Student Number

THE UNIVERSITY OF MELBOURNE

DEPARTMENT OF COMPUTING AND INFORMATION SYSTEMS

Examination – Semester 2, 2017

COMP90007 Internet Technologies

Exam Duration: 3 hours
Reading Time: 15 minutes

Total marks for this Exam: 60

Length: This paper has 41 pages including this cover page.

Authorized materials: Writing materials (e.g. pens, pencils). Calculators and all other books are not allowed.

The exam paper must remain in the exam room and be returned to the subject coordinator.

Instructions to Students:

- This paper contains 20 questions; each question is worth 3 marks.
- Answer questions in this exam booklet using pen only in the space provided after the questions. All even pages are intentionally left blank, which you can use for rough work. Note that only your answers within the given space on odd numbered pages will be marked.
- As a guide, two or three sentences should be sufficient to answer each question. Marks may be deducted for overly long answers or irrelevant information.
- Bullet points are acceptable in answering descriptive questions.
- *Any unreadable answers will be considered wrong*.

1	2	3	4	5	6	7	8	9	10

Q1. The performance of a network application is influenced by two major network characteristics: the bandwidth of the network (number of bits per second that the network can transport) and the latency (the delay experienced by each bit transported).

Give:
a. an example of a network that exhibits high bandwidth as well as high latency. [1 mark]

Transcontinental optic fiber link

b. an example of a network that exhibits low bandwidth as well as low latency. [1 mark]

Telephone modem

c. an example of a network that exhibits high bandwidth as well as low latency. [1 mark]

FTTH - Fiber to the Home

Q2. Consider the layered model for networks in Fig Q2.

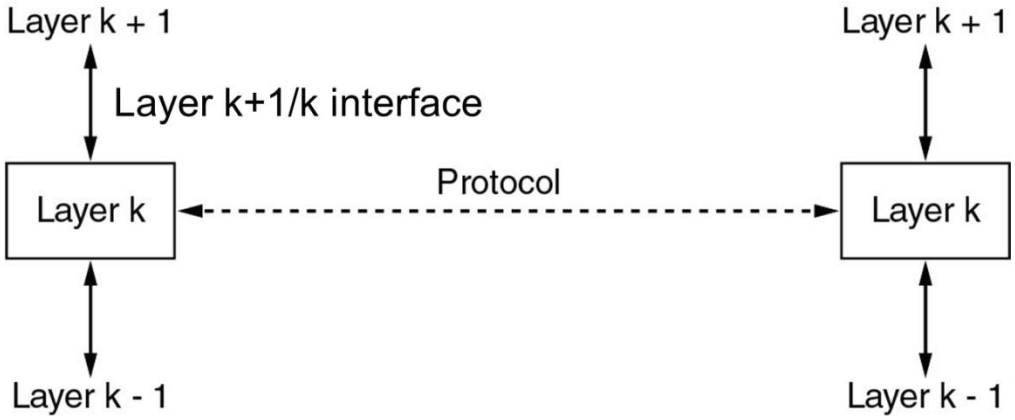


Fig Q2.

a. Briefly explain the difference between a protocol and a service in a layered protocol hierarchy. [1 mark]

Protocol is a set of rules within same layer and services are what the lower layers provide to the upper layer

b. Suppose the algorithms used to implement the operations at layer k are changed. How do these impact operations at layers k-1 and k+1? [1 mark]

If the algorithm is changed it won't affect k-1 or k+1 as it was the aim of layered model that provides more flexibility when layers are changed

c. Suppose there is a change in the set of operations provided by layer k. How do these impact operations at layers k-1 and k+1? [1 mark]

If the operations provided by layer k is changed then it will affect layer k+1 as the service provided will be different

Q3. Consider a television signal that is bandwidth limited to 2 MHz.

a. What is the minimum sampling rate such that the signal can be completely reconstructed? [1 mark]

Nyquist Theory 2B = 4 MHz=4M sample/s

b. If each sample of the signal is to be encoded using 1024 levels, how many bits/symbol are required for each sample? [1 mark]

Log2(1024)=10bit/sample

c. What is the minimum bit rate required to transmit this signal? [1 mark]

