14-740: Fundamentals of Computer and Telecommunication Networks

Fall 2018
Quiz #2
Duration: 75 minutes

Name: ANSWER KEY Andrew ID: _____

Important:

- Each question is to be answered in the space provided. Material written on the back of the page or in space above or below the question will not be graded.
- This is a closed book exam -- you may not use any reference materials, crib sheets, or formula cards.
- Calculators are not needed, nor allowed.
- **Write legibly**. Unreadable work will be considered incorrect.
- At the end of the final duration, you will be told to "Cease Work." Immediately stop writing and turn in your paper. Any writing after this point will result in a zero grade.

Page 2	_____ (22 possible)
Page 3	_____ (19 possible)
Page 4	_____ (32 possible)
Page 5	_____ (15 possible)
Page 6	_____ (12 possible)
Total	_____ (100 possible)

I understand that the CMU and course policies on cheating apply to this quiz.

_____

signature date

Matching: Fill in the blank to match each RDT tool to its usage. Each RDT tool has one or more possible answers from the list. Each element in the list gets used exactly once. (2 points each, 12 points total)

1. _____ Retransmission E

2. _____ Window C, A

3. _____ Sequence Number B

4. _____ Feedback G, F

5. _____ Timer D

6. _____ Checksum H

a. Allows for reuse of sequence numbers

b. Detects duplicate segment

c. Allows for pipelining of segments

d. Detects lost ACK / NAK

e. Recovery from lost or corrupted segment

f. Tells sender the segment was corrupted

g. Acknowledgement of segment receipt

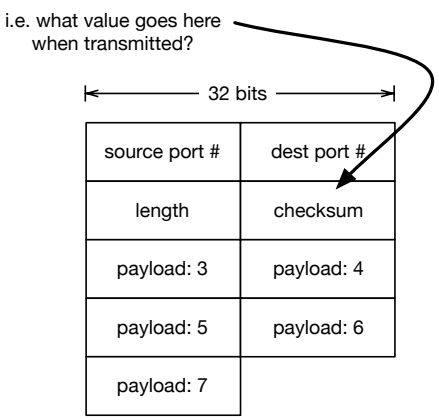
h. Detects bad length field in segment header

7. What does LFN stand for? If you don't recall the full name, provide a short description. (10 points)

LFN = Long, Fat Network. A network with high delay (or RTT) and high bandwidth.

Don't write down here. This is not considered "space provided." Anything you write down here will not be graded (nor even read).

8. Calculate the checksum that would be included (according to the methods described in class) for a UDP segment sent from port 1, to port 2, with a payload of the values 3, 4, 5, 6 and 7. Each payload value takes up 16 bits. Show your work for partial credit. (10 points)



Checksum algorithm: Add up the 16-bit values, wrapping carry. Then, flip the bits of the answer.

Add source port + dest port + length + payload bytes

1 + 2 + (length = 18 bytes) + 3 + 4 + 5 + 6 + 7 = 46.

46 in binary is 32 + 8 + 4 + 2 = 0000_0000_0010_1110.

Flip the bits to 1111_1111_1101_0001

9. In class, I gave a laundry list of 8-9 "marketing statements" about TCP's features. For instance, TCP is "reliable," as I've shown and described below. List 3 more such marketing statements and briefly describe each. (9 points)

Reliable	The data received matches the data sent, even in the presence of network errors.
Point-to-Point	One sender, one receiver.
Pipelined	Sliding window control algorithm allows for multiple segments in flight at any one time.
In-order byte stream	No message / record boundaries
Buffers at sender/receiver:	Allows applications to do other things
Full duplex data	Bi-directional data flow in the same connection
Connection-oriented	handshaking initializes sender / receiver state
Flow control	Sender will not overwhelm receiver
Congestion control	Sender will not overwhelm network

10. Transport-layer congestion control relies upon feedback to determine the network load. **Where does the feedback come from?** We discussed two methods for gathering such feedback. (10 points total)

A) Name (or concisely describe) the method used by TCP. (2 points)

End-to-end control

B) Name (or concisely describe) the other method, which is not in common use today. Then list one disadvantage and one advantage of this method. (2 points for method, 3 points each for others)

2nd Method: Network-assisted congestion control

Advantage: The router has the best understanding of it's current load.

Disadvantage: The router has to do additional work (sending feedback messages) at exactly the time when it is busiest.

