Client-Server Model: Interview Questions and Answers

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1. Fundamental Questions

1. What is the client-server model, and how does it work?

- The client-server model is a computing architecture where clients request services, and servers provide them.
- Clients initiate communication, while servers listen for incoming requests and respond accordingly.
- Common protocols used: HTTP, FTP, DNS, SMTP, etc.
- Example: When a user visits a website, the browser (client) requests the webpage from a web server.

2. How does a client communicate with a server?

- Clients communicate with servers via a network (Internet, LAN, Wi-Fi).
- They use standard protocols such as HTTP, TCP/IP, and WebSockets.
- The communication is typically in a request-response format.
- Example: A mobile app sending an API request to a backend server.

3. What are some real-world examples of the client-server model?

- **Web browsing:** Browsers request web pages from web servers.
- **Email services:** Email clients (Gmail, Outlook) communicate with mail servers (SMTP, IMAP, POP3).
- **Streaming services:** Clients (Netflix app) request video streams from media servers.
- **Online gaming:** Players (clients) interact with a game server that manages gameplay.

4. What is the difference between a client and a server?

- **Client:** Requests data or services (e.g., a web browser fetching a webpage).

- **Server:** Processes requests and returns responses (e.g., a web server hosting a website).

- Clients are typically user-facing applications, while servers handle business logic and data processing.

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2. Request-Response Cycle Questions

5. Explain the HTTP request-response cycle with an example.

- The **HTTP request-response cycle** involves the following steps:

    1. A client (browser) sends an **HTTP request** (e.g., `GET /index.html`).

    2. The request is transmitted over the network to the web server.

    3. The server processes the request (fetches the requested resource, queries a database if needed).

    4. The server sends back an **HTTP response** (status code + requested data).

    5. The browser renders the response (displays the webpage).

- Example: Visiting `https://example.com` triggers an HTTP request to the web server, which responds with the website's HTML, CSS, and JavaScript files.

6. What are the key differences between synchronous and asynchronous communication?

- **Synchronous Communication:**

    - The client sends a request and waits for the server's response before continuing.

    - Example: REST API requests.

- **Asynchronous Communication:**

    - The client sends a request but does not wait for a response before proceeding.

    - Example: WebSockets for real-time messaging, AJAX requests in web applications.

7. How does a browser load a webpage? Walk me through the steps.

1. User enters a URL (e.g., `https://example.com`).
2. The browser queries the **DNS server** to resolve the domain name to an IP address.
3. The browser sends an **HTTP GET request** to the web server.
4. The web server processes the request and retrieves the required resources (HTML, CSS, JavaScript, images).
5. The server sends an **HTTP response** with a status code and the requested data.
6. The browser parses and renders the content for the user.

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3. Architecture and Design Questions

8. What is the difference between stateless and stateful servers?

- **Stateless Servers:**
    - Do not retain client session data between requests.
    - Example: REST APIs, HTTP servers.
    - Advantage: Scalability and easy load balancing.
- **Stateful Servers:**
    - Maintain session information for clients.
    - Example: WebSockets for chat applications, online banking sessions.
    - Advantage: Personalized and persistent user experiences.

9. How does caching improve performance in a client-server model?

- **Caching** reduces the need for repeated data fetching, improving speed and reducing server load.
- Types of caching:
    - **Browser Cache:** Stores static assets (CSS, JS, images) locally.

- **CDN (Content Delivery Network):** Caches content geographically closer to users.
- **Server-side Cache:** Stores frequently accessed database queries or API responses.
- **Database Cache:** Uses Redis or Memcached to store query results.

10. How do load balancers work in a client-server architecture?

- **Load balancers** distribute incoming client requests across multiple servers.
- They prevent overload on a single server, improving reliability and scalability.
- Load balancing strategies:
  - **Round Robin:** Requests are distributed in a circular manner.
  - **Least Connections:** Requests go to the server with the fewest active connections.
  - **IP Hashing:** Requests from the same IP address go to the same server.

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4. Advanced Questions

11. What are some security challenges in the client-server model?

- **Man-in-the-Middle (MITM) Attacks:** Data interception; mitigated by HTTPS encryption.
- **DDoS Attacks:** Overloading a server with excessive requests; mitigated by rate limiting and CDNs.
- **SQL Injection:** Malicious database queries; prevented using parameterized queries.
- **Cross-Site Scripting (XSS):** Injecting malicious scripts into web pages.

12. How does WebSockets differ from traditional request-response communication?

- **WebSockets:**
  - Enable **real-time, bidirectional communication** between the client and server.

    - Unlike HTTP, WebSockets keep the connection **open** for continuous data exchange.
    - Used in **chat applications, stock price updates, real-time gaming**.
- **Traditional HTTP:**
    - Follows a request-response cycle.
    - Each request requires a new connection.
    - Better suited for static content retrieval.

13. What are some limitations of the client-server model? How can they be addressed?

- **Single Point of Failure:** A central server can become a bottleneck.
    - Solution: Use load balancing, replication, and failover mechanisms.
- **Scalability Issues:** High traffic can overwhelm the server.
    - Solution: Implement horizontal scaling (adding more servers) and caching strategies.
- **Security Risks:** Centralized data can be a target for attacks.
    - Solution: Implement encryption, authentication, and firewalls.

14. How would you design a scalable client-server system for a high-traffic application?

- **Use Load Balancers** to distribute traffic.
- **Implement Caching (CDN, Redis, Memcached)** to reduce load.
- **Use Microservices** instead of a monolithic architecture.
- **Scale horizontally** by adding more servers.
- **Optimize Database Queries** using indexing and read replicas.

This document provides **detailed answers** formatted for easy conversion into a PDF. Let me know if you'd like any refinements! 🚀