NETWORK ARCHITECTURE ASSIGNMENT 1

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1. **Suppose two hosts, A and B are separated by 40,000 kilometers and are connected by a direct link of R=1 Mbps. Suppose the propagation speed over the link is $2*10^8$ meters/sec. Consider sending a file of 4,000,000 bits from Host A to Host B.**

a. **Suppose the file is sent continuously as one big message. How long does it take to send the file, assuming it is sent continuously?**

Answer:

Distance between two hosts A and B: D = 40000km

R = 1 Mbps

Propagation Speed: $S = 2*10^8$ meters/sec

File Length: $L = 4*10^5$ bits

Transmission Delay: T= (L/R) seconds

$= (4*10^6) / 10^6 = 4$ seconds

Propagation Delay: P = (D/S) seconds

$= (40000 * 10^3) / (2 * 10^8) = 0.2$ seconds

Time Taken = Propagation delay+ Queuing delay + Processing delay + Transmission delay

Since it is a direct link, processing delay and queuing delay is 0

Time Taken = 0.2+0+0+4 = 4.2 seconds

Hence time taken to send the file continuously is **4.2 seconds**

b. **Suppose now the file is broken up into 1000 packets with each packet containing 4,000 bits. Suppose that each packet is acknowledged by the receiver and the transmission time of an acknowledgement packet is negligible. Finally, assume that the sender cannot send a packet until the preceding one is acknowledged. How long does it take to send the file?**

Answer:

Given that, the file is broken into 1000 packets and the size (L) of each packet is 4,000 bits.

The time taken by each packet to reach the receiver = Time taken for transmission of each packet (TS_{prop}) + Time taken for a packet to get propagated through the link (TS_{trans})

$TS_{prop} = D/S = (40000 * 10^3) / (2 * 10^8) = 0.2$ seconds

$TS_{trans} = L/R = 4000 / 10^6 = 0.004$ seconds

Time taken for acknowledgement from receiver = TR_{prop} + TR_{trans}

But, given the transmission time of the packet, here, is negligible, hence, TR_{trans} =0.

TR_{prop} = D/S = (40000 * 10^3) / (2 * 10^8) = 0.2 seconds

Total time taken to send the next packet, but after the transmission of the first packet
= Total time taken by a packet to reach the receiver+ Time taken by the acknowledgement
= TS_{prop} + TS_{trans} + TR_{prop} + TR_{trans} = 0.2 + 0.004 + 0.2+0 = 0.404 seconds

Hence Time Taken for 1000 packets is 1000*0.404 = **404 seconds**

c. Calculate the bandwidth-delay product, R*tprop. What does it mean? (Provide an interpretation of the bandwidth-delay product.)

Answer:

Bandwidth-delay Product Interpretation gives the maximum limit of any data i.e., number of bits that can be transmitted in a link at any point of time.

To calculate the bandwidth- delay Product, we should calculate propagation time.

Given that, bandwidth of the given link is, R = 1Mbps

Propagation time = distance/speed (seconds)
= (40000 * 10^3) / (2 * 10^8) = 0.2 seconds

So now, bandwidth- delay product = R* Tp (as shown)
= (1 Mbps) * (0.2 sec) **= 0.2 Mbps**

d. If there are two routers between Host A and B (rather than a direct link), and all three links have 1 Mbps links, how long does it take to send the file? (use the assumptions in 1.b)

Answer:

Given that two routers R1 and R2 are placed between A and B,

So, there will be total 3 links i.e. A to R1, R1 to R2, R2 to B

Total transmission delay will be 3*(L/R)

TS_{prop} = D/S
= (40000 * 10^3) / (2 * 10^8) = 0.2 seconds

TS_{trans} = 3 * (L/R)
= 3 * (4000 / 10^6) = 0.012 seconds

TR_{prop} = D/S

$= (40000 * 10^3) / (2 * 10^8) = 0.2$ seconds

The transmission time of the packet, for acknoledgment, is negligible, hence, $TR_{trans} = 0$

Total time taken by each packet = 0.2 + 0.012 + 0.2 + 0

= 0.412 seconds.

