

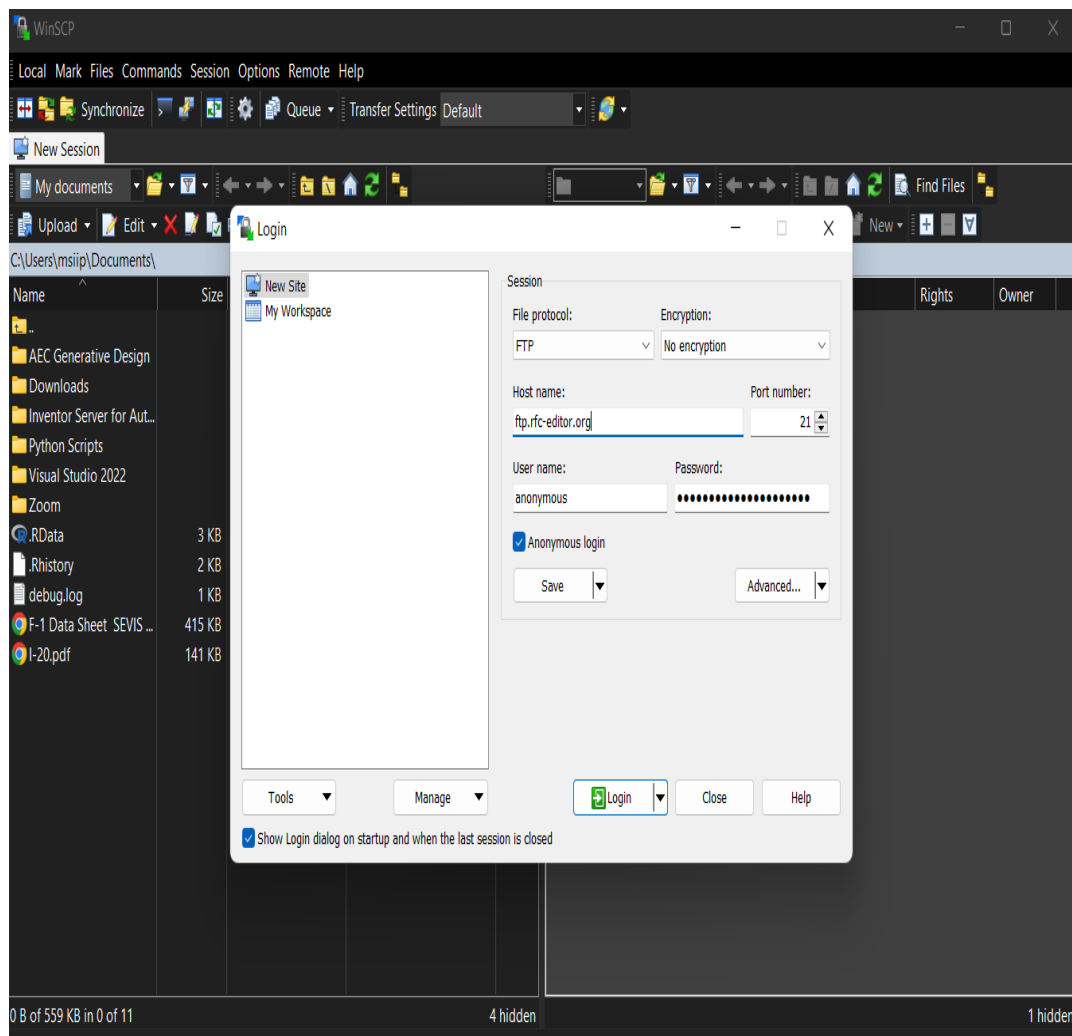
## CHAPTER 1: HOMEWORK

**Question 1. Use anonymous FTP to connect to ftp.rfc-editor.org (directory in-notes), and retrieve the RFC index. Also retrieve the protocol specifications for TCP, IP, and UDP.**