4000000 * 10

millisecond = 10^-3 s

microseconds = 10^-6 s

Q4. Frames of 1000 bits are sent over a 4-Mbps communication channel which has a propagation delay of 500 microseconds. Channel utilization is normally calculated by dividing the time to transmit a frame by the total time required for a successful transfer.

a. What is the maximum channel utilization for the stop-and-wait protocol? [2 marks]

Utilization efficiency = transmission delay /(transmission delay + propagation delay)
=(1000 bits / 4000000 bps) / (1/4000 + 2*500*10^-6)

b. What is the effect of decreasing the bandwidth on channel utilization in the above protocol? [1 mark]

The utilization efficiency will increase as the bandwidth decreases.

U=Tf /(Tf +2Tp+Ta)= (L/B)/(L/B+2Tp)=L/(L+2Tp*B)

Q5. Consider a 2-Mbps satellite communication link established between a station in The University of Melbourne and a station in Stanford University through a geo-stationary satellite having equal distance of 12,000 Km to the two stations.

a. Find the propagation delay between the end points of the communication link assuming that the signals travel at the speed of light, given by 3 x10^8 meters per second. [1.5 marks]

2*12000*10^3m/3*10^8=80ms

b. What is the round trip bandwidth delay product of the link? [1.5 marks]

2*10^6 bits/s*8*10^-2s=1.6*10^5bits

Q6. On the topic of error detection and correction:

a. Given the following 4 codewords of 8 bits (number of data bits=2, number of parity bits=6),

00000000;
00001111;
11110000;
11111111;

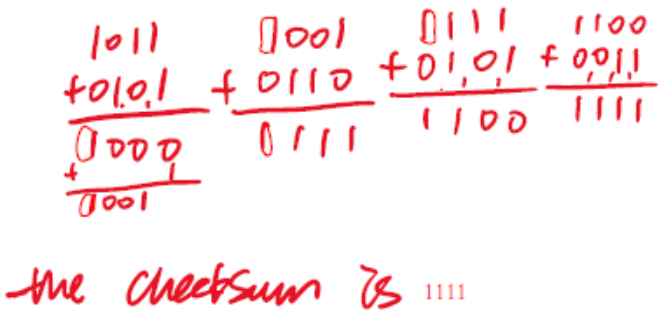
What is the Hamming distance of this code? [1 mark]

4

b. How many bit errors can this code correct? How many can it detect? [2 marks]

3 errors can be detected 1
error can be corrected

Q7. Suppose that a message 00110 10101 10010 11011 is transmitted using Checksum (4-bit word). What is the value of the checksum? [3 marks]



add from lowest four bits to highest four bits

Q8. Considering sliding window protocols in Data Link layer:
a. Briefly explain the main differences between Go-Back-N and Selective Repeat when dealing with a missing frame. [2 marks]

1. Go Back N discard all the frames after the bad frame while Selective will buffer the good frames after the bad frame.

2. Go Back N start to retransmit frame until timeout while the Selective will retransmit the frame once receive NAK signal. If the NAK is missing, the selective will still waiting for the time out.

b. Which of the protocols Go-Back-N or Selective Repeat requires increased buffer space at the receiver compared to the other? [1 mark]

selective

Q9. Briefly explain how the Binary Countdown Protocol works and describe the relative advantages over the Bit Map Protocol. [3 marks]

In the contention period stations transmit their addresses bit by bit starting fromthe most significant bit. The bits from all stations are ORed in the channel.At any point of time, if a station with “0” bit in its address detects “1” in thechannel, it backs out. Others continue to transmit. Only the channel that doesnot see any conflict with its address will win the right to send its frame at the endof the contention period.

Less overhead.

Q10. a. What is the main reason for packet fragmentation in routers? Provide one advantage of non-transparent fragmentation compared to transparent fragmentation. [1.5 marks]

Different routers have different maximum size of packet. Fragmentation (division of packets into fragments) allows network to meet size constraints.

