

Programming Assignment 3

CSE 310 Fall 2022

Due date: **November 26, 2022; 11:59 PM**

Submission via Blackboard

In this assignment, you will gain a better understanding of Internet Control Message Protocol (ICMP). You will learn to implement a Ping application using ICMP request and reply messages.

Ping is a computer network application used to test whether a particular host is reachable across an IP network. It is also used to self-test the network interface card of the computer or as a latency test. It works by sending ICMP "echo request" packets to the target host and listening for ICMP "echo reply" replies. The "echo reply" is sometimes called a pong. Ping measures the round-trip time, records packet loss, and prints a statistical summary of the echo reply packets received (the minimum, maximum, and the mean of the round-trip times and in some versions the standard deviation of the mean).

Your task is to develop your own Ping application in Python. Your application will use ICMP but, in order to keep it simple, will not exactly follow the official specification in RFC 1739. Note that you will only need to write the client side of the program, as the functionality needed on the server side is built into almost all operating systems.

You should complete the Ping application so that it sends ping requests to a specified host, separated by approximately one second. Each message contains a payload of data that includes a timestamp. After sending each packet, the application waits up to one second to receive a reply. If one second goes by without a reply from the server, then the client assumes that either the ping packet or the pong packet was lost in the network (or that the server is down).

You need to calculate the round-trip time for each packet and print it out individually. You will need to report the minimum, maximum, and average RTTs at the end of all pings from the client (i.e when the program is closed (control-c)).

In the resources section on Piazza, you will find the skeleton code for the client. You are to complete the skeleton code. The places where you need to fill in code are marked with **#Fill in start** and **#Fill in end**. Each place may require one or more lines of code.

Your program output should look like:

```
Pinging 8.8.8.8 using Python:
36 bytes from 8.8.8.8; time=12.9 ms
36 bytes from 8.8.8.8; time=15.4 ms
36 bytes from 8.8.8.8; time=12.0 ms
36 bytes from 8.8.8.8; time=9.5 ms
^C--- 8.8.8.8 ping statistics ---
round-trip min/avg/max 9.491/12.434/15.357 ms
```

Additional Notes

1. In “receiveOnePing” method, you need to receive the structure ICMP_ECHO_REPLY and fetch the information you need, such as checksum, sequence number, time to live (TTL), etc. Study the “sendOnePing” method before trying to complete the “receiveOnePing” method.
2. You do not need to be concerned about the checksum, as it is already given in the code.
3. This assignment requires the use of raw sockets. In some operating systems, you may need administrator/root privileges to be able to run your Pinger program.
4. The program execution should be stopped using Ctrl+C, like the ping command
5. See the end of this programming assignment for more information on ICMP.

Testing the Pinger

Test your Pinger for the following scenario and include screenshots for each.

- A. Test your client by sending packets to localhost, that is, 127.0.0.1.
- B. Test your client by sending packets to stonybrook.edu or cs.stonybrook.edu.
- C. Select and ping 4 servers; each in a different continent.
- D. Explain the differences in minimum round trip time to each of these servers in parts A, B, and C.

Your submission should include your ping implementation along with explanations for the pinger testing scenarios, above.

Submission Instructions

If you want to write your code in any other language, please talk to me. You need to submit your homework in a single zip file as follows:

- The zip file and (the root folder inside) should be named using your last name, first name, and the assignment number, all separated by a dash ('-') e.g. lastname-firstname-assignment3.zip
- The zip file should contain (i) your pinger.py code; (ii) a report with your screenshots and how you computed answers to all the parts; and (iii) instructions on how to run your code.

Internet Control Message Protocol (ICMP)

ICMP Header

The ICMP header starts after bit 160 of the IP header (unless IP options are used).

Bits	160-167	168-175	176-183	184-191
160	Type	Code	Checksum	
192	ID		Sequence	

- **Type** - ICMP type.
- **Code** - Subtype to the given ICMP type.
- **Checksum** - Error checking data calculated from the ICMP header + data, with value 0 for this field.
- **ID** - An ID value, should be returned in the case of echo reply.
- **Sequence** - A sequence value, should be returned in the case of echo reply.

Echo Request

The echo request is an ICMP message whose data is expected to be received back in an echo reply ("pong"). The host must respond to all echo requests with an echo reply containing the exact data received in the request message.

- Type must be set to 8.
- Code must be set to 0.
- The Identifier and Sequence Number can be used by the client to match the reply with the request that caused the reply. In practice, most Linux systems use a unique identifier for every ping process, and sequence number is an increasing number within that process. Windows uses a fixed identifier, which varies between Windows versions, and a sequence number that is only reset at boot time.
- The data received by the echo request must be entirely included in the echo reply.

Echo Reply

The echo reply is an ICMP message generated in response to an echo request, and is mandatory for all hosts and routers.

- Type and code must be set to 0.
- The identifier and sequence number can be used by the client to determine which echo requests are associated with the echo replies.
- The data received in the echo request must be entirely included in the echo reply.