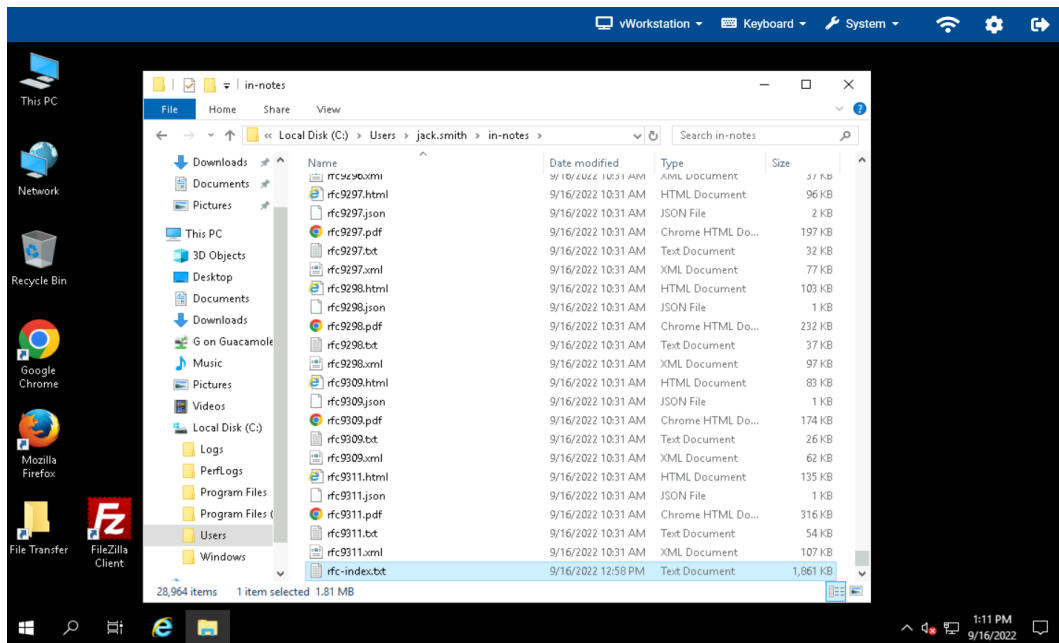
In many cases, when we have to access an anonymous FTP site, login can be done with FTP username “anonymous” and we do not need any identity username or password to access the files.

We have to use FTP (File Transfer Protocol) to connect to ftp.rfc-editor.org

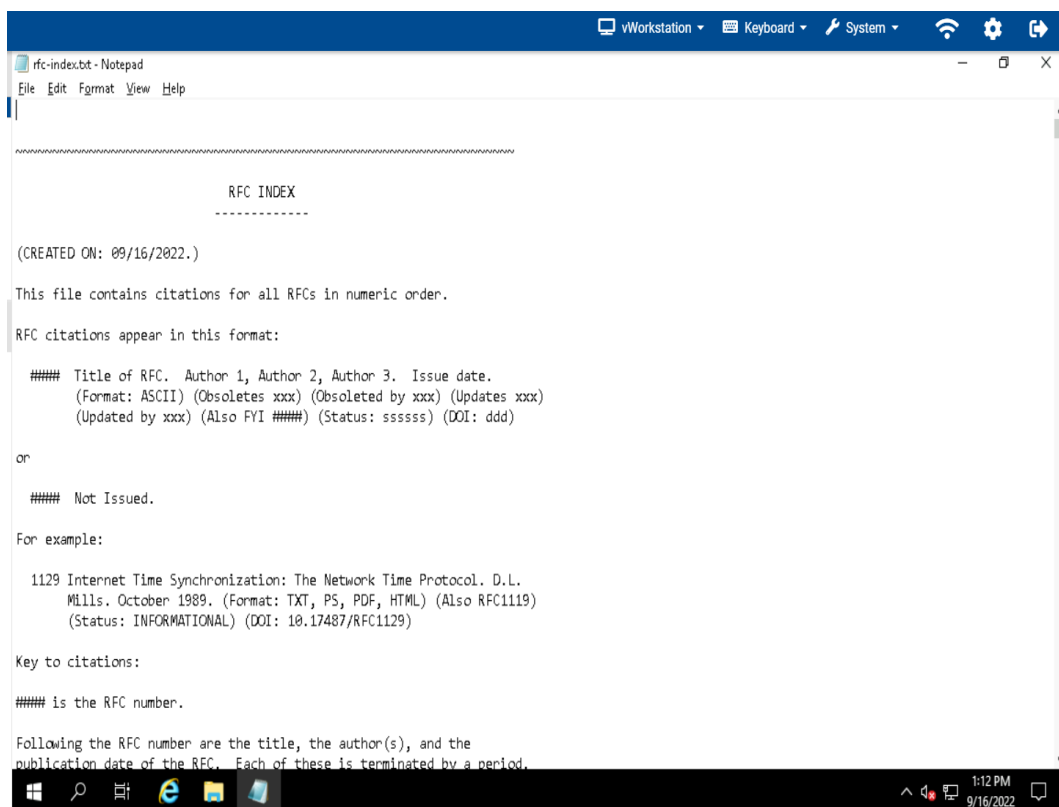
When we login into WinSCP as an anonymous, we will need to click the file protocol as an FTP, the host name is the URL or IP address of the web site, user name is anonymous. In addition, when we click on the “Anonymous login” we will receive a password automatically. Login information has been shown below:



Once we login, to retrieve the RFC index, we have to click on the folder in-notes which provide the RFC index. To access the RFC index, we need to download “rfc-index.txt” file. The file that we need to download has been shown below:

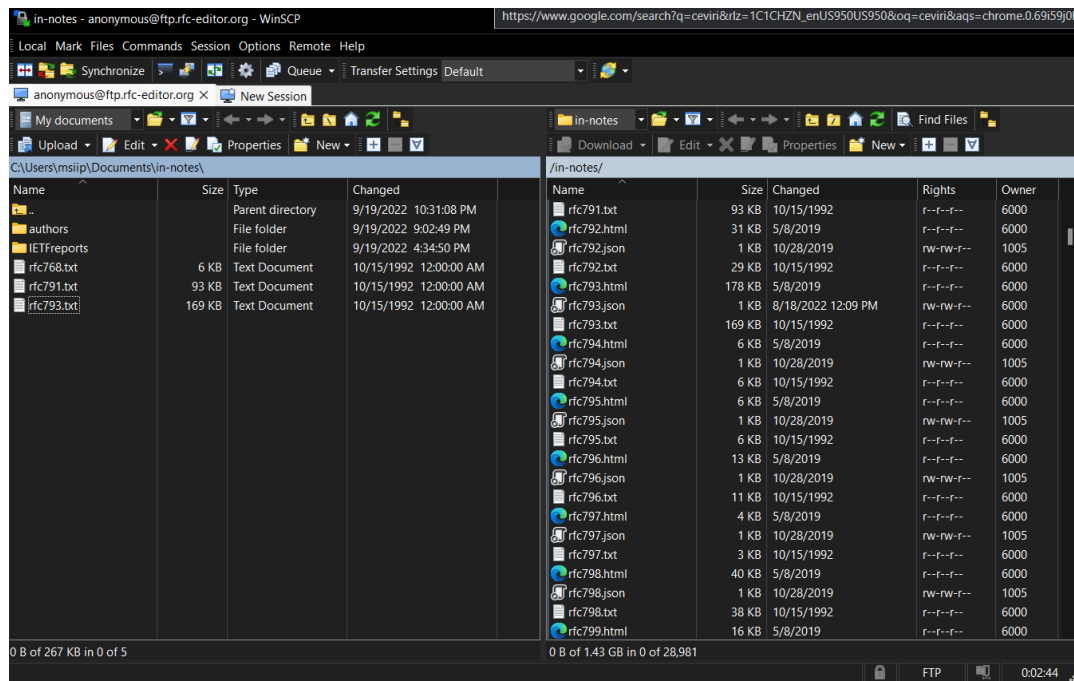


After downloading the file, we can access the information in the file. The information screen has been shown the below:

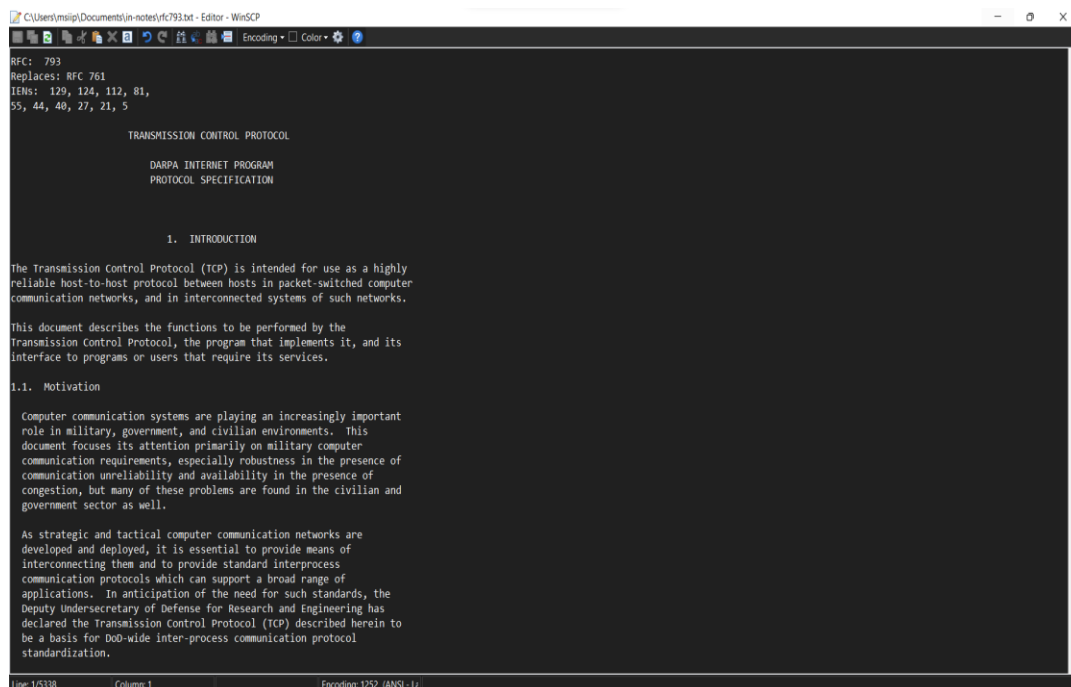


Usually, FTP is used to obtain RFC from <ftp.rfc-editor.org>. For instance, if we want to retrieve the RFC numbered “123” then the pathname has to be set like “in-notes/rfc123.txt”. To access to this numbers are accessible from <ftp.rfc-editor.org>. TCP pathname is rfc793.txt, IP pathname

is rfc791.txt, and UDP pathname is rfc768.txt. In the in-notes file we need to download those files to open. The files that we need to download has been shown below:



The protocol specification for TCP has been shown below:



The protocol specification for IP has been shown below:

## **MBone**

MBone (short for "multicast backbone") was an experimental backbone and virtual network built on top of the Internet for carrying IP multicast traffic on the Internet. Since the operators of most Internet routers have disabled IP multicast due to concerns regarding bandwidth tracking and billing, the MBone was created to connect multicast-capable networks over the existing Internet infrastructure.

The purpose of MBone was to minimize the amount of data required for multipoint audio/video-conferencing. MBone was free and it used a network of routers that support IP multicast, and it enables access to real-time interactive multimedia on the Internet. Many older routers do not support IP multicast.

## **ATM**

Asynchronous transfer mode (ATM) is a switching technique used by telecommunication networks that uses asynchronous time-division multiplexing to encode data into small, fixed-sized cells.

This is different from Ethernet or internet, which use variable packet sizes for data or frames. ATM is the core protocol used over the synchronous optical network (SONET) backbone of the integrated digital services network (ISDN).

## **MPEG**

The Moving Picture Experts Group (MPEG) is an alliance of working groups established jointly by ISO and IEC that sets standards for media coding, including compression coding of audio, video, graphics, and genomic data; and transmission and file formats for various applications.

MPEG formats are used in various multimedia systems. The most well-known older MPEG media formats typically use MPEG-1, MPEG-2, and MPEG-4 AVC media coding and MPEG-2 systems transport streams and program streams. Newer systems typically use the MPEG base media file format and dynamic streaming. Because of the various sophisticated compression techniques used, MPEGs, when compared to most audio and video formats, are smaller in size and more or less of same quality.

