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CSE 3461 Homework 1

1 **(8 points)** Suppose users share a 3 Mbps link. Each user requires 150 kbps when transmitting, but each user transmits only 10% of the time

(a) **(2 points)** When circuit switching is used, how many users can be supported?

20 Users can be supported because each user requires only 1/20th of the bandwith.

(b) **(2 points)** Assume packet switching is used for the rest of this problem. Find the probability that a given user is transmitting.

The probability that a given user is transmitting is $P = 10\%$ since each user can only transmit 10% of the time.

(c) **(2 points)** Suppose there are 120 users. Find the probability that exactly n users are transmitting simultaneously at any given time. (Hint: Use the binomial distribution.)

$P = \binom{120}{n} * 0.1^n * (0.9)^{120-n}$

(d) **(2 points)** Find the probability that there are 21 or more users transmitting simultaneously.

$P = \sum_{n=0}^{21} \binom{120}{n} 0.1^n * 0.9^{120-n}$

2 **(8 points)** A client is fetching a base HTML file with k referenced objects ($k > 0$) from an Internet server. Let the RTT be r. Assume that the transmission/reception time for each file and referenced objects, if any, is d. Further, the only transmission/reception bottleneck in the network is the access link through which the client is connected to the Internet. In terms of r, k, and d, compute the following delay for the following scenarios

(a) **(2 points)** Non-persistent HTTP with parallel TCP connections (there is no limit on the number of parallel connections).

Assuming there isn't a limit on the number of parallel connections, the client would need $2 * RTT$ time for the non-persistent HTTP connection and then add on the amount of time to retrieve just one object. (If there are n objects and there is no limit on the number of parallel objects, the client could have n parallel TCP connections, allowing it to download n objects in the same time as downloading just one). Additionally, there is a cost of d on the first HTML file.

$TotalTime = 2 * r + 2 * d$

(b) **(2 points)** Non-persistent HTTP with no parallel TCP connections.

Without a parallel connection, the client would only have to make a $2 * RTT$ trip for each object to download on a non-persistent connection as well as the intial setup cost.

$TotalTime = 2 * r * k * d + 2 * r + d$

(c) **(2 points)** Persistent HTTP with pipelining.

On a persitent HTTP connection, it just takes one RTT to set up a TCP connection. Then, it takes one more RTT to request the k number of objects. Finally, the additional d time for each object should be taken into consideration as well as one RTT for the HTML file (which adds another d time).

$TotalTime = 3 * r + k * d$

(d) **(2 points)** Persistent HTTP without pipelining.

Without pipelining and with persistent HTTP, it would take one RTT to set up a TCP connection and then one RTT for each additioanl request and reply per object as well as one RTT for the HTML file (which adds another d time).

$TotalTime = 2 * r + (k * r * d) + d$

3 **(4 points)**Compare and contrast wired and wireless networks. You can find information in the textbook and online. Please cite all references you found.

The main difference between wired and wireless networks is that wireless networks require the usage of an access point from which to send and receive packets. The access point is then connected to the enterprise's network which is in turn connected to the wired Internet. A wired network, on the otherhand, uses copper wire ethernet cables to connect to an ethernet switch and is then connected to the wired Internet (Textbook, 17). While most people think of Wi-Fi when talking about wireless networks, cellular networks operate in a similar fashion, with available range being in the magnitude of kilometers, rather than 10s of meters.

Furthermore, in its current form, wireless networks are slower than wired networks as well and are more prone to security failure. Additionally, network types differ between wired and wireless networks. A wired network can take the form of a Local Area Network, Metropolitan Area Network, or a Wide Area Network. Wireless networks on the other hand can be ad hoc networks, wireless LAN/MAN/WAN networks as well as Wireless Personal Area networks, or be classified by their access technology such as GSM, TDMA, and CDMA. Additioanlly, networks can be classified by their radio access technology: Wi-Fi, Bluetooth, Infrared, and Hyperlan2.

