses
NBNS: NetBios Name Service	Translates localhost names to IP addresses
DHCP: Dynamic Host Configuration Protocol	Assigns IP addresses
TelNet: Telephone Network	Interactive login; communication between computers
FTP: File Transfer Protocol	Commonly used for copying files to and from other computers
TFTP: Trivial File Transfer Protocol	Transfer small amount of data
SMTP: Simple Mail Transport Protocol	Sends email messages
POP3: Post office protocol	Extracts and retrieves email
IMAP: Internet Mail Access Protocol	Access email on a remote mail server
SNMP: Simple Network Management Protocol	Manages Network devices
NTP: Simple Network Time Protocol	clock synchronization between computer systems over packet-switched. It provides time for a day

HTTP

- The Hypertext Transfer Protocol (application-level protocol) is the foundation of communication on the **World Wide Web (WWW)**. It enables web browsers and servers to communicate by **requesting and delivering** web content.
- **Client** (Browser/User Agent) sends an HTTP Request to the Web Server.
- The **Web Server** processes the request and sends back an **HTTP Response**

HTTP request →

HTTP response ←

Client

Server

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HTTP Protocol

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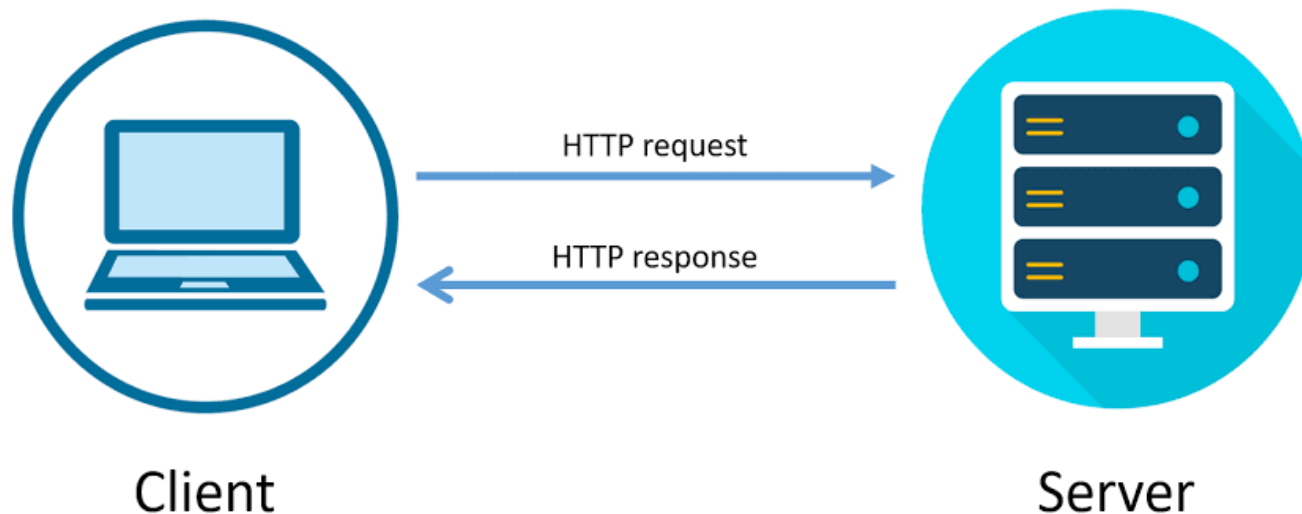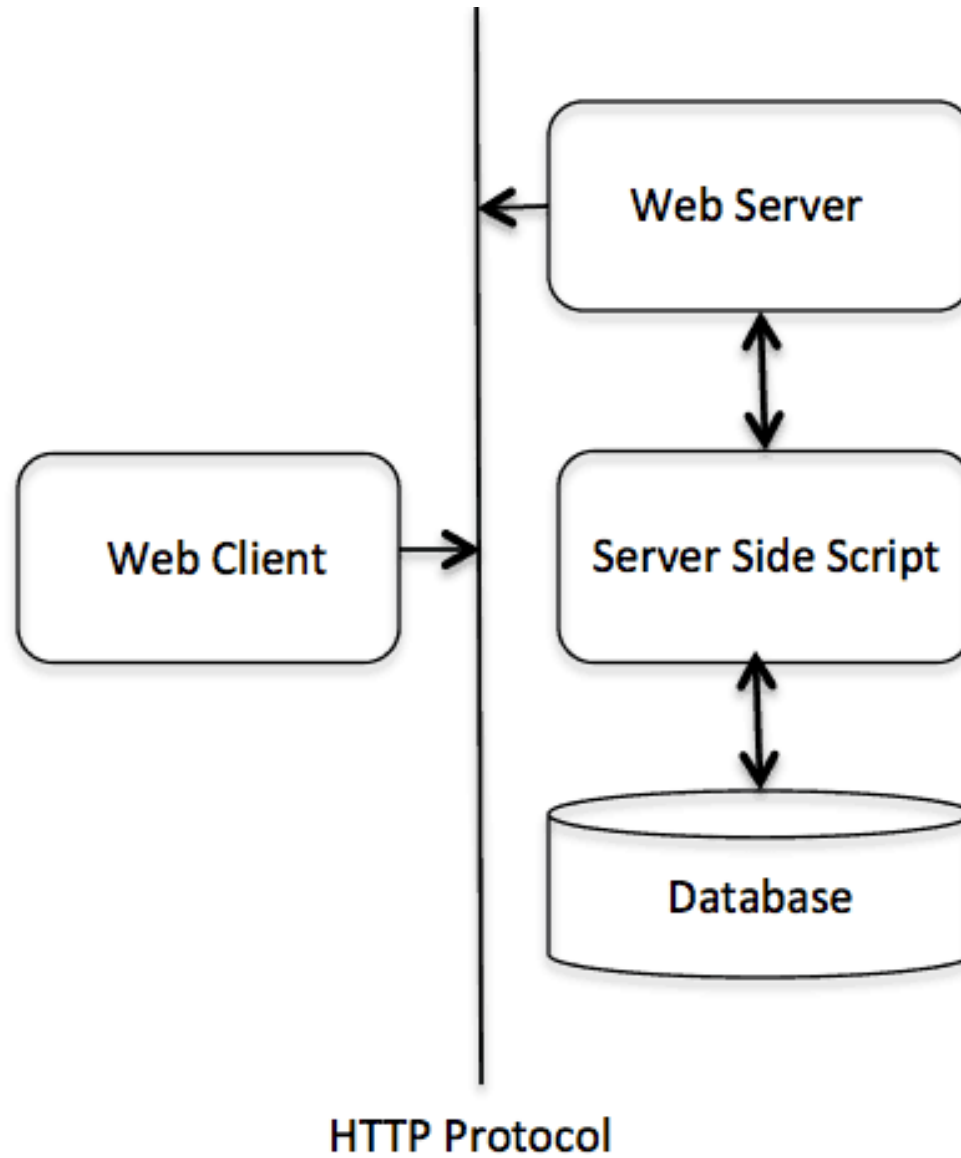
World Wide Web & Its Evolution

- The World Wide Web (WWW) is a **system of interlinked web pages** that can be accessed over the **Internet** using a web browser. It was invented by Tim Berners-Lee in 1989.

- Evolution of the web:
  - 📌 **Web 1.0 (1990s)** – Static web pages (Read-Only).
  - 📌 **Web 2.0 (2000s)** – Dynamic, user-generated content (Social Media, Blogs).
  - 📌 **Web 3.0 (Future)** – AI-driven, decentralized, blockchain-based web.

E-mail, Telnet, FTP

- **E-mail:** Electronic mail system used for communication.

- **Telnet:** Remote login protocol for accessing systems remotely.

