CECS 327 Assignment 1

1. **What advantages does a packet-switched network have over a circuit-switched network?**
   a. Packet switched networks allows users to use all of the available bandwidth at once and there is no bandwidth wasted.
   b. Packets travel independently in different paths
   c. Supports store and forward transmission

2. **What are the five layers in the Internet protocol stack? What are the principal responsibilities of each of these layers?**
   a. **Layer 1 – Physical**: This layer is the basic network hardware like the physical OSI layer it handles transmission of raw bits a communication link
   b. **Layer 2 – Network Interface**: This layer is the interface between the computer and network. It collects a stream of bits into larger aggregate called frames. MAC Frame Format. Frames are delivered to hosts based on MAC address.
   c. **Layer 3 – Internet(IP):** This layer adds a header that contains the source and destinations IP address. Format of packets. Mechanisms for forwarding packets. Unit of data exchange between nodes is called a datagram.
   d. **Layer 4- Transport(TCP/UDP):** specifies how to provide a reliable transfer from one application on one computer to an application on another. Unit of data exchange is a segment.
   e. **Layer 5 – Application**: Handles how one application uses the internet. Ensures applications programs communication with other application programs over a network. Concerned about the format of data exchanged between peers. Unit of data exchanged is a message.

3. **How long does it take a packet of length 1500 bytes to propagate over a link of distance 2500km, propagation speed of 2.5· 108 m/s, and transmission rate 2Mbps? Does this delay depend on packet length? Does this delay depend on transmission rate?**
   a. **TP (Propagation Delay) = (Distance across link) / (Speed-of-light delay) =** (2500000 m)/ (2.5*(10^8) m/sec) **= 0.01 s**
   b. **No**, this delay does not depend on packet length.
   c. **No**, this delay does not depend on transmission rate.

4. **Suppose a 1-Gbps point-to-point link is being set up between the Earth and a new lunar colony. The distance from the moon to the Earth is approximately 385,000 km, and data travels over the link at the speed of light—3 × 108 m/s.**
   a) **Calculate the minimum RTT for the link.**
   Minimum RTT = 2* (385,000*10^3 m)/ (3*(10^8) m/sec) = **2.5666 s**

   b) **Using the RTT as the delay, calculate the delay × bandwidth product for the link.**
   Delay x bandwidth = (2.5666 s)*(1 Gb/s) = **2.5666 Gb**

   c) **What is the significance of the delay × bandwidth product computed in (b)?**

The delay x bandwidth product computed in (b) is the size of the data that a sender can send before receiving a response. This means the sender can send up to 2.5666 Gb of data before a response is received.
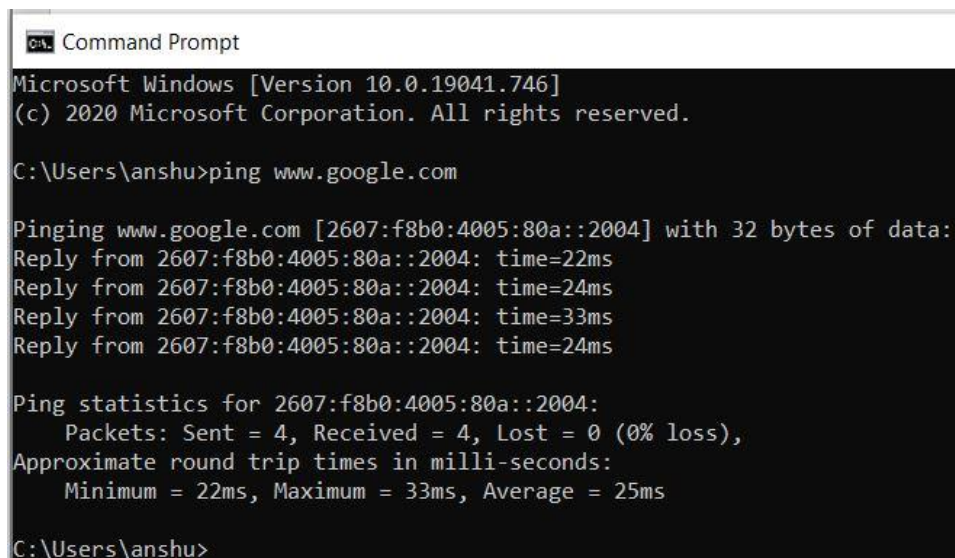
d) **A camera on the lunar base takes pictures of the Earth and saves them in digital format to disk. Suppose Mission Control on Earth wishes to download the most current image, which is 25 MB. What is the minimum amount of time that will elapse between when the request for the data goes out and the transfer is finished?**