Source: `http://www.technicaljournalsonline.com/ijeat/VOL%20V/IJAET%20VOL%20V%20ISSUE%20II%20APRIL%20JUNE%202014/Article%2009%20V%20II%202014.pdf`

4 **(6 points)** Consider the figure below. Answer the following questions. Assume we know the bottleneck link along the path from the server to the client is the first link with rate R_S bit/s. Suppose we send a pair of packets back to back from the server to the client and there is no other traffic on the path. Assume each packet has size L bits and both links have the same propagation delay d_{prop}.

(a) **(3 points)** What is the packet inter-arrival time at the destination? That is, how much time elapses from when the last bit of the first packet arrives until the last bit of the second packet arrives?

Packet Inter-Arrival Time = $L_{bits/request}/R_S$

(b) **(3 points)** Now assume that the second link is the bottleneck link (i.e., $R_c < R_s$. Is it possible that the second packet queues at the input queue of the second link? Explain. Now suppose that the server sends the second packet T seconds after sending the first packet. How large must T be to ensure no queueing before the second link? Explain.

Yes, it is possible that the second packet queues at the input queue of the first packet.

If the bottleneck is at $\mathrm{R_C}$ then T mus tbe of size: $L/R_c - L/R_S$.

If the bottleneck was at $\mathrm{R_S}$ the size would be 0 since the packet is originating from A.

5 **(8 points)** Read the `man` pages for `nslookup(1)` and `whois(1)`. If you are not very familiar with UNIX man pages, start with `man man`. For all parts below, describe the commands you use to obtain your answers.

(a) **(2 points)** Use `nslookup` and send DNS queries to `www.cse.ohio-state.edu`. Search for Type A, NS, and MX records and summarize your findings.

To query, I ran the commands `nslookup -type=NS www.cse.ohio-state.edu`, `nslookup -type=MX www.cse.ohio-state.edu`, and `nslookup -type=A www.cse.ohio-state.edu`. For both NS and MX, the query returned information about mail servers where as the type A just returned the Server, the address, and name.

(b) **(2 points)** Use `nslookup` to find a Web server that has multiple IP addresses. Does the server `www.osu.edu` have multiple IP addresses?

The server `www.osu.edu` does have multiple IP addresses.

(c) **(2 points)** What are the names and IP addresses of the authoritative name servers for the following machines: `www.csail.mit.edu` and `cs.illinois.edu`?

`Name: www.csail.mit.edu`

`Address: 128.30.2.155`

`Name: cs.illinois.edu`

`Address: 130.126.112.119`

(d) **(2 points)** What are the names and IP addresses of the machines on which email servers for the following recipients is running: `champion@cse.ohio-state.edu` and `person@cs.ucla.edu`? (If there are several mail server machines, provide information on only one).

`Name: cse.ohio-state.`

`Address: 164.107.112.224`

`Name: cs.ucla.edu`

`Address: 164.67.100.181`

6 **(6 points)** This question asks you to perform `traceroute` to various hosts. For all parts below, describe the commands you use to obtain your answers.