Non-transparent: the packet will not be reassembled until it reaches the destination, so it is efficient.
transparent: the packet will be reassembled in the intermediate router and then be fragmented again, less efficient.

b. What fields in the IPv4 packet header are needed in IP fragmentation for the destination host to resemble fragmented packets? [1.5 marks]

id; DF; MF; offset

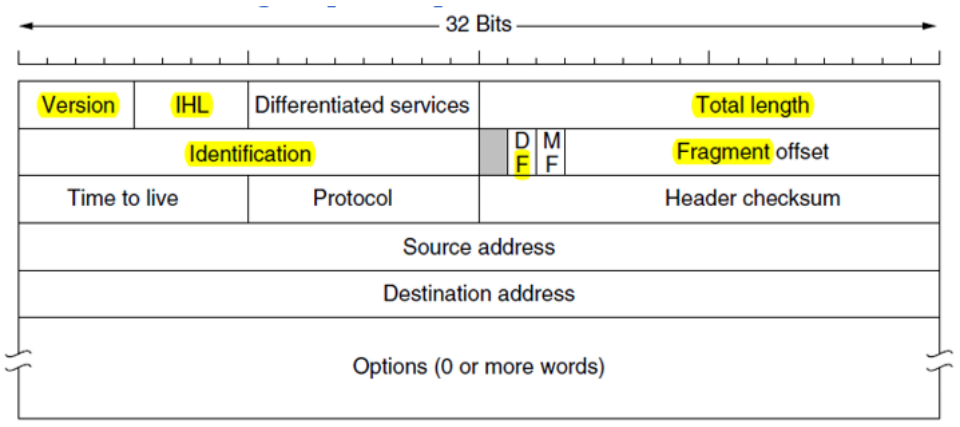


Figure 5-46. The IPv4 (Internet Protocol) header.

Q11. A large number of consecutive IP addresses are available starting at 212.40.0.0/18. Suppose that 3 organisations: A, B, and C request 2000, 500, 2000 addresses respectively, and in that order (A gets the smallest IP values in the range then B and C). For each of these, give the first IP address assigned, the last IP address assigned, and the mask in the w.x.y.z/s notation [3 marks]

Note:

Binary base 2	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}
Decimal	2048	1024	512	256	128	64	32	16	8	4	2	1

2000 ≈ 2^{11}

212.40.00000000.00000000

212.40.00000111.11111111 → 212.40.7.255

A: 212.40.0.0 /21

500 ≈ 2^{9}

212.40.00001000.00000000 → 212.40.8.0

212.40.00001001.11111111 → 212.40.9.255

B: 212.40.8.0/23

2000 ≈ 2^{11}

212.40.00010000.00000000 → 212.40.16.0

212.40.00010111.11111111 → 212.40.23.255

C: 212.40.16.0 /21

Q12. On the topic of routing protocols: [3 marks]

a. Briefly explain the algorithm used in link state routing (LSR) protocol. [2 marks]

1. . Discover its neighbors and learn their network addresse
2. . compute distance or cost to each neighbor
3. . Construct a packet telling all it has just learnted
4. . Send this packet to and receive packets from all other router
5. . Compute the shortest path to every other route

