PCD| Homework 1

1. Protocol Overview

In this experiment, two communication protocols (TCP and UDP) were compared to evaluate their performance under different transfer conditions, using two distinct methods: Streaming and Stop-and-Wait.

- **Streaming:** Data is transmitted in a continuous stream, without waiting for each packet to be acknowledged.
- **Stop-and-Wait:** After sending each packet, the client waits for acknowledgement from the server before sending the next packet.

Client/Server: The program was configured in a client-server mode, where the client sends data requests to the server, and the server responds to these requests. Depending on the chosen protocol, the client and server established various transmission conditions to evaluate the performance of each protocol.

- **TCP (Transmission Control Protocol):** A reliable, connection-oriented protocol that ensures data is delivered in a specific and correct order. It is used in applications that require reliability guarantees, such as web browsing (HTTP/HTTPS), file transfer (FTP), etc.
- **UDP (User Datagram Protocol):** A fast, connectionless protocol that does not guarantee packet delivery and does not provide flow control. It is used in real-time applications such as video streaming and online gaming.
- **QUIC (Quick UDP Internet Connections):** A protocol developed by Google, based on UDP, that offers high performance and low latency, while providing a security mechanism similar to TLS.

2.Statistics and comparisons of performance

		TCP	UDP
Streaming	500	0.93	1.84
	1000	1.87	3.68
Stop-and-wait	500	26.29	24.7
	1000	52.14	49.52

3. Detailed Analysis of Experimental Results

TCP in Streaming: TCP protocol offers lower latency than UDP for small packet sizes (500 and 1000 bytes). This can be explained by the fact that TCP offers more efficient flow control and guarantees packet delivery, which helps to avoid packet loss.

UDP in Streaming: Although UDP offers higher data transfer speed, latency is higher than TCP for small packet sizes. However, UDP remains an excellent option for scenarios where transfer speed is a priority and there are no requirements for reliable data delivery.

TCP in Stop-and-Wait: TCP protocol, in combination with Stop-and-Wait method, presents significantly higher latencies. This is because each packet must be acknowledged before sending the next one. TCP also requires more time to manage connections and retransmissions, which leads to poor performance under large packet transfer conditions.

UDP in Stop-and-Wait: Although UDP has lower latency than TCP in the Stop-and-Wait method, it does not guarantee packet delivery, which can lead to data loss in unstable networks. However, in scenarios where transfer speed is critical and data loss is acceptable, UDP remains a better choice than TCP.

	Advantages	Disadvantages
TCP	● High reliability, ensuring delivery of all packets. ● Better performance in small data transfer scenarios (Streaming). ● Flow control and acknowledgements for each transmitted packet.	● Higher latency, especially with Stop-and-Wait. ● Higher overhead due to connection management and acknowledgements.
UDP	● Low latency and high speed in streaming scenarios. ● Better performance than TCP for large data sizes.	● Lack of reliability, which can lead to data loss. ● No mechanisms for packet acknowledgement or retransmission.
Streaming	● Simple method, easy to implement. ● Ensures correct packet delivery through acknowledgement.	● High latency, especially for large data transfers. ● Low efficiency in fast network conditions.
Stop-and-wait	● High speed, suitable for continuous data transfers. ● Better efficiency in fast network conditions.	● Lack of reliability can lead to packet loss in unstable networks.