1. Introduction

The **TCP Calculation System** project involves developing a **distributed system** using exclusively **TCP sockets**, allowing multiple clients to connect simultaneously to a calculation server.

The main goal is to provide a reliable mechanism for performing remote mathematical operations while logging each operation for complete tracking via a **logging system**.

The main components are:

- A **TCP client** (implemented in C and Java) for sending requests.
- A **multi-threaded TCP server** capable of handling multiple clients in parallel.
- A **logging system** to store all operations, results, and errors.

2. Design

The system architecture consists of three main components:

2.1 TCP Client (C / Java)

- Sends two numbers (`NUMBER 1` , `NUMBER 2`) and an operator (`OPERATOR`) representing the operation (`+` , `-` , `*` , `/`) to the server.
- Waits for the result or an error message.

2.2 TCP Calculation Server

- Accepts multiple connections using multi-threading.
- Validates received data: checks for numeric input and handles division by zero.
- Computes the result and returns it to the client.
- Logs every operation or error to a file.

2.3 Logging System

- Stores all operations with a **timestamp**.
- Provides precise tracking and easy debugging.

3. Sequence Diagram

1. The client connects to the server via TCP.
2. The client sends `NUMBER 1`, `NUMBER 2`, and `OPERATOR`.
3. The server validates the received inputs.
4. If the data is correct, the server calculates the result.
5. The server sends `RESULT` or `ERROR` to the client.
6. The server logs the operation in the log file.

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4. Implementation and Testing

4.1 Data Validation

- Checks for non-numeric inputs.
- Handles errors such as **division by zero**.

4.2 Network Error Handling

- Connection and transmission errors are detected and handled.
- Clients receive appropriate messages in case of errors.

4.3 Example Logs (minimum 20 operations)

```
2025-12-12 14:00 - NUMBER: 5, NUMBER: 2, OPERATOR: +, RESULT: 7
2025-12-12 14:01 - NUMBER: 10, NUMBER: 0, OPERATOR: /, ERROR: Division by zero
2025-12-12 14:02 - NUMBER: 8, NUMBER: 3, OPERATOR: *, RESULT: 24
2025-12-12 14:03 - NUMBER: 15, NUMBER: 5, OPERATOR: -, RESULT: 10
...
```

4.4 Multi-Client Testing

- Multiple clients were connected simultaneously to test **multi-threading**.
- The server correctly handled each request independently.
- Results and errors were logged properly.

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5. Conclusion

The **TCP Calculation System** meets its objectives:

- Reliable communication via TCP between clients and server.

- Simultaneous handling of multiple clients through multi-threading.
- Complete logging for precise operation tracking.
- Correct handling of errors, including division by zero and invalid inputs.

The system is extensible for adding new types of operations or improving the logging format.