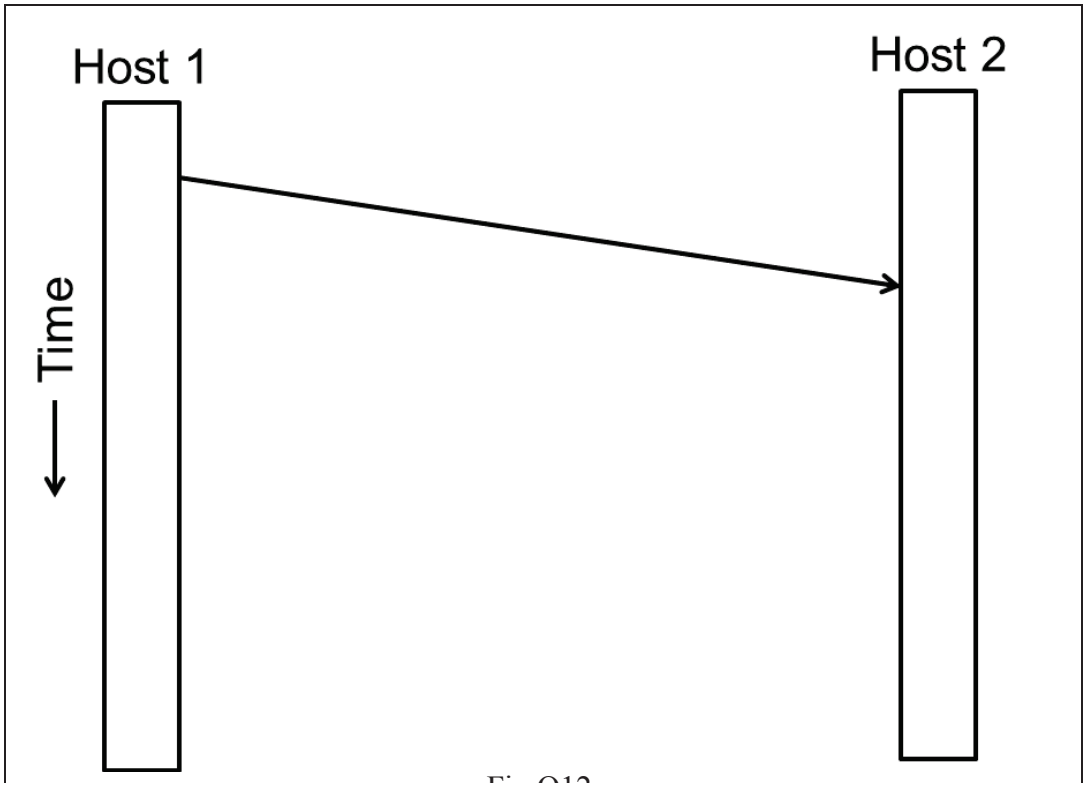
every node runs the algorithm to calculate the shortest path to other nodes.

c. Describe one of the key differences between distance vector routing and LSR. [1 mark]

Dis: global information shared locally;
LSR: local information shared globally.

Q13. Consider connection establishment and release in the transport layer, [3 marks]

a. List the steps in a successful 3-way handshake for connection establishment (assuming no error in transmission) by completing Fig. Q12. [1 mark]