Now, total time taken for 1000 packets = 1000* 0.412

= 412 seconds.

So, total time taken to send all the packets from A to B is = **206 seconds.**

2. **Read articles on two Internet pioneers from http://www.ibiblio.org/pioneers/index.html, and write 1~2 paragraph(s) of your personal perspective (why you chose the person, what part of the story strikes/interests you, or what you learned from the story, etc.) on each person's story (thus 2~4 paragraphs total).**

Answer:

- The articles in **http://www.ibiblio.org/pioneers/index.html** profiles ten individuals whose work has contributed significantly for the development of the Internet.
- Among them, about the two internet pioneers Doug Engelbart and Paul Baran is discussed below.
- **Paul Baran:**
  Paul Baran had two ideas which became very important in the development of **ARPANET**. The first idea was building a distributed network. The second was to develop a technique for data transmission that is also called as packet switching. He is an American Computer Engineer contributed his work solely in the development of computer networks.

  During the cold war, the main aim of RAND was to design a network which would survive from the nuclear attacks. Initially there are only two types of networks Centralized network and Decentralized network. If some of the system fails, whole system would go in vain and cannot communicate to other systems. As a solution to of robust network, Baran came up with an idea of Distributed network.

  In this network each node is connected to its neighboring nodes in a sort of lattice-like configuration. Therefore, to send data each node has several possible routes. If one route or neighboring node was destroyed, another path would be available.

  The main idea of packet switching is to divide large message into message blocks rather than sending the whole message at a time. These message blocks are called as packets.

- **Doug Engelbart:**
  Douglas Engelbart was born in 1925, in Oregon. He was touting the use of computers for online conferencing and collaboration. Engelbart's most famous invention is the computer mouse.

He set up his own research lab called it as the Augmentation Research Center. He developed NLS facilitated creation of digital libraries, storage and retrieval of electronic documents using hypertext. This is the first successful implementation of hypertext.

NLS created new graphical user interfaces implementing a windowing environment allowing user to e-mail other users as well as offering a variety of word processing options. Engelbart had developed NLS with ARPA funding. He saw it as a vehicle to extend NLS and increase distributed collaboration.

3. Discuss on computer virus, worm, spyware, malware, Trojan horse, and botnet (1~5 sentences each).

Answer:

Computer Virus:

It is a type of malware software program that is executed by infecting other computer programs. It may spread through pen drives, flash drives, Internet mails etc. These are created by humans. Virus performs harmful activities like stealing hard disk space, corrupting data and system. Hence, a virus can have a desolating effect not only on computer data but also on security of the computer. We can install any antivirus like MacAfee, Avg, Avast etc., to get rid of computer virus.

Worm:

Worm is malware program that spreads on itself and is not made by humans. It spreads to other computers with the help of computer networks. Worm causes only some damage to the computer like reducing the bandwidth of network but does not infect the computer by corrupting the files.

Spyware:

Spy is a person who secretly collects information about enemy and reports others. In the similar way, spyware is software that collects information about a person/organization without their knowledge. Sends their personal information to other entity. Spyware collects almost any kind of data such as user login details, credit card details, personal information etc. A spyware can create harmful things such as significant unwanted CPU activity, disk usage, and network traffic.

Malware:

Malware is a short form for malicious software. It is used to disrupt or damage the computer operation or system, collect sensitive and private information or gain access to private systems. Malware is sometimes called as computer contaminant. Anti-malware software used for malware are of two types where one of the software just avoids the installation of malware and the other is concerned with detecting and removing malware attacks done on the system.

Trojan horse:

Trojan horse is software which misrepresents itself to the user as useful and force the user to install it. Sometimes, we see on screen flashing that “Is your computer very slow/Computer at risk install this software to speed up your computer.” The user may think it’s true and install the software

which is actual a virus and slows down the computer. Anti-malware software used for malware are of two types where one of the software just avoids the installation of malware and the other is concerned with detecting and removing malware attacks done on the system.