- **FTP:** File Transfer Protocol used for exchanging files over the Internet.
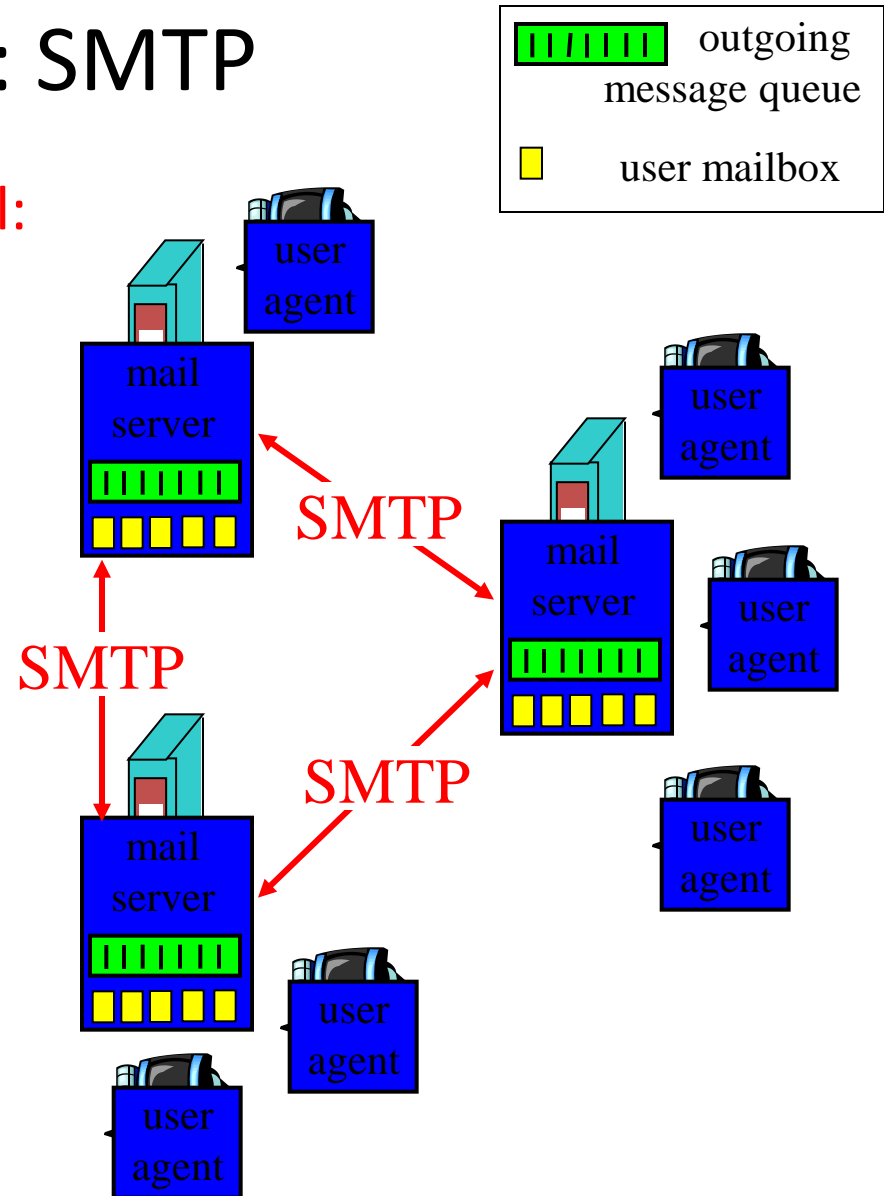
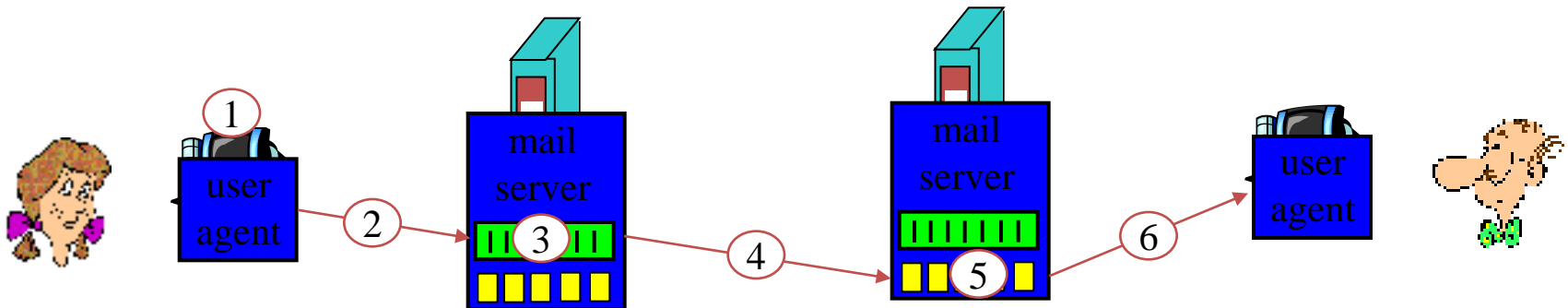# Email Protocols

- SMTP
- POP3
- IMAP

Email: SMTP

outgoing message queue

user mailbox

Three major components of Email:

– user agents

– mail servers

– simple mail transfer protocol: SMTP

- The protocol is very simple
- SMTP is a push protocol, information is pushed to a remote site
- Uses **port 25**
- Email Syntax: user@host.domain

Scenario: Alice sends message to Bob

1) Alice uses UA to compose message and "to"
   `bob@someschool.edu`

2) Alice's UA sends message to her mail server; message placed in message queue

3) Client side of SMTP opens TCP connection with Bob's mail server

4) SMTP client sends Alice's message over the TCP connection

5) Bob's mail server places the message in Bob's mailbox

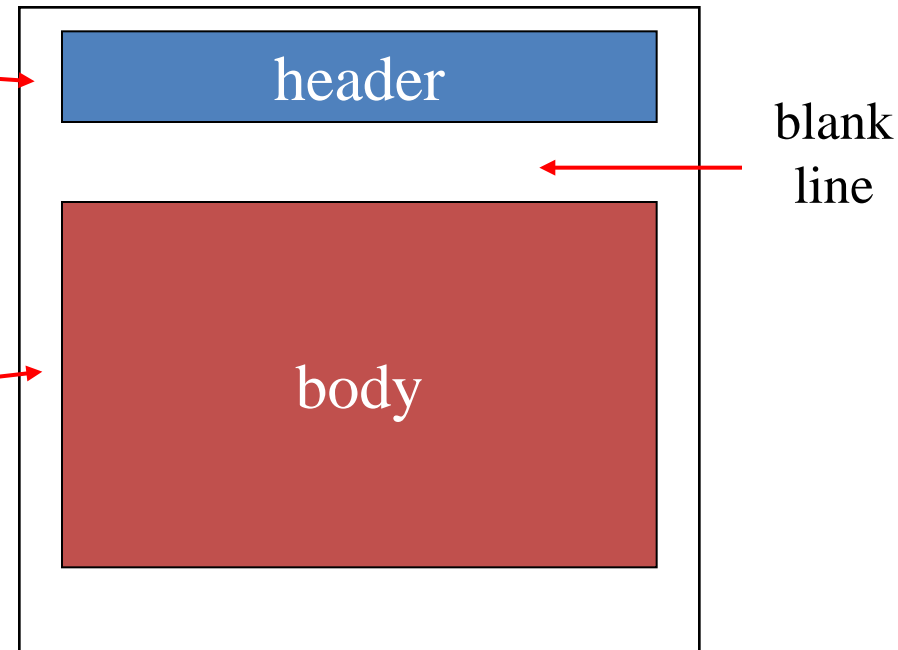6) Bob invokes his user agent to read message

Mail message format

SMTP: protocol for exchanging email msgs

RFC 822: standard for text message format:

- header lines, e.g.,
  - To:
  - From:
  - Subject:

  different from SMTP commands!

- body
  - the "message",

  ASCII characters only

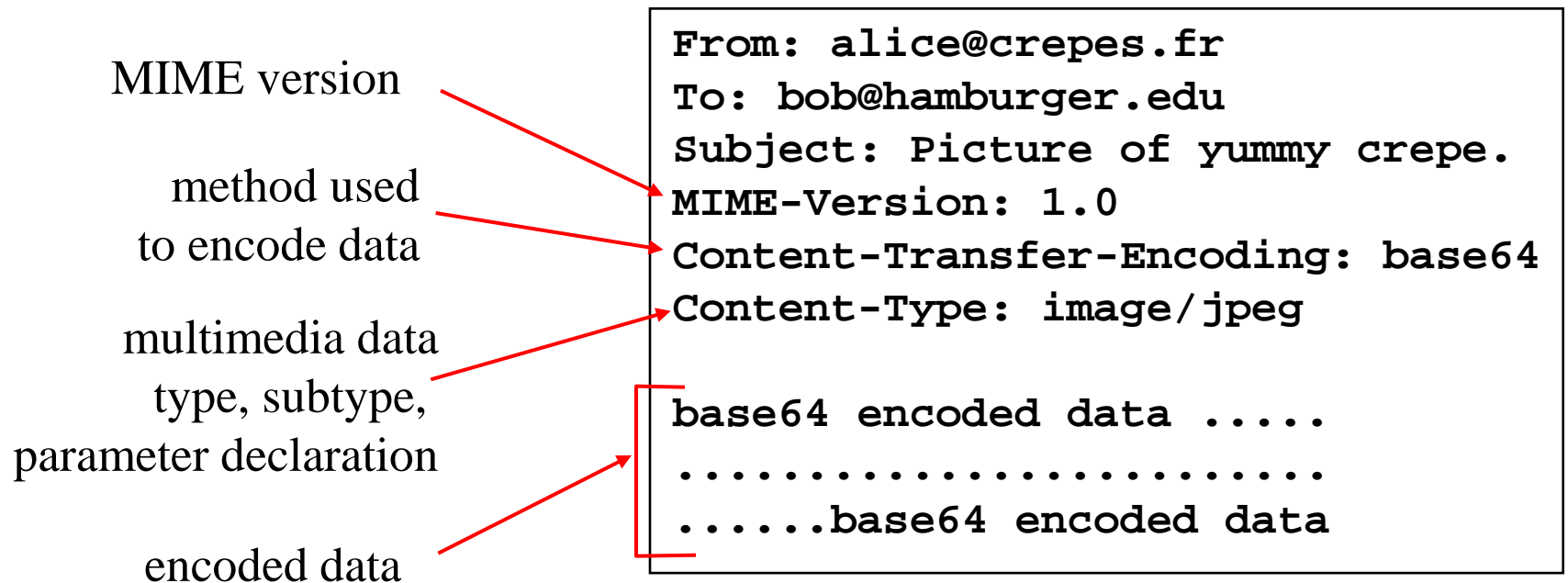| header |
| --- |

blank line

body

MIME

- MIME (**Multipurpose Internet Mail Extensions**) is an **extension of the Simple Mail Transfer Protocol (SMTP)** that enables **emails to support multimedia content** like images, audio, video, and file attachments.

