Module5

The HTTP Protocol: A Comprehensive Guide

The **HyperText Transfer Protocol (HTTP)** is the foundation of communication on the web, enabling the transfer of data between clients (browsers, mobile apps) and servers. Below is a detailed breakdown of its core components.

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1. HTTP Requests

An HTTP request is made by a client to request data from a server. A typical request contains:

- A **Request Line** (includes method, URL, and HTTP version)
- **Headers** (metadata like user-agent, content-type)
- **Body** (for methods like POST and PUT)

Example of an HTTP Request

```
GET /index.html HTTP/1.1

Host: www.example.com

User-Agent: Mozilla/5.0

Accept: text/html
```

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2. HTTP Responses

After receiving a request, the server sends an **HTTP response**, which includes:

- **Status Line** (HTTP version, status code, status message)
- **Headers** (metadata about the response)
- **Body** (actual content like HTML, JSON)

Example of an HTTP Response

```
HTTP/1.1 200 OK

Date: Mon, 25 Mar 2025 10:00:00 GMT

Content-Type: text/html

Content-Length: 1256



<html>

<head><title>Welcome</title></head>
```

```
<body><h1>Welcome to My Website</h1></body>
</html>
```

---

3. HTTP Methods

HTTP defines several request methods, each serving a specific purpose:

Method	Description
GET	Retrieve data from the server
POST	Submit data to be processed
PUT	Update a resource completely
DELETE	Remove a resource
PATCH	Partially update a resource
HEAD	Similar to GET but without the body
OPTIONS	Retrieves supported HTTP methods from the server

Example (GET and POST in HTML)

```
<!-- GET request (fetch data from server) -->
<form action="https://example.com/search" method="GET">
    <input type="text" name="query" placeholder="Search">
    <button type="submit">Search</button>
</form>

<!-- POST request (submit data to server) -->
<form action="https://example.com/login" method="POST">
    <input type="text" name="username" placeholder="Username">
    <input type="password" name="password" placeholder="Password">
    <button type="submit">Login</button>
</form>
```

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4. URLs (Uniform Resource Locators)

A **URL** is the web address of a resource. It follows this structure:

```
scheme://hostname:port/path?query_parameters#fragment
```

Example:

https://www.example.com:443/products?category=shoes#reviews

- https → Protocol
- www.example.com → Hostname
- 443 → Port (default for HTTPS)
- /products → Path
- ?category=shoes → Query parameters
- #reviews → Fragment

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5. REST (Representational State Transfer)

REST is an architectural style used in web services where APIs follow HTTP conventions. A **RESTful API** adheres to principles like:

- **Statelessness**: Each request is independent
- **Client-Server Architecture**
- **Cacheability**
- **Use of standard HTTP methods**

Example of REST API Request (GET request in JavaScript)

```
fetch('https://api.example.com/users')
  .then(response => response.json())
  .then(data => console.log(data))
  .catch(error => console.error('Error:', error));
```

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6. HTTP Headers

Headers provide metadata about the request/response.

Common Request Headers

Header	Description
User-Agent	Identifies client making the request
Accept	Specifies response content type
Authorization	Contains authentication credentials
Content-Type	Specifies request body format

Common Response Headers

Header	Description
Content-Type	Specifies response body format
Set-Cookie	Sets a cookie in the client
Cache-Control	Controls caching behavior

7. Cookies

Cookies store small data on the client for maintaining session state.

Example: Setting a Cookie (Server Response)

```yaml
Set-Cookie: sessionId=12345; Expires=Wed, 30 Mar 2025 12:00:00 GMT; Secure; HttpOnly
```

Reading Cookies in JavaScript

```
document.cookie; // Retrieves all cookies
```

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8. HTTP Status Codes

These indicate the result of a request.

Categories

Code Range	Meaning
1xx	Informational (e.g., 100 Continue)
2xx	Success (e.g., 200 OK, 201 Created)
3xx	Redirection (e.g., 301 Moved Permanently, 302 Found)
4xx	Client errors (e.g., 400 Bad Request, 401 Unauthorized, 404 Not Found)
5xx	Server errors (e.g., 500 Internal Server Error, 503 Service Unavailable)

9. HTTPS (Secure HTTP)

HTTPS encrypts data using **TLS/SSL** for security.

Difference Between HTTP and HTTPS

Feature	HTTP	HTTPS
Encryption	No	Yes (TLS/SSL)
Security	Vulnerable	Secure
Port	80	443

```
})
```

Feature	HTTP	HTTPS

Example: Forcing HTTPS Redirect (Apache)

```
RewriteEngine On

RewriteCond %{HTTPS} off

RewriteRule ^(.*)$ https://%{HTTP_HOST}%{REQUEST_URI} [R=301,L]
```

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10. HTTP Proxies

A **proxy server** acts as an intermediary between a client and a server.

Types of Proxies

- **Forward Proxy**: Handles requests from clients to servers.
- **Reverse Proxy**: Handles requests from clients on behalf of backend servers.

Example: Using an HTTP Proxy in cURL

```
curl -x http://proxy.example.com:8080 -L https://example.com
```

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11. HTTP Authentication

Authentication restricts access to resources.