Botnet:

Botnet is a collection of number of computer systems connected through internet that are been set up to forward transmissions to other computers on the Internet while the owners are unaware of it. Botnet is a combination of a 'robot' and a 'network'. Botnets are more versatile in their behavior of infection and are intermittently modified within hours of a new exploit done. These Bots requires very high scan rate to detect them.

4. Explore 'ping' and 'traceroute' (or 'tracert' on Windows) which are basic tools used to measure network performance and retrieve network status. Run 'ping' and 'traceroute' with at least three different hosts and options. Record the commands and their output.

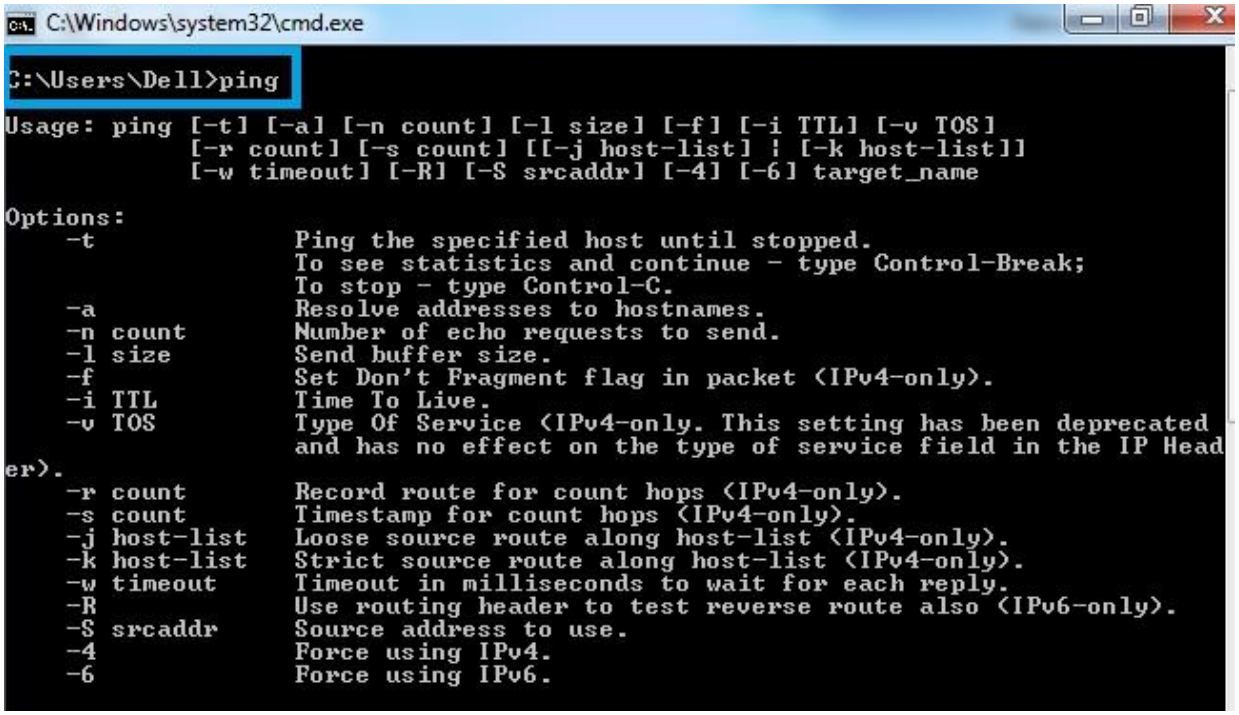
Answer:

i. ***PING:***

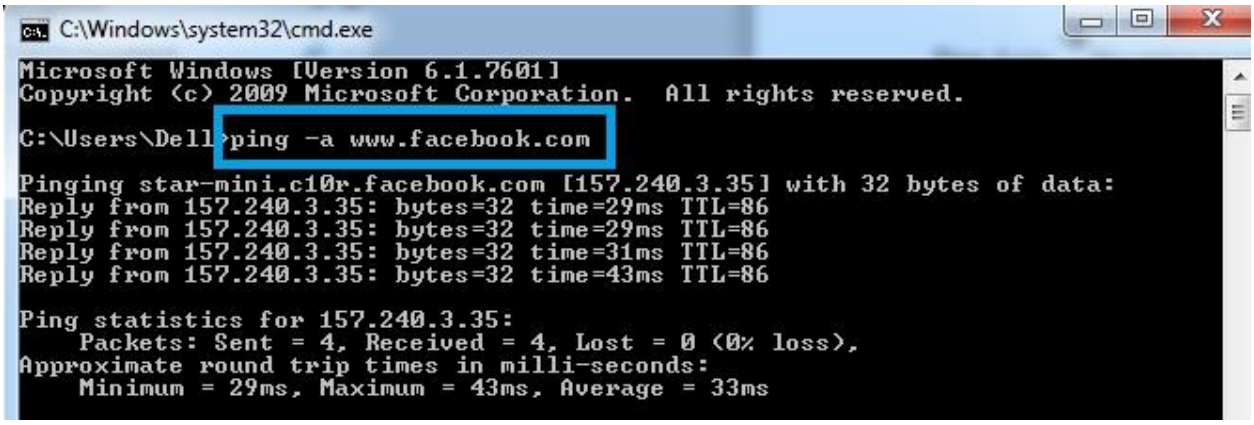
- Ping is a computer network software utility tool that is used to measure the round trip time of any messages which are sent from host to destination and back.

Syntax: ping [option] [host]

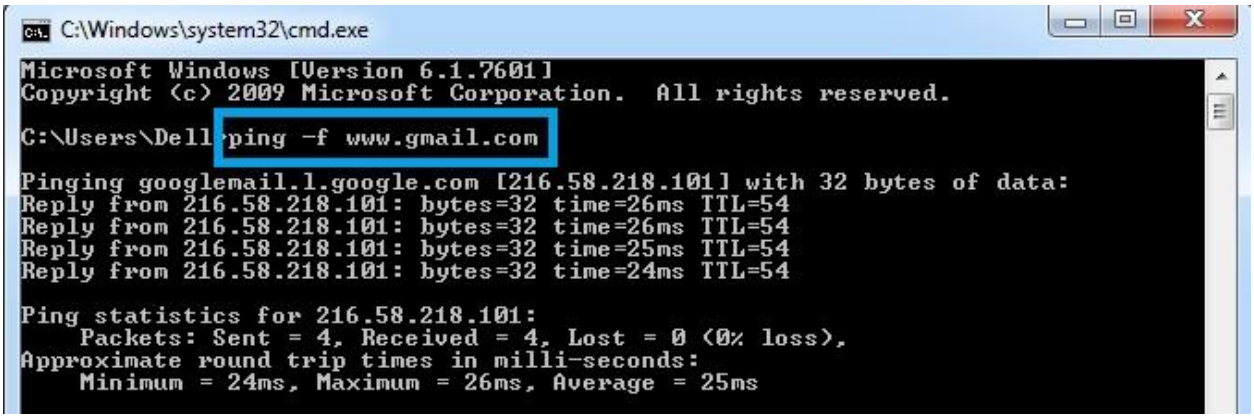
- The following are the options for Ping command: Just type 'ping' in command prompt.