## **IPv6**

Internet Protocol version 6 (IPv6) is the most recent version of the Internet Protocol (IP), the communications protocol that provides an identification and location system for computers on networks and routes traffic across the Internet. IPv6 was developed by the Internet Engineering Task Force (IETF) to deal with the long-anticipated problem of IPv4 address exhaustion, and is intended to replace IPv4. IPv6 uses 128-bit addresses, theoretically allowing  $2^{128}$ , or approximately  $3.4 \times 10^{38}$  total addresses.

## **Ethernet**

Ethernet is a family of wired computer networking technologies commonly used in local area networks (LAN), metropolitan area networks (MAN) and wide area networks (WAN). Ethernet has since been refined to support higher bit rates, a greater number of nodes, and longer link distances, but retains much backward compatibility. Over time, Ethernet has largely replaced competing wired LAN technologies such as Token Ring, FDDI and ARCNET.

Ethernet is widely used in homes and industry, and interworks well with wireless Wi-Fi technologies. The Internet Protocol is commonly carried over Ethernet and so it is considered one of the key technologies that make up the Internet.

**Question 3.** The Unix utility `whois` can be used to find the domain name corresponding to an organization or vice versa. Read the man page documentation for `whois` and experiment with it. Try `whois princeton.edu` and `whois princeton` for starters. As an alternative, explore the `whois` interface at <http://www.internic.net/whois.html>.

To receive the man page, we should type “man ping” in the terminal and then the following screen will appear. The man page screen has been shown below:

```

File Edit View Search Terminal Help
c0528687@swamp28 ~
PING(8)                                                                    PING(8)
NAME
    ping - send ICMP ECHO_REQUEST to network hosts

SYNOPSIS
    ping [-addbdfhlnqrNuvuWw] [-c count] [-F flowlabel] [-I interval] [-I interface] [-l preload] [-m mark] [-M mtu:size:option] [-M mss:option] [-w deadline] [-W timeout] [-p pattern] [-Q tos] [-s packetsize] [-S smtuW]
      [-t ttl] [-T timestamp option] [hop...] [destination]

DESCRIPTION
    ping uses the ICMP protocol's mandatory ECHO_REQUEST datagram to elicit an ICMP ECHO_RESPONSE from a host or gateway. ECHO_REQUEST datagrams ("pings") have an IP and ICMP header, followed by a struct timeval and then an arbitrary number of "pad" bytes used to fill out the packet.

    ping works with both IPv4 and IPv6. Using only one of them explicitly can be enforced by specifying -4 or -6.

    ping can also send IPv6 Node Information Queries (RFC4292). Intermediate hops may not be allowed, because IPv6 source routing was deprecated (RFC3895).

OPTIONS
    -4
        Use IPv4 only.

    -6
        Use IPv6 only.

    -a
        Audible ping.

    -A
        Adaptive ping. Interpacket interval adapts to round-trip time, so that effectively not more than one (or more, if preload is set) unanswered probe is present in the network. Minimal interval is 200msec for not super-user.
        On networks with low RTT this mode is essentially equivalent to flood mode.

    -b
        Allow ping'ing a broadcast address.

    -B
        Do not allow ping to change source address of probes. The address is bound to one selected when ping starts.

    -c count
        Stop after sending count ECHO_REQUEST packets. With deadline option, ping waits for count ECHO_REPLY packets, until the timeout expires.

    -d
        Set the SO_DEBUG option on the socket being used. Essentially, this socket option is not used by Linux kernel.

    -f
        Print timestamp (unix time + microseconds as in gettimeofday) before each line.

    -F
        Flood ping. For every ECHO_REQUEST sent a period "." is printed, while for every ECHO_REPLY received a backspace is printed. This provides a rapid display of how many packets are being dropped. If interval is not given, it
        sets interval to zero and outputs packets as fast as they come back or one hundred times per second, whichever is more. Only the super-user may use this option with zero interval.

    -f flowlabel
        IPv6 only. Allocate and set 20 bit flow label (in hex) on echo request packets. If value is zero, kernel allocates random flow label.

    -h
        Show help.

Manual page ping(8) line 1 ignores h for help or q to quit

