Total: 111

Chap 7.

Problems

- P1(2pt). Imagine a scenario where a sender and receiver using CDMA (Section 7.2.1 from the text) are exchanging data. Assume both the sender and receiver use a CDMA code of size 8, where M = -1, 1, -1, -1, 1, 1, -1, -1.

1. **Given the CDMA code above and the bit d=-1, what is the encoded output? Separate each value with a comma and no spaces**
2. **Given the CDMA code above and the output string: -1,1,-1,-1,1,1,-1,-1, what is the decoded bit value?**

- P2(2pt). This time, assume there are 2 senders whom interfere with each other and that the interfering transmitted bit signals are additive. The value received at a receiver, however, is now the sum of the transmitted bits from all senders.

  Assume that sender 1 has a CDMA code of (1, -1, -1, 1, -1, -1, -1, 1) and sender 2 has a CDMA code of (-1, -1, -1, 1, -1, 1, 1, 1) and their combined output is: (0, 2, 2, -2, 2, 0, 0, -2)

1. **Assuming you are receiver 1, what is the decoded bit? If it can't be done, answer with 'n/a'**
2. **2. Assuming you are receiver 2, what is the decoded bit? If it can't be done, answer with 'n/a'**

- P3(5pt). Consider the scenario shown in 그림 1 , in which there are four wireless nodes, A, B, C, and D. The radio coverage of the four nodes is shown via the shaded ovals; all nodes share the same frequency.

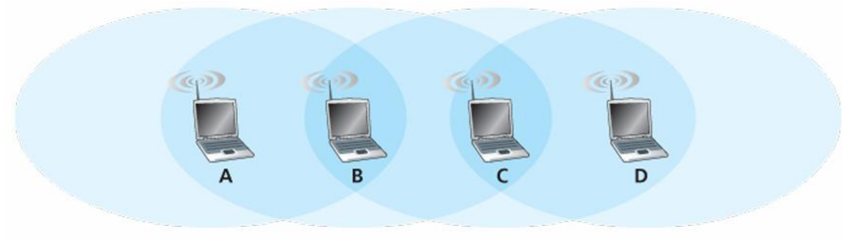


그림 1 Scenario for problem P3

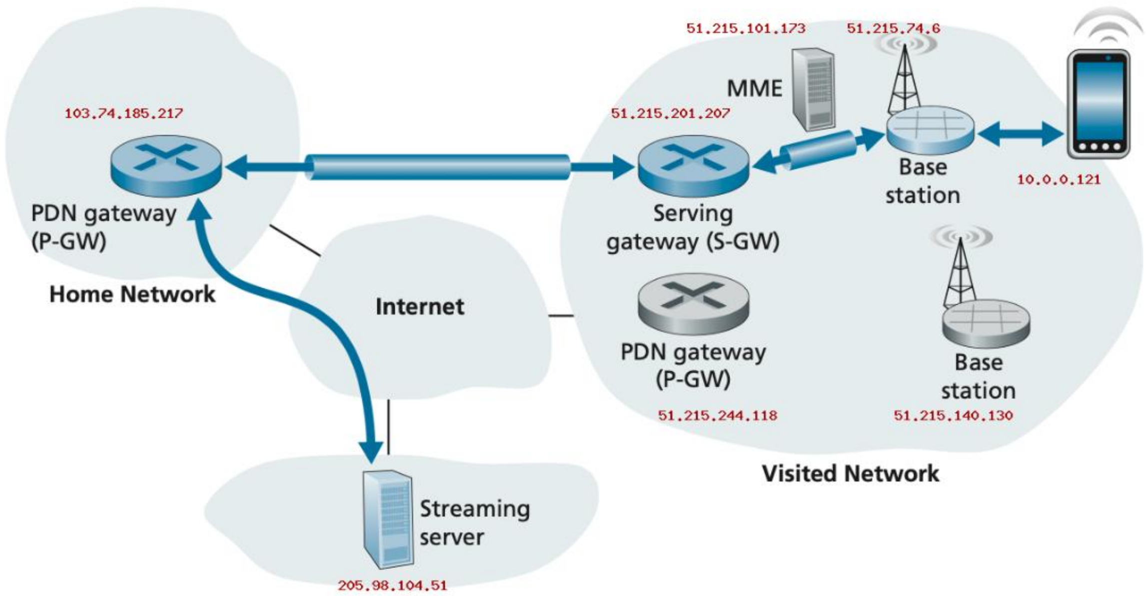
When A transmits, it can only be heard/received by B; when B transmits, both A and C can hear/receive from B; when C transmits, both B and D can hear/receive from C; when D transmits, only C can hear/receive from D.