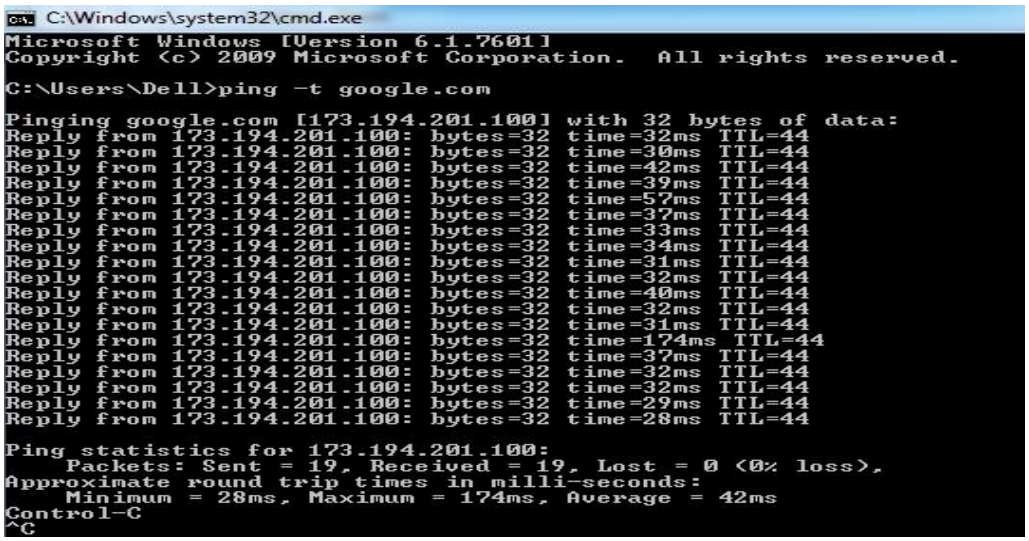
- **ping –a:** host is www.facebook.com



- **ping –f:** host is www.gmail.com



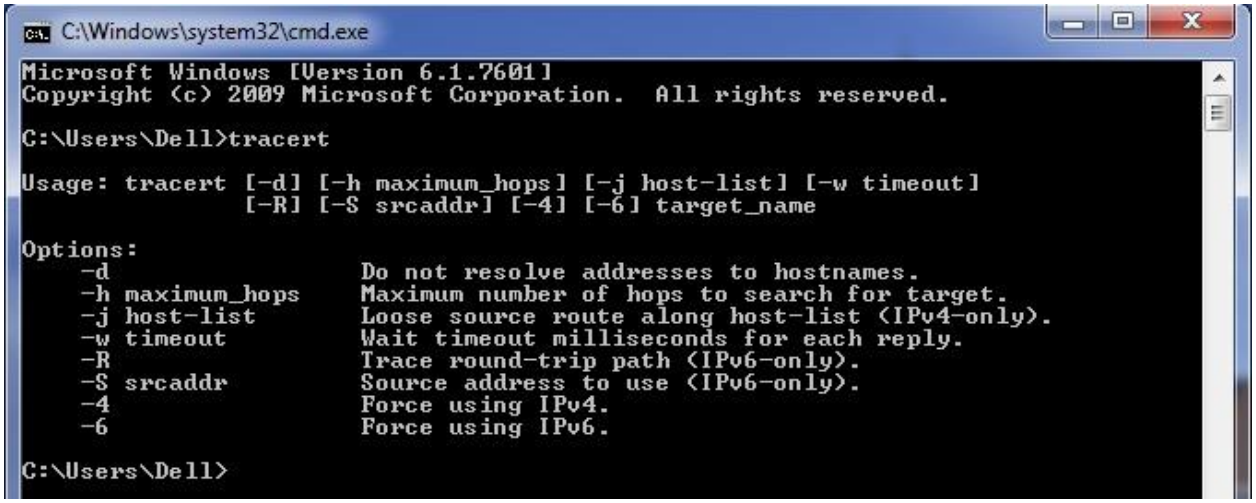
- **ping -t :** host is www.google.com



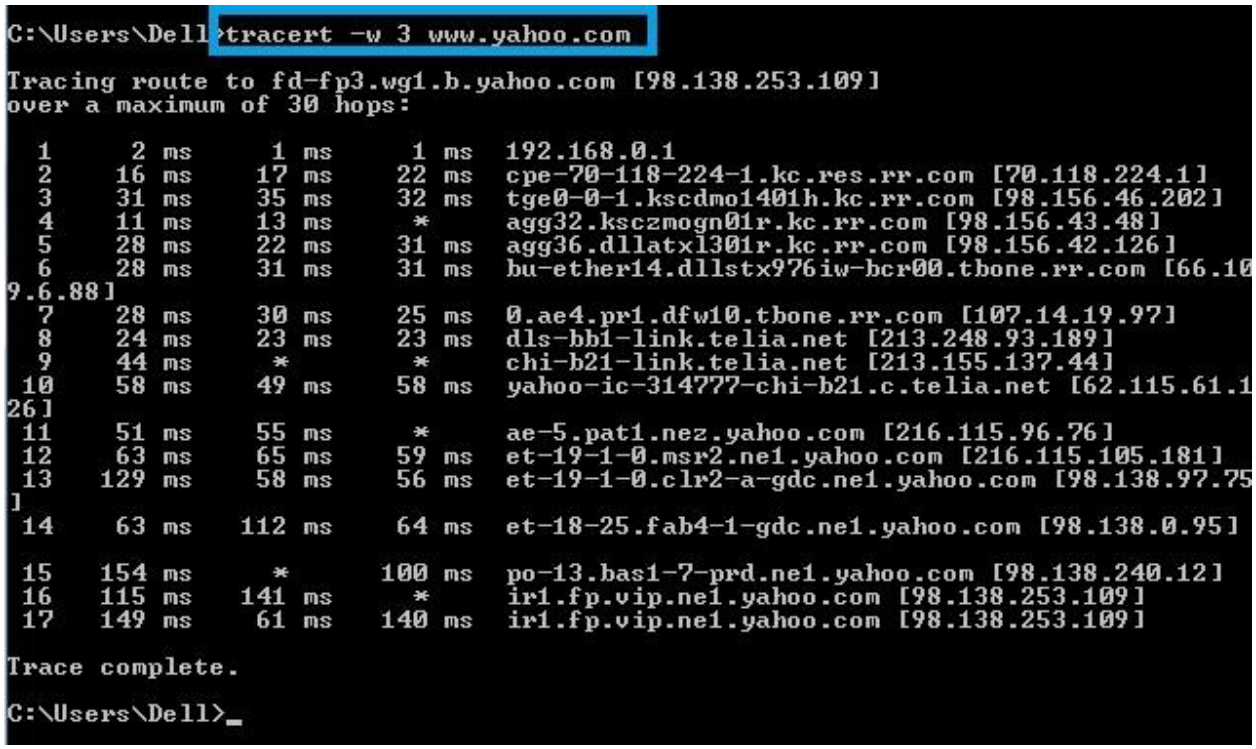
