Loughborough University

COMMUNICATION NETWORKS
(13ELP009)

January 2014 — 2 Hours

Answer **THREE** questions

Any University approved calculator is permitted

Each question carries **20 marks**

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1. A communication network with line capacities shown in Figure 1 may be considered to consist of a series of M/M/1 queues. The routing matrix shown in Table 1 details the routes that packets are taking between nodes in the network. Table 1 also shows the average traffic (in packets/second) which passes between each node pair. The mean packet size for the network is **1000 bits/packet.**

a) Calculate the mean waiting time for each line; [10 marks]

b) Calculate the mean number of hops per packet; [4 marks]

c) Calculate the mean delay per line; [4 marks]

d) Calculate the mean packet delay over the network. [2 marks]

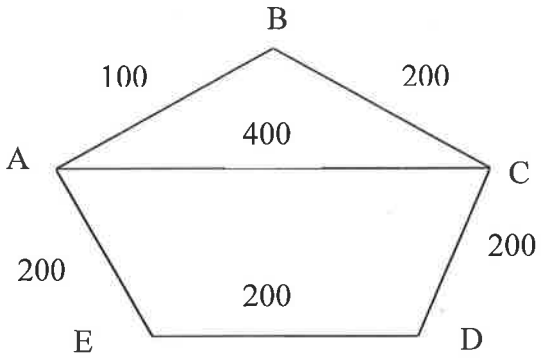

Figure 1: Network with full duplex line capacities in **kb/second**.

		Destination				
		A	B	C	D	E
Source	A		50 AB	150 AC	50 ACD	10 AE
	B	50 BA		20 BC	50 BCD	30 BCDE
	C	150 CA	20 CB		40 CD	10 CDE
	D	50 DCA	50 DCB	40 DC		20 DE
	E	10 EA	30 EDCB	10 EDC	20 EC	

Table 1: Routing matrix showing traffic in **packets/sec**.

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2. An Ethernet network operates at a data rate of **10 Mb/s** (note: M = 10^6 here), with the longest propagation time for the signal being **5μs**. If packets have a fixed length of **512 bits**, determine the channel efficiency assuming the probability that a station transmits during a contention slot is maximised for:

e) many stations ready to transmit; [10 marks]

f) 2 stations queued. [10 marks]

3. A computer communications example is shown in Fig. 2, where a program in "PC 1" transmits data to another program in "PC 2" via routers "R 1" and "R 2". Suppose the 5-layer protocol is applied.

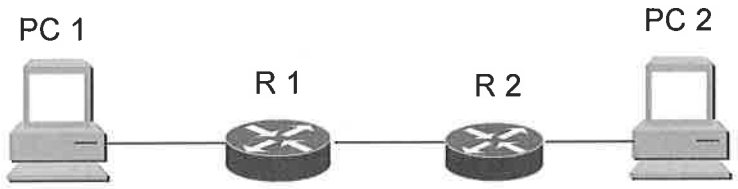

Fig 2: Computer communications from PC 1 to PC 2.

a) Describe the 5-layer structure and main function in each layer; [5 marks]

b) Determine whether all of the 5 layers must be applied at every station or not. Specify the layer structure for every station in Fig. 2 including "PC 1", "R 1", "R 2" and "PC 2"; [2 marks]

c) Use graphs to illustrate how data is organized from the top layer to the button layer; [5 marks]

d) Illustrate the IP address and MAC address for every station in Fig. 2. [4 marks]

e) Describe how the IP and MAC addresses are applied at every station when data is transmitted from "PC 1" to "PC 2". [4 marks]

4. This question has 2 parts.

a) A set of data is transmitted through a fibre channel. The fibre has a bandwidth of **1 M bit/s** (note: M =10^6 here). The fibre length is **1000 kilo-meters**, and signal propagation speed in the fibre is **2.0×10^5 kilo-meters/s**.

i. If the data set consists of **100 M bytes** (note: M =2^{20} here), calculate the time to transmit the data set. (Ignore the processing and queuing delays); [4 marks]

ii. If the data set consists of **1 byte**, repeat **a i)**; [4 marks]

iii. Comment on the results from **a i)** and **a ii)**; [2 marks]

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b) An Ethernet consists of a number of PC-s. Answer the following questions:

i. What is the topology of the Ethernet, or how are these PC-s are connected to each other? [2 marks]

ii. What causes the collision? [2 marks]

iii. What is the CSMA/CD protocol? [4 marks]

iv. How long is the "contention period" or "contention window"? [2 marks]

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