Introduction to computer networks HW1

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Chapter 1

P6

a) The propagation delay, dprop, in terms of m and s:

1) $d_{prop} = m/s$ seconds

b) The transmission time of the packet, dtrans, in terms of L and R:

$d_{trans} = L/R$ seconds.

c) Expression for the end-to-end delay:

$d_{end\text{-}to\text{-}end} = (m/s + L/R)$ seconds.

d) The bit is just leaving Host A.

e) The first bit is the link and has not reached Host B.

f) The first bit has reached Host B.

g) The distance m so that dprop equals dtrans:

$m = \frac{L}{R} s$

we know that 1 byte = 8 bits

1500 bytes = 1500 × 8

= 12 000 bits

$m = \frac{L}{R} s = \frac{12\,000}{10 \times 10^6} (2.5 \times 10^8)$

$= \frac{12}{10 \times 10^3} (2.5 \times 10^8)$

= 300 km

P8

a) The total of users can be supported, when circuit switching is used.

$$\text{The number of users} = \frac{\text{Transmission rate of the link used by the user}}{\text{Transmission rate required by each user}}$$

$$= \frac{10\ \text{Mbps}}{200\ \text{Kbps}}$$

we know that $1\ \text{Mbps} = 10^3\ \text{Kbps}$

$$= \frac{10\,000\ \text{Kbps}}{200\ \text{Kbps}}$$

$$= 50\ \text{users}$$

So the total number of users $= 50$

b)

Transmission rate $= 10\%$

$$\text{Probability} = \frac{1}{10} = 0.1$$

c)

$$P(n) = {}^{N}C_n (P)^n (1-P)^{N-n}$$

$$P(n) = {}^{120}C_n \left(\frac{1}{10}\right)^n \left(\frac{9}{10}\right)^{120-n}$$

Recall: Binomial distribution

$$P(n) = \binom{120}{n} \times p^n \times (1-P)^{120-n}$$

$\binom{120}{n}$: Different ways of choosing n users from 120 users

p^n : probability of choosing these n users

$(1-p)^{120-n}$: Probability of n-k users not being chosen.

d) The probability that there are 51 or more users transmitting simultaneously.

$$\text{Probability} = 1 - \sum_{n=0}^{50} \binom{120}{n} p^n (1-p)^{120-n}$$

$$= 1 - \sum_{n=0}^{50} \binom{120}{n} 0.10^n . 0.90^{120-n}$$

P.13

Calculate the average queuing delay:

a)

The first packet queing delay = 0

The second packet queing delay = $\frac{L}{R}$

The third packet queing delay = $2\frac{L}{R}$ and so on

The Nth packet queing delay = $(N-1)\frac{L}{R}$

Therefore, the average queing delay of Nth packet =

$$= \frac{\left(\frac{L}{R} + 2\frac{L}{R} + 3\frac{L}{R} + \cdots + (N-1)\frac{L}{R}\right)}{N}$$

$$= \frac{L}{RN} \sum_{i=1}^{N-1} i$$

$$= \left(\frac{L}{RN}\right) \frac{N(N-1)}{2}$$

$$= (N-1)\frac{L}{(2R)}$$

b) To transmit such batches, it takes LN/R seconds. Therefore, a new batch arrives then the queue is empty each time. Thus, the average delay of a packet across all batches is the average delay within one batch.

Hence the average queuing delay of a packet = $(N-1)\frac{L}{(2R)}$.

P.14

a) The transmission delay is L/R. The total delay is

Total delay = queing delay + transmission delay.

$$\frac{IL}{R(1-I)} + \frac{L}{R} = \boxed{\frac{L/R}{1-I}}.$$

b) Let $x = L/R$ be the transmission delay, Traffic intensity $I = \frac{La}{R} = xa$

Hence the total delay $= \boxed{\frac{x}{1-xa}}$

For $x=0$, the total delay $= 0$; as we increase x, total delay increases, approaching infinity as x approaches $1/a$.

