AALBORG UNIVERSITET

Department of Electronic Systems
Communication in Electronic Systems
Networking Part
Exam set example: Fall 2015

Important information:

- The exam questions here cover only the network part of the course, and therefore the weights of the questions add up to only 50%.
- The exam set is provided as a help for you during the exam preparation.
- There are two versions - one with answers, and one without answers.
- The answers provided are based on my quick re-visit of the questions, and this is the first release. If any questions are unclear, or if you disagree with the answers please let me know at jens@es.aau.dk so any mistakes could be clarified.
- If you have any questions or comments, don't hesitate to contact Jens at jens@es.aau.dk.

Problem 1 (3%) - Communication Networks

For each of the protocols below, indicate what layer (both number and name) in the TCP/IP Protocol Stack they belong to:

a) SSH *(Layer 7, Application layer)*
b) TCP *(Layer 4, Transport layer)*
c) IEEE 802.11 *(Layer 1/2, Host-to-network layer)*
d) User Datagram Protocol *(Layer 4, Transport layer)*
e) FTP *(Layer 7, Application layer)*
f) Bittorent *(Layer 7, Application layer)*
g) Ethernet *(Layer 1/2, Host-to-network layer)*

Problem 2 (4%) - Communication Networks

a) Assume you have two computers A and B communicating over TCP, IP and Ethernet. Assume that a specific frame contains 200 bytes including the headers of Ethernet, IP, and UDP. How much payload does this frame contain? *200-18-20-8=154 bytes*

b) Assume that it takes 2 ms from a bit leaves A to the bit is received in B. Assume also that the bandwidth of the line is 2Mbit/s. How long does it take to transfer the frame from A to B? (round to nearest ms). (hint: You need to calculate how long it takes from the first bit leaves A until the last bit has arrived at B). *With the bandwidth of 2Mbit/s it takes 0,8 ms before the last bit is put on the line. Then it takes 2 ms for the transfer. So the correct result is 3 ms.*

Problem 3 (5%) - Communication Networks

You regulate a flow of packets using a token bucket, feeding into a leaky bucket. Assume that the token bucket has a rate of 10 packets per second, and a capacity of 100 tokens. The leaky bucket has a rate of 20 packets per second. Assume that the token bucket is full of tokens when the following flows arrive:

- First 150 packets arrive
- After 10 seconds another 100 packets arrive
- After another 30 seconds, another 200 packets arrive.

How man seconds will it take before all the packets have left the leaky bucket?
50 seconds

Problem 4 (7%) - Communication Networks

Which of the following statements are true? *(true statements marked in **bold**)*

a) In UDP a packet is considered lost if the sender is not notified by the receiver that the packet was correctly received (it does not receive an acknowledgement)

b) **With NAT it is possible that more users can share a single external IP address.**
c) Random Early Detection works with UDP, since it makes use of UDPs slow start mechanism.
d) **Slotted Aloha is generally more efficient than pure Aloha.**

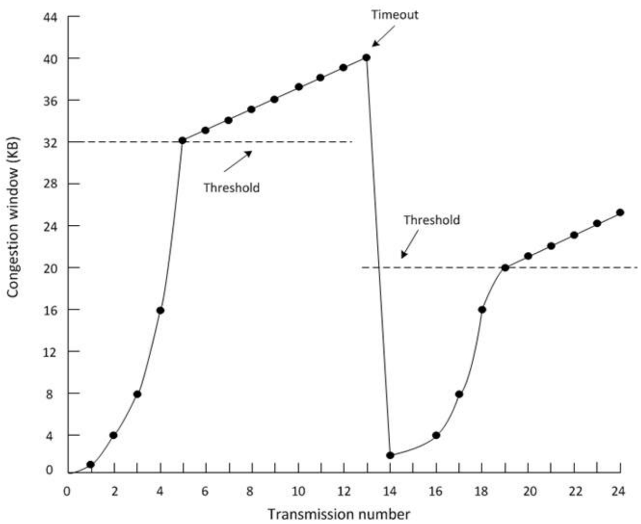
e) **When setting up a TCP connection, the first two packets of the handshake have the SYN bits set.**
f) **UDP is generally more suitable for video conferences than TCP.**
g) **The IP header contains information about the total packet length.**
h) **The TCP header has a length of 20 bytes, but it can be larger if options are used.**
i) **Error correction requires more overhead than error detection**
j) If you have an Internet connection with a speed of 10Mbit/s, then it takes more than five seconds to download a file of one Megabyte
k) With Distance Vector Routing each node keeps an overview (map) of the full network (or subnetwork).
l) **In TCP, using selective acks will usually result in the same or fewer transmissions than if selective acks are not used.**
m) The minimum framelength in Ethernet is necessary in order to do avoid too much overheads.
n) **Distance Vector Routing suffers from the count-to-infinity problem.**

Problem 5 (4%) - Communication Networks

Assume that 20 packets are sent from A to B using TCP. For simplicity, we assume that each packet contains 20 byte of data, and that the sequence number of the first packet is 0. Unfortunately packets number 3 and 4 are lost and retransmitted, so they arrives to the receiver just after Packet no. 6. What will be the acknowledgement number upon receipt of the following packets? You can assume that only packet number 3 and 4 are lost (so the packets arrive in the following order: 1,2,5,6,3,4,7,8,9,10).

