1 TCP Services

The Acknowledgement Number field in the TCP segment header is (implicitly or explicitly) associated with providing which of the following services offered by TCP? No explanation is required. Simply select one or more alternatives below. It may be possible to receive partial marks depending on your answer.

Select one or more alternatives:

- [ ] None of the services included in the options
- [ ] Congestion Control ✔
- [ ] Multiplexing/Demultiplexing
- [ ] Flow Control
- [x] Reliable In-order Byte Stream Delivery ✔

Maximum marks: 1

2 RDT

IMPORTANT: This question focuses on generic pipelined reliable delivery protocols (GBN and SR) and not specifically on TCP. Keep this in mind when providing your answers.

Assume that we are using 4 bit sequence numbers and the window size is 8. Assume that data only flows in one direction from a sender to a receiver. Supposed that the receiver has received all packets up to and including sequence number 10 and next receives packets with sequence numbers 9, 11 and 0, in that order.

(a) Assume that Go-Back-N is used. What are the sequence numbers in the ACK(s) sent out by the receiver in response to the above noted packets. Simply enter the answers in the space provided below. No explanation is necessary. 0.5 mark for each answer.

ACK sent in response to packet with sequence number 9 = 10 ✓

ACK sent in response to packet with sequence number 11 = 11 ✓

ACK sent in response to packet with sequence number 0 = 11 ✓

(b) Now assume that instead of Go-Back-N, Selective Repeat is used. What are the sequence numbers in the ACK(s) sent out by the receiver in response to the above noted packets. Simply enter the answers in the space provided below. No explanation is necessary. 0.5 mark for each answer.

ACK sent in response to packet with sequence number 9 = 10 ✗ (9)

ACK sent in response to packet with sequence number 11 = 11 ✓

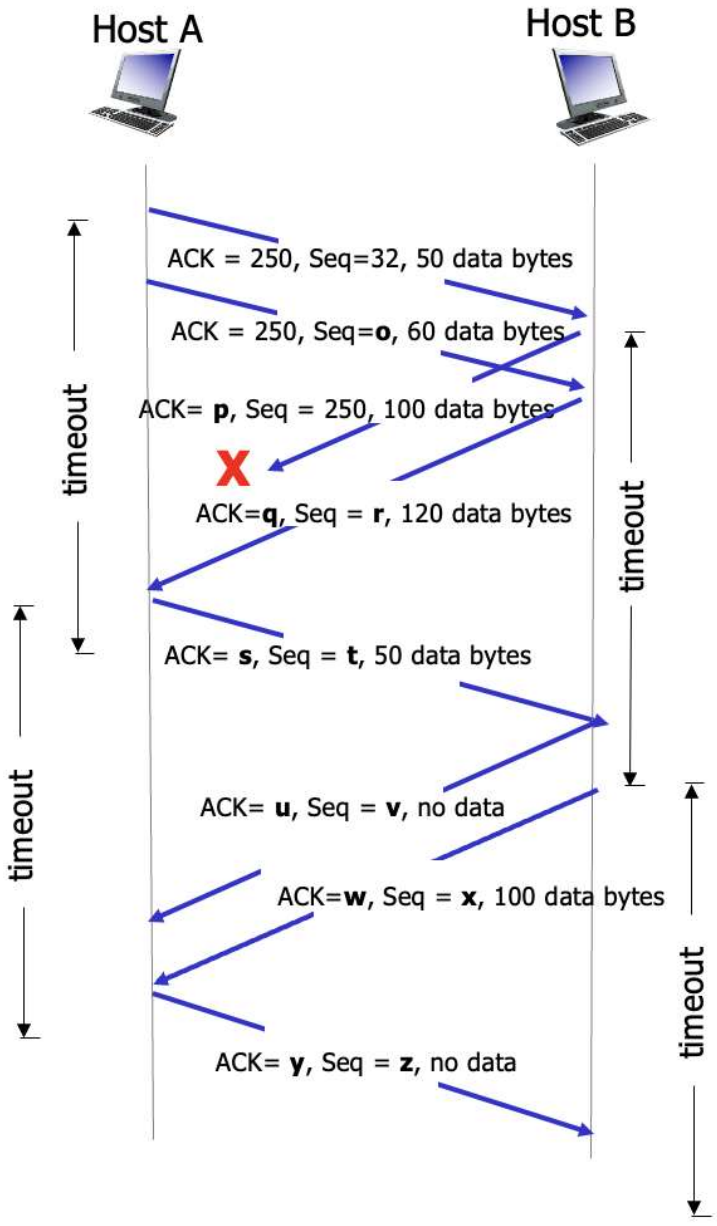
ACK sent in response to packet with sequence number 0 = 11 ✗ (0)