Transmission time = 25 MB/1 Gbps = (25 MB)/ (1000 MB/s) = 0.025 s

Minimum total time = Transmission time + RTT = 0.025s + 2.5666s = **2.5916 s or 2.6 s**

Hands-on Activity

5   Measuring Round Trip Times with Ping: In Windows, open a command prompt. Use the -? Flag on the ping command and find out a list of options available for the ping command.

a) Try a simple ping www.google.com. Record the minimum, maximum and average round trip times.


```
Command Prompt

Microsoft Windows [Version 10.0.19041.746]
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C:\Users\anshu>ping www.google.com

Pinging www.google.com [2607:f8b0:4005:80a::2004] with 32 bytes of data:
Reply from 2607:f8b0:4005:80a::2004: time=22ms
Reply from 2607:f8b0:4005:80a::2004: time=24ms
Reply from 2607:f8b0:4005:80a::2004: time=33ms
Reply from 2607:f8b0:4005:80a::2004: time=24ms

Ping statistics for 2607:f8b0:4005:80a::2004:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 22ms, Maximum = 33ms, Average = 25ms

C:\Users\anshu>
```

Minimum = 22ms
Maximum = 33ms
Average = 25ms

b) Try the option ping –n 2 www.google.com. And then try ping –n 7 www.google.com. What differences do you notice?

Command Prompt

```
C:\Users\anshu>ping -n 2 www.google.com

Pinging www.google.com [2607:f8b0:4005:80a::2004] with 32 bytes of data:
Reply from 2607:f8b0:4005:80a::2004: time=31ms
Reply from 2607:f8b0:4005:80a::2004: time=31ms

Ping statistics for 2607:f8b0:4005:80a::2004:
    Packets: Sent = 2, Received = 2, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 31ms, Maximum = 31ms, Average = 31ms

C:\Users\anshu>ping -n 7 www.google.com

Pinging www.google.com [2607:f8b0:4005:80a::2004] with 32 bytes of data:
Reply from 2607:f8b0:4005:80a::2004: time=25ms
Reply from 2607:f8b0:4005:80a::2004: time=22ms
Reply from 2607:f8b0:4005:80a::2004: time=24ms
Reply from 2607:f8b0:4005:80a::2004: time=24ms
Reply from 2607:f8b0:4005:80a::2004: time=24ms
Reply from 2607:f8b0:4005:80a::2004: time=24ms
Reply from 2607:f8b0:4005:80a::2004: time=25ms

Ping statistics for 2607:f8b0:4005:80a::2004:
    Packets: Sent = 7, Received = 7, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 22ms, Maximum = 25ms, Average = 24ms

C:\Users\anshu>
```

From this, we noticed that then – n 2 and -n 7 referred to the number of packets that were sent and received 2 packets for -n 2 and 7 for -n 7. All minimum, maximum and average is a little different on both of the cases. -n 7 was a bit faster however, that may be due to the personal computer.

c) Try ping 10.0.0.50 and write down what output you get and explain why you get the result.

```
C:\Users\anshu>ping 10.0.0.50

Pinging 10.0.0.50 with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 10.0.0.50:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Users\anshu>
```

This basically tells that the any of the 4 test packets that we sent was not received by the receiver and/or my computer did not receive a response, could be one of the nodes in the transmit path is failing to receive the data or could be the firewall by the admin disabled the ping security parameters.

d) Try ping www.imperialequestriancenter.com Did you receive any responses for the packets you sent? What are some reasons as to why you might have not got a response?

```
C:\Users\anshu>ping www.imperialequestriancenter.com

Pinging www.imperialequestriancenter.com [64.29.151.209] with 32 bytes of data:
Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 64.29.151.209:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Users\anshu>
```

It's the same as part c, server didn't receive any 4 packets and nodes in the transmit path is fail to receive the data or could be firewall has disabled the ping request for security parameters.

