CS3251 HW1

Wenqi He

September 3, 2018

P1

Assume that a reliable connection will be established between client and server, so the user only needs to authenticate at the beginning of each session. Also data should be encrypted before transmission and no packet loss should be allowed.

Login

ATM:

```
LOGIN [card number] [password]
```

Bank:
[Verifies user credentials and starts session timer]

```
LOGIN [card number] OK
```

[If authentication failed]

```
LOGIN [card number] ERROR
  Reason: Authentication failed
```

ATM: *[Displays error on screen]*

Query Account Balance

ATM:

```
QUERY [card number]
```

Bank:
[Looks up account balance in the database]

```
QUERY [card number] OK
  Balance: 3000.00
```

ATM: *[Displays account balance on screen]*

Withdraw From Account

ATM:

```
WITHDRAW [card number]
  Amount: 40.50
```

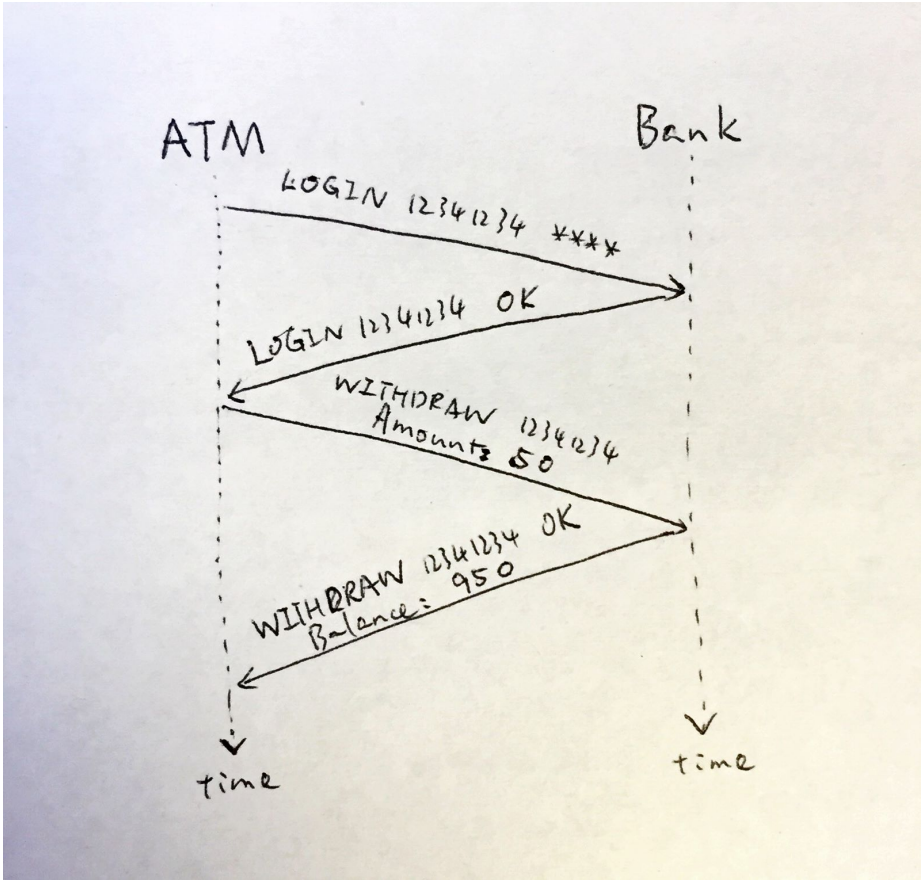
Bank:
[Queries database. If balance lower than amount requestsed]

```
WITHDRAW [card number] ERROR
  Reason: Insufficient fund
```

[Otherwise, updates the database]

```
WITHDRAW [card number] OK
  Balance: 2959.50
```

ATM: *[Dispenses cash]*



P7

The time for A to gather a packet is $\frac{56 \cdot 8}{64 \cdot 10^3} = 7 \cdot 10^{-3}s = 7ms$. The transmission delay is $\frac{56 \cdot 8}{2 \cdot 10^6} = 0.224 \cdot 10^{-3}s = 0.224ms$. So the total delay is

$$d_{proc} + d_{tran} + d_{prop} = 7 + 0.224 + 10 = 17.224ms$$

P8

a

$\frac{3 \cdot 10^6}{150 \cdot 10^3} = 20$ users.

b

The probability is 0.1.

c

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

d

$$P(N \geq 21) = \sum_{n=21}^{120} P(N = n) = \sum_{n=21}^{120} \binom{120}{n} \cdot 0.1^n \cdot 0.9^{120-n}$$

P18

The three Traceroute's to www.google.com were performed on 12:46, 16:10 and 19:19 on September 1st. [See output on the last page]

a

- 12:46 - Average RTT: 6.164ms; Standard deviation: 5.774
- 16:10 - Average RTT: 7.910ms; Standard deviation: 15.608
- 19:19 - Average RTT: 5.766ms; Standard deviation: 5.153

b

- 12:46 - 10 routers
- 16:10 - 10 routers
- 19:19 - 10 routers

All paths are different except for the first 2-3 routers.

P22

At each link, the probability that the packet is successfully transmitted is $1-p$. There are N links in total, so the probablity that all of them successfully transmit the packet is $(1-p)^N$.

The probability that a single packet needs to be retransmitted is $1-(1-p)^N$. In other words, on average, the server needs to retransmit each packet $1-(1-p)^N$ times.

P23

a

All bits experience the same propagation delay, and there won't be any queueing delay if $R_s < R_c$, so the inter-arrival time is determined only by the transmission delay of the bottleneck, which is L/R_s

b

Yes, because the rate of packets arriving is greater than the rate of packets leaving the switch.

