DEPARTMENT OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

6.033—Computer System Engineering

Handout 27—April 21, 1995

Quiz #2

This quiz contains 5 problems whose relative weights are indicated below. Please place each answer on the page with the question and hand in this booklet at the end of the examination.

Put your name on this cover sheet AND at the bottom of each page of this booklet. The booklet may be separated for grading so that each problem can be evaluated by one grader. Be sure that you don't put part of the answer to a problem on the back of a sheet for another problem!

Some parts of some problems may be much harder than others. Read them all through first and attack them in the order that allows you to make the most progress. Write down any assumptions and show your work, or you risk losing partial credit. Be neat. If we can't figure out your answer we can't give you credit. On answers that involve numbers, be sure to specify clearly the units of your answer.

Circle your recitation instance:

1. 10:00—Dally/Lew
7. 11:00—Dally/Phillips
5. 11:00—Corbató/Dampier
2. 11:00—Hawley/Lew
6. 12:00—Hawley/Dampier
3. 1:00—Saltzer/Phillips
8. 1:00—Corbató/Mitra
9. 1:00—Bedichek/Shih
4. 2:00—Saltzer/Mitra

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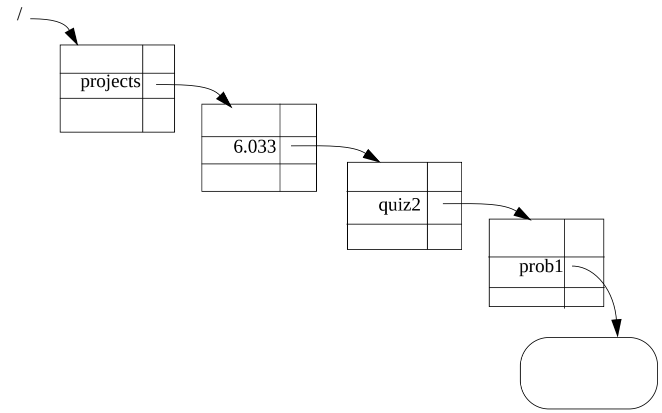
Problem	Your Score	Maximum Score
1		10
2		25
3		25
4		15
5		25
Total		100

Name: ________________________________

1. *(10 points)* Consider the UNIX file system naming hierarchy illustrated below:



You have been handed the following path name:

/projects/6.033/quiz2/prob1

and you are about to resolve the third component of that path name, the name "quiz2".

1a. Circle the closure, and write the word "closure" next to the thing you have circled.

1b. Circle the context, and write the word "context" next to the thing you have circled.

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2. *(25 points)* To obtain high throughput, communication applications pipeline messages: after sending the first packet of a message, they immediately send the next one without waiting for an acknowledgement of the first packet. A key question is how to establish how many packets to pipeline between a request and its acknowledgement (i.e., what is the window size).

2a. *(5 points)* Assume the client and the server are connected by an 800,000 byte/sec link. Also assume that the client and the server produce and consume packets at the same rate. Using the server's acknowledgements, the client measures the round-trip between itself and the server to be 10 milliseconds. If the client is sending 1000-byte packets, what is the smallest window size that allows the client to achieve 800,000 byte/sec throughput?

2b. *(5 points)* A popular scheme for establishing the window size in the Internet is *slow start*. In a simple version of slow start, a client starts with a small window size and increases the window size. Assume that the client starts with a window size of one packet. Also assume that for every packet, the server responds with an acknowledgement telling the client to double the window size. How long would it take for the client to know it has reached the maximum throughput?

2c. *(5 points)* Another scheme for establishing the window size is *fast start*. In fast start, a client starts by assuming a default large window size (say 8 packets) and sends the server a burst of that size. On the server's response, the window is adjusted to the size that is supplied by the server. If a client starts with a window size of 8, how long does it take for the client to know it has achieved the maximum throughput?

2d. *(10 points)* In the circumstances described above, fast start seems to be preferable. In what circumstances would it be preferable to use slow start over fast start? You may assume that one of the back-pressure techniques used in the Internet is dropping packets.