11. Define AS and ASN (don't just tell me what they stand for). Then, in one word, tell me the solution to solve the scale problem of internet routing. (Hint: the solution is a superpower often employed by computer engineers.) (5, 5 and 2 points. 12 points total)

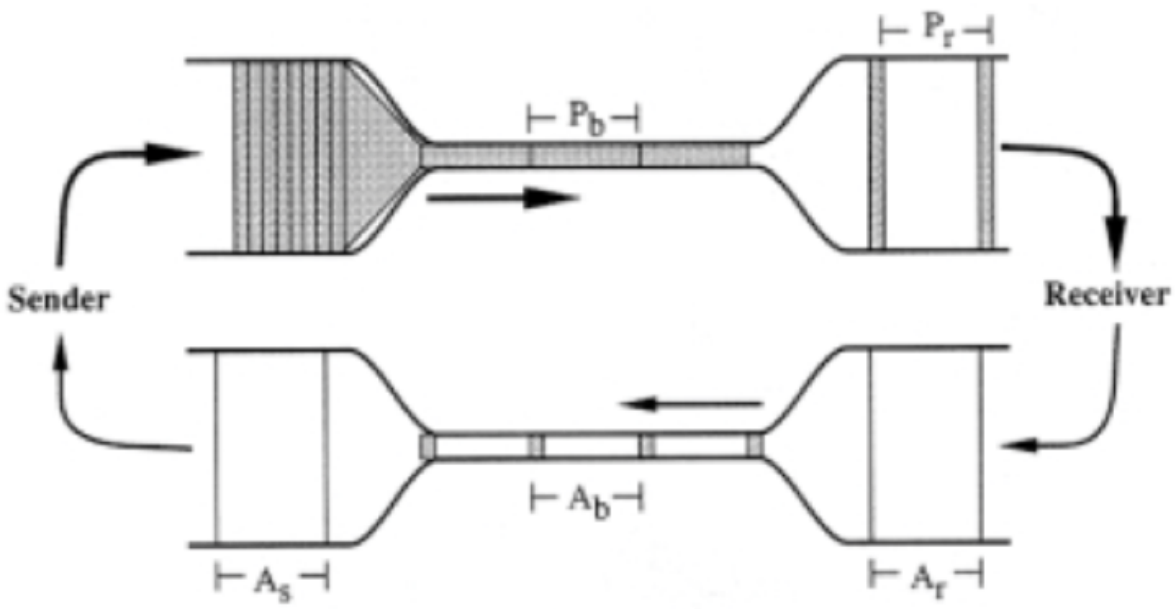
AS: An organization with its own unified routing policy.

ASN: A number used to identify that organization.

Solution: Hierarchy

12. Normally, NAT rewrites a packet's IP address, and UDP/TCP port numbers (it also modifies TTL and checksums to match). Describe one situation where, because of NAT, a value in the payload needs to be modified. (10 points)

For FTP / SIP and a few other protocols, the IP address is also specified in the payload. In such cases, NAT needs to go into the payload and fix-up the IP address



13. The picture above appears as Figure 1 in Congestion Avoidance and Control , by Van Jacobson (i.e. Jacobson88). Prove you did the reading by concisely describing the concept he was describing about a TCP connection. A totally correct answer could be 2 or 3 words. Note: You don't need to describe the details of the picture. (15 points)

"Self-clocking" or "Conservation of Packets" are both good answers. "Operation at Equilibrium" would be good as well.

14. List, in rough order, the operations performed on each IPv4 packet by a router in the network core. These operations are those described early in the course as "processing delay," so don't include reception, queueing or transmission. You could imagine this as pseudo-code for a router's operations on each packet. Another way to think about it is to think of the IP packet header fields and all the associated operations. (12 points)

Assume the packet has no options. You need not specify all the details for fragmenting, just list "fragment packet" as operation

Packet has been received

0) Verify version is 4. {this step not graded}

1) Verify checksum. [This must be first]

2) Decrement TTL, drop (and send ICMP) if zero

3) Recalculate checksum

4) Look up destination address in forwarding table, determine outgoing link

4a) if no route, return ICMP {this step not graded}

This step must be before #5, as MTU is a property of the outgoing link

5) if outgoing link MTU > HdrLen + Datagram Length,

if DF=1

drop packet (and emit ICMP error message)

(do not continue processing packet)

else

fragment packet

Place packet in Queue for transmission