# CITY UNIVERSITY OF HONG KONG

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| Course code & title | : | EE3009 Data Communications & Networking |
| Session | : | Semester B 2019/20 |
| Time allowed | : | Two hours |

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This paper has 5 pages (including this cover page).

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1. This paper consists of 4 questions.
2. Answer ALL questions.

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*This is an **open-book** examination.*

**Departmental hotline (3442-7740)**

*Candidates are allowed to use the following materials/aids:*

*Portable battery operated calculator.*

*Materials/aids other than those stated above are not permitted. Candidates will be subject to disciplinary action if any unauthorized materials or aids are found on them.*

Question 1 (30%)

Host A sends a packet of 72 bytes to host B via two routers. The distance between host A and the first router is 20 m. The distance between host B and the second router is 25 m. The distance between the two routers is 500 m. The propagation speed is $2 \times 10^8$ m/sec. The recommended transmission rates are: 10 Mbps between host A and the first router, and 100 Mbps between the second router and host B. Each router spends 1.2 msec to perform error detection. If there is no congestion in the network, the recommended end-to-end delay for host A to send the packet to host B should not be longer than 3 msec.

(a) At what time the last bit of the packet leaves host A?

(b) At what time the last bit of the packet reaches the first router?

[4 marks]

(c) At what time the first bit of the packet reaches the second router?

[6 marks]

(d) Show your analysis and suggest the physical medium for the link between the two routers.

[8 marks]

(e) What are the pros and cons of the physical medium as suggested in part (d)?

[8 marks]

Question 2 (30%)

Host A sends a file of 91,300 bytes to Host B over a TCP connection. Assume the maximum segment size (MSS) is 144 bytes. The segment has no options field. The network layer adopts IPv4. The datagram has no options field. The data-link layer adopts PPP with a header of 6 bytes. Assume no bytes are stuffed in each frame. Each packet is sent out over a 100 Mbps link.

(a) What are the pros and cons of adopting TCP in the transport layer?

[4 marks]

(b) What is the size of the first packet?

[4 marks]

(c) What is the size of the last packet?

[4 marks]

(d) What is the sequence number (in hexadecimal) of the last segment?

[4 marks]

(e) Assume no congestion, calculate the time (in msec) required to transmit the file.

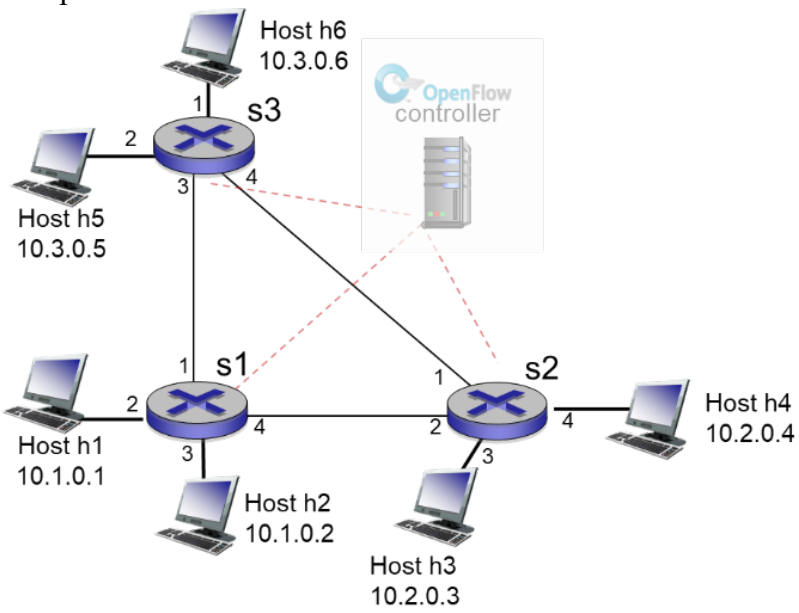
[6 marks]

(f) If congestion is possible, suggest and describe in detail two methods that can be used to handle congestion.

[8 marks]

Question 3 (20%)

Consider the SDN OpenFlow network as shown below.




(a) Suppose that the desired forwarding behavior for datagrams arriving at s3 is as follows:

- any datagrams arriving on input port 4 from hosts h3 or h4 that are destined to hosts h1 or h2 should be forwarded over output port 3
- any datagrams arriving on input port 3 from hosts h1 or h2 that are destined to hosts h3 or h4 should be forwarded over output port 4
- any arriving datagrams on input ports 3 or 4 and destined to hosts h5 or h6 should be delivered to the host specified
- hosts h5 and h6 should be able to send datagrams to each other

Specify the flow table entries in s3 that implement this forwarding behavior.

[12 marks]

(b) Host h1 sends a 3300-byte datagram to host h6. Suppose the maximum transmission unit (MTU) is 500 bytes.

(i) How many fragments are generated?

(ii) What is the length of the last fragment?

[8 marks]

Question 4 (20%)

A network links host A and host B at a distance of 1 Km. Host A sends to host B data frames, each of size 1,250 bytes. Assume the propagation speed is $4 \times 10^8$ m/sec.

(a) It is recommended to use CSMA-CD. Show your analysis, and hence suggest the physical layer and the physical medium such that the efficiency of 0.8 or higher can be achieved.

A token-ring LAN interconnects hosts A and B using the physical medium as suggested in part (a) with a star topology. All the input and output lines of the station interfaces are connected to a cabinet where the actual ring is placed. The distance between each station to the cabinet is 80 m. The ring latency per station is 8 bits. The ring speed is 70 Mbps.

(b) What are the pros and cons of using token-ring LAN as compared with CSMA-CD?

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