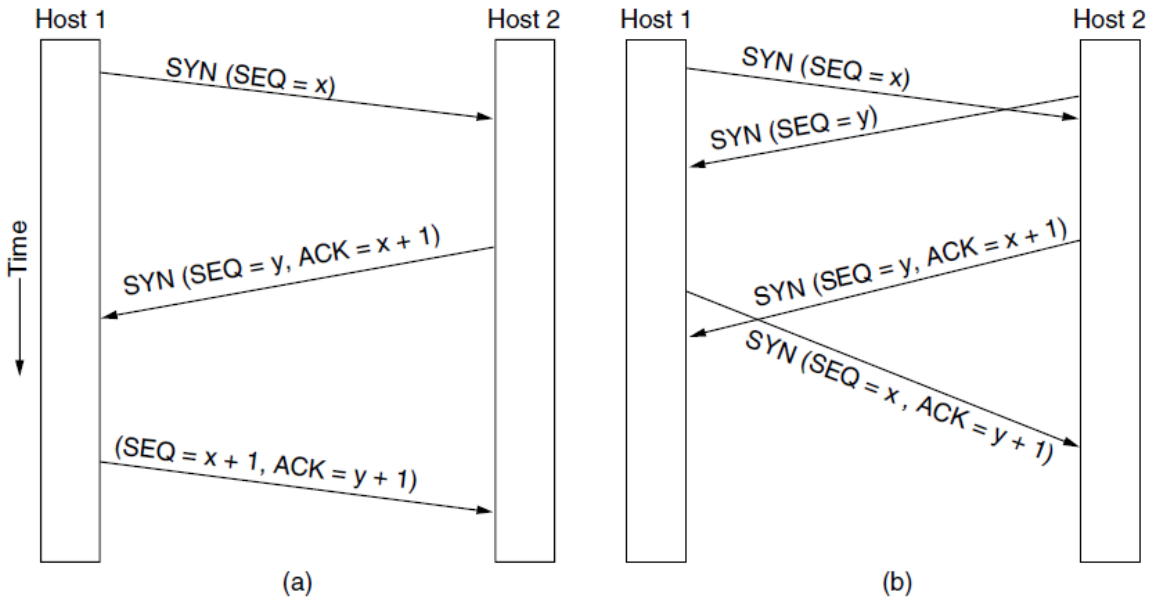


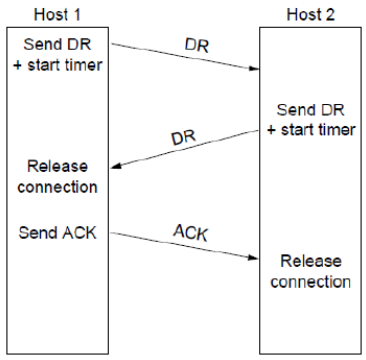
Figure 6-37. (a) TCP connection establishment in the normal case. (b) Simultaneous connection establishment on both sides.

b. Compare the symmetric and asymmetric connection release. [1 mark]

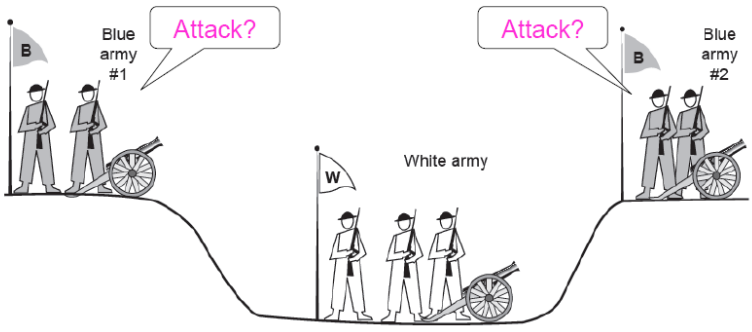
sym: disconnect both ends
asym: disconnect one ends

c. How does TCP deal with two Army problem in connection release? [1 mark]

- 3 way handshake
- Finite retry
- Timeouts
- Normal release sequence, initiated by transport user on Host 1
  - DR=Disconnect Request
  - Both DRs are ACKed by the other side



- How to we decide the importance of the last message? Is it essential or not?
- No protocol exists which can resolve this ambiguity- Two-army problem shows pitfall of agreement



Q14. a. Explain why it is necessary to have both the Transport layer and the Network layer for end-to-end connectivity. [1.5 Mark]

Transport layer to provide reliable service based on unreliable connection(TCP protocol), also it provides congestion and flow control. Network layer provides network path for packets through routers.

b. Explain why it is necessary to have both the Transport layer and the Network layer in the case of a host running multiple application processes at the same time. [1.5 Mark]

During the process, both IP address(provided by Network) and port number(provided by Transport) are needed.

Q15. a. Considering the transport layer, network layer and datalink layer, what is the difference between congestion control and flow control? [1 mark]

congestion control is to control the traffic of data going from sender to the receiver.
flow control controls the traffic of the data entering the network, avoid receivers being flooded with data from the sender

b. Considering the slow-start method in the transport layer, where the sender *starts* with *one segment*, indicate the maximum number of unacknowledged segments that the sender can have in the network after receiving 4 ACKs (Assume there is no packet loss). [1 mark]

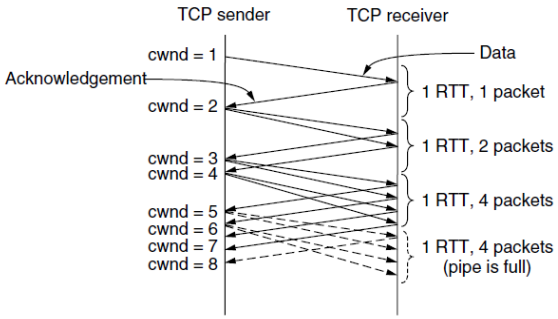


Figure 6-44. Slow start from an initial congestion window of one segment.