The switch starts to send out the first packet when the second packet arrives. Sending out the first packets takes $T_c = \dfrac{L}{R_c}$ seconds, and receiving the second packets takes $T_s = \dfrac{L}{R_s}$ seconds. To ensure the first packet is completely sent out when when the second packet is fully received and ready to be sent out,

$$T \geq T_c - T_s = \frac{(R_s - R_c)L}{R_s R_c}$$

P31

a

It takes $\frac{8 \cdot 10^6}{2 \cdot 10^6} = 4s$.

The data need to be transmitted 3 times, so the total time is $4s \cdot 3 = 12s$

b

It takes $\frac{10^4}{2 \cdot 10^6} = 5 \cdot 10^{-3}s$.

It should be fully received $5 \cdot 10^{-3}s$ after the first packet starts being sent from the first switch to the second.

c

The first packet takes $3 \cdot 5 \cdot 10^{-3}s$ to reach the destination. After the first packet arrives, each of the following 799 packets only takes an additional $5 \cdot 10^{-3}s$, so the total time is

$$5 \cdot 10^{-3}s \cdot (3 + 799) = 4.01s$$

It takes significantly less time to move the file with segmentation, because each bit now only needs to wait for a small chunk of the file to arrive before it can move on to the next switch.

P33

Similar to P31(b), the first packet takes $3 \cdot \frac{S+80}{R}$, the rest $\frac{F}{S} - 1$ packets each takes an additional $\frac{S+80}{R}$. So in total, the delay is

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

$$T'(S) = \frac{1}{R}\left(\frac{F}{S} + 2\right) + \frac{S+80}{R}\left(-\frac{F}{S^2}\right) = 0$$

$$S = \sqrt{40F}$$

Traceroute output

12:46pm

```
 1  128.61.16.1 (128.61.16.1)  7.205 ms  2.623 ms  2.406 ms
 2  143.215.253.218 (143.215.253.218)  2.584 ms  2.435 ms  2.296 ms
 3  143.215.254.91 (143.215.254.91)  3.124 ms  3.120 ms  3.449 ms
 4  143.215.194.109 (143.215.194.109)  3.373 ms  3.211 ms  5.348 ms
 5  74.125.48.33 (74.125.48.33)  3.115 ms  3.149 ms  4.042 ms
 6  108.170.249.76 (108.170.249.76)  4.132 ms  3.698 ms
    108.170.249.163 (108.170.249.163)  4.085 ms
 7  209.85.250.96 (209.85.250.96)  4.500 ms
    72.14.233.199 (72.14.233.199)  4.064 ms  4.386 ms
 8  216.239.40.131 (216.239.40.131)  31.525 ms  10.459 ms  10.559 ms
 9  74.125.37.222 (74.125.37.222)  10.461 ms
    72.14.234.55 (72.14.234.55)  10.510 ms
    72.14.234.53 (72.14.234.53)  10.811 ms
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  172.217.197.106 (172.217.197.106)  11.940 ms * *
```

16:10pm

```
 1  128.61.16.1 (128.61.16.1)  4.142 ms  2.832 ms  2.385 ms
 2  143.215.253.218 (143.215.253.218)  2.402 ms  2.556 ms  2.278 ms
 3  143.215.254.91 (143.215.254.91)  3.351 ms  3.075 ms  3.347 ms
 4  143.215.194.109 (143.215.194.109)  83.651 ms  3.736 ms  3.340 ms
 5  74.125.48.33 (74.125.48.33)  3.297 ms  8.067 ms  3.196 ms
 6  108.170.249.162 (108.170.249.162)  3.274 ms
    108.170.249.163 (108.170.249.163)  3.674 ms
    108.170.249.44 (108.170.249.44)  3.625 ms
 7  72.14.233.199 (72.14.233.199)  28.006 ms
    209.85.246.223 (209.85.246.223)  4.060 ms
    72.14.233.199 (72.14.233.199)  5.883 ms
 8  209.85.244.143 (209.85.244.143)  3.919 ms
    216.239.50.104 (216.239.50.104)  3.909 ms
    108.170.230.67 (108.170.230.67)  4.313 ms
 9  216.239.51.195 (216.239.51.195)  7.589 ms
    108.170.231.171 (108.170.231.171)  5.257 ms
    216.239.50.57 (216.239.50.57)  8.419 ms
10  * * *
```

```
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  yb-in-f104.1e100.net (64.233.185.104)  5.423 ms  3.624 ms  3.838 ms
```

19:19pm

```
 1  128.61.16.1 (128.61.16.1)  3.985 ms  1.876 ms  1.824 ms
 2  143.215.253.218 (143.215.253.218)  1.893 ms  1.904 ms  1.726 ms
 3  143.215.254.91 (143.215.254.91)  2.447 ms  2.751 ms  24.431 ms
 4  143.215.194.109 (143.215.194.109)  2.909 ms  2.783 ms  2.698 ms
 5  74.125.48.33 (74.125.48.33)  2.657 ms  2.675 ms  2.770 ms
 6  108.170.249.67 (108.170.249.67)  3.291 ms  3.331 ms  3.904 ms
 7  108.170.229.80 (108.170.229.80)  4.615 ms
    209.85.246.223 (209.85.246.223)  5.562 ms
    216.239.63.88 (216.239.63.88)  9.736 ms
 8  216.239.40.119 (216.239.40.119)  10.408 ms
    216.239.40.133 (216.239.40.133)  10.510 ms
    216.239.40.119 (216.239.40.119)  10.160 ms
 9  209.85.251.243 (209.85.251.243)  14.793 ms
    209.85.243.184 (209.85.243.184)  10.042 ms
    72.14.234.53 (72.14.234.53)  10.003 ms
10  * * *
11  * * *
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  172.217.197.105 (172.217.197.105)  12.190 ms * *
```