Assignment#2: Socket Programming

TCP vs. UDP Comparison

NOTE: All submissions will be made through **GitHub only**. Details will be shared on Discord Channel for the assignment.

Objective:

This assignment helps understand the differences between **TCP (connection-oriented)** and **UDP (connectionless)** communication by implementing **client-server applications** and measuring **latency**, **packet loss**, and **throughput**.

Submission Requirements:

1. The complete Python scripts (*tcp_server.py*, *tcp_client.py*, *udp_server.py*, *udp_client.py*).

2. A *README.md* file explaining:

- How to run the programs

- Expected outputs

- Observations about TCP vs UDP behavior (*See the Comparison section*)

- How you have accomplished this. (Small para pointing to references online/offline that you used to advance your understanding)

3. Test Log Files (*tcp_log.txt*, *udp_log.txt)*

Task Overview:

1. Implement **TCP** and **UDP client-server models**.

2. Send **multiple messages** from the client to the server.

3. Measure **latency (round-trip time)** and **throughput** for both protocols.

4. Simulate **packet loss** in UDP by randomly dropping packets.

5. Analyze the results and compare **TCP** vs. **UDP**.

Part 1: TCP-based Client-Server Application

- The **server**:

  - Listens for incoming TCP connections.

  - Responds with "**Received: <message>**".

  - Measures the time taken for each message to be sent and acknowledged.

- The **client**:

  - Sends 100 messages sequentially.

  - Records the **time taken** for each round-trip.

- Calculates the **average latency** and **throughput**.

Part 2: UDP-based Client-Server Application

- The **server**:
  - Listens for UDP packets.
  - Simulates **packet loss** by randomly ignoring some packets.
  - Responds with "**Received: <message>**" for others.
- The **client**:
  - Sends 100 messages sequentially.
  - Tracks **round-trip time** and **dropped packets**.
  - Calculates **average latency**, **packet loss rate**, and **throughput.**

Testing:

1. Run the TCP Server

```
python tcp_server.py
```

2. Run the TCP Client

```
python tcp_client.py
```

3. Run the UDP Server

```
python udp_server.py
```

4. Run the UDP Client

```
python udp_client.py
```

5. Record results

- **Record your terminal output** when running the above programs.
- Must provide:
  - Screenshot of the **TCP & UDP client output**.
  - Log files (*tcp_log.txt*, *udp_log.txt*) showing **real execution** (*This is different from step one and should be done side-by-side as you doing the tests*).

Comparison and Analysis

1. Latency Comparison

- Compare the average **round-trip time (RTT)** for **TCP and UDP**.
- Why does UDP have **lower latency** than TCP? -

2. Reliability and Packet Loss

- What happens when some UDP packets are **lost**?
- Why does TCP ensure that **all packets arrive correctly**?

3. Throughput Analysis

- Which protocol is **faster** for bulk data transfer?

- Why does TCP introduce **overhead** due to acknowledgments?

4. Use Cases

- When should an application use **TCP** instead of **UDP**?

- Give **real-world examples** (e.g., HTTP, VoIP, video streaming).