

P1

From XMU, traceroute.



a.

In Ubuntu try to traceroute www.bilibili.com, but fail.

```
hadoop@ubuntu:~$ traceroute www.bilibili.com
traceroute to www.bilibili.com (120.240.49.148), 30 hops max, 60 byte packets
 1  _gateway (192.168.72.2)  0.334 ms  0.186 ms  0.129 ms
 2  * * *
 3  * * *
 4  * * *
 5  * * *
 6  * * *
 7  * * *
 8  * * *
 9  * * *
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
```

In Windows, the use of tracert is the same as traceroute in Linux.

After trying tracert various IP, I found that foreign IP takes more hops than domestic IP commonly. Therefore, I found a large number of hops of a route is Google's public DNS 8.8.8.8, which takes 18 hops to get to the destination. The hops are as follows.

```
C:\Users\86157>tracert 8.8.8.8

通过最多 30 个跃点跟踪
到 dns.google [8.8.8.8] 的路由:

 1      *          *          *          请求超时。
 2      3 ms       1 ms       1 ms       172.31.10.33
 3      *          *          *          请求超时。
 4      4 ms       2 ms       2 ms       210.34.2.30
 5      4 ms       3 ms       *          112.48.16.133
 6      7 ms       5 ms       4 ms       183.250.112.21
 7      6 ms       4 ms       4 ms       112.50.220.65
 8      7 ms       6 ms       6 ms       111.24.11.61
 9     22 ms      20 ms      20 ms       221.183.98.50
10     20 ms      20 ms      20 ms       111.24.5.166
11     24 ms      22 ms      22 ms       221.183.68.145
12     23 ms       *          23 ms       221.183.25.117
13    192 ms     198 ms     191 ms       221.183.55.81
14     53 ms       *          59 ms       223.120.2.101
15      *          *          *          请求超时。
16     46 ms      45 ms      46 ms       223.119.17.154
17     50 ms      46 ms      46 ms       209.85.244.77
18     49 ms      46 ms      46 ms       66.249.95.129
19     47 ms      45 ms      46 ms       dns.google [8.8.8.8]
```

Also, when I tried to tracert www.google.com, I found it impossible to get the destination.

```
C:\Users\86157>tracert www.google.com

通过最多 30 个跃点跟踪
到 www.google.com [202.160.129.6] 的路由:

 1      *          *          *          请求超时。
 2      1 ms      1 ms      1 ms      172.31.10.29
 3      *          *          *          请求超时。
 4      4 ms      2 ms      2 ms      210.34.2.26
 5     19 ms      3 ms      3 ms      112.48.16.133
 6      4 ms      4 ms      4 ms      183.250.167.137
 7      8 ms      8 ms      8 ms      218.207.222.25
 8      9 ms     10 ms      7 ms      112.50.255.10
 9     13 ms     13 ms     12 ms      172.31.254.65
10     32 ms     27 ms     31 ms      100.84.0.9
11     34 ms     34 ms     28 ms      203.90.236.193
12     32 ms     30 ms     36 ms      218.189.5.55
13      *          *          *          请求超时。
14      *          *          *          请求超时。
15      *          *          *          请求超时。
16      *          *          *          请求超时。
17      *          *          *          请求超时。
18      *          *          *          请求超时。
19      *          *          *          请求超时。
20      *          *          *          请求超时。
21      *          *          *          请求超时。
22      *          *          *          请求超时。
23      *          *          *          请求超时。
24      *          *          *          请求超时。
25      *          *          *          请求超时。
26      *          *          *          请求超时。
27      *          *          *          请求超时。
28      *          *          *          请求超时。
29      *          *          *          请求超时。
30      *          *          *          请求超时。
```

At last, I baidu that which country is the farthest from China. So I found a website of Argentina, which takes 22 hops to get to the destination. The hops are as follows.

```
通过最多 30 个跃点跟踪
到 www.bluevertigo.com ar [72.47.244.98] 的路由:

 1 * * * 请求超时。
 2 3 ms 1 ms 1 ms 172.31.10.33
 3 * * * 请求超时。
 4 4 ms 3 ms 2 ms 210.34.2.30
 5 3 ms 2 ms 3 ms 112.48.16.133
 6 5 ms 5 ms 5 ms 183.250.112.21
 7 7 ms 5 ms 5 ms 218.207.222.81
 8 9 ms 15 ms 7 ms 111.24.11.61
 9 19 ms 18 ms 18 ms 111.24.5.85
10 20 ms 18 ms 19 ms 111.24.14.150
11 21 ms 21 ms 21 ms 221.176.22.158
12 34 ms 29 ms 32 ms 221.183.25.117
13 46 ms 53 ms 43 ms 221.183.68.126
14 233 ms 202 ms 200 ms 223.120.22.14
15 188 ms 263 ms 201 ms 223.120.13.185
16 182 ms 268 ms 200 ms 223.120.6.54
17 250 ms 202 ms 200 ms ae-17.edge6.Seattle1.Level3.net [4.68.39.221]
18 290 ms 304 ms 302 ms ae-2-13.edge1.LosAngeles9.Level3.net [4.69.216.162]
19 251 ms 277 ms 304 ms ae6.ibrsa0106-01.lax1.bb.godaddy.com [4.53.228.238]
20 234 ms 279 ms 203 ms 148.72.34.25
21 307 ms 304 ms 305 ms e2.2.cr01.lax01.mtsvc.net [72.10.63.126]
22 210 ms 303 ms 304 ms 72.10.63.118
23 200 ms 200 ms 199 ms agaaacgeco.gs11.gridserver.com [72.47.244.98]

跟踪完成。
```