6. Understanding Internet routes using Traceroute: In Windows, open a command prompt. Use the -? Flag on the tracert command and find out a list of options for the tracert command.

    a.   Try a simple tracert www.google.com. How many hops there were between your computer and www.google.com?

```
Command Prompt

Microsoft Windows [Version 10.0.19041.746]
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C:\Users\anshu>tracert www.google.com

Tracing route to www.google.com [2607:f8b0:4005:80a::2004]
over a maximum of 30 hops:

  1     4 ms     3 ms     3 ms  2600:8801:aa03:4800:deeb:69ff:fedc:d1ee
  2    20 ms    64 ms    14 ms  2600:8801:aaff:ffff::1111
  3    11 ms     *        *     2001:578:200:4:3000::2a
  4    10 ms    15 ms    12 ms  2001:578:200:4:3000::26
  5    16 ms    15 ms    15 ms  2001:578:1:0:172:17:249:33
  6    23 ms    22 ms    27 ms  2001:4860:1:1::131a
  7     *        *        *     Request timed out.
  8    23 ms    24 ms    24 ms  2001:4860:0:1::433a
  9    26 ms    25 ms    28 ms  2001:4860:0:1110::14
 10    24 ms    26 ms    22 ms  2001:4860::c:4000:de40
 11    24 ms    25 ms    25 ms  2001:4860::c:4002:292d
 12    27 ms    26 ms    25 ms  2001:4860::9:4000:f389
 13    26 ms     *        *     2001:4860:0:1006::1
 14    24 ms    24 ms    23 ms  2001:4860:0:1::1f71
 15    23 ms    25 ms    22 ms  sfo07s17-in-x04.1e100.net [2607:f8b0:4005:80a::2004]

Trace complete.

C:\Users\anshu>
```

    So we have total number of 15 hops between my pc and server google.com

    b.   Compare tracert www.google.com and tracert www.ieee.org. What hops are the same for each destination?

```
Command Prompt

C:\Users\anshu>tracert www.ieee.org

Tracing route to e1630.c.akamaiedge.net [104.100.55.120]
over a maximum of 30 hops:

  1     2 ms     2 ms     2 ms  192.168.0.1
  2    18 ms    18 ms    12 ms  10.134.92.1
  3    20 ms    39 ms    56 ms  100.120.108.54
  4    19 ms    61 ms    24 ms  100.120.108.0
  5    26 ms    88 ms    36 ms  68.1.1.199
  6    30 ms    26 ms    29 ms  ip70-167-151-14.at.at.cox.net [70.167.151.14]
  7    27 ms    25 ms    25 ms  a104-100-55-120.deploy.static.akamaitechnologies.com [104.100.55.120]

Trace complete.

C:\Users\anshu>
```

Google and IEEE servers both went from servers up to the LAX servers yet sent back various quantities of hops and www.google.com has 15 hops while www.ieee.org has 7 hops between my PC and their server.