```

When we type command “whois princeton.edu” in Linux the following screen appears on the terminal.

```

File Edit View Search Terminal Help
00528687@swang28-
root@swang28:~# whois princeton.edu
This registry database contains ONLY .EDU domains.
The data in the EDUCAUSE whois database is provided
by EDUCAUSE for information purposes in order to
assist in the process of obtaining information about
or related to .edu domain registration records.

The EDUCAUSE Whois database is authoritative for the
.EDU domain.

A web interface for the .EDU EDUCAUSE Whois Server is
available at: http://admin.educase.edu

By submitting a whois query, you agree that this information
will not be used to allow, enable, or otherwise support
the transmission of unsolicited commercial advertising or
solicitations via e-mail. The use of electronic processes to
harvest information from this server is generally prohibited
except as reasonably necessary to register or modify .edu
domain names.

.....
Domain Name: PRINCETON.EDU

Registrar:
    Princeton University
    Office of Information Technology
    701 Carnegie Center, Suite 301
    Princeton, NJ 08540
    USA

Administrative Contact:
    Princeton University
    Princeton University
    87 Prospect Ave #306
    Office of Information Technology
    Networking & Monitoring Services
    Princeton, NJ 08540
    USA
    +1.6092582774
    netlump@princeton.edu

Technical Contact:
    Princeton University
    Princeton University
    87 Prospect Ave #306
    Office of Information Technology
    Networking & Monitoring Services
    Princeton, NJ 08540
    USA
    +1.6092582774
    netlump@princeton.edu

Name Servers:
    NS-05.AKAM.NET
    NS06.DHODGHADEASY.COM
    NS-38.AKAM.NET

```

**Question 8. What properties of postal addresses would be likely to be shared by a network addressing scheme? What differences might you expect to find? What properties of telephone numbering might be shared by a network addressing scheme?**

Postal addresses are of variable length. Postal address can define as (Name, House no, City, State, Zip code). Example- (Ipek, 456, Austin, Texas, 12345)

A network addressing scheme is a mechanism through which packets get transferred from one node to another node. A network mechanism is very essential for any network. The best example to it is TCP/IP protocol in which the Internet address works like a postal address. Actually, Internet address consists of two parts one is network address and the other is host address.

This double part address allows the packet to reach to a particular network (contained in network address) and within that network to a particular host (contained in host address). Network address can define as 123.456.78.90

Properties of postal addresses including differences with Network address

- Postal addresses are strongly hierarchical, the hierarchy being geographical.
- Location specifiers move from a generalized location to more specific location same like our post system in which the post comes to a city first (generalized location) to a person's house (specific location).
- Addresses also contains routing information embedded in it.
- Postal addresses are generally long and length of addresses is variable.
- Postal addresses contain a specific amount of redundant information. Means It contains copies of data.
- Postal addresses are capable of tolerating minor errors and abnormalities.

Properties of telephone numbering including difference with postal address

- Telephone numbers are almost same like network addresses
- These types of addresses are strictly numeric.
- Like Postal addresses they are also geographically hierarchical,
- Telephone addressee has fixed length address.
- These addresses or the numbers are administratively assigned
- They do 1 to 1 correspondence with the interlinked nodes

**37. The Unix utility ping can be used to find the RTT to various Internet hosts. Read the man page for ping, and use it to find the RTT to [www.cs.princeton.edu](http://www.cs.princeton.edu) in New Jersey and [www.cisco.com](http://www.cisco.com) in California. Measure the RTT values at different times of day, and compare the results. What do you think accounts for the differences?**