(a) **(2 points)** Perform `traceroute` to two hosts, each in a different city in China. Submit a print-out of the two `traceroute` operation from the site. How many links are the same in the two `traceroutes`? Is the transpacific link the same?

```
wine@winebaths:~
wine@winebaths:~ 80x24
[wine@winebaths ~]$ traceroute www.gov.cn
traceroute to www.gov.cn (209.177.92.5), 30 hops max, 60 byte packets
 1  DD-WRT (192.168.1.1)  0.252 ms  0.450 ms  0.444 ms
 2  10.207.192.1 (10.207.192.1)  13.069 ms  26.217 ms  26.598 ms
 3  dynamic-76-73-172-177.knology.net (76.73.172.177)  26.603 ms  26.801 ms  26.
794 ms
 4  76-73-166-126.knology.net (76.73.166.126)  26.589 ms  26.586 ms  26.584 ms
 5  76-73-166-125.knology.net (76.73.166.125)  26.581 ms * *
 6  static-69-73-0-139.knology.net (69.73.0.139)  26.774 ms  25.918 ms  25.882 m
s
 7  user-75-76-127-229.knology.net (75.76.127.229)  26.058 ms  26.672 ms  19.135
 ms
 8  ae14.chi11.ip4.gtt.net (77.67.77.109)  18.363 ms  27.780 ms  27.768 ms
 9  xe-11-3-0.sjc10.ip4.gtt.net (89.149.182.69)  76.062 ms xe-5-1-0.sjc10.ip4.gt
t.net (89.149.186.250)  70.661 ms xe-11-3-0.sjc10.ip4.gtt.net (89.149.182.69)  7
6.060 ms
10  as4436.ip4.gtt.net (77.67.70.130)  74.631 ms  74.628 ms  74.236 ms
11  as37958.ae2-907.cr1.sjc1.us.as4436.gtt.net (69.22.143.98)  73.214 ms  74.614
 ms  69.972 ms
12  209.177.92.5 (209.177.92.5)  64.102 ms  73.987 ms  65.048 ms
[wine@winebaths ~]$
```

```
wine@winebaths:~
wine@winebaths:~ 80x42
[wine@winebaths ~]$ traceroute www.tencent.com
traceroute to www.tencent.com (183.60.38.45), 30 hops max, 60 byte packets
 1  DD-WRT (192.168.1.1)  0.257 ms  0.437 ms  0.435 ms
 2  10.207.192.1 (10.207.192.1)  32.832 ms  32.991 ms  32.988 ms
 3  dynamic-76-73-172-177.knology.net (76.73.172.177)  31.572 ms  32.592 ms  32.
792 ms
 4  216.156.103.29.ptr.us.xo.net (216.156.103.29)  56.523 ms  57.609 ms  57.607
ms
 5  ae1d0.mcr2.columbus-oh.us.xo.net (216.156.1.30)  103.424 ms  102.631 ms  103
.422 ms
 6  vb1121.rar3.chicago-il.us.xo.net (216.156.0.61)  103.786 ms  101.603 ms  101
.549 ms
 7  te-4-1-0.rar3.denver-co.us.xo.net (207.88.12.22)  104.080 ms  99.067 ms  97.
865 ms
 8  207.88.12.122.ptr.us.xo.net (207.88.12.122)  95.530 ms  96.472 ms  95.522 ms
 9  207.88.12.191.ptr.us.xo.net (207.88.12.191)  97.265 ms  87.084 ms  87.594 ms
10  207.88.12.144.ptr.us.xo.net (207.88.12.144)  91.936 ms  91.277 ms  88.862 ms
11  207.88.12.147.ptr.us.xo.net (207.88.12.147)  89.979 ms  97.505 ms  97.496 ms
12  te0-12-1-0.rar3.chicago-il.us.xo.net (207.88.12.141)  96.377 ms  94.810 ms
92.062 ms
13  207.88.14.213.ptr.us.xo.net (207.88.14.213)  101.380 ms  110.114 ms  100.239
 ms
14  206.111.14.114.ptr.us.xo.net (206.111.14.114)  86.574 ms  85.017 ms  73.710
ms
15  202.97.90.133 (202.97.90.133)  74.513 ms  73.356 ms  78.774 ms
16  202.97.58.229 (202.97.58.229)  265.151 ms  264.199 ms  264.707 ms
17  * 202.97.34.85 (202.97.34.85)  241.455 ms 202.97.60.157 (202.97.60.157)  243
.729 ms
18  202.97.35.249 (202.97.35.249)  249.218 ms 202.97.34.181 (202.97.34.181)  247
.784 ms  246.679 ms
19  119.147.222.46 (119.147.222.46)  255.712 ms 121.14.112.182 (121.14.112.182)
 236.493 ms 119.147.223.182 (119.147.223.182)  246.019 ms
20  219.133.57.6 (219.133.57.6)  241.041 ms 219.133.57.14 (219.133.57.14)  265.7
24 ms  274.064 ms
21  58.60.8.254 (58.60.8.254)  250.893 ms 58.60.8.242 (58.60.8.242)  251.259 ms
58.60.8.246 (58.60.8.246)  238.428 ms
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
```