- MIME allows emails to contain:
  - ✓ **Rich text formatting** (HTML emails)
  - ✓ **Attachments (PDF, Word, Excel, images, videos, etc.)**
  - ✓ **Multiple content types in a single email**
  - ✓ **International characters (Unicode support)**

MIME

How MIME Works in Emails?

1. **User Composes an Email** (including text, images, or attachments).
2. **MIME Encodes the Email** into a format that can be sent over SMTP.
3. **SMTP Transfers the Email** to the recipient's mail server.
4. **Recipient's Email Client Decodes MIME** and displays the content properly: retrieves the content using POP3 / IMAP

MIME version

method used
to encode data

multimedia data
type, subtype,
parameter declaration

encoded data

```
From: alice@crepes.fr
To: bob@hamburger.edu
Subject: Picture of yummy crepe.
MIME-Version: 1.0
Content-Transfer-Encoding: base64
Content-Type: image/jpeg

base64 encoded data .....
.........................
......base64 encoded data
```

MIME

Feature	SMTP Without MIME	SMTP With MIME
Content Type	Only **plain text** (7-bit ASCII)	Supports **text, images, audio, video, and attachments**
Attachments	❌ Not Supported	✅ Supported (PDFs, Images, Word files, etc.)
HTML Emails	❌ No (Only plain text)	✅ Yes (Rich text, HTML formatting)
Encoding	7-bit ASCII only	Base64, Quoted-Printable for non-text data
Multiple Parts (Multipart Emails)	❌ No	✅ Yes (Plain text + HTML in one email)
International Characters (Unicode)	❌ No (Only English characters)	✅ Yes (Supports UTF-8, non-English languages)

POP3

- **Post Office Protocol**
- Mail access client Protocol / message retrieval protocol
- Uses **port 110 (Default) / 995 (SSL/TLS)**
- Messages are **downloaded to client (local device)**.
- Once downloaded, the email is deleted from the server (by default)
- Does not easily allow multiple clients.
  - Since emails are **removed from the server**, accessing them from multiple devices is difficult.

IMAP

- **Internet Mail Access Protocol**
- Improved POP3
- Works on **Port 143 (Default)** or **Port 993 (SSL/TLS).**
- Keep all messages on thethe server
- Emails are retrieved **without deleting them from the server**.
- **Only Transfers What is Needed:**
  - ✓ Retrieves just the **email headers** (subject, sender, date) first.
  - ✓ Downloads the full email **only when opened** to save bandwidth.
- IMAP keeps user state across sessions:
  - – Keeps track of **which messages have been read, replied to, or deleted** across different devices.
  - – Allows user to organize messages in folders. Users can create custom folders (e.g., **Work, Personal, Important**). Messages can be stored and moved between folders.

Comparison of Email Protocols

Protocol	Purpose	Storage	Sync Across Devices	Security (TLS/SSL)
SMTP	Sending emails	Not applicable	No	✅ Yes (TLS/SSL)
POP3	Receiving emails	Local device	❌ No	✅ Yes (Port 995)
IMAP	Receiving emails	Server	✅ Yes	✅ Yes (Port 993)

TELNET

- **Telnet (Telecommunication Network)** is a **network protocol** used to establish a **remote text-based connection** to another computer over a **TCP/IP network**. It enables users to access and control a remote system **as if they were physically present**, using a command-line interface.

- Uses **TCP Port 23** for communication.

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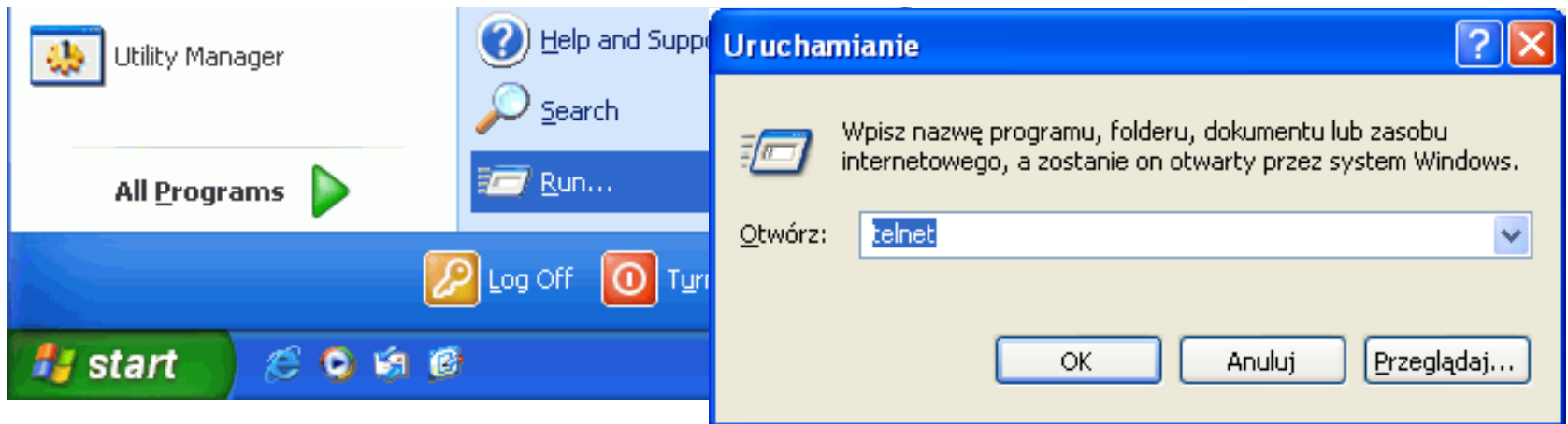
How Telnet Works?

1️⃣ **User initiates a Telnet connection** to a remote server using a Telnet client.

2️⃣ **Telnet client sends login credentials** (username and password).

3️⃣ **Remote server grants access**, allowing command execution.

4️⃣ **User executes commands remotely** via the command-line interface.

Access National Library via telnet
## telnet://alpha.bn.org.pl


National Library
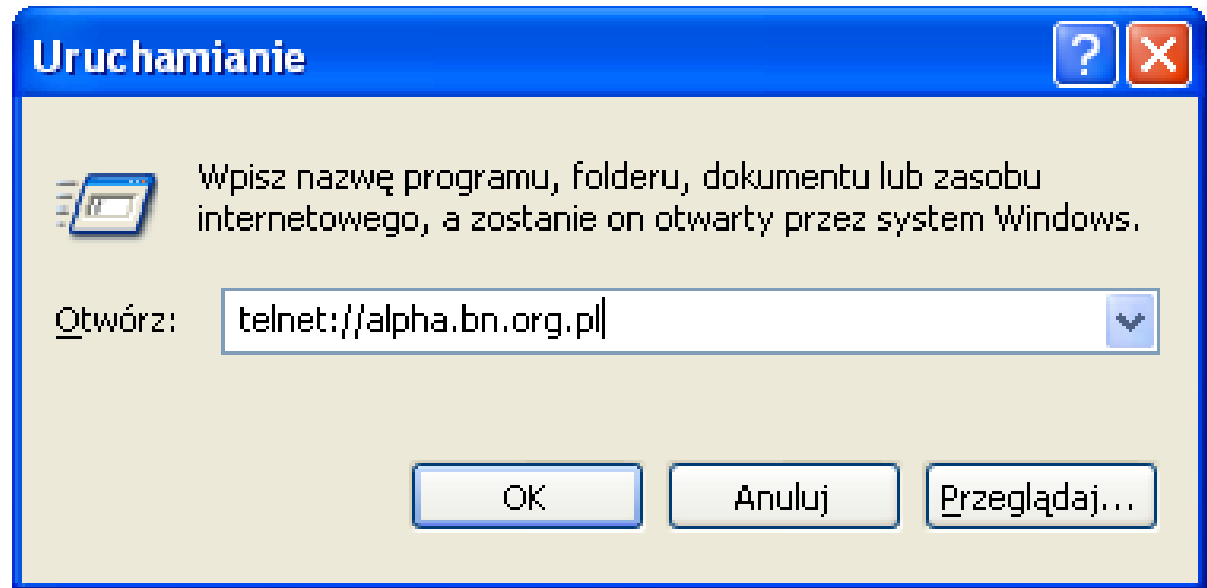
FTP

- **FTP (File Transfer Protocol)** is a standard network protocol used to **transfer files** between a client and a server over a **TCP/IP** network.

- FTP is a **client-server protocol** that allows users to **upload, download, and manage files** on a remote server. It operates over the **Internet or a local network.**

How FTP Works?