Chapter 2

P.4

a) The document request was http://gaia.cs.umass.edu/cs453/index.html. The Host: field indicates the server's name and /cs453/index.html indicates the file name.

b) The browser is running HTTP version 1.1, as indicated just before the first pair.

c) The browser is requesting a persistent connection, as indicated by the Connection: Keep-alive.

d) This a trick question. This information is not contained in an HTTP message anywhere. So there is no way to tell this from looking at the exchange of HTTP messages alone. One would need information from the IP datagrams (that carried the TCP segment that carried the HTTP GET request) to answer this question.

e) Mozilla/5.0. The browser type information is needed by the server to send different versions of the same object to different types of browsers.

Chapter 2

P.6

a) Overall operation stated that for HTTP 1.1, persistent connections are the default behavior of any HTTP connection. That is, unless otherwise indicated, the client should assume that the server will maintain a persistent connection, even after error responses from the server.

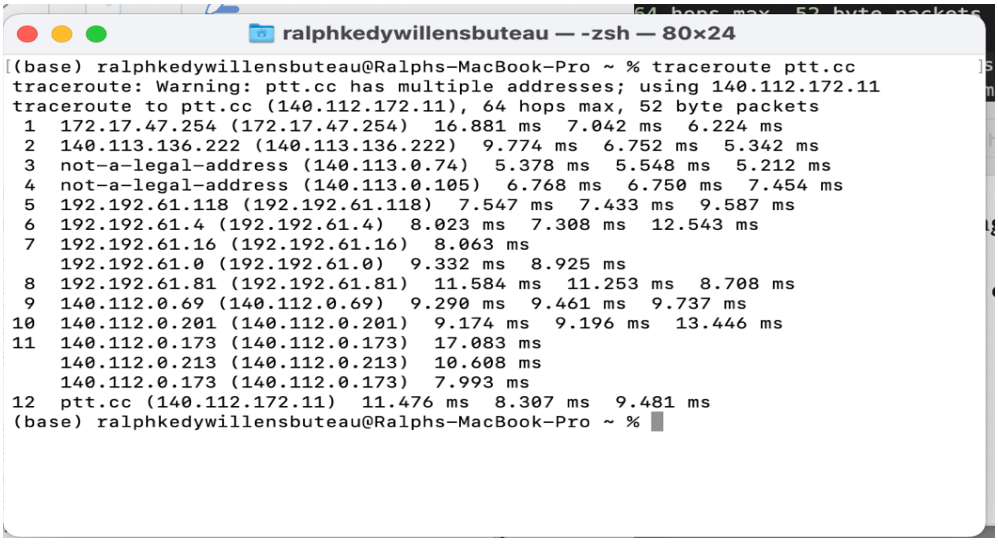
The closing of a connection can be initiated by either the client or the server using the connection header must include the connection token, "close" in the request. If the server wishes to close the connection, it must include the same "close" token in connection header along with its response. This connection header is the last request for that connection. Both the client and server can close a connection.

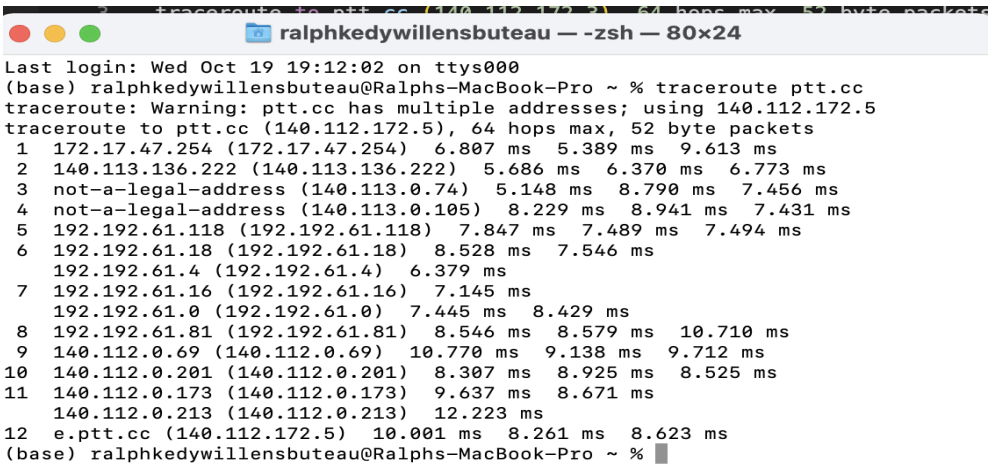
b) There are no encryption services provided by HTTP.

c) Yes, a client can open three or more simultaneous connections with a given server, although the suggested number of concurrent persistent connections is two.

d) Closing the connection by one side is possible while the other side is transmitting. This is because HTTP is stateless and therefore neither party knows the others state.