- Packet no. 1 - *20*
- Packet no. 2 - *40*
- Packet no. 3 - *60*
- Packet no. 4 - *120*
- Packet no. 5 - *40*
- Packet no. 6 - *40*
- Packet no. 7 - *140*
- Packet no. 8 - *160*
- Packet no. 9 - *180*
- Packet no. 10 - *200*

Problem 6 (5%) - Communication Networks



Assume a simple version of TCP slow start is implemented as follows (the figure shows the principle):

- The initial congestion window size is set to 1 packet
- The initial Threshold is set to 4 packets
- Until the Threshold has been reached, the sending rate is doubled for every transmission.
- After the Threshold has been reached, the sending rate is increased by one until packet loss is detected.
- After packet loss is detected, the congestion window is again set to 1 packet.

Assume that a transfer of 25 packets is sent, and that packet numbers 7 and 16 are lost. How many transmissions does it take before the transfer is completed? You can assume that acknowledgements are received for all packets before the next packets are sent.

T1=1
T2=2,3
T3=4,5,6,7 (number 7 is lost, threshold=2, cw=1)
T4=7
T5=8,9 (threshold reached)
T6=10,11,12
T7=13,14,15,16 (number 16 is lost, threshold=2 , cw=1)
T8=16
T9=17,18 (threshold reached)
T10=19,20,21
T11=22,23,24,25

Problem 7 (2%) - Communication Networks

Assume a message of 100 bytes is to be sent from one host (A) to another host (B). Assuming that communication is done using classical Ethernet, IPv4 and TCP, how many packets would in total needed to be sent (ignore the closing of the connection)

a) from A to B
and
b) from B to A

Answers:
a) 3. From A to B we have two packets for the TCP handshake, and one with the payload data.
b) 2. From B to A we have one packet for the TCP handshake, and one with the ack.

Problem 8 (8%) - Communication Networks

Assume that a home network is connected to the Internet through a gateway using NAT. The network can be described as such:

- The internal host addresses are in the range 192.168.1.2 – 192.168.1.254
- The NAT box has an internal address of 192.168.1.1
- The NAT box has an external address of 198.60.42.15

Assume that a TCP packet containing an HTTP request is sent from the HOST 192.168.1.13 (port: 10.000) to the SERVER 194.71.107.13 using standard HTTP port. Assume that the connection is stored in the NAT box' translation table with the index 15.000.

When the packet leaves the HOST, what is the

a) Source IP *192.168.1.13*
b) Source port *10.000*
c) Destination IP *194.71.197.13*
d) Destination port *80*

When the packet leaves the NAT box, what is the

e) Source IP *198.60.42.15*
f) Source port *15.000*
g) Destination IP *194.71.197.13*
h) Destination port *80*

When the packet sent in response leaves the SERVER, what is the

i) Source IP *194.71.197.13*
j) Source port *80*
k) Destination IP *198.60.42.15*
l) Destination port *15.000*

When the packet sent in response leaves the NAT box, what is the

m) Source IP *194.71.197.13*
n) Source port *80*
o) Destination IP *192.168.1.13*

p) Destination port *10.000*

Problem 9 (6%) - Communication Networks

Assume that you are implementing a smart meter, which transmits a short message every 5 seconds. The payload of the message is 15 bytes. No data is sent in return.

a) Assuming that the message is transmitted over Ethernet, IP and UDP, how much bandwidth is needed to ensure that the communication can take place? State the answer in bits/s, and round up to closest integer. *Taking into account the headers we need to be able to send at least 15+18+20+8= 61 bytes. However, ethernet frames need to be at least 64 bytes. So the minumum bandwidth needed is 64*8 bits / 5 seconds = 103 bits/s.*

b) Assuming that the message is transmitted over Ethernet, IP and TCP, how much bandwidth is needed to ensure that the communication can take place? State again the answer in bit/s, and round up to closest integer. You can assume that in addition to the message itself and its acknowledgement you need the 3way handshake to setup the connection as well as one message in each direction to close down the connection. Assume the connection is symmetric, so you need only to do the calculation for the direction that requires the largest bandwidth. Assume that a connection has to be setup and taken down for each message that is sent. *It is easy to see that the direction from the meter to the server requires the largest bandwidth, since here is payload and since the three-way handshake requires more messages from the sending part. For the three-way handshake we have 2 packets of 64 bytes. For the message with payload we have 15+18+20+20=73 bytes. And for the message to close the connection another 64 bytes. So in total 265 bytes = 2120 bits per 5 seconds. Answer: 424 bits/s.*

Problem 10 (5%) - Communication Networks

A TCP machine is sending full windows of 65.535 bytes on a 1Mbit/s channel that has a 50 msec roundtrip time (two-way-delay). What is the line efficiency (in percent – closest integer), assuming that Windows Scaling is not enabled?

With a 50 msec roundtrip delay, it takes (at least) 50 msec between we can send the 65.535 bytes = 524.280 bits. This corresponds to around 10,5Mbit/s, which is higher than the 1Mbit/s. Therefore the line efficiency becomes 100%.

Problem 11 (1%) - Communication Networks

a) What kind of information would usually be included in the IP header? (choose one or more)
   - **Destination IP address**
   - Destination port
   - Acknowledgement number
   - Sequence number
   - **Header length**
   - SYN bits when a connection is established

- MAC address