

P1

a.如图所示，键入tracert ubuntu.com，共经过21个跃点，数量较多

策略：选用国外网站，经过的跃点比选用国内网站更多

```
ubuntu@ubuntu:~$ tracert ubuntu.com
Traceroute to ubuntu.com (91.189.88.180), 30 hops max, 60 byte packets
 1 * * *
 2 172.31.10.33 (172.31.10.33) 7.138 ms 7.074 ms 7.007 ms
 3 * * *
 4 210.34.2.30 (210.34.2.30) 6.528 ms 6.366 ms 6.239 ms
 5 112.40.16.133 (112.40.16.133) 6.131 ms 8.148 ms 8.050 ms
 6 183.250.167.137 (183.250.167.137) 7.335 ms 6.784 ms 6.671 ms
 7 112.50.219.61 (112.50.219.61) 10.264 ms 112.50.219.65 (112.50.219.65) 10.104 ms 112.50.219.69 (112.50.219.69) 10.009 ms
 8 112.50.255.10 (112.50.255.10) 10.266 ms 10.159 ms 12.397 ms
 9 172.31.254.65 (172.31.254.65) 15.396 ms * 16.711 ms
10 100.84.0.9 (100.84.0.9) 40.115 ms 43.074 ms 42.909 ms
11 203.90.236.193 (203.90.236.193) 42.817 ms 42.708 ms *
12 218.189.5.53 (218.189.5.53) 44.791 ms * 49.812 ms
13 36.255.56.8 (36.255.56.8) 36.389 ms 36.250 ms 36.168 ms
14 100ge14-1.core1.hkg1.he.net (184.104.194.65) 111.518 ms 184.105.223.118 (184.105.223.118) 50.457 ms 100ge14-1.core1.hkg1.he.net (184.104.194.65) 106.739 ms
15 184.105.223.117 (184.105.223.117) 97.929 ms 97.710 ms 97.801 ms
16 port-channel1.core2.mrs1.he.net (184.104.197.42) 240.425 ms 240.653 ms 100ge2-1.core1.stn1.he.net (184.105.222.102) 164.868 ms
17 100ge5-2.core1.par2.he.net (184.105.81.29) 251.368 ms port-channel1.core2.mrs1.he.net (184.104.197.42) 239.905 ms 247.902 ms
18 100ge5-2.core1.par2.he.net (184.105.81.29) 276.021 ms 100ge1-1.core1.lon2.he.net (184.105.223.253) 282.585 ms 100ge5-2.core1.par2.he.net (184.105.81.29) 276.668 ms
19 100ge0-36.core1.lon7.he.net (184.104.196.6) 265.193 ms 100ge11-1.core1.lon2.he.net (184.105.223.253) 221.243 ms 215.338 ms
20 100ge0-36.core1.lon7.he.net (184.104.196.6) 261.557 ms 264.940 ms 333.095 ms
21 swp26.annegrit.canonical.com (184.104.203.50) 233.491 ms 91.189.88.180 (91.189.88.180) 233.323 ms swp26.annegrit.canonical.com (184.104.203.50) 274.858 ms
ubuntu@ubuntu:~$
```

b.如图所示，键入tracert -A [www.baidu.com](http://www.baidu.com)，经过6个ISP

策略：随意输入[www.baidu.com](http://www.baidu.com)，即经过6个ISP

P2.

平均每秒电话数  $\lambda = \frac{60000}{24 \times 60 \times 60} = 0.194$  次/秒

电话处理时长  $\mu = 180$  秒, 每秒可处理  $\frac{1}{180}$  个电话,  $\frac{\lambda}{\mu} = \frac{0.194}{180} = 0.001077$

$P_0 = \frac{1}{1 + \frac{\lambda}{\mu} + \frac{1}{2!} (\frac{\lambda}{\mu})^2 + \dots + \frac{1}{N!} (\frac{\lambda}{\mu})^N}$ ,  $P_N = \frac{1}{N!} (\frac{\lambda}{\mu})^N P_0 = 0.01$

解得  $N = 100$

P3  
四核:  $\lambda = 15$  /s  $\mu = 20$  /s  $\rho = \frac{\lambda}{\mu} = \frac{3}{4}$   $S = \frac{1}{\mu} = \frac{1}{20}$  s

average queueing delay:  $w = S \frac{\rho}{1-\rho} = 0.15$  s

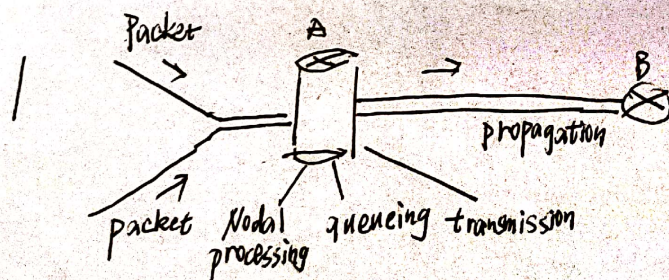
queueing + trans =  $0.15 + \frac{1}{20} = 0.2$  s