Ch1.
P.18
Traceroutes between NYCU and ptt.cc
a)
The average(mean) of the round-trip delays at each of the three hours is 7.901 ms, 9.018 ms, and 8.209 ms, respectively. The standard deviations are 1.51 ms, 1.73 ms, and 1.35 ms, respectively.



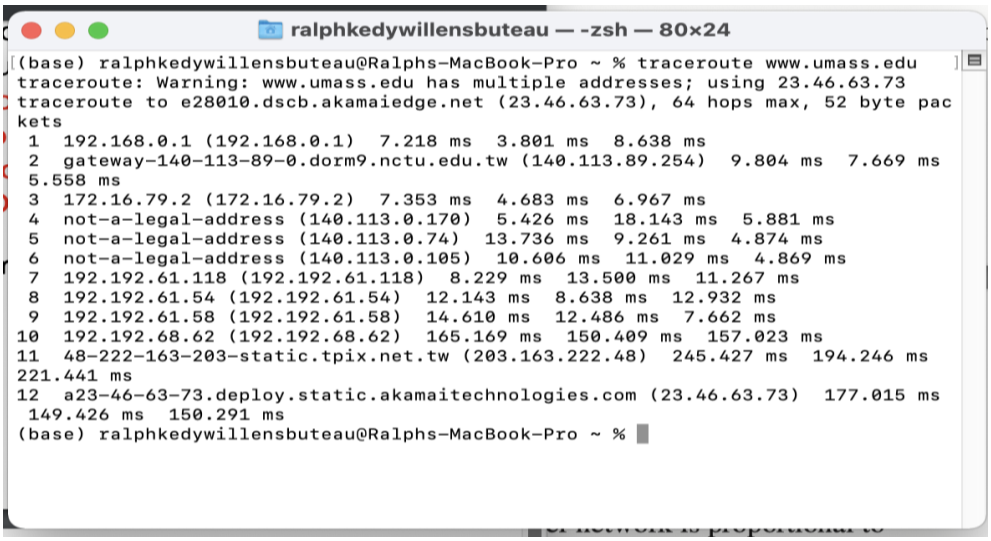


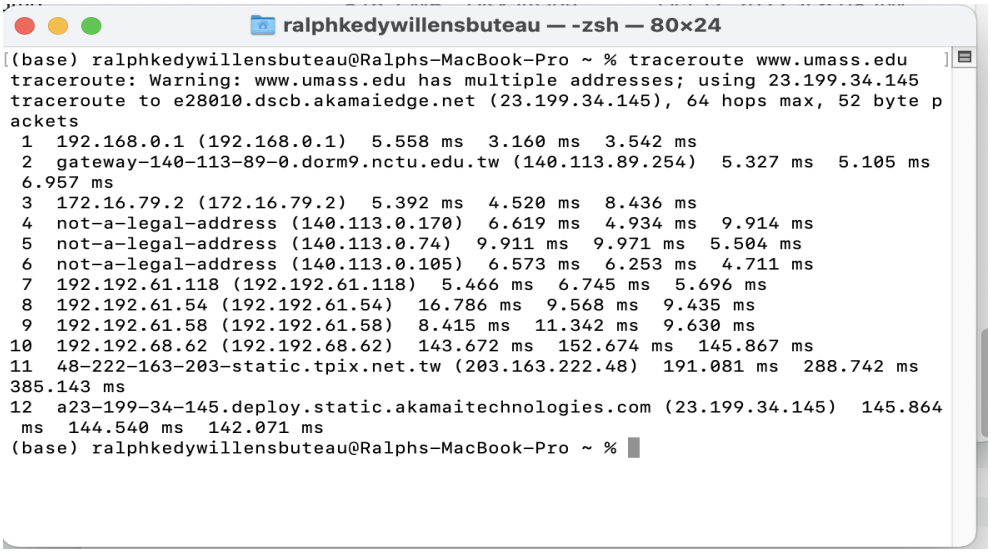
b) In this example, the traceroutes have 12 routers in the path at each of the three hours. Yes, the paths changed during the hours. the IPs of the destination are different between hours. It is probably for server load balance.