5

c. Considering the additive increase method in the transport layer, where the sender *starts* with *one segment*, indicate the maximum number of unacknowledged segments that the sender can have in the network after receiving 4 ACKs (Assume there is no packet loss). [

3

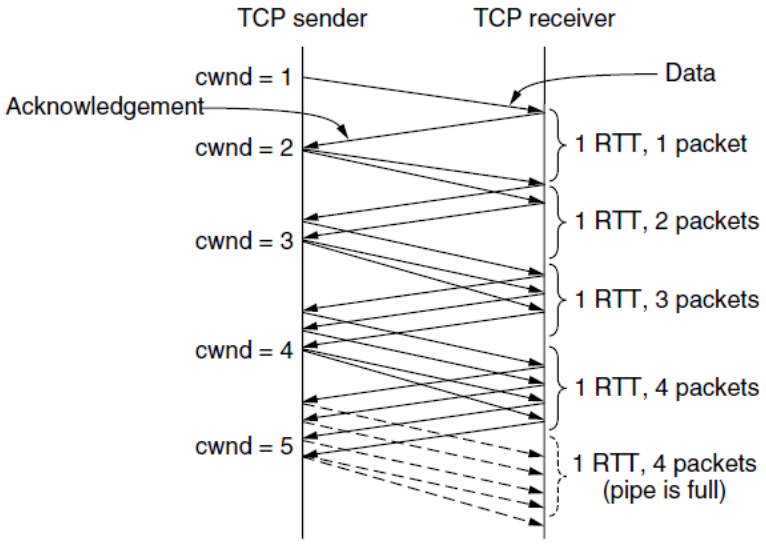


Figure 6-45. Additive increase from an initial congestion window of one segment.

Q16. a. Explain how caching improves the performance of DNS resolution. [1 Mark]

less DNS lookup from server, save time

b. What is the difference between persistent and non-persistent connections in the context of HTTP protocol? [1 Mark]

HTTP 1.0(non-persistent connection): single connection for each transaction for client-server pair

HTTP 1.1(persistent connection): persistent connection for client-server pair

c. Name two benefits of voice over IP (VoIP) over public switched telephone network (PSTN). [1 mark]

save money, flexible, compatible to data/voice/audio

Q17. A media player is connected to an audio streaming server with a one-way "distance" (propagation delay) of 200 milliseconds. It's outputs at 1 Mbps. The server sends the data at fix rate of 2 Mbps. If the media player has a 4 MB buffer, what can you say about the position of the low-water mark and the high-water mark? [2 marks]

high mark: 0.8M below top;
low mark: 0.4M bits from bottom.

2BD

b. Why do we need buffer in media player? [1 mark]

reduce jitter, play video more fluently

Q18. a. Explain the difference between symmetric key and public key encryption. [1.5 Marks]

1. sym use same key for both encryption and decryption, while pub use two different keys to encrypt and decrypt.
2. different encrypion and decryption algorithm.

b. How many bits of decrypted plaintext will be corrupted due to a single bit error in the transmitted ciphertext using stream cipher mode? Briefly justify your answer. A schematic diagram of Encryption and Decryption functions in the stream cipher mode is given in Fig. Q16 for your reference. [1.5 marks]

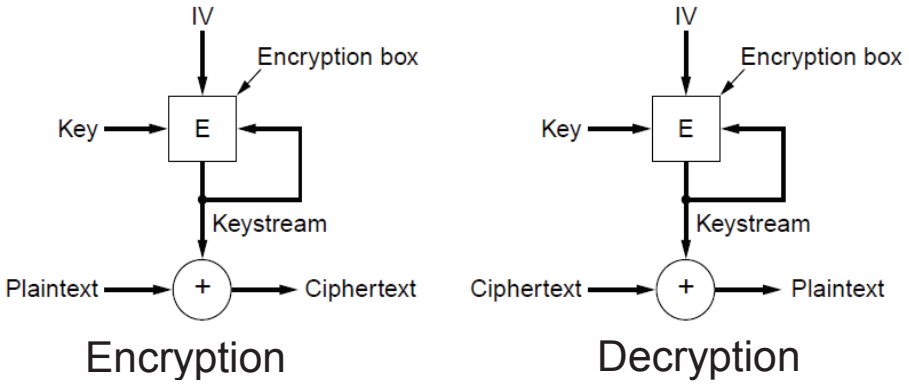


Fig. Q16.