Maximum marks: 3

3 TCP Sequence Number

Consider the sequence of segments exchanged over a TCP Reno connection between Host A and Host B as depicted in the picture below. Assume that all segments sent prior to the sequence of segments shown below have been correctly received at both hosts. Neglect connection setup and teardown. A total of 8 segments are shown of which one segment sent from Host B (with sequence number 250) is lost. No other segments are lost. The relevant timeout periods are indicated for you to determine if any one of the segments may be a retransmission. In the event of a timeout, the oldest unacknowledged segment is immediately retransmitted. Disregard TCP congestion control.

Determine the values for the ACK and Sequence numbers which are depicted using letters o, p, q, r, ... z and enter these values in the spaces provided below. You do not have to provide an explanation. 0.33 mark for each correct value.



o= 82

p = 82

q = 142

r = 350 ✓

s = 250 ✓

t = 142 ✓

u = 192 ✓

v = 470 ✓

w = 192 ✗ (82)

x = 250 ✓

y = 470 ✓

z = 192 ✓

Maximum marks: 4

4 Consider the following traces which show the evolution of the TCP congestion window, represented as multiples of the Maximum Segment Size (MSS), over time from 5 different and unrelated TCP Reno connections.

Connection A: 1, 2, 4, 8, 16, 17, 18, 19
Connection B: 1, 2, 4, 8, 9, 10, 11, 12
Connection C: 1, 2, 4, 5, 6, 3, 4, 5
Connection D: 1, 2, 3, 4, 1, 2, 3, 4
Connection E: 1, 2, 4, 8, 16, 32, 1, 2

Answer the four questions in the right frame.

(a) TCP Congestion Control Q1

Which of the 5 connections are in congestion avoidance state at the end (i.e. end of the traces shown in the question)? You can select multiple options.

Select one or more alternatives:

- [ ] E
- [x] A ✓
- [x] C ✓
- [x] D ✓
- [x] B ✓
- [ ] None of the connections

Maximum marks: 1

(b) TCP Congestion Control Q2

Sort the connections in the order (from highest to lowest) of their initial slow start threshold (ssthresh) and indicate the sorted sequence in the space provided below. No explanation is required. Your answer should essentially be some combination of the letters ABCDE. Do not add commas or spaces between the letters.

EABCD

Note that for some connections, it is possible to determine the precise value of the initial ssthresh, whereas for others it is not. However, there is enough information available for you to answer this question.

Maximum marks: 1

(c) TCP Congestion Control Q3

Which of the 5 connections experienced a packet loss as detected by the reception of 3 duplicate acknowledgement packets? You can select multiple options.

Select one or more alternatives:

- [ ] A
- [ ] D
- [ ] None of the connections
- [ ] B
- [ ] E
- [x] C

Maximum marks: 1

(d) TCP Congestion Control Q4

Which of the 5 connections experienced a packet loss as detected by the expiration of the retransmission timer (i.e. a timeout)? You can select multiple options.

Select one or more alternatives:

- [ ] None of the connections
- [ ] A
- [x] D ✓
- [x] E ✓
- [ ] C
- [ ] B

Maximum marks: 1

5 IP Address Aggregation

Assume that an ISP has 4 subscribers which have been allocated the following IP address blocks:

61.44.180.0/24
61.44.181.0/24
61.44.182.0/24
61.44.183.0/24

The ISP would like to aggregate the above blocks into a single address block and advertise this block for the purpose of routing. The advertised IP address block should not contain IP addresses that do not belong to the above 4 blocks of addresses.

Note down the advertised IP address block in the space provided below in the a.b.c.d/x format. No explanation is required.

61.44.180.0/22 ✓

Maximum marks: 1.5

6 Prefix Match

Consider a router with the following forwarding table.