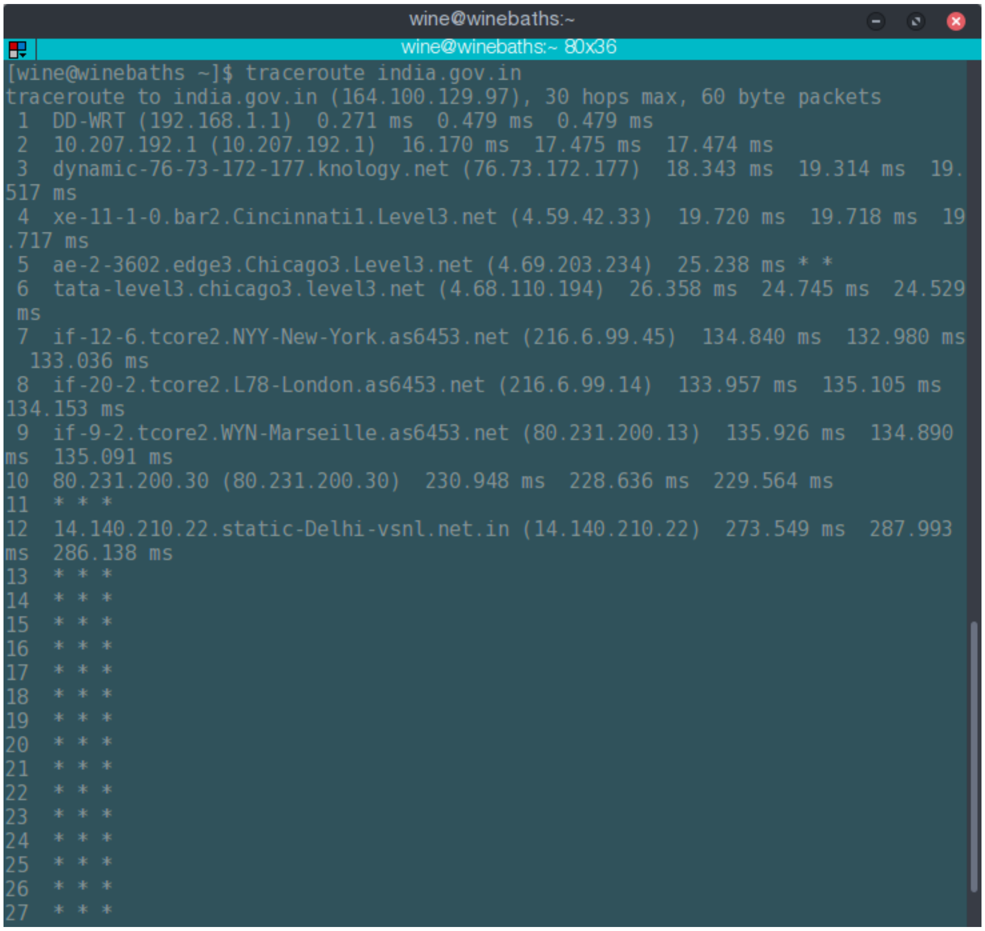
The only two links that are the same are the initial two. The transpacific link is not the same.

To get the traceroute, I ran the following commands;

`traceroute www.gov.cn`

`traceroute www.tencent.com`

(b) **(2 points)** Repeat (a) but choose one city in china and another city in India.