Suppose now that each node has an infinite supply of messages that it wants to send to each of the other nodes. If a message's destination is not an immediate neighbor, then the message must be relayed. For example, if A wants to send to D, a message from A must first be sent to B, which then sends the message to C, which then sends the message to D. Time is slotted, with a message transmission time taking exactly one time slot, e.g., as in slotted Aloha. During a slot, a node can do one of the following: (i) send a message, (ii) receive a message (if exactly one message is being sent to it), (iii) remain silent. As always, if a node hears two or more simultaneous transmissions, a collision occurs and none of the transmitted messages are received successfully. You can assume here that there are no bit-level errors, and thus if exactly one message is sent, it will be received correctly by those within the transmission radius of the sender.

1. **Suppose now that an omniscient controller (i.e., a controller that knows the state of every node in the network) can command each node to do whatever it (the omniscient controller) wishes, i.e., to send a message, to receive a message, or to remain silent. Given this omniscient controller, what is the maximum rate at which a data message can be transferred from C to A, given that there are no other messages between any other source/destination pairs?**

2. **Suppose now that A sends messages to B, and D sends messages to C. What is the combined maximum rate at which data messages can flow from A to B and from D to C?**
3. **Suppose now that A sends messages to B, and C sends messages to D. What is the combined maximum rate at which data messages can flow from A to B and from C to D?**
4. **Suppose now that the wireless links are replaced by wired links. Repeat questions (1) through (3) again in this wired scenario.**
5. **Now suppose we are again in the wireless scenario, and that for every data message sent from source to destination, the destination will send an ACK message back to the source (e.g., as in TCP). Also suppose that each ACK message takes up one slot. Repeat questions (1)–(3) above for this scenario**

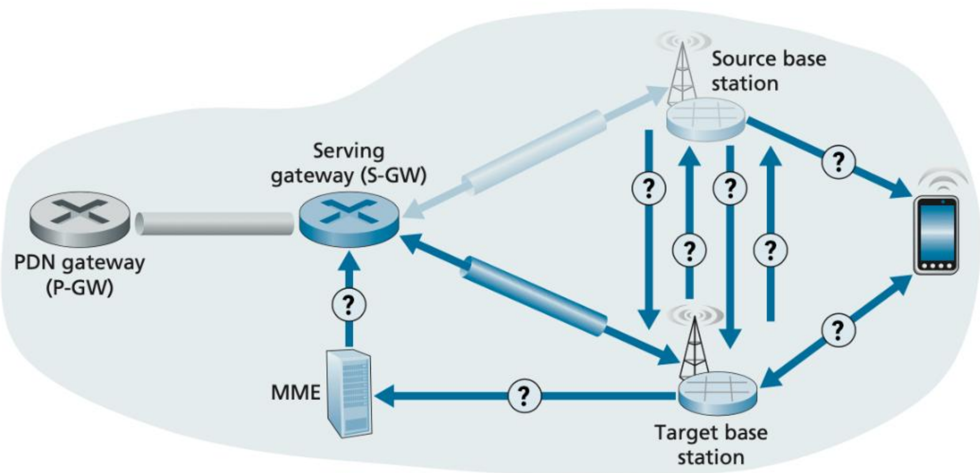
- P4(30pt). In the graphic below, a mobile phone has a TCP connection with the streaming server using wireless 4G. Assume that both the mobile phone and the server use TCP port 8678 and any intermediary nodes that tunnel the datagrams use port 10186.



1. **What is the source IP address of the datagram sent from the mobile phone to the base station?**
2. **What is the destination IP address of the datagram sent from the mobile phone to the base station?**
3. **What is the transport-layer port number in the datagram sent from the mobile phone to the base station?**
4. **What transport-layer protocol is indicated in the datagram sent from the mobile phone to the base station?**
5. **Is there an encapsulated datagram within the datagram sent from the mobile phone to the base station? Answer Yes or No**
6. **What is the source IP address of the datagram sent from the base station to the serving gateway?**
7. **What is the destination IP address of the datagram sent from the base station to the serving gateway?**
8. **What is the transport-layer port number in the datagram sent from the base station to the serving gateway?**
9. **What transport-layer protocol is indicated in the datagram sent from the base station to the serving gateway?**

