Homework 1 **Zhanghao Wu (516030910593)**
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P1

Massages

Considering the actions the ATM should take, I design the messages in Table 1 for the protocol.

Table 1: Massages from ATM to centralized computer

Message (*data*)	Description
LOGIN (*card_id*)	Inform centralized computer that a card with *card_id* is in the ATM
PWD (*password*)	User enters the password and ATM sends it to centralized computer
BALANCE	User queries balance
WDW (*amout*)	User requests withdrawing *amount* of money
BYE	User is done

In response, the centralized computer of the bank may need the messages in Table 2.

Table 2: Massages from centralized computer to ATM

Message (*data*)	Description
PWD	Ask for password of the card
OK	Tell the ATM that the last action ends in good for PWD or WDW
ERR	Tell the ATM that the last action ends in error for PWD or WDW
AMT (*amount*)	Response to BALANCE
BYE	Permit the ATM to give back the card and return to home page

Assumptions

Assumptions made by my protocol are shown below:

1. The connection between the ATM and the centralized computer of the bank will never disconnected.
2. The communication between the ATM and the centralized computer of the bank is safe that no fake massage will be accepted and none of the massages can be duplicated.
3. The application on each side will never get the same massage twice.

Diagram

The case of a simple withdrawal with no errors is shown in the Figure 1

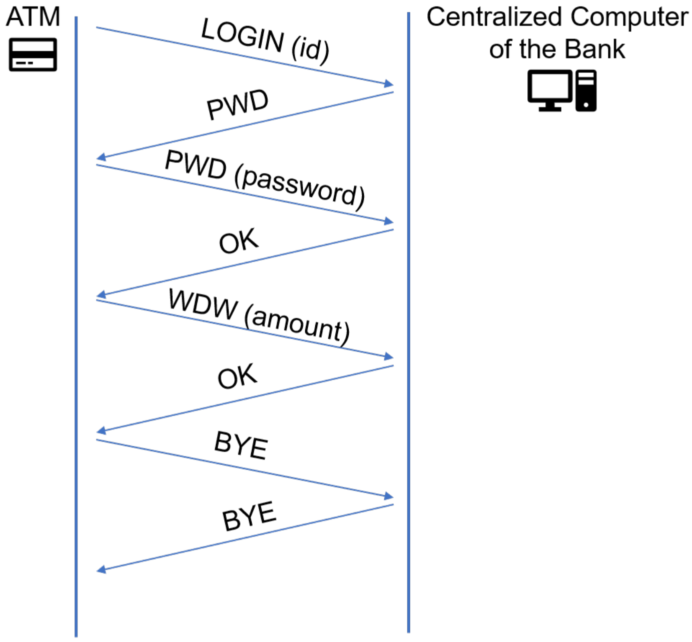

Figure 1: A simple withdrawal with no errors

P2

For sending P packets back-to-back over the N links, firstly, we consider the total time the P^{th} packet should wait to be sent. Evidently, for the i^{th} packet, it should wait L/R since the $i-1^{th}$ packet starts transmission. Therefore, the P^{th} packet should wait $(P-1)L/R$ to start transmission. And the time the P^{th} packet take to travel thru the N links is NL/R. Therefore, the total time for sendding P such packets back-to-back over the N links is $(N+P-1)L/R$.

P9

a. The maximum number of users that can be supported simultaneously under circuit switching is $N = 1Mbps/100kbps = 10$

b. The probability for exactly i users are sending data is $\binom{i}{M}p^i$. Therefore, the probability that more than N users are sending data equals to $\sum_{i=N}^{M}\binom{i}{M}p^i$

P14

a. As each packet consists of L bits, the transmission delay is $\frac{L}{R}$. Therefore, the total delay = queuing delay + transmission delay = $\frac{IL}{R(1-I)} + \frac{L}{R} = \frac{L}{R(1-I)}$

b. Let $x = \frac{L}{R}$. Then the total delay is $\frac{x}{1-ax}$. And the plot of the function are shown in Figure 2.

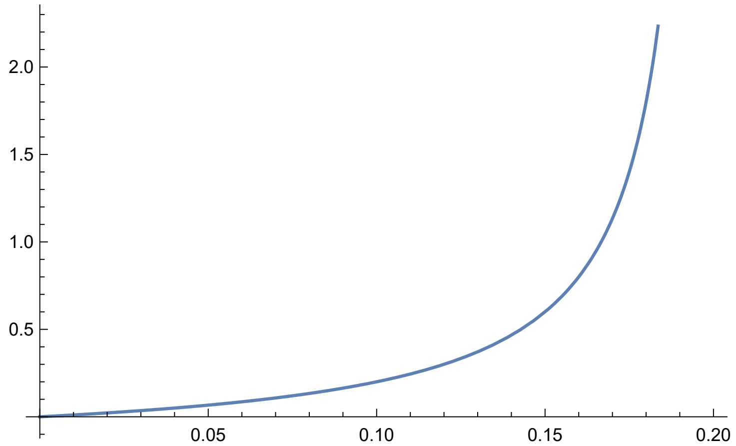

Figure 2: The total delay function (a=5) with respect to $\frac{L}{R}$

P16

According to the problem, the transmission delay = $\frac{\text{1 packet}}{\text{transmission rate}}$ = 10 msec. Therefore, d = transimission delay + queuing delay = 2 msec.Hence, the average packet arrival rate $a = \frac{N}{d} = \frac{\text{10 packets}}{\text{0.02 sec}}$ = 500 packets/sec

P25

a. The propagation delay dprop = distance/propagation speed = 0.08 sec. The bandwidth-delay product= R · dprop = 0.16 Mb

b. As 0.16 M is smaller tha the file size $0.8M$.The maximum number of bits that will be in the link at any given time equals to the bandwidth-delay product, i.e. 0.16 M

c. The bandwidth-delay product is the maximum number of bits that can be in the link at a given time.

d. As there are 0.16 M bits in the link, the width of a bit in the link is $\frac{2\times10^7 \text{ meters}}{0.16\times10^6 \text{ bits}}$ = 125 meters/bits, which is longer than a football field(120 meters).

e. The propagation delay equals $\frac{m}{s}$. And the bandwidth-delay product equals $\frac{mR}{s}$. Therefore the length of a bit is $\frac{m}{\frac{mR}{s}} = \frac{s}{R}$