⬛1⬛ The user (client) **connects to an FTP server** using an FTP client (FileZilla, WinSCP, Command Prompt).
⬛2⬛ The client **authenticates** using a username and password (or anonymous login).
⬛3⬛ The client can **upload/download/manage files** on the remote server.
⬛4⬛ The connection remains open until the user **logs out or disconnects**.

ftp.cyf-kr.edu.pl

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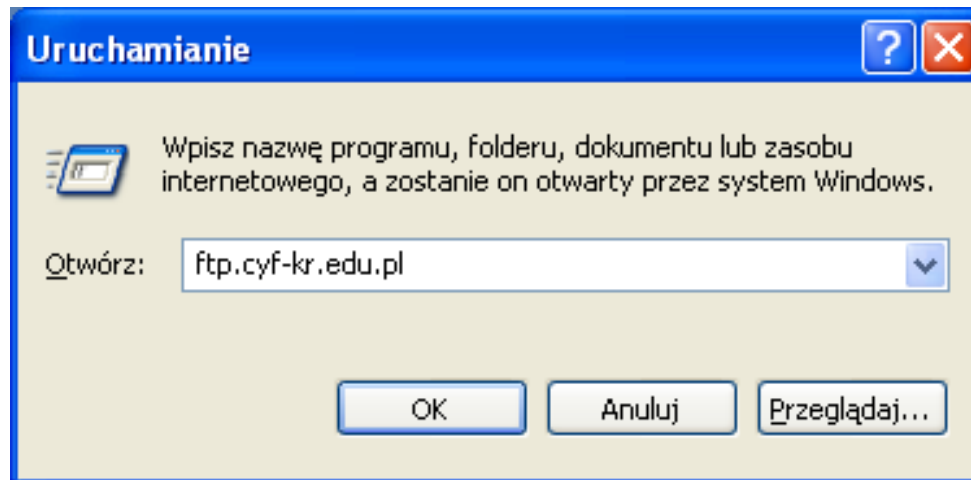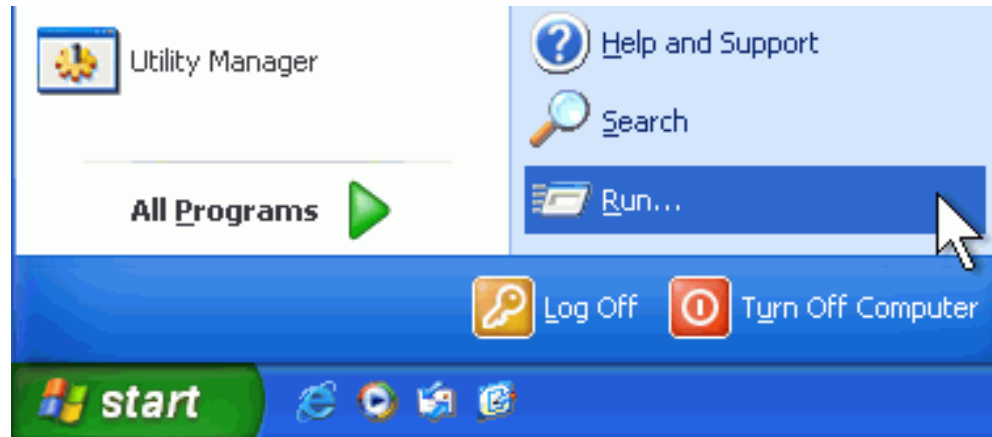
E-commerce & Cloud Computing

- **E-commerce:** Buying and selling goods online (Amazon, Flipkart, etc.).
- It allows businesses and consumers to conduct transactions online through **websites, mobile apps, and digital payment systems**.

Cloud Computing:

- Internet-based computing services (AWS, Google Cloud, Azure).
- **It** is a web-based technology that provides **on-demand computing resources** (such as servers, storage, databases, networking, and software) over the Internet.
- It eliminates the need for **physical hardware** and allows businesses to **scale, store, and process data efficiently**.

E-commerce Models

Model	Description	Example
B2B (Business to Business)	Transactions between businesses	Alibaba, IndiaMART
B2C (Business to Consumer)	Businesses sell to individual customers	Amazon, Flipkart
C2C (Consumer to Consumer)	Consumers sell directly to other consumers	OLX, eBay
C2B (Consumer to Business)	Individuals offer services/products to businesses	Fiverr, Upwork
D2C (Direct to Consumer)	Brands sell directly to consumers	Nike, Apple

Cloud Computing Models

Cloud Model	Description	Example
IaaS (Infrastructure as a Service)	Provides virtualized computing resources (servers, storage, networking)	AWS EC2, Google Compute Engine
PaaS (Platform as a Service)	Provides a platform to develop, run, and manage web applications	Google App Engine, Heroku
SaaS (Software as a Service)	Delivers software applications over the web	Google Drive, Microsoft 365

Video Conferencing

- Enables real-time audio and video communication over the internet.

- Popular tools: Zoom, Google Meet, Microsoft Teams.

- Used for business meetings, education, telemedicine.

Internet Service Providers (ISP)

- **(ISP)** is a company or organization that **provides internet access** to users, businesses, and organizations (Airtel, Jio, BSNL).

- ISPs enable **wired and wireless connectivity** to the **Internet** through various technologies.

IP Address, URL, DNS

- **IP Address:** Unique address of a device on a network (IPv4, IPv6).

- **URL:** Uniform Resource Locator, used to access websites.

- **DNS:** Domain Name System translates domain names to IP addresses.
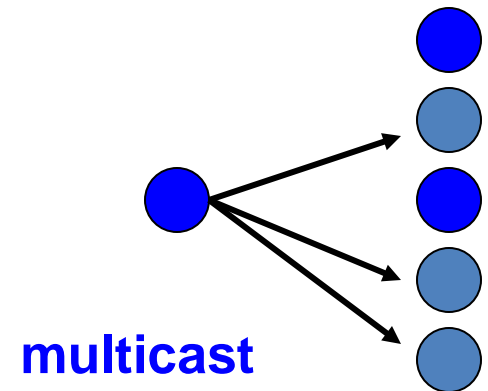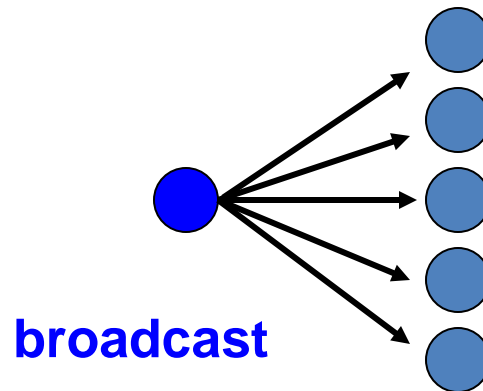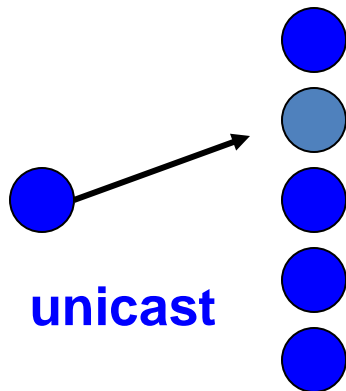
Internet Protocol
The waist of the hourglass

- **IP is the waist of the hourglass of the Internet protocol architecture**

Applications

HTTP FTP SMTP

TCP UDP

IP

Data link layer protocols

Physical layer protocols
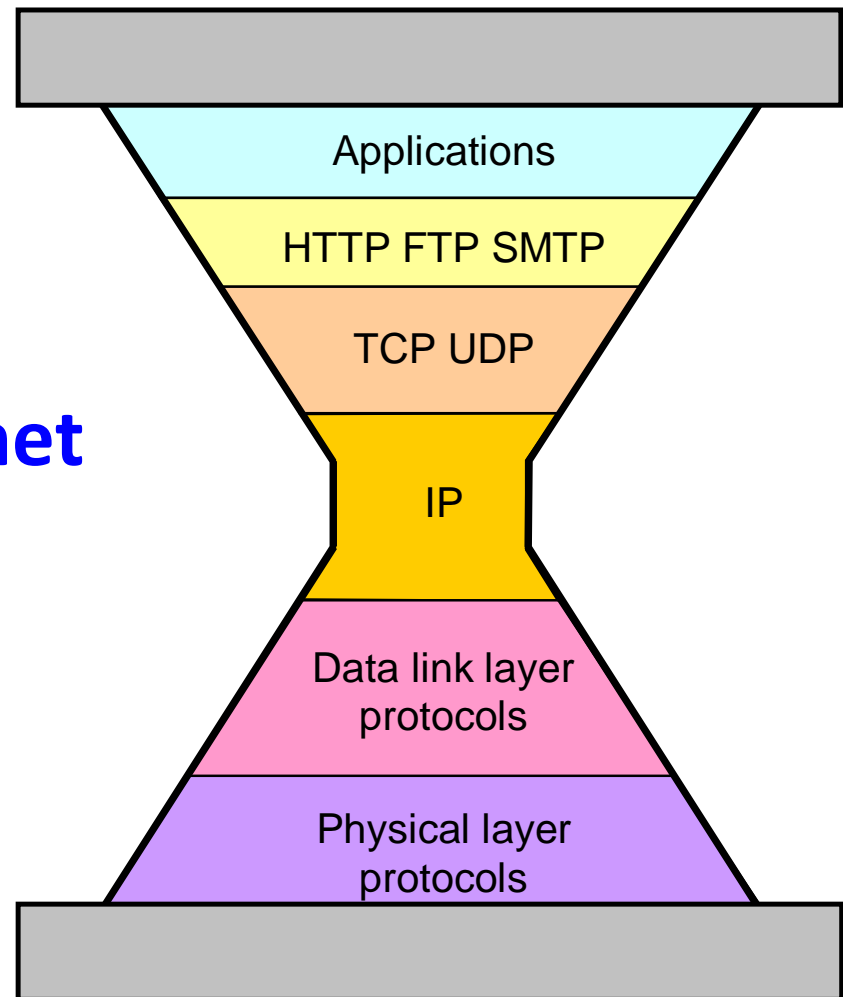
IP Service

- IP supports the following services:
  - one-to-one   (unicast)
  - one-to-all   (broadcast)
  - one-to-several   (multicast)