ii. ***TRACEROUTE:***

- This command helps us find path travelled by a packet till it reaches the destination.
- It also tells us how long each hop takes from route to route.

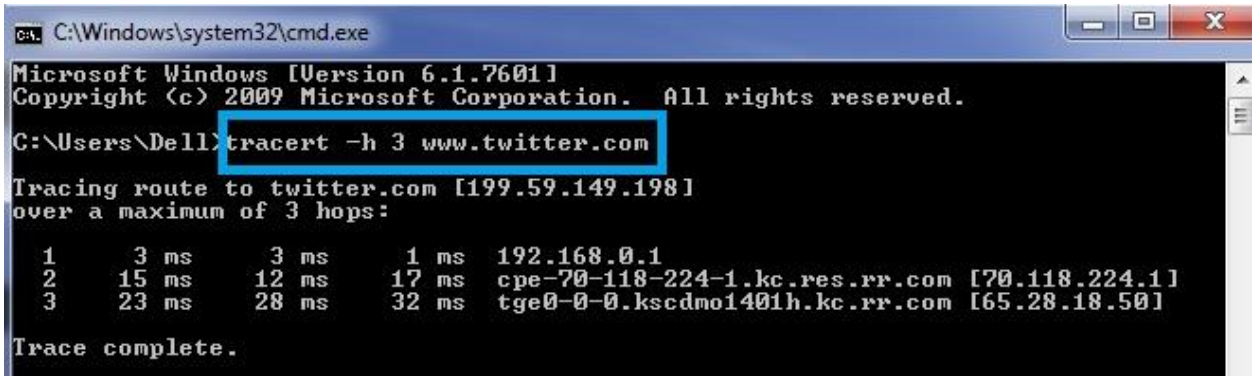
Syntax: tracert [option] [host]