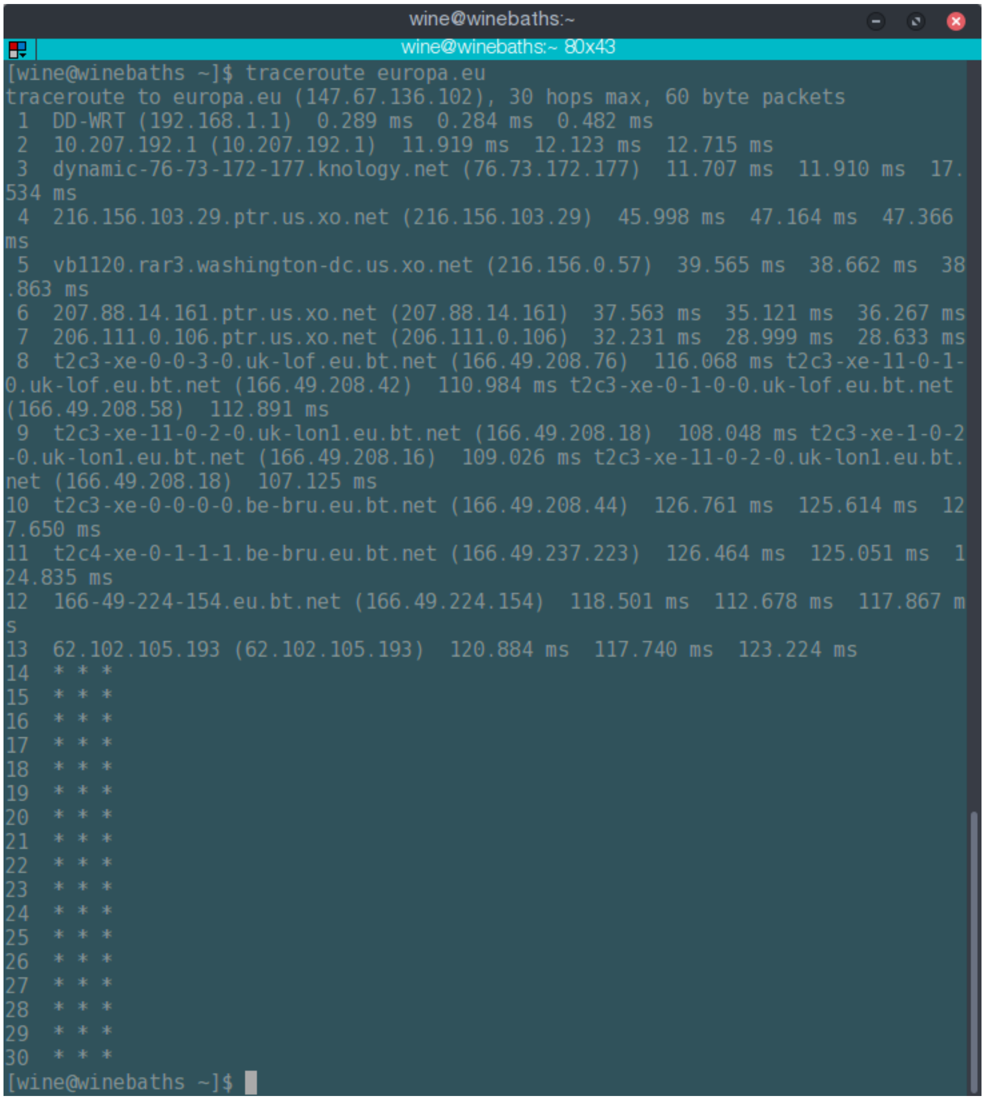


```
wine@winebaths:~
wine@winebaths:~ 80x36
[wine@winebaths ~]$ traceroute india.gov.in
traceroute to india.gov.in (164.100.129.97), 30 hops max, 60 byte packets
 1  DD-WRT (192.168.1.1)  0.271 ms  0.479 ms  0.479 ms
 2  10.207.192.1 (10.207.192.1)  16.170 ms  17.475 ms  17.474 ms
 3  dynamic-76-73-172-177.knology.net (76.73.172.177)  18.343 ms  19.314 ms  19.
517 ms
 4  xe-11-1-0.bar2.Cincinnati1.Level3.net (4.59.42.33)  19.720 ms  19.718 ms  19
.717 ms
 5  ae-2-3602.edge3.Chicago3.Level3.net (4.69.203.234)  25.238 ms * *
 6  tata-level3.chicago3.level3.net (4.68.110.194)  26.358 ms  24.745 ms  24.529
 ms
 7  if-12-6.tcore2.NYY-New-York.as6453.net (216.6.99.45)  134.840 ms  132.980 ms
  133.036 ms
 8  if-20-2.tcore2.L78-London.as6453.net (216.6.99.14)  133.957 ms  135.105 ms
134.153 ms
 9  if-9-2.tcore2.WYN-Marseille.as6453.net (80.231.200.13)  135.926 ms  134.890
ms  135.091 ms
10  80.231.200.30 (80.231.200.30)  230.948 ms  228.636 ms  229.564 ms
11  * * *
12  14.140.210.22.static-Delhi-vsnl.net.in (14.140.210.22)  273.549 ms  287.993
ms  286.138 ms
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
```