unicast

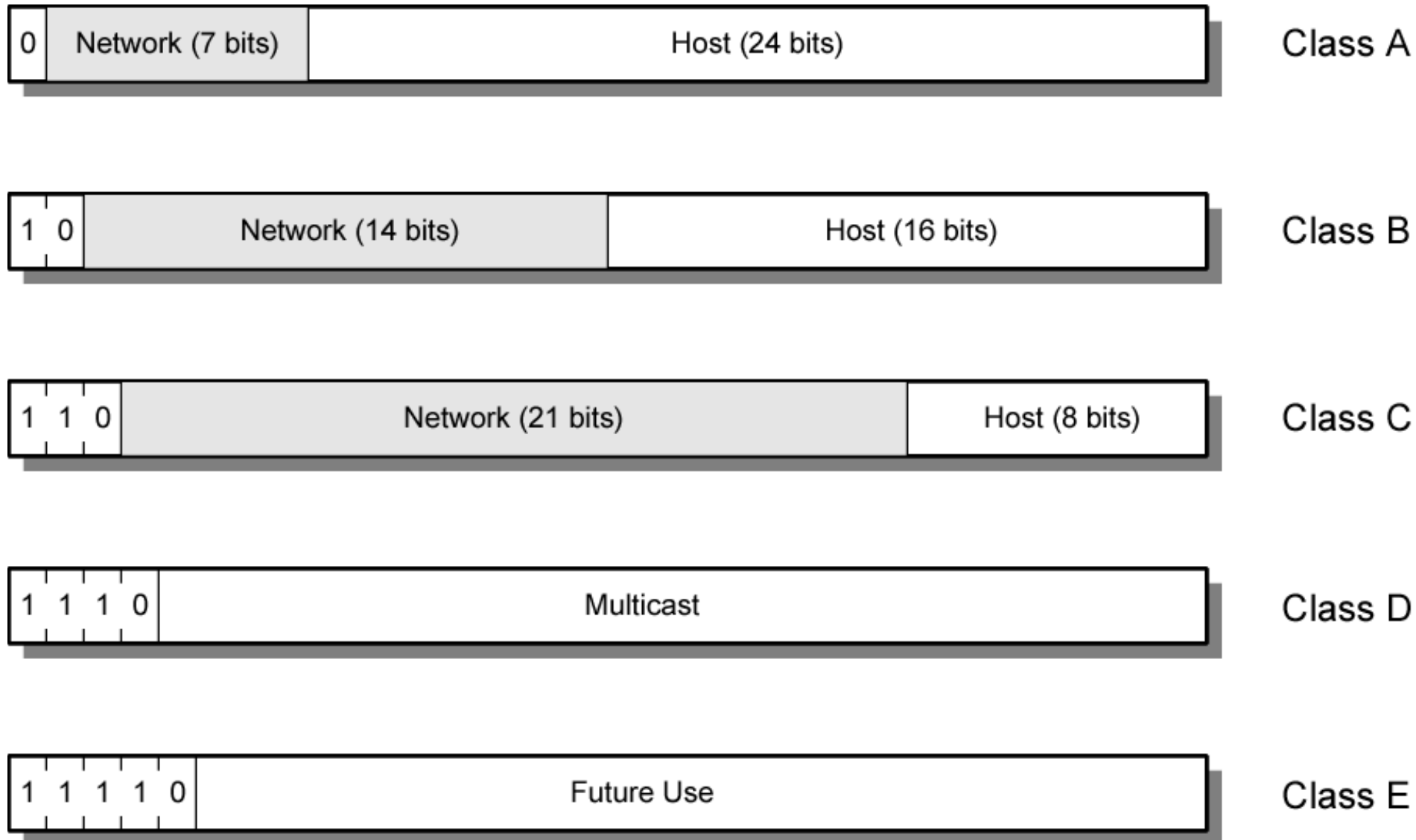**broadcast**

multicast

- IP multicast also supports a many-to-many service.
- IP multicast requires support of other protocols (IGMP, multicast routing)

IP Address

- An IP address is a 32-bit sequence of 1s and 0s.

- A way to identify machines on a network
  - A unique identifier
  - A numerical label

  - IP address consist of four sections, (0 to 255)

  - Five classes of IP Addresses : A, B, C, D, E
    - Class A - reserved for Governments
    - Class B - reserved for medium companies
    - Class C - reserved for small companies
    - Class D - reserved for multicasting
    - Class E - reserved for future use

IPv4 Address Formats

| 0 | Network (7 bits) | Host (24 bits) | | Class A |

| 1 | 0 | Network (14 bits) | Host (16 bits) | | Class B |

| 1 | 1 | 0 | Network (21 bits) | Host (8 bits) | | Class C |

| 1 | 1 | 1 | 0 | Multicast | | Class D |

| 1 | 1 | 1 | 1 | 0 | Future Use | | Class E |

Hostnames

- The "real" name of a computer on the internet is its **four-byte IP address**

- People, however, don't like to remember numbers, so we use hostnames instead

- This allows users to access websites using easy-to-remember names instead of complex numerical IP addresses.

- For example, the hostname cis.upenn.edu is 158.130.12.9

- Examples: www.example.com, www.google.com

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Host Name

- **host name**, breaking it into three parts:
    1. **Subdomain (www)** – A prefix used for a specific service (like the web server).
    2. **Second-Level Domain (example)** – The main name registered by a user or company.
    3. **Top-Level Domain (TLD) (.com)** – The highest level in the DNS hierarchy.
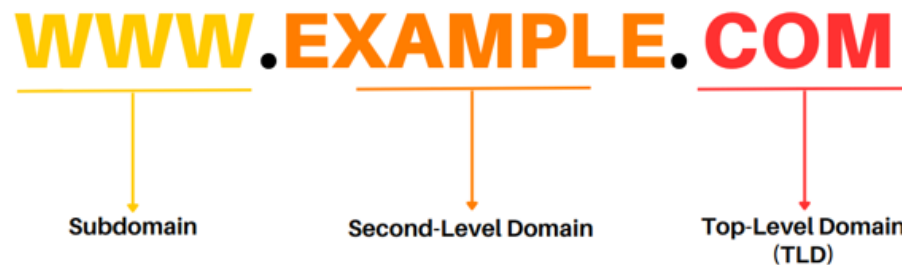
- The **authoritative DNS server** for www.example.com holds the actual IP address and returns the **IP address.**

TLD

- Top-Level Domain (TLD)

- A portion of the Internet domain name space

  - **General TLDs: com, gov, edu etc**

  - **Country-Code TLDs**: .us (USA), .in (India), .uk (United Kingdom), .cn (China)

  - **Sponsored TLDs:** (.museum, .aero, .jobs

  - **New gTLDs:** .tech, .app, .blog, .xyz, .shop

    Examples:
    •**www.google.com** → .com is the TLD.
    •**www.nit.ac.in** → .in is the TLD (for India).
    •**www.mit.edu** → .edu is the TLD (for educational institutions).