When we type “man ping” in terminal in Linux, the following screen appears. It gives information about its synopsis, options, description, ICMP packet details, TTL details, bugs, security etc. The man page screen has been shown below:

```

c00528687@wampa28: ~
File Edit View Search Terminal Help
PING(8) iputils PING(8)
NAME
    ping - send ICMP ECHO_REQUEST to network hosts
SYNOPSIS
    ping [-aabbcdffhlmmnqvVwX] [-c count] [-F flowlabel] [-i interval] [-I interface] [-l preload] [-m mark] [-M mtu] [-n] [-O] [-P] [-p pattern] [-q] [-s packetsize] [-S sndbuf]
    [-t ttl] [-T timestamp option] [hop...] [destination]
DESCRIPTION
    ping uses the ICMP protocol's mandatory ECHO_REQUEST datagram to elicit an ICMP ECHO_RESPONSE from a host or gateway. ECHO_REQUEST datagrams ("pings") have an IP and ICMP header, followed by a struct timeval and then an
    arbitrary number of "pad" bytes used to fill out the packet.
    ping works with both IPv4 and IPv6. Using only one of them explicitly can be enforced by specifying -4 or -6.
    ping can also send IPv6 Node Information Queries (RFC4209). Intermediate hops may not be allowed, because IPv6 source routing was deprecated (RFC5955).
OPTIONS
    -4
        Use IPv4 only.
    -6
        Use IPv6 only.
    -a
        Audible ping.
    -A
        Adaptive ping. Interpacket interval adapts to round-trip time, so that effectively not more than one (or more, if preload is set) unanswered probe is present in the network. Minimal interval is 200msec for not super-user.
        On networks with low rtt this mode is essentially equivalent to flood mode.
    -b
        Allow pinging a broadcast address.
    -B
        Do not allow ping to change source address of probes. The address is bound to one selected when ping starts.
    -c count
        Stop after sending count ECHO_REQUEST packets. With deadline option, ping waits for count ECHO_REPLY packets, until the timeout expires.
    -d
        Set the SO_DEBUG option on the socket being used. Essentially, this socket option is not used by Linux kernel.
    -D
        Print timestamp (unix time + microseconds as in gettimeofday) before each line.
    -f
        Flood ping. For every ECHO_REQUEST sent a period "." is printed, while for every ECHO_REPLY received a backspace is printed. This provides a rapid display of how many packets are being dropped. If interval is not given, it
        sets interval to zero and outputs packets as fast as they come back or one hundred times per second, whichever is more. Only the super-user may use this option with zero interval.
    -F flowlabel
        IPv6 only. Allocate and set 20 bit flow label (in hex) on echo request packets. If value is zero, kernel allocates random flow label.
    -h
        Show help.
Manual page ping(8) line 1 (press h for help or q to quit)

```

When we use command “ping [www.cs.princeton.edu](http://www.cs.princeton.edu)” and then “ping [www.cisco.edu](http://www.cisco.edu)” in terminal in Linux, the following screen appears:

```

Windows PowerShell
Windows Terminal can be set as the default terminal application in your settings. Open Settings

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Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

PS C:\Users\msiip> ping www.cs.princeton.edu

Pinging wwwprx.cs.princeton.edu [2607:7700:0:1d:0:1:8070:883d] with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 2607:7700:0:1d:0:1:8070:883d:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
PS C:\Users\msiip> ping www.cisco.com

Pinging e2867.dsca.akamaiedge.net [2600:1408:c400:38d::b33] with 32 bytes of data:
Reply from 2600:1408:c400:38d::b33: time=130ms
Reply from 2600:1408:c400:38d::b33: time=117ms
Reply from 2600:1408:c400:38d::b33: time=104ms
Reply from 2600:1408:c400:38d::b33: time=142ms

Ping statistics for 2600:1408:c400:38d::b33:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 104ms, Maximum = 142ms, Average = 123ms
PS C:\Users\msiip>

```

When we measure the RTT values times of day, the results are different. These differences are generated because of the parameters like traffic in the network, load at the server etc. change very frequently. For instance, during peak morning and evening hours, the traffic over the networks is high. During these times, the RTT is higher. Even the network topology has a considerable amount of contribution in the same. If the topology in the path towards destination is easily formed then RTT will be much lesser.

**Question 38.** The Unix utility traceroute, or its Windows equivalent tracert, can be used to find the sequence of routers through which a message is routed. Use this to find the path from your site to some others. How well does the number of hops correlate with the RTT times from ping? How well does the number of hops correlate with geographical distance?