c. Try tracert www.ubc.ca and then try the option tracert –d www.ubc.ca. What differences do you notice?

```
C:\Users\anshu>tracert www.ubc.ca

Tracing route to ubc.ca [206.87.224.15]
over a maximum of 30 hops:

  1     2 ms     2 ms     2 ms  192.168.0.1
  2    33 ms    10 ms    15 ms  10.134.92.1
  3    15 ms    11 ms    13 ms  100.120.108.56
  4    52 ms    30 ms    15 ms  100.120.108.2
  5    17 ms    15 ms    17 ms  langbprj01-ae1.rd.la.cox.net [68.1.1.13]
  6    17 ms    14 ms    15 ms  100ge16-2.core1.lax1.he.net [216.218.224.117]
  7    16 ms    18 ms    15 ms  100ge14-1.core1.lax2.he.net [72.52.92.122]
  8    39 ms    53 ms    40 ms  100ge15-2.core1.pdx1.he.net [184.104.193.142]
  9    41 ms    50 ms    60 ms  100ge5-2.core1.sea1.he.net [184.105.64.137]
 10    65 ms    44 ms    45 ms  100ge14-1.core1.yvr1.he.net [184.105.64.110]
 11    45 ms    52 ms    43 ms  bcnet.10gigabitethernet1-4.core1.yvr1.he.net [184.105.148.150]
 12    45 ms    45 ms    46 ms  cr2-100g-bb3920ae2.vncv1.bc.net.bc.net [207.23.253.117]
 13    45 ms    48 ms    46 ms  134.87.30.149
 14    47 ms    50 ms    47 ms  137.82.88.122
 15    46 ms    45 ms    46 ms  a22-a0.net.ubc.ca [137.82.123.113]
 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     *        *        *     Request timed out.
 25     *        *        *     Request timed out.
 26     *        *        *     Request timed out.
 27     *        *        *     Request timed out.
 28     *        *        *     Request timed out.
 29     *        *        *     Request timed out.
 30     *        *
```

With the -d command the traceroute does not resolve IP Addresses to hostname so it only returns Ip addresses of all the servers.

```
Select Command Prompt

C:\Users\anshu>tracert -d  www.ubc.ca

Tracing route to ubc.ca [206.87.224.15]
over a maximum of 30 hops:

  1     3 ms     2 ms     4 ms  192.168.0.1
  2    20 ms    12 ms    15 ms  10.134.92.1
  3    13 ms    24 ms    13 ms  100.120.108.56
  4    26 ms    45 ms    28 ms  100.120.108.2
  5    14 ms    16 ms    17 ms  68.1.1.13
  6    17 ms    16 ms    36 ms  216.218.224.117
  7    18 ms    17 ms    31 ms  72.52.92.122
  8    81 ms    55 ms    96 ms  184.104.193.142
  9    96 ms   135 ms   189 ms  184.105.64.137
 10    46 ms    45 ms    44 ms  184.105.64.110
 11    46 ms    60 ms    45 ms  184.105.148.150
 12    53 ms    48 ms    47 ms  207.23.253.117
 13    45 ms    69 ms    54 ms  134.87.30.149
 14    45 ms    45 ms    59 ms  137.82.88.122
 15    48 ms    48 ms    45 ms  137.82.123.113
 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     *        *        *     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.
```

d. Compare round trip times to the number of hops from a local host to the three hosts, www.tsinghua.edu.cn, www.usyd.edu.au and www.harvard.edu at different times of a day (e.g, morning, afternoon and evening). What correlation(s) do you find? Are these your expectations? Explain.

After comparing the round trip times and the number of hops on three hosts at various occasions in the day, we can say that the number of hops made between my PC and the last server has continued as before regardless of the day time. In any case, we unquestionably anticipated that the number of hops from my PC to harvard.edu would be the most distance between here to Harvard. Simultaneously,

the server for www.tsinghua.edu. is at a much farther distance which implies the most measure of hops to arrive at the last server.

	www.tsinghua.edu.cn	www.usyd.edu.au	www.harvard.edu
Morning	146ms, 151ms, 148ms	211ms, 215ms, 219ms	11ms, 4ms, 6s
	21 hops	15 hops	12 hops
Afternoon	153ms, 147ms, 141ms	213ms, 219ms, 221ms	8ms, 5ms, 9ms
	21 hops	15 hops	12 hops
Evening	147ms, 149ms, 168ms	215ms, 216ms, 221ms	9ms, 7ms, 9ms
	21 hops	15 hops	12 hops

e. Run traceroute on your local machine, then paste the output in the following link. What do you conclude? Include a screenshot in your response.

I run down my own system Ip address. And that's what I got only 1 hop.