# CMSC 417 Midterm #2 (Spring 1997) - Solutions

1.) (15 points) Define **and** explain the following terms:

a) forbidden region: *illegal combinations of time/sequence numbers that could permit data from old connections to be accepted as part of a current connection. Caused by node crashes or sequence number wrap around.*

b) flow control: *matching rates between producers and consumers. Can be done at the link or network layers.*

c) two army problem: *explains the problem of communicating over an unreliable network. The problem is that two parties can never know if the last message sent was correctly received. This problem relates to deleting a connection between two hosts.*

d) MTU: *Maximum Transfer Unit. The largest packet/frame size that can travel over a network or link.*

e) bit stuffing: *a way to prevent the occurrence of a frame boundary string from occurring in data. After a specific sub-string of the pattern is seen, a bit is inserted to prevent the target string from appearing.*

2.) (15 points) Error correction and detection.

a) What is the minimum number of error recovery bits required to recover from an n bit error? Explain why this number of bits is sufficient.

*let n = m + r, m is the message length, r is the number of error recovery bits. To be able to recover from a d bit error we need to have n choose d invalid messages for every valid message. n choose d is the number of ways you can flip exactly d bits in an n bit message. There are $2^m$ valid messages so: [(n choose d) + 1] $2^m$ <=2 but n = m + r so [(m + r) choose d + 1] <= $2^r$*

$$\boxed{\frac{(m+r)!}{(m+r-d)!d!}+1<=2^r}$$

*so that the bit pattern with n errors is the closest (min. hamming distance) bit pattern to the correct message (it's n bits away and the rest will be at least n+1).*

b) If the ratio of error detection bits to payload bits remains constant, what are the tradeoffs between having the error bits applied to a single character vs. a block of characters?

***Bigger blocks*** *can detect longer burst errors*
***Smaller blocks*** *reduce latency when sending small frames and reduce the amount of data to be re-transmitted when an error occurs.*

3.) (20 points) One way to support mobile hosts is by assigning a host a temporary IP address in its new location, **and** continuing to use its old address by tunneling IP through IP back to an agent running on the mobile host's home network.

a) Explain the steps required to permit a mobile host to register on a local network and start receiving packets using its permanent IP address.

1) *connect to local server (agent) on the foreign network and request temp IP address.*
2) *local agent contacts home agent to inform it of the mobile host's temporary IP address.*
3) *home agent starts tunneling packets destined from the mobile host on its temporary.*

*Other answers that provide the same information exchange are possible.*

b) Give one advantage and one disadvantage of this approach to IP mobility compared with having a mobile host only use its permanent IP address.

*+ only need the remote agent to setup the transfer, not forward each packet*
*+packets can be sent directly to the mobile host at its temporary IP address to prevent sending packets long distances twice.*
*- software could cache temporary IP address and re-use it after the mobile moves again.*
*- uses two IP addresses*

c) When tunneling IP through IP, it is not possible to always maintain a one for one match between tunneled packets and the native packet. Why? Explain the potential performance implications of this limitation.

*Tunneled packet needs an IP header and if the packet to tunnel is already at the MTU for the network, the extra size will require it to be fragmented. Fragmentation will slow down the network due to extra overhead of processing two packets and the need to re-transmit all parts of a fragment if one is lost.*

4.) (15 Points) IP Addresses

a) The Internet is running out of IP addresses to assign, but there are substantially less than four billion hosts on the Internet. Explain why this is happening.

*Internal fragment due to IP addresses being assigned in blocks rather than one at a time.*

b) Joe Hacker reads about IPv6 (with 128 bit address) and is concerned about routing table size. He decides that the best solution is to encode latitude and longitude into IP addresses. Explain how this might be used to reduce routing table size. Provide a reason why this might not reduce routing table size.

*Geographic information could be used as the basis of hierarchical routing. Nodes would store detailed routing information for its local region and only sparse information for distant nodes. The problem is that due to administrative domains and different ISP's physical location is not equivalent to nearest neighbor for routing purposes.*

5.) (15 Points) Consider a network where on average, messages between two hosts must travel through 10 routers (and thus 11 hops). On average, one packet in every 1,000 is lost as is passes through a router.

a) If one packet in 100 is garbled per hop, what is the probability of a packet making it through the network if no link level re-transmission is used? What if link-level re-transmission is used?

*With re-transmission, link garbling does not occur so* $p = .999^{10}$

*Without re-transmission, link garbling and router drops can happen so* $p = .999^{10} \times .99^{11}$

b) Repeat part a if the probability of a link garbling a packet is 1 in a billion.

*With re-transmission, link garbling does not occur so* $p = .999^{10}$

*Without re-transmission,* $p = .999^{10} \times (1-10^{-9})^{11}$*, conclusion don't need link retransmission when link error probability is very low.*

6.) (15 points) Congestion Control

a) Why is congestion control more important in a network carrying traffic whose bandwidth requirements vary dynamically during a session compared with fixed bandwidth traffic?

*With static traffic, congestion avoidance via call admission can be used. With dynamic traffic, call admission leads to under utilization of the network due to conservative allocation choices.*

b) In TCP (Jacobson) congestion control, the variance in round-trip times for packets implicitly influences the congestion window. Explain how a high variation in the round-trip time affects the congestion window. What is the impact of this high variation on the throughput for a single connection?

*With all other things being the same (i.e. losses and congestion), high variance in RTT will lead to a long timeouts for re-tranmission. This will make congestion detection slower since we only close the window when a packet is dropped (detected via a timeout). As a result, it is more likely the network will get into a congested state, this will reduce the throughput of our connection.*