TLD

It is the highest level in the **Domain Name System (DNS) hierarchy**, appearing at the rightmost part of a domain name (e.g., .com, .edu, .org).
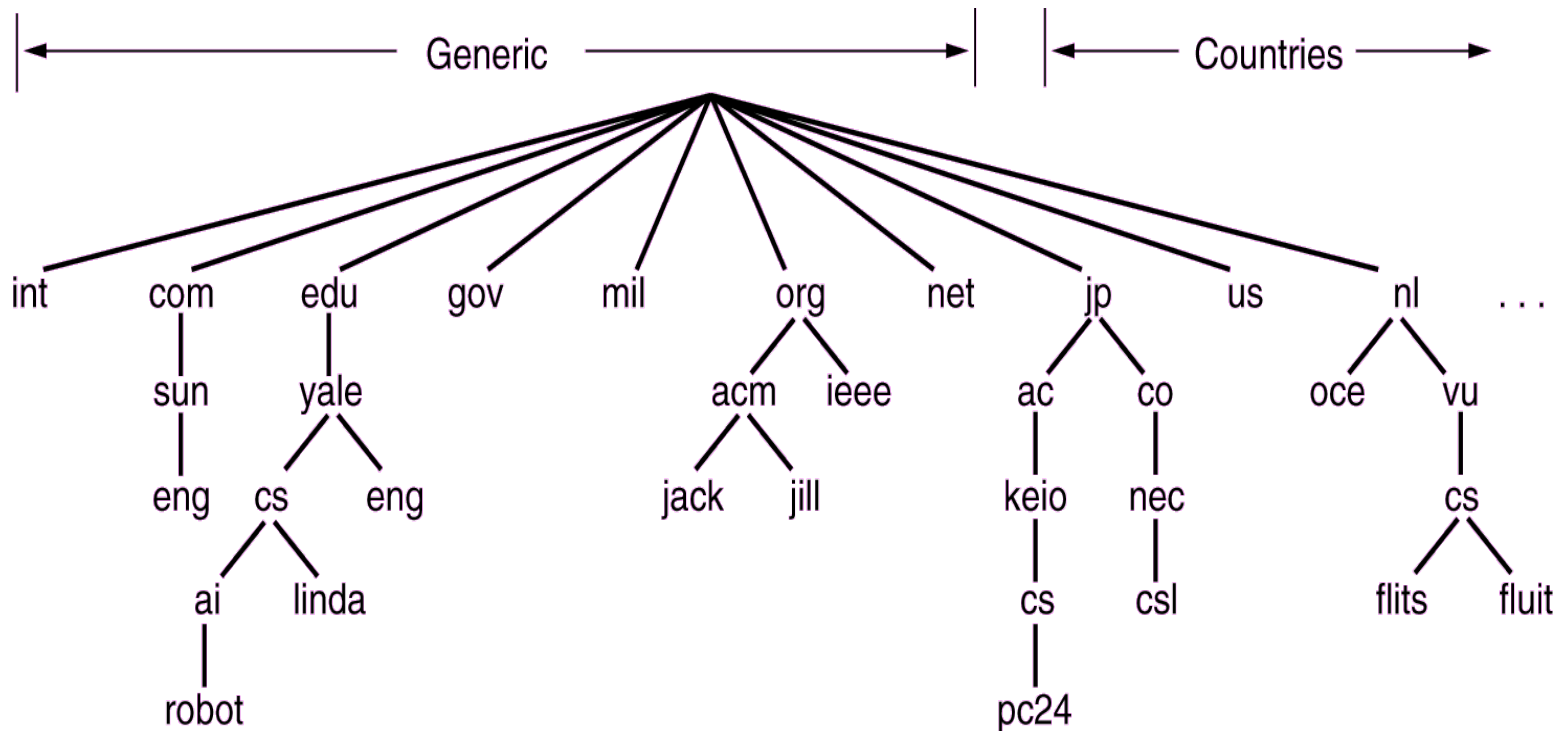
Domain name vs Host name

Feature	Domain Name	Hostname
Definition	The registered name of a website or entity on the internet.	A specific name assigned to a computer or service in a network.
Scope	Identifies an organization (e.g., example.com).	Identifies a specific device (e.g., www.example.com).
Includes TLD?	Yes, always (.com, .org, etc.).	Yes, in FQDNs (www.example.com), but not always.
Used in DNS?	Yes, used in DNS records.	Yes, mapped to an IP address via DNS.
Example	example.com, google.com	www.example.com, mail.google.com

Domain Name System - DNS

- The **Domain Name System (DNS)** is a **hierarchical and decentralized** naming system that translates **human-readable** domain names (e.g., google.com) into IP addresses (e.g., 142.250.183.206), which computers use to identify each other.
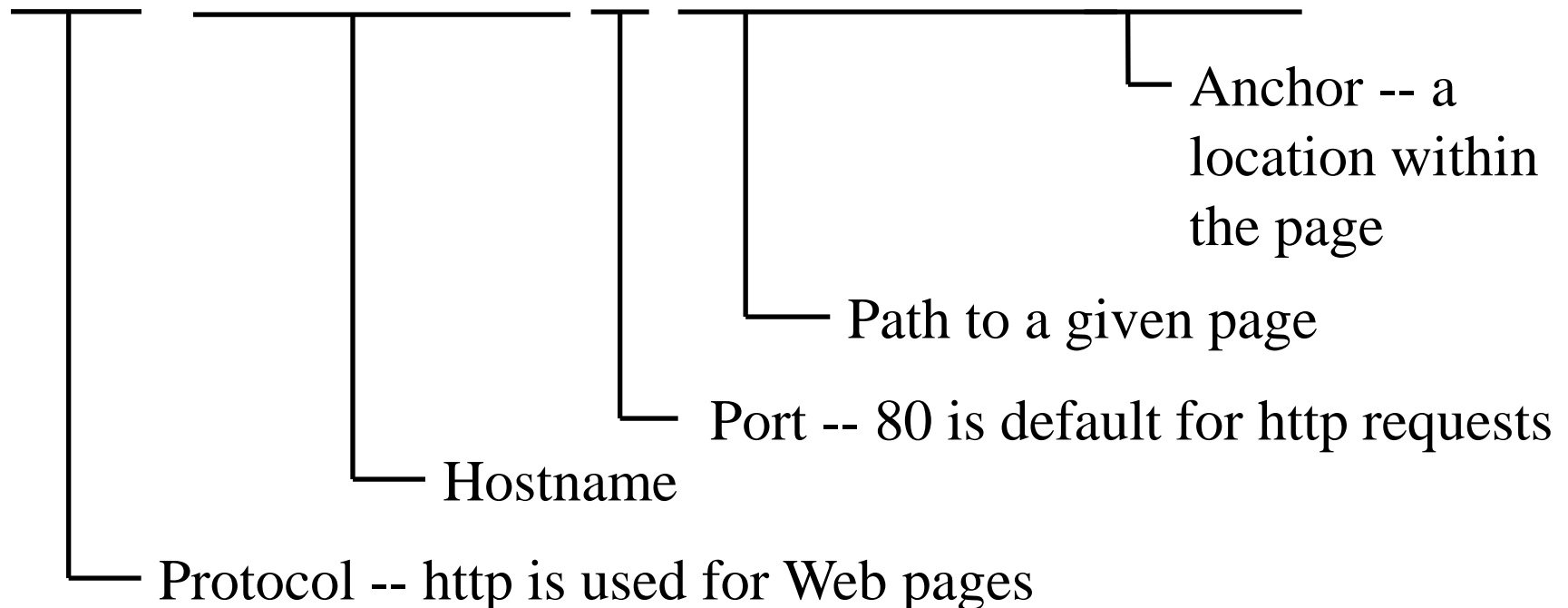
URLs

- A URL, Uniform Resource Locater, defines a location on the Web

```
URI = "http:" "//" host [ ":" port ] [ abs_path [ "?" query ]]
```
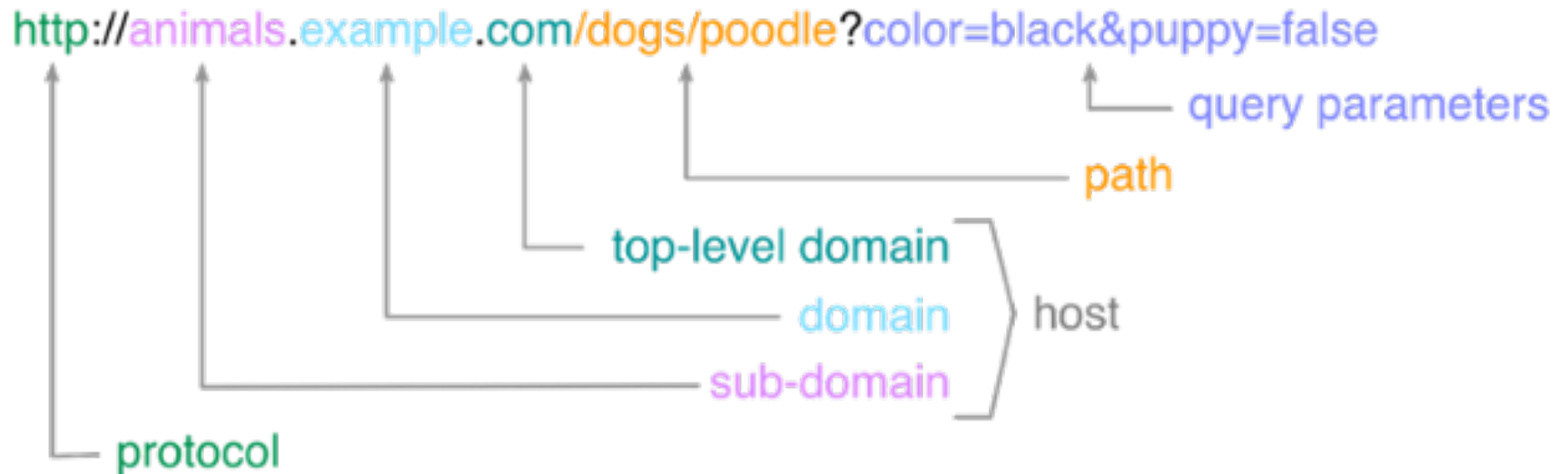
- A URL has up to five parts:

http://www.xyz.com:80/ad/index.html#specials

Anchor -- a location within the page

Path to a given page

Port -- 80 is default for http requests

Hostname

Protocol -- http is used for Web pages

URL

URLs are used to find web pages, images, videos, and more.

