TCP & UDP comparison

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1 Abstract

Choosing the wrong transport protocol can have alarming consequences for your application. It is paramount to make a informed decision, otherwise the quality of your application may suffer from speed or data loss. In this paper, we will look at the difference in features between the two main transport protocols, UDP and TCP. We will conclude which is faster based on a experiment, finally we discuss their use cases based on the results and their features.

2 Introduction

In this article we will answer the following; does protocol features have an influence on their speed? which protocol is the fastest? and how does it all affect their use cases?

3 TCP and UDP differences

3.1 What is a transport protocol

When two computers need to communicate over a network, they need to make use of the network stack. A part of the network stack is the transport layer, TCP and UDP are both members of this layer, and its responsibility is to ensure that packets is routed from one computer to its destination computer through a network.[1]

3.2 How does TCP work?

TCP(Transmission Control Protocol) firstly establishes a connection with its destination server using a threeway handshake. When this is achieved, the protocol may begin sending packets. [1]

TCP ensures that all packets arrives at their destination in the correct order. This is achieved using delivery acknowledgement, everytime the destination server receives packets it sends a signal to the source server, informing it of which packets it has received.[1]

TCP ensures stability through the help of windowing. Windowing is a technique that helps TCP scale up its packets size, by increasing the amount of packets it sends when there is a successful transmission between the two servers. This technique scales up and down based on the success of the transmissions the two servers, the process is repeated until all data is sent through the network and has arrived at its destination. [1]

3.3 How does UDP work?

UDP (User Datagram Protocol) does not establish a connection with its destination server, this protocol does thereby not guarantee the packets arrival nor the packets arriving in the correct order, it simply sends the data, and does not wait for any sort of confirmation.[1]

4 Experiment

4.1 Benchmark

Hardware setup: This experiment was run on the following hardware Asus motherboard, Intel i7-10700k 3.8/5.1GHz, 32GB RAM, RTX 2070 super, the program was run in IntelliJ IDEA.

4.2 Setup

In order to determine which of the two transport protocols is faster, we created a speed test. It was written in Java, it contains a TCP & UDP server which could both receive a request, and corespondent clients. The clients purpose is to send the exact same 1GB of data, to their correspondent server trough localhost and log the time it took in milliseconds. To have a realistic sample size each program ran a thousand times and saved the results.

4.3 Code Sample

Listing 1 shows the TCP client, if you wish to view the full codebase it can be accessed in the following link: `https://github.com/Perlten/team7/tree/exam/ufo/exam/`

Listing 1: TCP & UDP client

```
 1    System.out.println("Reading data file");
 2    byte[] data = Main.loadDataFromFile();
 3    System.out.println("Sending data");
 4
 5    System.out.println("Send TCP");
 6    List<Long> tcpResList = new ArrayList<>();
 7    for (int i = 0; i < Main.SAMPLE_SIZE; i++) {
 8        long time = Main.sendOverTcp(data);
 9        tcpResList.add(time);
10    }
11
12    System.out.println("Send UDP");
13    List<Long> udpResList = new ArrayList<>();
14    for (int i = 0; i < Main.SAMPLE_SIZE; i++) {
15        long time = Main.sendOverUdp(data);
16        udpResList.add(time);
17    }
18
19    Main.saveResToFile(tcpResList, "./tcpRes.txt");
20    Main.saveResToFile(udpResList, "./udpRes.txt");
```

We start by reading the data that will be sent from the clients to the servers on line 2. We send a request with the given data "SAMPLE_SIZE" times, the time it takes in milliseconds is saved to a list. This is done with TCP on line 6-10, UDP performs the same opration on line 14-17. Lastly we save the results from UDP and TCP in their respectively result files.

4.4 Results

The output of the experiment is presented in the table below, the original results can be found here: `https://github.com/Perlten/team7/tree/exam/ufo/exam/results`

Type	TCP	UDP
Data size	1000	1000
Min	412	412
Q1	566	421
Median	627	424
Q3	641	428
Max	905	516

Figure 1: UDP TCP data

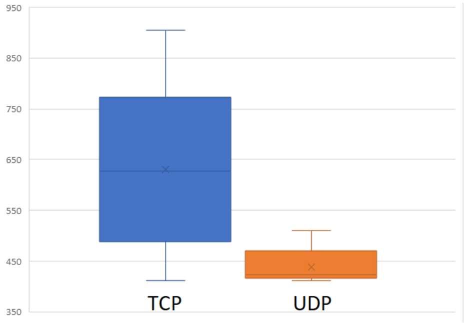

Figure 2: UDP TCP boxplot.

The results shown in the table is a direct comparison of the speed TCP and UDP runs at. It gives a clear picture of the variants in run times the two protocols may experience. TCP has big swings in runtimes, where as UDP is very consistent, this assumption is reflected in the numbers. The delta between TCP´s max and min values is 493 contrary to UDP´s delta which is 104. Based on the median there as a 32.3% speed advantage in the favor of UDP.

5 Conclusion & Use cases

The results of our experiment concludes UDP to be the fastest protocol by 32.3%, which makes sense when taking into consideration that UDP sends the data through the network without expecting any response.

Numerous features slow down TCP such as the handshake at the beginning of each new request, acknowledgment of each request, and windowing. However it is these feature that guarantee that all packets arrives and is in correct order, which is the great strength of TCP.[2]

You cannot conclude which protocol is the better of the two, each has multiple use cases. If you rely on extreme speed, and can accept that some packets may be lost, such as in video games, UDP is the preferred choice. If however you need consistency and reliability such as when sending files, loading webpages or anything of the sort, TCP is the preferred choice, as it ensures all packets to arrive and arrive in the correct order.[1]

The most important aspect is to know the strength and weakness of each protocol and apply the best suited protocol to the problem at hand.

References

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[2] Hari Balakrishnan, Venkata N. Padmanabhan, Srinivasan Seshan and Randy H. Katz(Stanford university): A Comparison of Mechanisms for Improving TCP Performance
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