b.

Similarly, I tried foreign IP and finally got the largest of ISPs. But I can't find a good way to show the ISP concisely. The ISPs are as follows:

```
C:\Users\86157>tracert www.traceroute.org

通过最多 30 个跃点跟踪
到 www.traceroute.org [193.141.43.158] 的路由:

 1      *          *          *      请求超时。
 2      1 ms       1 ms       1 ms    172.31.10.33
 3      *          *          *      请求超时。
 4      2 ms       2 ms       1 ms    210.34.2.30
 5      3 ms       2 ms       2 ms    112.48.16.133
 6      5 ms       5 ms       5 ms    183.250.112.21
 7      5 ms       5 ms       4 ms    218.207.222.81
 8      7 ms       6 ms       6 ms    111.24.11.61
 9      18 ms      18 ms      18 ms    111.24.5.85
10      17 ms      17 ms      21 ms    111.24.5.174
11      20 ms      20 ms      19 ms    221.176.24.158
12      19 ms      67 ms      19 ms    221.176.24.58
13      44 ms      200 ms     44 ms    221.183.55.65
14      189 ms     191 ms     191 ms    223.120.12.41
15      197 ms     197 ms     196 ms    223.120.6.218
16      206 ms     204 ms     198 ms    ae29.cr3-lax1.ip4.gtt.net [173.205.45.153]
17      320 ms     320 ms     322 ms    ae2.crl-dus6.ip4.gtt.net [89.149.143.214]
18      332 ms     331 ms     331 ms    traceroute.org [193.141.43.158]
```

福建省厦门市教育网、中国移动、美国 GTT、爱尔兰、德国。

P2

2.

$$\lambda = \frac{25}{36} \text{ s}^{-1}, \quad S = \frac{1}{\mu} = \frac{180}{n} \text{ s}, \quad p = \frac{\lambda}{\mu} = \frac{125}{n}$$

$$p_0 = 1 - p = \frac{n - 125}{n} = 99\%,$$

$n = 12500$ is the number of lines

P3

3. $\lambda = 15/s$, $\mu = \frac{200}{4} = \cancel{50ms} \text{ } 50ms$, $\mu = 20/s$
 $\rho = \frac{\lambda}{\mu} = \frac{3}{4}$, $S = 50ms$,

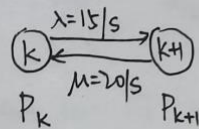
the average service time is $d = S \cdot \frac{1}{1-\rho} = 150ms$

dual-core: $\frac{1}{\mu} = \frac{200}{2} = 100ms$, $\mu = 10/s$, $\rho = \frac{\lambda}{\mu} = \frac{3}{2} > 1$

In this case, more requests arriving than can be serviced

The average delay is infinite.

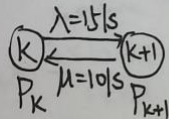
quad-core:



at equilibrium: $P_k \cdot \lambda = P_{k+1} \cdot \mu$, $\rho = \frac{\lambda}{\mu} = \frac{3}{4}$

~~where~~ $0 \leq k \leq n-1 \Rightarrow P_k < P_{k+1}$ and delay is small

dual-core:



at equilibrium: $P_k \cdot \lambda = P_{k+1} \cdot \mu$, $\rho = \frac{\lambda}{\mu} = \frac{3}{2}$

$0 \leq k \leq n-1 \Rightarrow P_{k+1} > P_k$, queueing ~~the~~ delay tends to be infinite

P4

4. a. $d_{\text{prop}} = \frac{m}{s}$
- b. $d_{\text{trans}} = \frac{L}{R}$
- c. $d = d_{\text{prop}} + d_{\text{trans}} = \frac{m}{s} + \frac{L}{R}$
- d. It has been transmitted to ~~the~~, at the starting point
- e. ~~At the starting point of~~
On the ~~the~~
- f. On the next packet switch
- g. $\frac{m}{s} = \frac{L}{R} \Rightarrow m = \frac{120}{56 \times 10^3} \times 2.5 \times 10^8 = \frac{75}{14} \times 10^5 \text{ meters}$