10. **Is there an encapsulated datagram within the datagram sent from the base station to the serving gateway? Answer Yes or No**
11. **What is the source IP address of the encapsulated datagram?**
12. **What is the destination IP address of the encapsulated datagram?**
13. **What is the transport-layer port number in the encapsulated datagram?**
14. **What transport-layer protocol is indicated in the encapsulated datagram?**
15. **What is the source IP address of the datagram sent from the serving gateway to the PDN gateway?**
16. **What is the destination IP address of the datagram sent from the serving gateway to the PDN gateway?**
17. **What is the transport-layer port number in the datagram sent from the serving gateway to the PDN gateway?**
18. **What transport-layer protocol is indicated in the datagram sent from the serving gateway to the PDN gateway?**
19. **Is there an encapsulated datagram within the datagram sent from the serving gateway to the PDN gateway? Answer Yes or No**
20. **What is the source IP address of the encapsulated datagram?**
21. **What is the destination IP address of the encapsulated datagram?**
22. **What is the transport-layer port number in the encapsulated datagram?**
23. **What transport-layer protocol is indicated in the encapsulated datagram?**
24. **What is the source IP address of the datagram sent from the PDN gateway to the server?**
25. **What is the destination IP address of the datagram sent from the PDN gateway to the server?**
26. **What is the transport-layer port number in the datagram sent from the PDN gateway to the server?**
27. **What transport-layer protocol is indicated in the datagram sent from the PDN gateway to the server?**
28. **Is there an encapsulated datagram within the datagram sent from the PDN gateway to the server? Answer Yes or No**
29. **Is data encrypted between the mobile phone and the base station? Answer Yes or No**
30. **Does the server know about any of the wireless tunneling? Answer Yes or No**

- P5(7pt). Consider the scenario, where a mobile phone connected to a base station (source) is streaming a video from the internet, and the mobile phone is going to switch to a closer base station (target) without interrupting their video stream. This process (called a handover) is shown in the diagram below.



Take a look at the statements below and put them in the correct order.

A. The target base station checks whether it has the resources to support the mobile device and its quality of service requirements. If so, it pre-allocates channel resources (e.g., time slots) on its radio access network and other resources for that device. This pre-allocation of resources frees the mobile device from having to go through the time-consuming base-station association protocol discussed earlier, allowing handover to be executed as fast as possible. The target base station replies to the source base station with a Handover Request Acknowledge message, containing all the information at the target base station that the mobile device will need to associate with the new base station.

B. The source base station receives the Handover Request Acknowledgement message and informs the mobile device of the target base station's identity and channel access information. At this point, the mobile device can begin sending/receiving datagrams to/from the new target base station. From the mobile device's point of view, handover is now complete! However, there is still a bit of work to be done within the network.

C. At this point, the target base station can also begin delivering datagrams to the mobile device, including datagrams forwarded to the target base station by the source base station during handover, as well as datagrams newly arriving on the reconfigured tunnel from the Serving Gateway. It can also forward outgoing datagrams received from the mobile device into the tunnel to the Serving Gateway.

D. The target base station confirms back to the source base station that the tunnel has been reconfigured, allowing the source base station to release resources associated with that mobile device.

E. The current (source) base station selects the target base station, and sends a Handover Request message to the target base station.

F. The source base station will also stop forwarding datagrams to the mobile device and instead forward any tunneled datagrams it receives to the target base station, which will later forward these datagrams to the mobile device.

G. The target base station informs the MME that it (the target base station) will be the new base station servicing the mobile device. The MME, in turn, signals to the Serving Gateway and the target base station to reconfigure the Serving- Gateway-to-base-station tunnel to terminate at the target base station, rather than at the source base station.

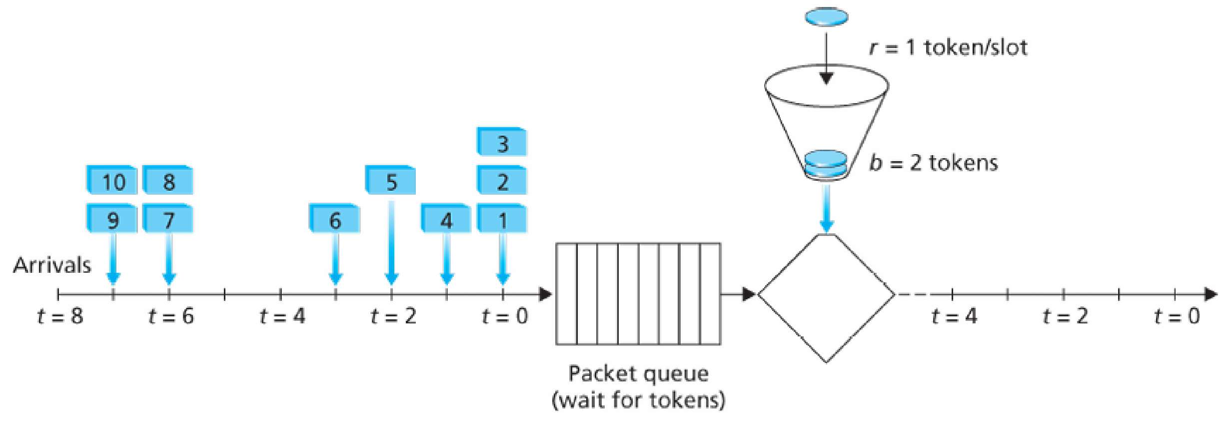
1. **Which lettered step (A-G) above corresponds to the first step in the handover process?**
2. **Which lettered step (A-G) above corresponds to the second step in the handover process?**
3. **Which lettered step (A-G) above corresponds to the third step in the handover process?**
4. **Which lettered step (A-G) above corresponds to the fourth step in the handover process?**
5. **Which lettered step (A-G) above corresponds to the fifth step in the handover process?**
6. **Which lettered step (A-G) above corresponds to the sixth step in the handover process?**
7. **Which lettered step (A-G) above corresponds to the seventh and final step in the handover process?**