Destination	Interface
128.8.16.0/20	Port 1
128.8.24.0/21	Port 2
128.8.128.0/24	Port 3
128.8.128.0/28	Port 4
Default	Port 5

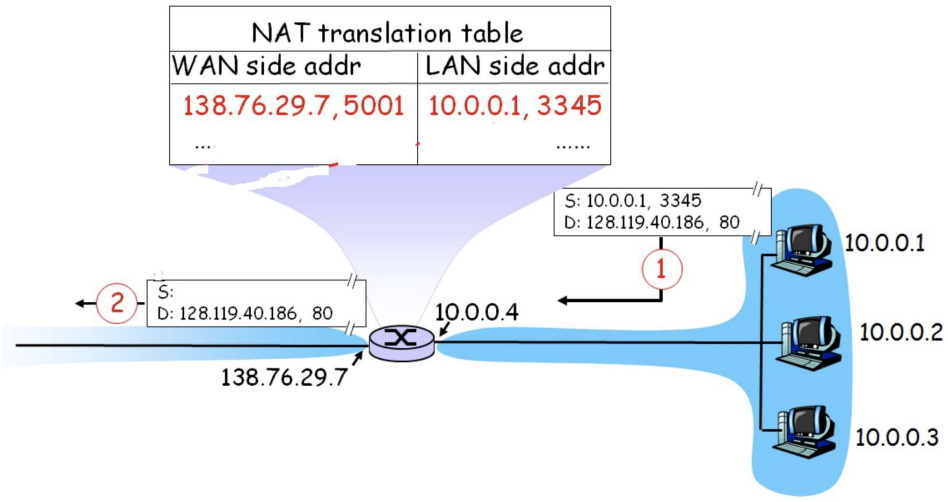
Which interface would an IP datagram with destination address 128.8.128.7 be forwarded to?
Select one alternative:

- Port 2
- Port 4 ✓
- Port 1
- Port 5
- Port 3

Maximum marks: 1

7 NAT

The figure below shows a network with a NAT router. In step 1, host 10.0.0.1 sends a datagram from its port 3345 to a destination host 128.119.40.186's port 80 (not shown in the figure). The router will modify certain header fields after examining the NAT translation table shown in the figure. In step 2, the destination IP address and port number of the outgoing datagram are provided. What are the source IP address and port number within this datagram?



Source IP address (in a.b.c.d format): 138.76.29.7

Source port number: 5001

Maximum marks: 1

8 Fragmentation

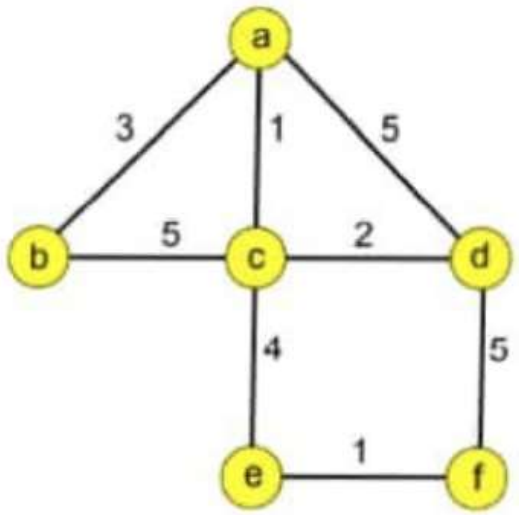
An IP datagram which is itself a fragment (of a larger datagram) is of size 1080 bytes (inclusive of the IP header) and has an offset field of 70. It arrives at a router which has to forward it on an outgoing link with MTU of 780 bytes, and thus needs to create two fragments. What are the offset fields of these two fragments (fill in the values in the provided spaces)? Assume that IP headers are always 20 bytes (i.e. no options are used).

Offset for first fragment: 70

Offset for second fragment: 165

Maximum marks: 1.5

9 Consider the 6-node network shown in the figure below with link costs as shown. Note that each link shown in this network is bidirectional and has the same cost in either direction.



Answer the two questions in the right frame.

(a) LSR Dijkstra

Execute Dijkstra's algorithm at Node **b** to determine the shortest path from Node **b** to every other node in the network. You will have to draw an appropriately sized table using the table option in the menu at the top of the text area below (similar to the one shown in the lecture notes on Dijkstra's algorithm). You are required to show all steps.

Note: There is an option to draw a table in the menu bar at the top in the answer window below.