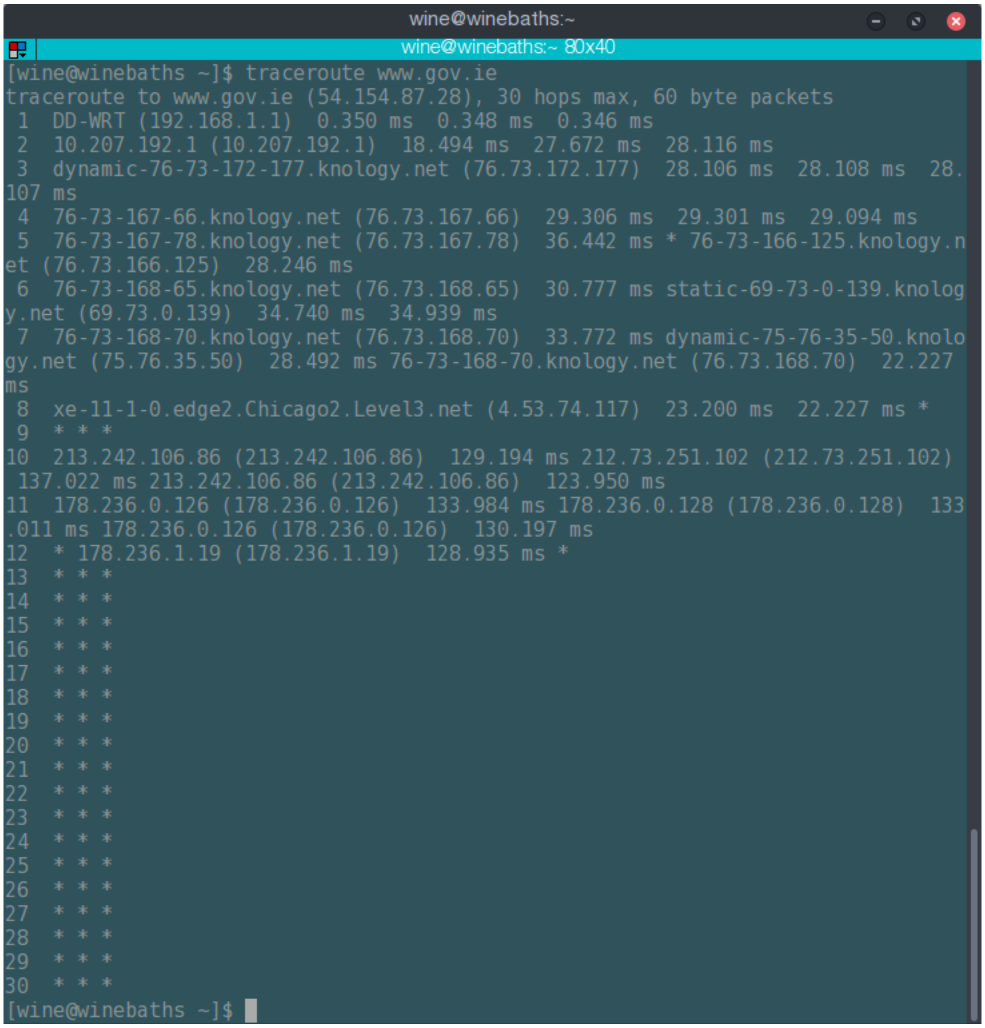
`traceroute india.gov.in`

This traceroute shared another link with the `gov.cn` website, but none of them after that.