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3. *(25 points)* Secure Inc. is developing an improved version of AFS, Secure AFS (SAFS), which automatically encrypts files to guarantee better privacy of information. When a request to store a file arrives, SAFS enciphers the file using the client's key. On arrival of a request to read a file, SAFS looks up the client key, deciphers the file, and sends the file back to the client. SAFS keeps for each client a separate key to encipher and decipher files.

3a. *(5 points)* The designers of Secure Inc. are wondering how long it would take to crack an enciphered file that is encrypted using RSA with 512-bit key, which is what is typically used today. To crack an RSA-enciphered file one has to factor the key. The designers know from the literature that factoring a 100 decimal digit number takes about 1 month using idle cycles from 300 3-MIPS SUN-3 workstations. It is estimated that factoring an additional 3 decimal digits roughly doubles the computation time needed. How many 3-MIPS computers are needed to factor a 155 decimal digit number (which corresponds to about 512 bits) in one month?

3b. *(5 points)* If processors are doubling computation performance per year, how many computers would it take to factor a 512-bit key in one month in the year 2000?

3c. *(5 points)* Let's assume that enciphering and deciphering can be done at 250 Kbyte/sec. How much would the throughput be reduced for reading files stored by SAFS, if the current maximum throughput without enciphering/deciphering is 800 Kbyte/sec? (You may assume that enciphering/deciphering cannot be pipelined with sending/receiving.)

3d. *(10 points)* Secure Inc. is also considering adding automatic compression of files to SAFS. Compression reduces redundancy of information in a file so that the file takes less disk space. Should they first compress files, then encipher them, or should they first encipher files and then compress them? Explain your answer briefly.

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4. *(15 points)* Baybank is struggling to convince itself of the validity of a message it just received, and has asked your help in what to do next. So far, they know the following two facts to be true:

Louis says (Ben says (Transfer $1,000,000 to Alyssa))

Jim speaks for Ben

According to Ben's account representive, Ben's account has enough money for such a transaction, so if they can convince themselves that Ben really said that, they will do the transfer.

4a. *(5 points)* Which of the following things should they attempt to establish the truth of?

a. Louis speaks for Jim

b. Ben speaks for Louis

c. Ben says (Jim speaks for Louis)

4b. *(10 points)* Why?

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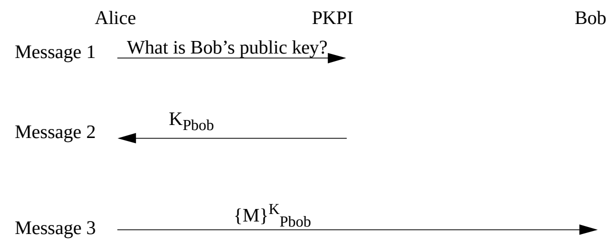
5. *(25 points)* Ben Bitdiddle and Louis Reasoner have founded a startup company, named Public Key Publication, Inc. (PKPI), whose business is distributing public keys. Their idea is that people who have a key-pair for use with a public-key system need a way of letting other people know the public key of their key-pair. Ben and Louis are not interested in creating keys, but just in acting as a public key distributor.

Ben and Louis have designed the following protocol, in which Alice sends a private message to Bob. They need your help in debugging the protocol. K_{Pxyz} is the public key of principal xyz.



Messages 1 and 2 constitute the PKPI protocol; message 3 is the beginning of Alice's protocol with Bob and is not under the control of PKPI; message 3 is shown here only to place the PKPI protocol in context.

5a. *(5 points)* Louis believes that Eve, the passive eavesdropper, will find that she cannot learn anything by overhearing the PKPI protocol in use. Give an argument that supports Louis' position, or an example demonstrating that Louis is mistaken.

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5b. *(10 points)* Louis originally hoped that Lucifer, the active attacker, wouldn't be able to cause any problems, either, but since hearing the 6.033 lecture on the topic he is not sure. Give an example of an active attack that demonstrates that Louis needs to revise the PKPI protocol to protect against Lucifer.

5c. *(10 points)* Ben suggests that the protocol could be improved by changing Message 2. What should Message 2 contain, and how should it be enciphered, so that Alice can be confident that no one but Bob can decipher message 3?

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