Fill in your answer here

Step	N'	D(a)P(a)	D(c)P(c)	D(d)P(d)	D(e)P(e)	D(f)P(f)
0	a	3,a	5,b			
1	ab		4,a	8,a		
2	abc			6,c	8,c	
3	abcd				8,c	11,d
4	abcde					9,e
5	abcdef					

Maximum marks: 2.5

(b) LSR Forwarding Table

Based on the execution of the Dijkstra's algorithm in the above question, draw the forwarding table for node **b**, which contains the outgoing link for reaching every other node in the network. A link between two nodes x and y should be denoted as (x, y).

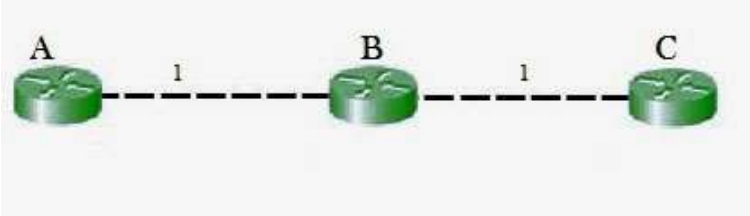
Fill in your answer here

a	(b,a)
c	(b,a)
d	(b,a)
e	(b,a)
f	(b,a)

Maximum marks: 1

10 Distance Vector MCQ

Consider the following network comprised of 3 routers. The link costs of both links are 1 as shown and do not change. Assume that the network uses Distance Vector routing protocol with Poisoned Reverse enabled. In the final distance vector update sent by router B to router A, (i.e. just before it achieves convergence), what is the cost to router C advertised by router B?



Select one alternative:

- infinity ✗
- none of the provided choices
- 2
- 1 ✓
- 3

Maximum marks: 1

11 Ethernet Back-off

Consider an Ethernet host that is on a shared network where CSMA/CD is enabled. This host has a frame to transmit but encounters 3 successive (i.e. back-to-back) collisions when it tries to transmit the frame as per the CSMA/CD protocol. Which of the following is an **invalid** sequence of values of K that this host may have chosen while executing the exponential backoff algorithm employed by the Ethernet CSMA/CD protocol after each collision. The choices are a sequence of 3 numbers that denote potential K values chosen after each of the 3 collisions.

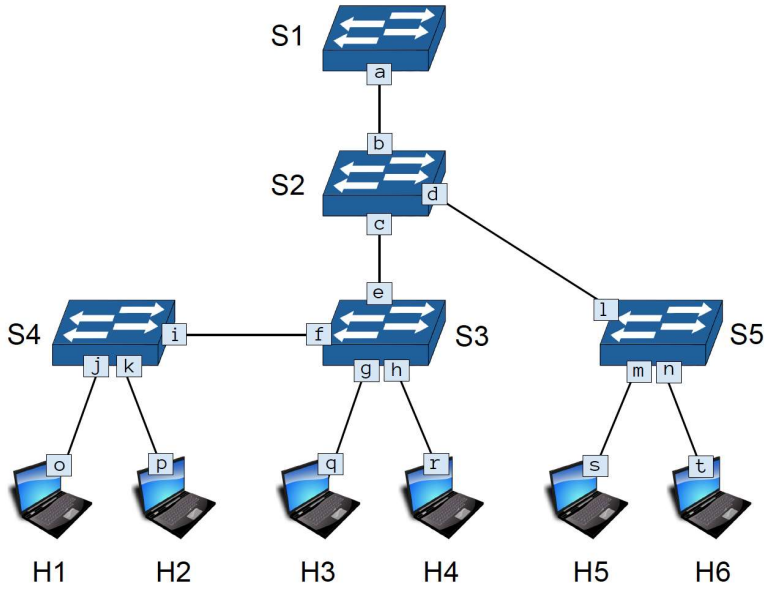
Select one alternative:

- 1, 0, 6
- 1, 1, 1
- 1, 2, 0
- 1, 2, 8 ✔
- 1, 3, 7 ✖

Maximum marks: 1.5

12 Ethernet Switches

Consider the network in the figure below. The switch tables of all the switches are initially empty. Any switch table entries created for any of the interactions described below remain till the end of the questions. There is no other traffic on the network other than what is explicitly stated in the questions. Each question is worth 1 mark.



Host H6 sends Ethernet frame f1 to host H2. Frame f1 has source MAC address *t* and destination MAC address *p*. Answer the two questions below.

1) Which hosts other than H2 will receive frame f1?