- **tracert –w:** host www.yahoo.com



- **tracert –h :** host www.twitter.com



- **tracert –d :** host www.twitter.com

5. Explore nslookup which is a program to query Internet domain name servers. Record the commands and their output.

Answer:

- **nslookup** means 'name server lookup'
- **nslookup** is used to query Domain Name System (DNS) to obtain domain name/ IP address.
- It operates in both interactive and non-interactive mode.

a. Find out the ip address(es) of www.yahoo.com

- Query Type = a
- IP address of www.yahoo.com is 98.138.253.109

```
C:\Users\Dell>nslookup
Default Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

> set type=a
> www.yahoo.com
Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

Non-authoritative answer:
Name:    fd-fp3.wg1.b.yahoo.com
Addresses:  98.138.253.109
          98.138.252.30
Aliases:  www.yahoo.com
```

b. Find out the name servers and their IP addresses of yahoo.com domain.

- Query Type = ns

```
C:\Users\Dell>nslookup
Default Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

> set type=ns
> yahoo.com
Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

Non-authoritative answer:
yahoo.com       nameserver = ns5.yahoo.com
yahoo.com       nameserver = ns4.yahoo.com
yahoo.com       nameserver = ns2.yahoo.com
yahoo.com       nameserver = ns3.yahoo.com
yahoo.com       nameserver = ns1.yahoo.com
yahoo.com       nameserver = ns6.yahoo.com
```

```
C:\Users\Dell>nslookup ns1.yahoo.com
Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

Non-authoritative answer:
Name:    ns1.yahoo.com
Addresses:  2001:4998:130::1001
          68.180.131.16
```

c. Find out the email servers and their IP addresses of yahoo.com domain.

- Query Type = mx

```
C:\Users\Dell>nslookup
Default Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

> set type=mx
> yahoo.com
Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

Non-authoritative answer:
yahoo.com       MX preference = 1, mail exchanger = mta7.am0.yahoodns.net
yahoo.com       MX preference = 1, mail exchanger = mta5.am0.yahoodns.net
yahoo.com       MX preference = 1, mail exchanger = mta6.am0.yahoodns.net
> _
```

- Incoming Email Server:

```
C:\Users\Dell>nslookup pop.mail.yahoo.com
Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

Non-authoritative answer:
Name:    pop.mail.gm0.yahoodns.net
Addresses:  67.195.124.56
          66.218.74.149
          98.138.89.212
Aliases:  pop.mail.yahoo.com
```

- Outgoing Email Server:

```
C:\Users\Dell>nslookup smtp.mail.yahoo.com
Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

Non-authoritative answer:
Name:    smtp.mail.global.gm0.yahoodns.net
Addresses:  63.250.193.228
          98.138.105.21
          98.139.211.125
Aliases:  smtp.mail.yahoo.com
```

d. Try two other options (same server, different command parameters).

- Query Type = hinfo

```
C:\Users\Dell>nslookup
Default Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

> set type=hinfo
> yahoo.com
Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

yahoo.com
        primary name server = ns1.yahoo.com
        responsible mail addr = hostmaster.yahoo-inc.com
        serial  = 2016090301
        refresh = 3600 (1 hour)
        retry   = 300 (5 mins)
        expire  = 1814400 (21 days)
        default TTL = 600 (10 mins)
>
```