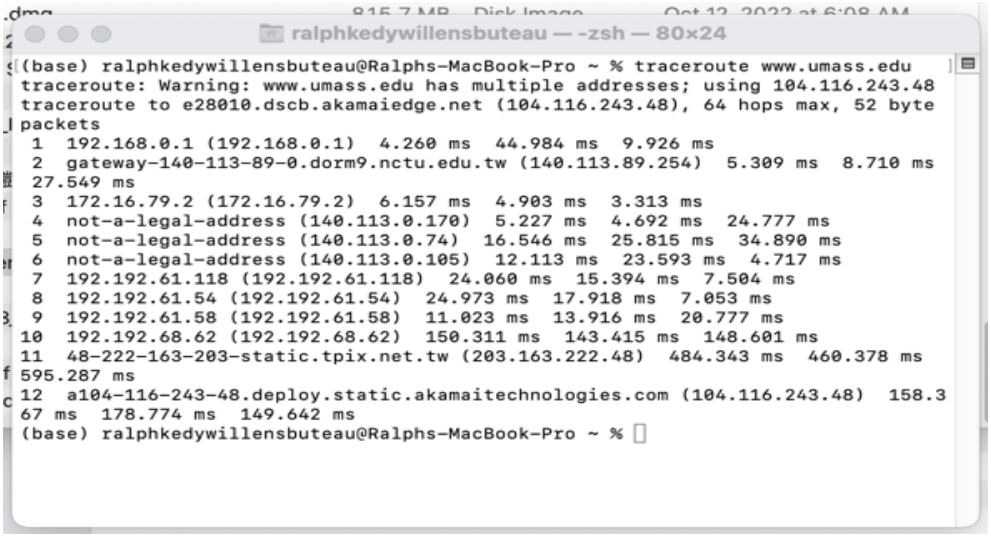
c)Traceroute packets passed through 3 ISP networks from Source to destination. Yes, in this experiment the largest delays occurred at peering interfaces between adjacent ISPs.

d)
traceroutes from dorm9.nctu.edu.tw to www.umass.edu

The average(mean) of the round-trip delays at each of the three hours is 51.59 ms, 53.75 ms, and 79.97 ms, respectively. The standard deviations are 74.98 ms, 87.31 ms, and 139.36 ms, respectively. the traceroutes have 12 routers in the path at each of the three hours. No, the paths didn't change during any of the hours. Traceroute packets passed through 4 ISP networks from Source to destination. Yes, in this experiment the largest delays occurred at peering interfaces between adjacent ISPs.


ralphkedywillensbuteau — -zsh — 80×24
(base) ralphkedywillensbuteau@Ralphs-MacBook-Pro ~ % traceroute www.umass.edu
traceroute: Warning: www.umass.edu has multiple addresses; using 23.46.63.73
traceroute to e28010.dscb.akamaiedge.net (23.46.63.73), 64 hops max, 52 byte pac
kets
1 192.168.0.1 (192.168.0.1) 7.218 ms 3.801 ms 8.638 ms
2 gateway-140-113-89-0.dorm9.nctu.edu.tw (140.113.89.254) 9.804 ms 7.669 ms
5.558 ms
3 172.16.79.2 (172.16.79.2) 7.353 ms 4.683 ms 6.967 ms
4 not-a-legal-address (140.113.0.170) 5.426 ms 18.143 ms 5.881 ms
5 not-a-legal-address (140.113.0.74) 13.736 ms 9.261 ms 4.874 ms
6 not-a-legal-address (140.113.0.105) 10.606 ms 11.029 ms 4.869 ms
7 192.192.61.118 (192.192.61.118) 8.229 ms 13.500 ms 11.267 ms
8 192.192.61.54 (192.192.61.54) 12.143 ms 8.638 ms 12.932 ms
9 192.192.61.58 (192.192.61.58) 14.610 ms 12.486 ms 7.662 ms
10 192.192.68.62 (192.192.68.62) 165.169 ms 150.409 ms 157.023 ms
11 48-222-163-203-static.tpix.net.tw (203.163.222.48) 245.427 ms 194.246 ms
221.441 ms
12 a23-46-63-73.deploy.static.akamaitechnologies.com (23.46.63.73) 177.015 ms
149.426 ms 150.291 ms
(base) ralphkedywillensbuteau@Ralphs-MacBook-Pro ~ %