Select one or more alternatives:

- [x] H3
- [x] H1
- [x] H4
- [x] H5
- [ ] none of the other hosts

2) Which switches will receive frame f1?

Select one or more alternatives

- [x] S3
- [x] S4
- [x] S5
- [x] S2
- [x] S1

Immediately after this, Host H4 sends Ethernet frame f2 to host H6. Frame f2 has source MAC address *r* and destination MAC address *t*. Answer the two questions below.

3) Which hosts other than H4 will receive frame f2?

Select one or more alternatives

- [x] None of the other hosts
- [ ] H3
- [ ] H2
- [ ] H1
- [ ] H5

4) Which switches will receive frame f2?

Select one or more alternatives

- [x] S2
- [x] S5
- [x] S3
- [ ] S1
- [ ] S4

Immediately after this, Host H2 sends Ethernet frame f3 to host H4. Frame f3 has source MAC address *p* and destination MAC address *r*. Answer the two questions below.

5) Which hosts other than H4 will receive frame f3?

Select one or more alternatives

- [ ] None of the other hosts
- [ ] H5
- [ ] H3
- [ ] H6
- [x] H1

6) Which switches receive frame f3?

Select one or more alternatives

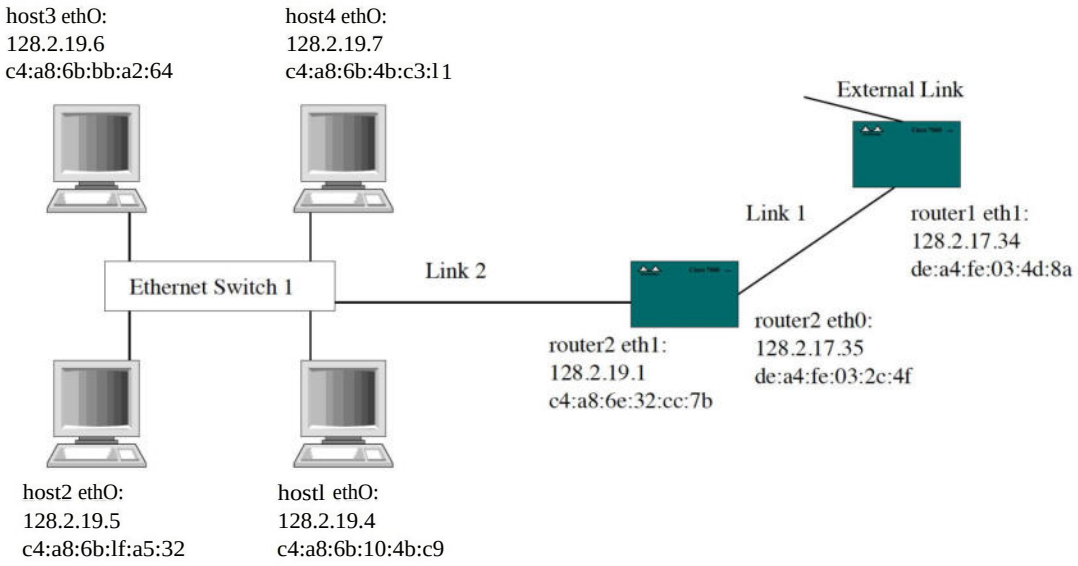
- [ ] S5
- [ ] S2
- [ ] S1
- [x] S3
- [x] S4

Maximum marks: 6

13 in the partial network topology shown above, a well-formed IP datagram with a destination IP of 128.2.19.5 and TTL of 8 arrives at routeri via the external link. Assume that the forwarding tables in the two routers are configured correctly to ensure that this datagram is delivered correctly to the destination host.

The illustrated network comprises two subnets. Link 1 is one subnet with the address block 128.2.17.34/31. The second subnet is made up of the Ethernet switch, link 2 and the 4 hosts and has the address block 128.2.19.0/25.

Both subnets use Ethernet as the link layer. The MAC and IP addresses of the host and router interfaces are shown.



Answer the three questions in the right frame.

(a) Network/Link Layer Q1

What is the subnet mask of ethO on hostI? Simply enter your answer in the a.b.c.d format in the space provided below.