Search Engines & Web Browsers

- **Search Engine:** Retrieves relevant web pages (Google, Bing, Yahoo).
  - Works using **crawling, indexing, and ranking** algorithms.
- **Web Browser:** Software to access the web (Chrome, Firefox, Edge).

How Search Engines Work?

- **Crawling (Discovering Web Pages)** 🕷️

  ➢ Search engines use **web crawlers (bots, spiders)** to scan the **Internet** for new and updated web pages.
  ➢ Crawlers follow hyperlinks (links between web pages) to discover new content.
  ➢ Pages are downloaded and stored in the search engine's database.

- **Indexing (Organizing and Storing Content)** 📚

  ➢ The **content, keywords, metadata, and images** are processed and stored in an **index (database)**.
  ➢ If a page is **not indexed**, it **won't appear in search results**.

- **Ranking (Displaying Relevant Results)** 📊

  ➢ When a user enters a **search query**, the search engine retrieves the **most relevant** pages from its index.
  ➢ Pages are ranked based on **algorithms**

Web Browser

- A **web browser** is a **software application** that allows users to **access, retrieve, and display web pages** from the **World Wide Web**.

- It enables navigation of websites, viewing of multimedia, and interaction with online content.

- Today, browsers like **Chrome, Firefox, Safari, and Edge** dominate the market, continuously improving with **privacy, speed, and compatibility enhancements**.

Web Browsers - Evolution

Year	Browser	Description
1990	WorldWideWeb (Nexus)	First web browser, created by Tim Berners-Lee.
1992	Lynx	A **text-based browser** (no images, only text).
1993	Mosaic	First browser to support **images embedded with text**.
1994	Netscape Navigator	First **widely used** browser, dominated the 1990s.
1995	Internet Explorer (IE)	Microsoft's first browser, pre-installed with Windows.
1996	Opera	Developed as a research project, later released publicly.
2003	Safari	Apple's browser, originally for macOS, later expanded to iOS.
2004	Mozilla Firefox	Open-source browser, built as a successor to Netscape.

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Web Browsers - Evolution

Year	Browser	Description
2008	**Google Chrome**	Fast, lightweight browser that became dominant worldwide.
2011	**Opera Mini**	A mobile-focused browser designed for fast browsing.
2015	**Microsoft Edge**	Introduced as a replacement for Internet Explorer.
2016	**Brave**	A privacy-focused browser that blocks ads and trackers.
2019	**New Microsoft Edge (Chromium-based)**	Rebuilt Edge using the **Chromium engine** for better performance.
2019	**Vivaldi**	A browser designed for **power users**, with heavy customization.
2020	**DuckDuckGo Browser**	Privacy-focused browser with built-in tracker blocking.
2022	**Arc Browser**	A new, minimalist browser with an AI-driven experience.
2023	**Orion Browser**	A Mac-exclusive browser focusing on **privacy and performance**.

Top 5 browsers

Rank	Browser	Market Share (%)	Primary Platform	Key Features
1	Google Chrome	66.68%	Windows, macOS, Linux, Android, iOS	Fast, secure, supports extensions, syncs across devices
2	Apple Safari	18.07%	macOS, iOS	Optimized for Apple devices, privacy-focused, energy-efficient
3	Microsoft Edge	5.25%	Windows, macOS, Android, iOS	Chromium-based, integrated with Windows, AI features
4	Mozilla Firefox	2.65%	Windows, macOS, Linux, Android	Open-source, privacy-focused, customizable
5	Samsung Internet	2.23%	Android (Samsung devices)	Optimized for Samsung devices, ad-blocking, secure browsing

Reference: Statcounter Global Stats

Web Servers

- To dispense the web page when it is requested by web clients (browser)
- Computers on which this web server program run are usually called as servers , for hosting web.
- In web hosting, the web servers enable the hosting providers to handle multiple domains (or multiple websites) on a single server.

- Main uses of web server:
  - To own a website, maintains the data need to be displayed on web page
  - To use server-side technologies such as PHP, json

How Web servers work?

1. Obtaining the IP Address from domain name:

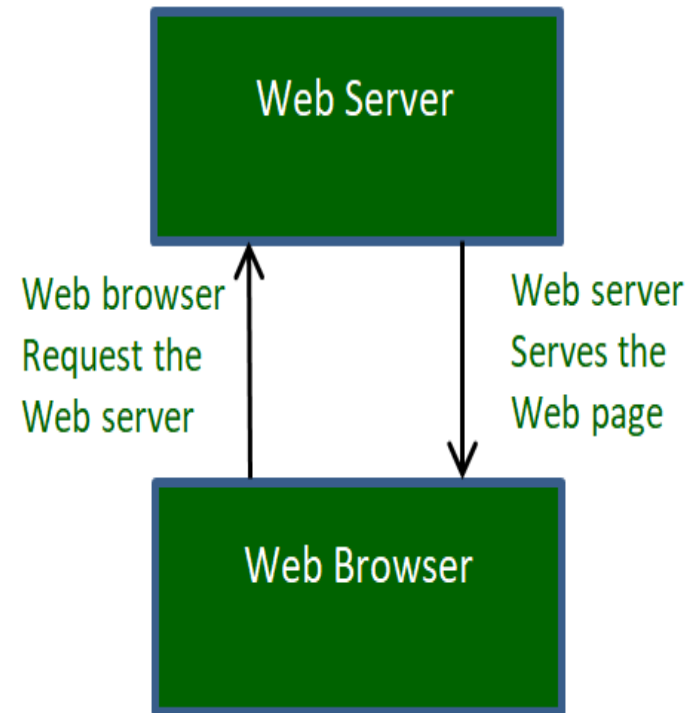- By searching in its cache.
- By requesting one or more DNS

2. Browser requests the full URL

   After knowing the IP Address, the browser
   now demands URL from the web server.

3. Web server responds to request:
   by sending the desired pages, or error messages

4. Browser displays the web page:

Web Server

Web browser
Request the
Web server

Web server
Serves the
Web page

Web Browser

Popular Web Servers

Web Server	Market Share (%)
Nginx	33.8%
Apache HTTP Server	26.9%
Cloudflare Server	23.3%
LiteSpeed	14.4%
Microsoft IIS	4.1%

Reference: W3Techs Web Server Usage Statistics

- Nginx is renowned for its high performance and scalability, making it a popular choice for handling numerous concurrent connections.
- Apache is a versatile and widely adopted open-source web server, appreciated for its robustness and extensive module support.
- Cloudflare's server infrastructure provides content delivery network (CDN) services, enhancing website performance and security.

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Static Web: HTML, CSS

- **HTML** stands for **H**yper**T**ext **M**arkup **L**anguage
  - It is a text file containing small markup tags that tell the Web browser how to display the page

- **CSS** stands for **C**ascading **S**tyle **S**heets
  - It defines how to display HTML elements

Dynamic Web: Client-Side Programmability

- Scripting language: a lightweight programming language
- Browser scripting: **JavaScript**
  - Designed to add interactivity to HTML pages
  - Usually embedded into HTML pages
  - What can a JavaScript Do?
    - Put dynamic text into an HTML page
    - React to events
    - Read and write HTML elements
    - Validate data before it is submitted to a server
    - Create cookies