ralphkedywillensbuteau — -zsh — 80×24
(base) ralphkedywillensbuteau@Ralphs-MacBook-Pro ~ % traceroute www.umass.edu
traceroute: Warning: www.umass.edu has multiple addresses; using 23.199.34.145
traceroute to e28010.dscb.akamaiedge.net (23.199.34.145), 64 hops max, 52 byte p
ackets
1 192.168.0.1 (192.168.0.1) 5.558 ms 3.160 ms 3.542 ms
2 gateway-140-113-89-0.dorm9.nctu.edu.tw (140.113.89.254) 5.327 ms 5.105 ms
6.957 ms
3 172.16.79.2 (172.16.79.2) 5.392 ms 4.520 ms 8.436 ms
4 not-a-legal-address (140.113.0.170) 6.619 ms 4.934 ms 9.914 ms
5 not-a-legal-address (140.113.0.74) 9.911 ms 9.971 ms 5.504 ms
6 not-a-legal-address (140.113.0.105) 6.573 ms 6.253 ms 4.711 ms
7 192.192.61.118 (192.192.61.118) 5.466 ms 6.745 ms 5.696 ms
8 192.192.61.54 (192.192.61.54) 16.786 ms 9.568 ms 9.435 ms
9 192.192.61.58 (192.192.61.58) 8.415 ms 11.342 ms 9.630 ms
10 192.192.68.62 (192.192.68.62) 143.672 ms 152.674 ms 145.867 ms
11 48-222-163-203-static.tpix.net.tw (203.163.222.48) 191.081 ms 288.742 ms
385.143 ms
12 a23-199-34-145.deploy.static.akamaitechnologies.com (23.199.34.145) 145.864
ms 144.540 ms 142.071 ms
(base) ralphkedywillensbuteau@Ralphs-MacBook-Pro ~ %


ralphkedywillensbuteau — -zsh — 80×24
(base) ralphkedywillensbuteau@Ralphs-MacBook-Pro ~ % traceroute www.umass.edu
traceroute: Warning: www.umass.edu has multiple addresses; using 104.116.243.48
traceroute to e28010.dscb.akamaiedge.net (104.116.243.48), 64 hops max, 52 byte
packets
1 192.168.0.1 (192.168.0.1) 4.260 ms 44.984 ms 9.926 ms
2 gateway-140-113-89-0.dorm9.nctu.edu.tw (140.113.89.254) 5.309 ms 8.710 ms
27.549 ms
3 172.16.79.2 (172.16.79.2) 6.157 ms 4.903 ms 3.313 ms
4 not-a-legal-address (140.113.0.170) 5.227 ms 4.692 ms 24.777 ms
5 not-a-legal-address (140.113.0.74) 16.546 ms 25.815 ms 34.890 ms
6 not-a-legal-address (140.113.0.105) 12.113 ms 23.593 ms 4.717 ms
7 192.192.61.118 (192.192.61.118) 24.060 ms 15.394 ms 7.504 ms
8 192.192.61.54 (192.192.61.54) 24.973 ms 17.918 ms 7.053 ms
9 192.192.61.58 (192.192.61.58) 11.023 ms 13.916 ms 20.777 ms
10 192.192.68.62 (192.192.68.62) 150.311 ms 143.415 ms 148.601 ms
11 48-222-163-203-static.tpix.net.tw (203.163.222.48) 484.343 ms 460.378 ms
595.287 ms
12 a104-116-243-48.deploy.static.akamaitechnologies.com (104.116.243.48) 158.3
67 ms 178.774 ms 149.642 ms
(base) ralphkedywillensbuteau@Ralphs-MacBook-Pro ~ %