255.255.255.0 Q (255.255.255.128., 255.255.255.128)

Maximum marks: 0.5

目标MAC地址是“FF.FF.FF.FF.FF.FF”，这表示向同一网段内的所有主机发出这样的询问：“128.2.19.5的MAC地址是什么？”网络上其他主机并不响应ARP询问，只有主机B接收到这个帧时，才向主机A做出这样的回应：“128.2.19.5的MAC地址是00-aa-00-62-c6-09”。这样，主机A就知道了主机B的MAC地址，它就可以向主机B发送信息了。

(b) Network/Link Layer Q2

Assume that the datagram mentioned in the question with destination IP address 128.2.19.5 is the first packet to be forwarded on this partial network and that the ARP tables on all interfaces are empty. Consequently, ARP requests will be sent out on both Link1 and Link2 to facilitate forwarding this datagram. Remember that an ARP query is encapsulated in a link layer frame. Fill in the answers below with regards to these ARP queries. No explanation is required.

The source MAC address of the Ethernet frame containing the ARP query sent on link 1 =

de:a4:fe:03:4d:8a ✓

The destination MAC address of the Ethernet frame containing the ARP query sent on link 1 =

de:a4:fe:03:2c:4f ✗ (ff:ff:ff:ff:ff:ff)

The ARP query sent on link 1 is requesting the MAC address that corresponds to the following IP address = 128.2.19.5 ✗ (128.2.17.35, 128.2.17.35.)

The source MAC address of the Ethernet frame containing the ARP query sent on link 2 =

c4:a8:6e:32:cc:7b ✓

The destination MAC address of the Ethernet frame containing the ARP query sent on link 2 =

c4:a8:6b:1f:a5:32 ✗ (ff:ff:ff:ff:ff:ff)

The ARP query sent on link 2 is requesting the MAC address that corresponds to the following IP address = 128.2.19.5 ✓

Maximum marks: 2

目标MAC地址是“FF.FF.FF.FF.FF.FF”，这表示向同一网段内的所有主机发出这样的询问：“128.2.19.5的MAC地址是什么？”网络上其他主机并不响应ARP询问，只有主机B接收到这个帧时，才向主机A做出这样的回应：“128.2.19.5的MAC地址是00-aa-00-62-c6-09”。这样，主机A就知道了主机B的MAC地址，它就可以向主机B发送信息了。

(c) Network/Link Layer Q3

Let us refer to the Ethernet frame which encapsulates the IP datagram noted in the question that arrives at eth0 of Router 2 as *packet 1*. Let us refer to the Ethernet frame which encapsulates this IP datagram as it is forwarded on eth1 of Router 2 as *packet 2*.

Which of the following IP and Ethernet header fields will be different when you compare *packet 1* with *packet 2*?

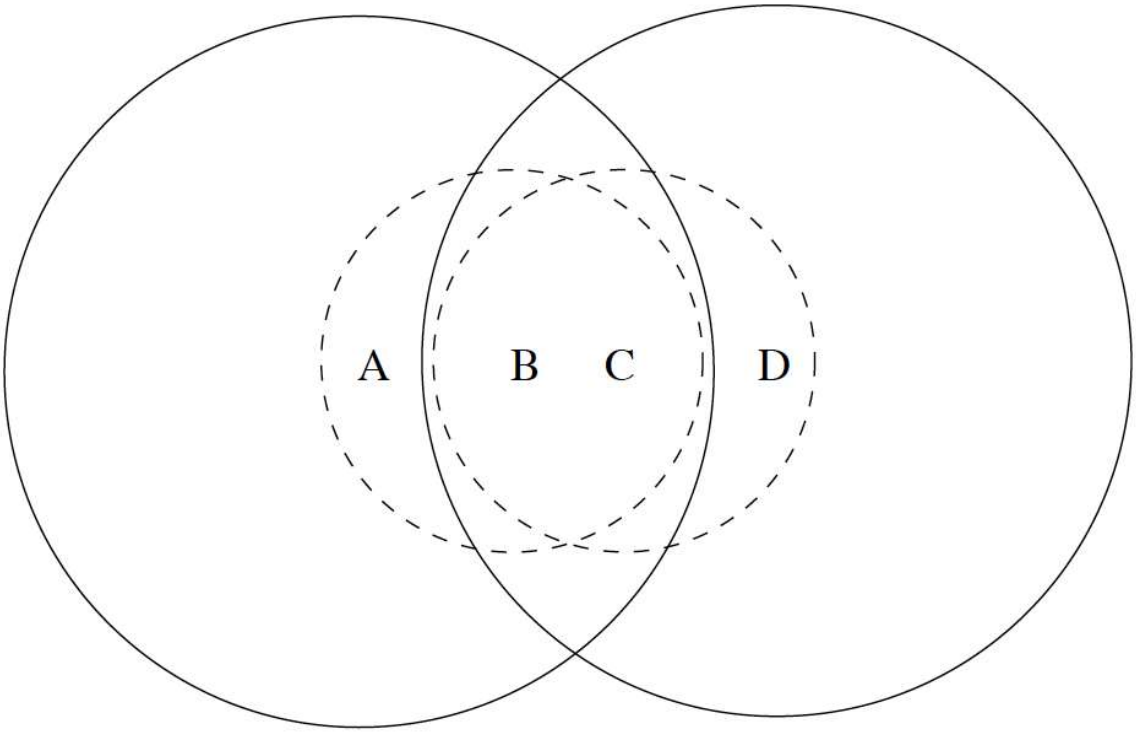
Select one or more alternatives:

- [x] Destination MAC address (Ethernet header)
- [ ] Identification (IP header)
- [ ] TTL (IP header)
- [x] Source MAC address (Ethernet header)
- [ ] Protocol (IP header)
- [ ] Checksum (IP header)
- [ ] IP destination address (IP header)
- [ ] Type (Ethernet header)
- [ ] IP source address (IP header)
- [x] CRC (Ethernet header)

Maximum marks: 2

14 WiFi

Consider the wireless topology shown below, comprised of 4 nodes which are all currently active. The solid circles represent the transmission radius of nodes A and D, respectively, and the dashed circles represent the transmission range of B and C, respectively. As illustrated, the transmission range of A and D is greater than that of B and C. Assume that the transmissions of two nodes' will interfere at a receiver if and only if they transmit at the same time and their transmission areas overlap. In these questions, assume that losses only occur due to collisions.



Answer the following questions. Answers without proper explanations will not receive marks.

(1) When node A transmits to node B, list the potential hidden nodes from A (in either direction, i.e. those who might interfere with A's transmission or those who A's transmission might interfere with)? Explain your answer. (1.5 marks)

(2) Assume that all nodes are using the 802.11 MAC protocol with RTS/CTS enabled. Assume that C is currently transmitting to D and has reserved the channel as per the RTS/CTS protocol. Assume that node A wishes to transmit to node B while C is transmitting to D. Is this possible? Explain why or why not? (1.5 marks)

Fill in your answer here

(1) When the node A trainsmit to node B, from the graph above can get that node D which cannot receive transmission from node A, which means node D is out of the transmission range of node A. And node B, C are fall in the transmission range of node A. Hence D is the hidden nodes from A.

(2) It is not possible for node A transmit to node B while C is transmitting to node D. When C is transmitting to node D, as the graph shows, A would be the potential hidden nodes while transmitting. Then node B would get RTS/CTS from node C, D. And node B will not send an CTS to node A because of node B has already known that the node C is transmitting to node D.

Maximum marks: 3

15 Security

Ayda wants to transmit the assignment marks from her home computer to Salil at UNSW. She is worried that an enterprising COMP3331/9331 student may have hacked a router along the path and might modify the message to improve their mark. So when Ayda sends a message M to Salil, she also calculates H = Hash(M) and appends H to the message. Salil receives M and H, and calculates H' = Hash(M), only accepting the message as valid if H' = H. You can assume that Hash is a well-known secure hash function that is one-way and collision resistant.

Could an enterprising COMP3331/9331 succeed in changing their mark? If yes, then explain how the attack can be launched. If not, then explain how the approach mentioned above is secure. If the attack is possible, also propose a modification to the way marks are transmitted between Ayda and Salil that would prevent the attack and ensure message integrity in a more general sense.

Fill in your answer here

This method can't prevent cracking. Because everyone knows the hash function, the attacker can modify the information and generate the corresponding hash value by using the public hash function. You can make the hash function private or use other encryption algorithms with private properties.

Maximum marks: 2.5

16 Security MCQ

Salil has put up his public key on his webpage. He has included a certificate from a certification authority called VeriSign. You wish to download his public key and confirm that it indeed belongs to him. For this verification, you will need to use the following key on the certificate:

Select one alternative:

- Salil's private key
- Your public key
- Verisign's private key ✗
- Your private key
- Versign's public key ✓

Maximum marks: 1