I'm using windows operating system that is why I am presenting the tracert command and there results after executing them. When we type comman “tracert” with the web site we will receive the RTT of the web site. I used [www.google.com](http://www.google.com) and louisiana.edu. The following screens appears:

```

Windows PowerShell
Windows Terminal can be set as the default terminal application in your settings. Open Settings

PS C:\Users\msiip> tracert louisiana.edu

Tracing route to louisiana.edu [2607:7700:0:1d:0:1:8246:88e]
over a maximum of 30 hops:

  1  33 ms  15 ms  17 ms  2607:fb90:1bd5:fa56:9539:6a79:271e:dd0a
  2  77 ms  78 ms  92 ms  2607:fb90:1bd5:fa56:0:19:6eal:5640
  3  *      *      *      Request timed out.
  4  *      *      *      Request timed out.
  5  85 ms  106 ms  77 ms  fd00:976a:14fb:cba::2
  6  115 ms  92 ms  98 ms  2607:7700:0:1d:0:1:aa4:8ce2
  7  *      126 ms  187 ms  2607:7700:0:1d:0:1:abl:4c35
  8  *      88 ms  116 ms  2607:7700:0:1d:0:1:aa4:b2ad
  9  156 ms  153 ms  106 ms  ae18.er2.iad10.us.zip.zayo.com [2607:7700:0:1d:0:1:80b1:6cf1]
 10  *      *      *      Request timed out.
 11  *      *      *      Request timed out.
 12  *      *      *      Request timed out.
 13  119 ms  112 ms  96 ms  be3884.ccr42.dca01.atlas.cogentco.com [2607:7700:0:1d:0:1:9a36:1ett]
 14  120 ms  132 ms  93 ms  bc2113.ccr42.atl01.atlas.cogentco.com [2607:7700:0:1d:0:1:9a36:18de]
 15  131 ms  112 ms  120 ms  be2690.ccr42.iah01.atlas.cogentco.com [2607:7700:0:1d:0:1:9a36:1c82]
 16  172 ms  201 ms  164 ms  be3382.rcr21.msy01.atlas.cogentco.com [2607:7700:0:1d:0:1:9a36:5156]
 17  162 ms  184 ms  159 ms  be3520.rcr51.jan01.atlas.cogentco.com [2607:7700:0:1d:0:1:9a36:2bb1]
 18  188 ms  161 ms  169 ms  2607:7700:0:1d:0:1:2668:fa52
 19  *      *      *      Request timed out.
 20  *      *      *      Request timed out.
 21  *      *      *      Request timed out.
 22  *      *      *      Request timed out.
 23  *      *      *      Request timed out.
 24  *      *      *      Request timed out.
 25  *      *      *      Request timed out.
 26  *      *      *      Request timed out.
 27  *      *      *      Request timed out.
 28  *      *      *      Request timed out.
 29  *      *      *      Request timed out.
 30  *      *      *      Request timed out.

Trace complete.
PS C:\Users\msiip>

```

```

Windows PowerShell
Windows Terminal can be set as the default terminal application in your settings. Open Settings

PS C:\Users\msiip> tracert www.google.com

Tracing route to www.google.com [2607:f8b0:4002:c88::93]
over a maximum of 30 hops:

  1  10 ms  3 ms  7 ms  2607:fb90:1bd5:fa56:9539:6a79:271e:dd0a
  2  120 ms  114 ms  67 ms  2607:fb90:1bd5:fa56:0:19:6eal:5640
  3  *      *      *      Request timed out.
  4  *      *      *      Request timed out.
  5  *      *      *      Request timed out.
  6  *      *      *      Request timed out.
  7  *      *      *      Request timed out.
  8  *      *      *      Request timed out.
  9  *      *      *      Request timed out.
 10  156 ms  127 ms  107 ms  2001:4860:1:1:0:1:0:106
 11  90 ms  198 ms  104 ms  2001:4860:0:1163::c
 12  160 ms  *      94 ms  2001:4860::c:4002:43fa
 13  118 ms  114 ms  119 ms  2001:4860::cc:4000:fb6f
 14  *      *      *      Request timed out.
 15  *      *      *      Request timed out.
 16  *      *      *      Request timed out.
 17  *      *      *      Request timed out.
 18  *      *      *      Request timed out.
 19  *      *      *      Request timed out.
 20  *      *      *      Request timed out.
 21  *      *      *      Request timed out.
 22  *      *      *      Request timed out.
 23  *      *      *      Request timed out.
 24  122 ms  127 ms  124 ms  yx-in-f147.1e100.net [2607:f8b0:4002:c88::93]

Trace complete.
PS C:\Users\msiip>

```