Server-Side Programmability

- The requests cause the response to be generated
- Server scripting:
  - **PHP:** Open source, strong database support (*.php)
  - **Node.JS** – Server side JavaScript
  - ASP: Microsoft product, uses .Net framework (*.asp)
  - Java via JavaServer Pages (*.jsp)
  - CGI/Perl: Common Gate Way Interface (*.pl, *.cgi)
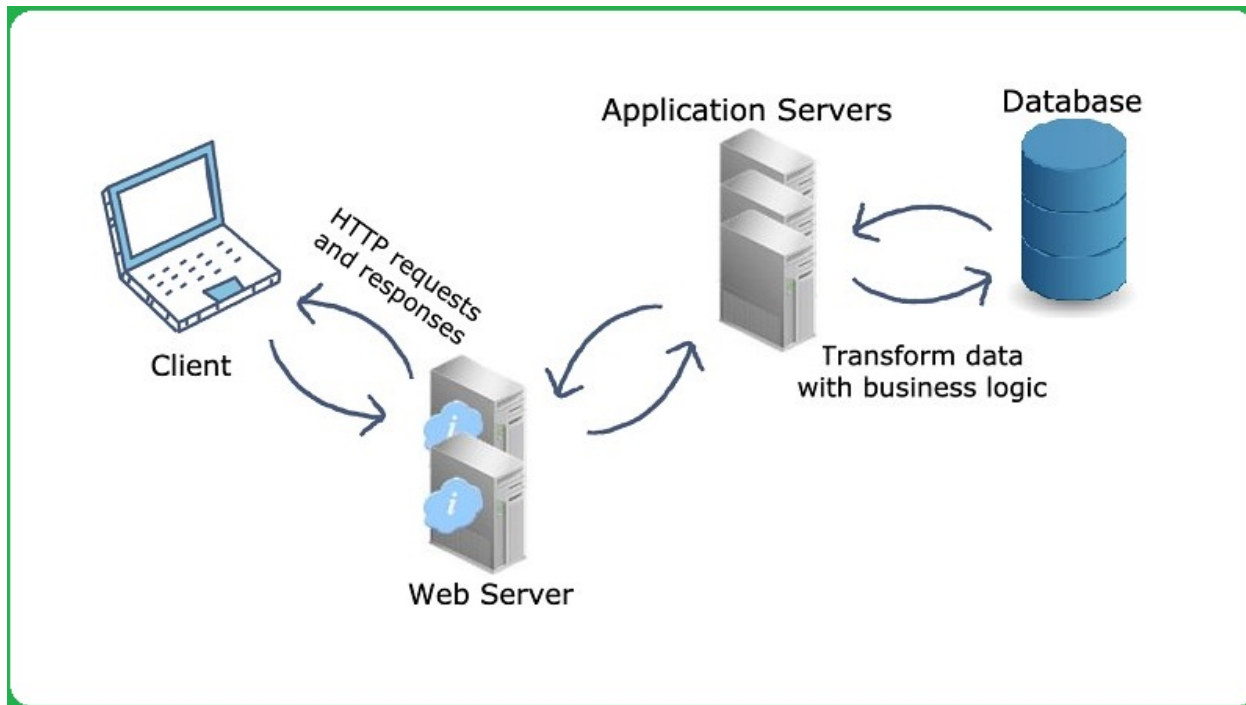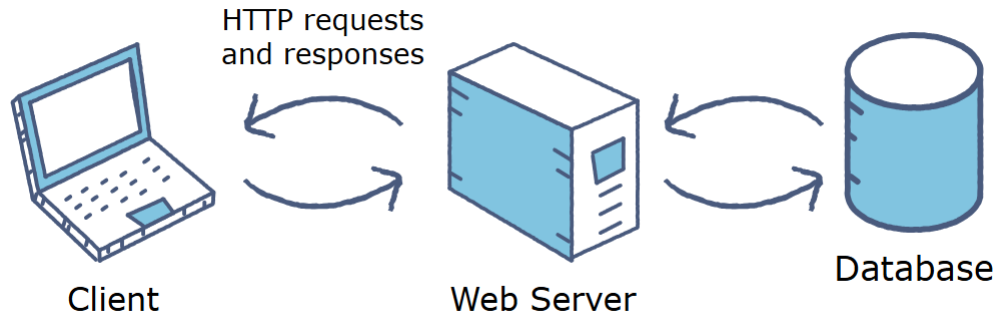 - …

Transmitting DATA in Web Application
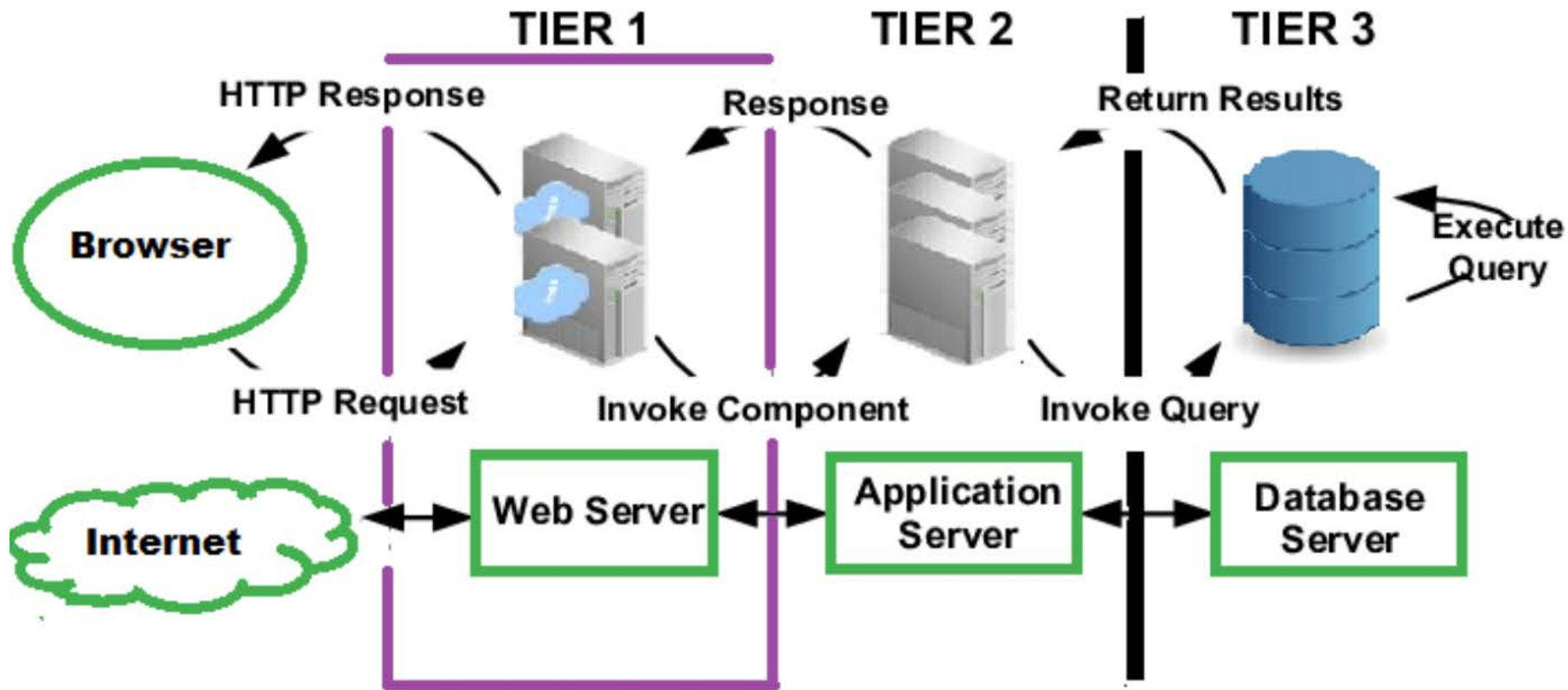
- MySQL
- XML
- JSON
- …
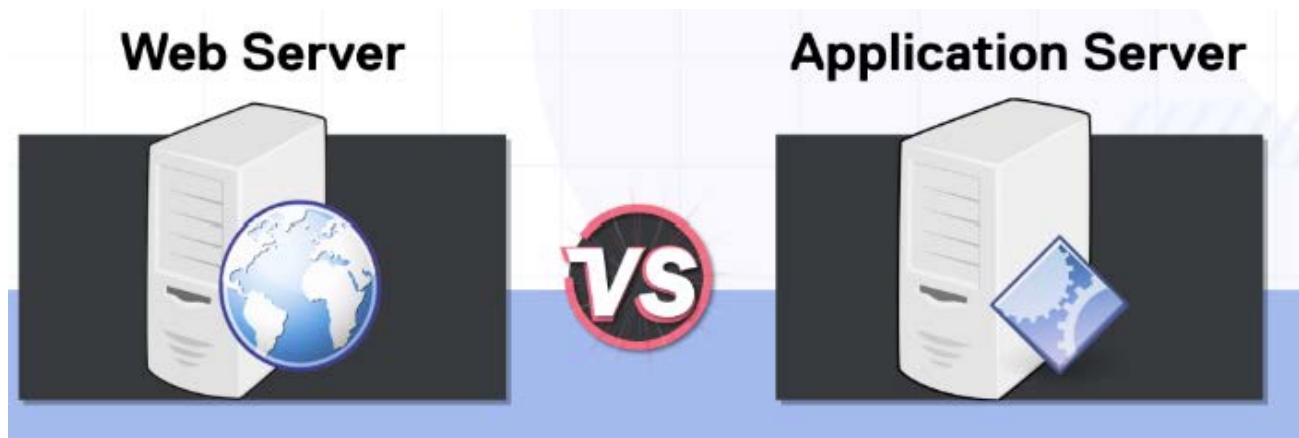
- **Web Server:** Handles HTTP requests and serves static content.

- **Application Server:** Processes business logic and dynamic requests.

- Examples: Apache, Nginx (Web Server); Tomcat, WebLogic (Application Server).

Web Server Vs Application Server

Three tier Architecture

Web Server vs. Application Server

Feature	Web Server 🌐	Application Server 🖥️
Purpose	Handles **HTTP requests**, serves **static content (HTML, CSS, JavaScript, images)**	Executes **business logic**, processes **dynamic content (database interactions, APIs, application logic)**
Example Use Case	Serving a **static website** like a portfolio, blog, or documentation	Running a **dynamic application** like an e-commerce site or a banking system
Content Type	Static content	Dynamic content
Supports	Serves **HTML, CSS, JavaScript, images, and videos**	Runs **JSP, Servlets, PHP, Python, .NET, Java EE applications**
Processing Power	Only **for HTTP requests**, does not execute server-side logic	Handles **business logic**, database transactions, and APIs
Connection Handling	Uses **HTTP protocol** for request/response cycle	Uses **multi-threading and session management** to handle requests
Examples	**Apache HTTP Server, Nginx, Microsoft IIS, LiteSpeed**	**Tomcat, JBoss, WebLogic, WebSphere, GlassFish**

Thank You

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