双核:

$\lambda = 15$  /s  $\mu = \frac{10}{2} = 5$  /s  $\rho = \frac{\lambda}{\mu} = \frac{3}{1} = 3$   $S = \frac{1}{\mu} = \frac{1}{5}$  s

average queueing delay:  $w = S \frac{\rho}{1-\rho} = 0.3$  s

queueing + trans =  $0.3 + 0.1 = 0.4$  s





P4

a.  $d_{\text{drop}} = m/s$  ~~see~~

b.  $d_{\text{trans}} = L/R$  s

c.  $(L/R + m/s)$  s

d. 刚开始主机A

e. 在主机A传输至B的过程中

f. 已到达主机B

g.  $m = \frac{L}{R} \leq 976$  km

P5

a.  $d_{\text{drop}} = \frac{20000 \text{ km}}{2.5 \times 10^8 \text{ m/s}} = 0.08$  ~~ms~~

$R \times d_{\text{drop}} = 2 \times 10^6 \times 0.08 \text{ bits} = 160000 \text{ bits}$

b. 80000

c. 8000

d.  $\frac{20000 \text{ km}}{160000 \text{ bits}} = 125 \text{ m}$

e. 宽度  $w = \frac{S \text{ m}}{R \text{ bits/s}} = \frac{S \text{ m}}{R \text{ bits/s}} = \frac{S \text{ m}}{R \text{ bits/s}} = \frac{RS}{m}$

$$P_6. t = \left( \frac{56 \times 8}{64 \times 10^3} + \frac{56 \times 8}{2 \times 10^6} + 0.01 \right) s = 0.0172 s$$

P<sub>7</sub>. 使用 Feibex 传输

$$t = \frac{40 \times 1024 \times 1014 \times 8}{100} s \approx 3.32 \times 10^6 s \approx 38.5 \text{ day}$$

P<sub>8</sub>.

a. 电路交换网络更适合, 因为是以稳定速率传输数据, 可以为每个 application 保留带宽而不会造成显著浪费。建立和断开连接的成本也会在会话的较长持续时间

内分摊。  
b. 每条链路都有足够的带宽处理所有应用程序的数据速率的总和, 因此不会阻塞。故无需拥塞控制机制。

P<sub>9</sub>.

$$a. \text{用户数} = \frac{3 \text{ Mbps}}{150 \text{ Kbps}} = 20$$

b. 由题得可能性为  $\frac{1}{10}$

$$c. P_n = \frac{1}{n!} C_{20}^n \left(\frac{1}{10}\right)^n \left(\frac{9}{10}\right)^{20-n}$$

$$d. P_n = 1 - P\left(\sum_{i=1}^{120} x_i \leq 10\right) = 1 - P\left(\frac{\sum_{i=1}^{120} x_i - 4}{\sqrt{120 \times 0.1 \times 0.9}} \leq \frac{6}{\sqrt{120 \times 0.1 \times 0.9}}\right) = P(Z \leq 1.83) = 0.9641$$

P<sub>10</sub>.

$$a. t_1 = \frac{8 \times 10^6}{2 \times 10^6} s = 4s \quad t_2 = 4 \times 3s = 12s$$

$$b. \frac{1 \times 10^4}{2 \times 10^6} = 5 \times 10^{-3} s \quad 2 \times 5 \times 10^{-3} = 10^{-2} s$$

$$c. (5 \times 3 + 799 \times 5) ms = 4.01 s$$



d. 没有消息分段不能容忍整比特错误, 则在出现比特错误时需重传

重新传输所有消息。

没有消息分段, 有些消息会组成巨大的数据包, 造成其它数据包排在其后面遭受大量延迟。

e. 数据包必需按顺序传输。

产生更多数据包, 包头总量也会更多, 造成浪费。

P11.

$$t = \frac{80+S}{R} \times 3 + \left(\frac{F}{S} - 1\right) \left(\frac{80+S}{R}\right) = \left(\frac{80+S}{R}\right) \left(\frac{F}{S} + 2\right)$$

对该函数求导, 可得  ~~$S = \sqrt{\frac{160F}{R}}$~~   $S = 2\sqrt{10F}$

P12.

Skype 利用互联网和电话网络之间的接口, 使用其专用的协议, 达成 PC 向普通电话打电话的功能