- Query Type = any

```
C:\Users\Dell>nslookup
Default Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

> set type=any
> yahoo.com
Server:  dns-cac-lb-01.rr.com
Address:  209.18.47.61

Non-authoritative answer:
yahoo.com
        primary name server = ns1.yahoo.com
        responsible mail addr = hostmaster.yahoo-inc.com
        serial  = 2016090301
        refresh = 3600 (1 hour)
        retry   = 300 (5 mins)
        expire  = 1814400 (21 days)
        default TTL = 600 (10 mins)
yahoo.com       internet address = 98.139.183.24
yahoo.com       internet address = 98.138.253.109
yahoo.com       internet address = 206.190.36.45
yahoo.com       AAAA IPv6 address = 2001:4998:58:c02::a9
yahoo.com       AAAA IPv6 address = 2001:4998:c:a06::2:4008
yahoo.com       AAAA IPv6 address = 2001:4998:44:204::a7
yahoo.com       MX preference = 1, mail exchanger = mta6.am0.yahoodns.net
yahoo.com       MX preference = 1, mail exchanger = mta7.am0.yahoodns.net
yahoo.com       MX preference = 1, mail exchanger = mta5.am0.yahoodns.net
yahoo.com       nameserver = ns2.yahoo.com
yahoo.com       nameserver = ns5.yahoo.com
yahoo.com       nameserver = ns4.yahoo.com
yahoo.com       nameserver = ns1.yahoo.com
yahoo.com       nameserver = ns6.yahoo.com
yahoo.com       nameserver = ns3.yahoo.com
yahoo.com       text =

        "v=spf1 redirect=_spf.mail.yahoo.com"

ns1.yahoo.com   internet address = 68.180.131.16
ns1.yahoo.com   AAAA IPv6 address = 2001:4998:130::1001
ns2.yahoo.com   internet address = 68.142.255.16
> _
```

6. Explore IETF web page (www.ietf.org) and find out how many RFCs are there currently? Then, list at least 5 working groups. Among those working groups, choose one of them and summarize its activities in one page, i.e., objective of the charter, documents/issues published or discussed in the working group.

- **IETF** means Internet Engineering Task Force which is international community of network operators, vendors, designers and researchers who concerned with the evolution of the Internet architecture and correct operation of the Internet.
- Its main aim is to provide high quality internet.
- IETF's development is organized into several areas which together comprise the **IESG** (Internet Engineering Steering Group). In each area, there are several **Working Groups** (WG).
- Each WG has one or more chairs defines what the work is and before when it has to be done.
- The main purpose of the working group is to address a specific problem or produce guidelines.
- They are also used to produce one or more specific deliverables and eventually are terminated when the goal is reached.

- **Requests for Comments (RFC)** series contain both technical and organizational notes about the Internet.
- Total number of RFC's at present is 7748.
- There are many areas in IETF
  - Operations and Management Area
  - Routing Area
  - Security Area
  - Transport Area
  - Applications and Real-Time Area
  - General Area
  - Internet Area

- Each Area has Working Groups(WGs) , some of them are
  - appsawg - ART Area General Applications Working Group
  - core - Constrained Restful Environments
  - httpbis - Hypertext Transfer Protocol
  - savi - Source Address Validation Improvements
  - grow - Global Routing Operations
  - ippm – IP Performance Metrics

IP Performance Metrics (IPPM):

- The IP Performance Metrics (IPPM) develops and maintains metrics that are applied to reliability, quality, performance of Internet data.
- It also maintains applications running over transport layer protocols (e.g. TCP, UDP) over IP.
- It develops and maintains protocols for the measurement of these metrics.
- It provides unbiased quantitative performance measurements.
- WG encourages work that improves availability of information about context in which measurements are taken.
- The IPPM WG interacts with other areas of IETF whose scope intersects with requirement of these metrics.
- IPPM WG produces documents that define specific metrics and procedures for accurately measuring these metrics.
- It produced protocols for communicating among test equipment to enable the measurement of the the metrics

Documents:

- The below are few documents published under group IPPM
  1. Control and Monitoring Differentiated Service Code Point in Two-Way Active Measurement Protocol (TWAMP)

- This document describes OPTIONAL feature for active performance measurement of protocols allowing the use of time stamp format.
- One-Way Active Measurement Protocol (OWAMP) defines that only the NTP format time stamp used in OWAMP-Test protocol.
- Two-Way Active Measurement Protocol adopted OWAMP-Test format and extended it by adding format for test packet.

2. Two-Way Active Measurement Protocol (TWAMP) Light Data Model
   - This document specifies the data model for implementing both session-sender and session-reflector for two way Active Measurement Protocol (TWAMP) Light mode.

3. Active and Passive Metrics and Methods (with Hybrid Types In-Between)
   - This paper defines both Active and Passive performance assessment.
   - Also defines the construction of Metrics and Methods which described as either Active/Passive.