Chap 9.

Problems

- P1(10pt). True or false:

1. **If stored video is streamed directly from a Web server to a media player, then the application is using TCP as the underlying transport protocol.**
2. **When using RTP, it is possible for a sender to change encoding in the middle of a session.**
3. **All applications that use RTP must use port 87.**
4. **If an RTP session has a separate audio and video stream for each sender, then the audio and video streams use the same SSRC.**
5. **In differentiated services, while per-hop behavior defines differences in performance among classes, it does not mandate any particular mechanism for achieving these performances.**



6. **Suppose Alice wants to establish an SIP session with Bob. In her INVITE message she includes the line: m=audio 48753 RTP/AVP 3 (AVP 3 denotes GSM audio). Alice has therefore indicated in this message that she wishes to send GSM audio.**
7. **Referring to the preceding statement, Alice has indicated in her INVITE message that she will send audio to port 48753.**
8. **SIP messages are typically sent between SIP entities using a default SIP port number.**
9. **In order to maintain registration, SIP clients must periodically send REGISTER messages.**
10. **SIP mandates that all SIP clients support G.711 audio encoding**

- P2(2pt). Consider the figure below, which shows a leaky bucket policer being fed by a stream of packets. The token buffer can hold at most two tokens, and is initially full at t=0. New tokens arrive at a rate of one token per slot. The output link speed is such that if two packets obtain tokens at the beginning of a time slot, they can both go to the output link in the same slot. The timing details of the system are as follows:
  A. Packets (if any) arrive at the beginning of the slot. Thus in the figure, packets 1, 2, and 3 arrive in slot 0. If there are already packets in the queue, then the arriving packets join the end of the queue. Packets proceed towards the front of the queue in a FIFO manner.
  B. After the arrivals have been added to the queue, if there are any queued packets, one or two of those packets (depending on the number of available tokens) will each remove a token from the token buffer and go to the output link during that slot. Thus, packets 1 and 2 each remove a token from the buffer (since there are initially two tokens) and go to the output link during slot 0.
  C. A new token is added to the token buffer if it is not full, since the token generation rate is r = 1 token/slot.
  D. Time then advances to the next time slot, and these steps repeat.

Answer the following questions:

1. **For each time slot, identify the packets that are in the queue and the number of tokens in the bucket, immediately after the arrivals have been processed (step 1 above) but before any of the packets have passed through the queue and removed a token. Thus, for the t=0 time slot in the example above, packets 1, 2, and 3 are in the queue, and there are two tokens in the buffer.**
2. **For each time slot indicate which packets appear on the output after the token(s) have been removed from the queue. Thus, for the t=0 time slot in the example above, packets 1 and 2 appear on the output link from the leaky buffer during slot 0.**

1.

Time Slot	Packets in the queue	Number of tokens in bucket
0		
1		
2		
3		
4		
5		
6		
7		
8		

2.

Time Slot	Packets in output buffer
0	
1	
2	
3	
4	
5	
6	
7	
8	

- P3(27pt). Repeat P2 but assume that r=2. Assume again that the bucket is initially full.

Time Slot	Packets in the queue	Number of tokens in bucket
0		
1		
2		
3		
4		
5		
6		
7		
8		

Time Slot	Packets in output buffer
0	
1	
2	
3	
4	
5	
6	
7	
8	

- P4(1pt). A packet flow is said to conform to a leaky bucket specification (r, b) with burst size b and average rate r if the number of packets that arrive to the leaky bucket is less than rt+b packets in every interval of time of length t for all t. Will a packet flow that conforms to a leaky bucket specification (r, b) ever have to wait at a leaky bucket policer with parameters r and b? **Justify your answer.** (Yes or No)