(c) **(2 points)** Perform two `traceroutes` to two hosts, each in a different city in Europe. How many links are common to the two `traceroutes`? Do the `traceroutes` diverge before reaching Europe?



```
wine@winebaths:~
wine@winebaths:~ 80x43
[wine@winebaths ~]$ traceroute europa.eu
traceroute to europa.eu (147.67.136.102), 30 hops max, 60 byte packets
 1  DD-WRT (192.168.1.1)  0.289 ms  0.284 ms  0.482 ms
 2  10.207.192.1 (10.207.192.1)  11.919 ms  12.123 ms  12.715 ms
 3  dynamic-76-73-172-177.knology.net (76.73.172.177)  11.707 ms  11.910 ms  17.
534 ms
 4  216.156.103.29.ptr.us.xo.net (216.156.103.29)  45.998 ms  47.164 ms  47.366
ms
 5  vb1120.rar3.washington-dc.us.xo.net (216.156.0.57)  39.565 ms  38.662 ms  38
.863 ms
 6  207.88.14.161.ptr.us.xo.net (207.88.14.161)  37.563 ms  35.121 ms  36.267 ms
 7  206.111.0.106.ptr.us.xo.net (206.111.0.106)  32.231 ms  28.999 ms  28.633 ms
 8  t2c3-xe-0-0-3-0.uk-lof.eu.bt.net (166.49.208.76)  116.068 ms t2c3-xe-11-0-1-
0.uk-lof.eu.bt.net (166.49.208.42)  110.984 ms t2c3-xe-0-1-0-0.uk-lof.eu.bt.net
(166.49.208.58)  112.891 ms
 9  t2c3-xe-11-0-2-0.uk-lon1.eu.bt.net (166.49.208.18)  108.048 ms t2c3-xe-1-0-2
-0.uk-lon1.eu.bt.net (166.49.208.16)  109.026 ms t2c3-xe-11-0-2-0.uk-lon1.eu.bt.
net (166.49.208.18)  107.125 ms
10  t2c3-xe-0-0-0-0.be-bru.eu.bt.net (166.49.208.44)  126.761 ms  125.614 ms  12
7.650 ms
11  t2c4-xe-0-1-1-1.be-bru.eu.bt.net (166.49.237.223)  126.464 ms  125.051 ms  1
24.835 ms
12  166-49-224-154.eu.bt.net (166.49.224.154)  118.501 ms  112.678 ms  117.867 m
s
13  62.102.105.193 (62.102.105.193)  120.884 ms  117.740 ms  123.224 ms
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
[wine@winebaths ~]$
```



```
wine@winebaths:~
wine@winebaths:~ 80x40
[wine@winebaths ~]$ traceroute www.gov.ie
traceroute to www.gov.ie (54.154.87.28), 30 hops max, 60 byte packets
 1  DD-WRT (192.168.1.1)  0.350 ms  0.348 ms  0.346 ms
 2  10.207.192.1 (10.207.192.1)  18.494 ms  27.672 ms  28.116 ms
 3  dynamic-76-73-172-177.knology.net (76.73.172.177)  28.106 ms  28.108 ms  28.
107 ms
 4  76-73-167-66.knology.net (76.73.167.66)  29.306 ms  29.301 ms  29.094 ms
 5  76-73-167-78.knology.net (76.73.167.78)  36.442 ms * 76-73-166-125.knology.n
et (76.73.166.125)  28.246 ms
 6  76-73-168-65.knology.net (76.73.168.65)  30.777 ms static-69-73-0-139.knolog
y.net (69.73.0.139)  34.740 ms  34.939 ms
 7  76-73-168-70.knology.net (76.73.168.70)  33.772 ms dynamic-75-76-35-50.knolo
gy.net (75.76.35.50)  28.492 ms 76-73-168-70.knology.net (76.73.168.70)  22.227
ms
 8  xe-11-1-0.edge2.Chicago2.Level3.net (4.53.74.117)  23.200 ms  22.227 ms *
 9  * * *
10  213.242.106.86 (213.242.106.86)  129.194 ms 212.73.251.102 (212.73.251.102)
 137.022 ms 213.242.106.86 (213.242.106.86)  123.950 ms
11  178.236.0.126 (178.236.0.126)  133.984 ms 178.236.0.128 (178.236.0.128)  133
.011 ms 178.236.0.126 (178.236.0.126)  130.197 ms
12  * 178.236.1.19 (178.236.1.19)  128.935 ms *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
[wine@winebaths ~]$
```

To get the traceroute, I ran the following commands;

`traceroute www.gov.ie`

`traceroute www.europa.eu`

The traceroutes diverge before getting to europe. The only two links that are common in the traceroute are the first two.