1 no decrypted ciphertext used in other ciphertexts' decryption. Since the keystream depends only on the IV and the key, it is not affected by transmission errors in the ciphertext. Thus, a 1-bit error in the transmitted ciphertext generates only a 1-bit error in the decrypted plaintext.

Q19. Consider the TCP transmission policy shown in Fig. Q19, fill in the missing information in boxes (i), (ii), (iii), (iv), (v), and (vi). [3 marks]

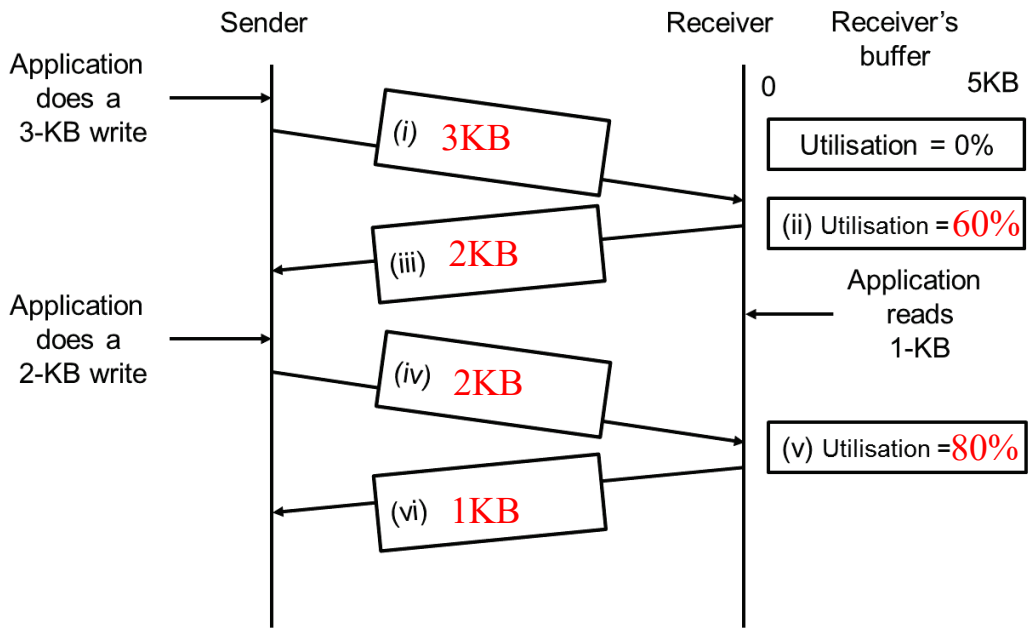


Fig. Q19.

R return the rest size of buffer to S; 3/5=60%

For the second sending, if segment is larger than 2KB, the value is still 2KB since there is only 2KB left in the buffer.

R read 1KB, so there is only 4KB in the buffer, 4/5=80%

Q20. Refer to the weighted, undirected graph of Fig. Q20, where the weights represent the distance between two router nodes. Determine the shortest path from Node A to Nodes B, C, D, E, F, G, and H by labelling each node (in parentheses) with its distance from Node A along the best-known path. For example, B (4,A) indicates the distance from Node A is 4 and the best known path is from Node A. Note: use blank even pages for your calculations and only write your answers in the space given below Fig. Q20. [3 marks]

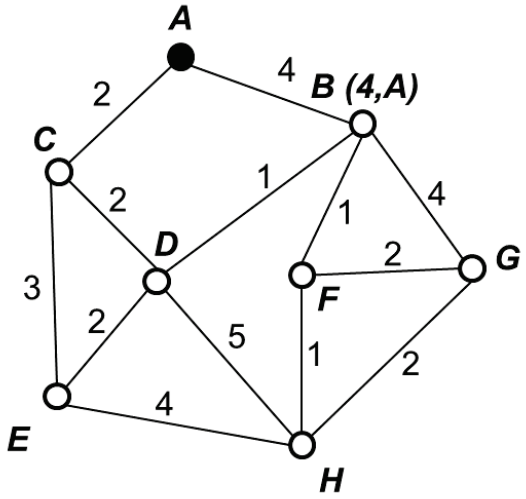


Fig. Q20.

B(4,A) C(2,A) D(4,C) E(5,C) F(5,B) G(8,B) H(6,F)