P5-P7

5. a. $R \cdot d_{\text{prop}} = 2 \times 10^6 \times \frac{2 \times 10^7}{2.5 \times 10^8} = \frac{4 \times 10^{13}}{2.5 \times 10^8} = 1.6 \times 10^5 \text{ bits}$

b. $d_{\text{prop}} = 8 \times 10^{-2} \text{ s}$. $d_{\text{trans}} = \frac{8 \times 10^5}{2 \times 10^6} = 4 \times 10^{-1} \text{ s}$

$d_{\text{trans}} > d_{\text{prop}}$, Therefore the maximum number of bits is $R \cdot d_{\text{prop}} = 1.6 \times 10^5 \text{ bits}$

c. 链路上可容纳的最大比特数

d. $\frac{1.6 \times 10^5}{1.6 \times 10^5} \times \frac{2 \times 10^7}{1.6 \times 10^5} = 125 \text{ m}$. Yes, maybe I don't actually know

e. $\frac{m}{R \cdot \frac{m}{S}} = \frac{S}{R}$

6. $d_{\text{proc}} = \frac{56 \times 8}{64 \times 10^3} \text{ s} = 7 \text{ ms}$ $d_{\text{trans}} = \frac{56 \times 8}{2 \times 10^6} \text{ s} = 2.24 \times 10^{-1} \text{ ms}$

$d_{\text{total}} = 7 + 0.224 + 10 = 17.224 \text{ ms}$

7. ~~No~~ I prefer to use FedEx.

Dedicated link: $d_{\text{trans}} = \frac{4 \times 10^{13}}{1 \times 10^8} = 4 \times 10^5 \text{ s}$

$d_{\text{trans}} = \frac{4 \times 10^{13} \times 8}{1 \times 10^8} \text{ s} = 3.2 \times 10^6 \text{ s} \approx 37 \text{ days}$

Though it is dedicated, it takes so long time to transfer so large data. Nobody can assure the electricity supply.

So FedEx is better.

P8-P9

8. a. Circuit-switched network.

Reasons: The transmitting rate is steady, and the application will continue running for a long period of time. Reservation and a single partition bandwidth are suitable for steady and a long period. Also, when too many clients use the application simultaneously, the rate may fluctuate.

b. No. Because the sum of rates is still less than the capacities of every link. The link is large enough so the queue wouldn't be longer than the maximum, so there is no congestion to control.

9. (a) the number of users is $\frac{3 \times 10^6}{1.5 \times 10^5} = 20$

(b) 10%

(c) $C_{120}^n \cdot (0.1)^n \cdot (0.9)^{120-n}$

(d) $\sum_{n=21}^{120} C_{120}^n (0.1)^n (0.9)^{120-n}$

P10

10. a. $d_{\text{trans}} = \frac{L}{R} = \frac{8 \times 10^6}{2 \times 10^6} \text{ s} = 4 \text{ s}$

from source host to destination host: $3d_{\text{trans}} = 12 \text{ s}$

b. $\Delta t = \frac{L}{R} = \frac{1 \times 10^4}{2 \times 10^6} = 5 \times 10^{-3} \text{ s} = 5 \text{ ms}$

At $2\Delta t = 10 \text{ ms}$

c. Time of the first packet arrives destination is $3\Delta t = 15 \text{ ms}$

The 800th packet starts time: $0 + (800-1) \times \Delta t = 3995 \text{ ms}$

Total time: 4010 ms

By taking message segmentation, it gets much faster than (a). Message segmentation makes it efficient to transmit data in packet-switched packets.

d. If multiple and huge messages are transmitted without message segmentation simultaneously, they will queue up and the time of which will be incredible.

e. The link and packet switch have to tolerate the additional cost of per packet header.

P11

1). $d_{\text{trans}} = \frac{80+S}{R}$, ^{suppose} the number of segments is $n = \frac{F}{S}$

Total time is $t = 3d_{\text{trans}} + (n-1)d_{\text{trans}} = (\frac{F}{S} + 2) \cdot \frac{80+S}{R}$

In the expression of t , F and R are both fixed

To determine S , we get $t = \frac{80F}{R} \cdot \frac{1}{S} + \frac{2}{R}S + \frac{F+160}{R}$

$$S = \sqrt{\frac{R}{2} \cdot \frac{80F}{R}} = 2\sqrt{10F}$$

P12

In my opinion, a PC transmits data by using packet switching network while an ordinary phone use circuit switching network. Therefore, after Skype receives voice data from us through packet switching network, this application rearranges packets and transforms them into a certain data form, which is suitable for circuit switching network so that our original voice can be sent to our target receiver through circuit switching network.