Types of HTTP Authentication

Type	Description
Basic Auth	Sends username & password in Base64
Bearer Token	Uses a token (e.g., OAuth)
API Keys	Uses a unique API key for access

Example: Basic Authentication (Request Header)

```
Authorization: Basic dXNlcm5hbWU6cGFzc3dvcmQ=
```

Example: Bearer Token Authentication

```
fetch('https://api.example.com/data', {

  headers: {

    'Authorization': 'Bearer your_token_here'

  }

})
```

```
.then(response => response.json())
.then(data => console.log(data));
```

Web Functionality

Web functionality refers to how a web application operates on both the **server-side** and **client-side**, as well as how it manages state and sessions.

1. Server-Side Functionality

Server-side functionality refers to the logic and operations executed on the web server rather than the user's browser. It is responsible for processing requests, interacting with databases, and generating dynamic responses.

Key Components:

- **Web Server:** Handles HTTP requests and responses (e.g., Apache, Nginx, IIS).
- **Application Server:** Runs the business logic (e.g., Node.js, Django, ASP.NET).
- **Database Server:** Stores and retrieves data (e.g., MySQL, PostgreSQL).
- **Server-Side Programming Languages:** PHP, Python, Java, C#, Ruby, Node.js.
- **Security Mechanisms:** Authentication, authorization, data validation.

How Server-Side Works:

1. A user sends a request (e.g., clicking a button on a webpage).
2. The request is processed by the web server and sent to the application logic.
3. The application retrieves data from a database if needed.
4. The server generates an HTML response and sends it back to the browser.
5. The user sees the final content displayed in their web browser.

Advantages of Server-Side Processing:

- More secure as code is not exposed to users.
- Can handle complex computations and business logic.
- Reduces load on the client’s device.
- Works across different devices and browsers.

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2. Client-Side Functionality

Client-side functionality refers to operations executed in the user's browser rather than the web server. This includes user interface (UI) interactions, dynamic page updates, and local data storage.

Key Components:

- **HTML:** Structure and layout of web pages.
- **CSS:** Styling and design elements.
- **JavaScript:** Adds interactivity (e.g., form validation, animations, event handling).
- **Frameworks/Libraries:** React.js, Angular, Vue.js, jQuery.
- **APIs:** Fetches data dynamically (e.g., AJAX, Fetch API, WebSockets).
- **Local Storage:** Saves small data sets on the user's device (LocalStorage, SessionStorage, IndexedDB).

How Client-Side Works:

1. The user requests a webpage, and the browser downloads the necessary files.
2. JavaScript runs scripts to make the page interactive.
3. The user interacts with the webpage (e.g., clicks a button).
4. JavaScript updates the UI without reloading the page.
5. Data can be fetched asynchronously from a server via APIs.

Advantages of Client-Side Processing:

- Faster and more responsive UI updates.
- Reduces server load by offloading work to the client.
- Enables dynamic interactions without reloading pages.
- Works offline using service workers and caching.

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3. State and Sessions

A **state** in web applications refers to data that persists between interactions, while **sessions** manage temporary user-specific data.

Types of States:

1. **Application State:** Data relevant to the entire application (e.g., current theme setting).
2. **Session State:** User-specific data stored on the server or client for a short period.
3. **Persistent State:** Data saved in cookies, local storage, or databases for long-term use.

Session Management Methods:

- **Cookies:** Small text files stored in the browser (can be persistent or session-based).
- **Session Storage:** Data stored in the browser but deleted when the tab is closed.

- **Local Storage:** Data stored in the browser that persists even after closing the tab.
- **Server Sessions:** Stores user data on the server with a session ID in cookies.
- **JWT (JSON Web Token):** Secure token-based authentication that stores session data.

Encoding Schemes

Encoding schemes convert data into different formats for safe transmission and storage.

1. URL Encoding

URL encoding is used to convert characters into a format that can be safely transmitted via URLs.

Why URL Encoding?

- URLs can only contain certain characters.
- Spaces, special symbols, and non-ASCII characters need encoding.

Example:

- Original: Hello World!
- URL Encoded: Hello%20World%21

Common Encoded Characters:

Character	Encoded Value
Space	%20
&	%26
/	%2F
?	%3F

2. Unicode Encoding

Unicode is a universal character encoding system that supports multiple languages.

Common Unicode Formats:

- **UTF-8:** Variable-length encoding, backward-compatible with ASCII.
- **UTF-16:** Uses 16-bit encoding, suitable for scripts like Chinese.
- **UTF-32:** Uses 32-bit encoding, supports all Unicode characters.

Example (UTF-8 Encoding of "A"):

- Character: A
- UTF-8 Hex: 0x41

3. HTML Encoding

HTML encoding ensures special characters are displayed correctly in web pages.

Why HTML Encoding?

- Prevents cross-site scripting (XSS) attacks.
- Ensures HTML tags are treated as text rather than code.

Common Encoded Characters:

Character	Encoded Value
<	&lt;
>	&gt;
&	&amp;
"	&quot;

Example:

- Original: <h1>Hello</h1>
- Encoded: &lt;h1&gt;Hello&lt;/h1&gt;

4. Base64 Encoding

Base64 encoding is used to encode binary data as text.

Uses of Base64 Encoding:

- Embedding images in HTML/CSS.
- Encoding binary data in JSON APIs.
- Sending attachments in emails.

Example:

- Original Text: Hello
- Base64 Encoded: SGVsbG8=

Decoding Base64:

- SGVsbG8= → Hello

5. Hex Encoding

Hex encoding represents binary data in hexadecimal (base-16) format.

Uses of Hex Encoding:

- Cryptographic keys and hashes.
- Binary file representation.
- Debugging and network communication.

Example:

- Original: Hello
- Hex Encoded: 48 65 6C 6C 6F