NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF COMPUTER SCIENCE

QUALIFICATION: BACHELOR OF COMPUTER SCIENCE HONOURS: COMMUNICATION NETWORKS	
QUALIFICATION CODE: 08BCCH	**LEVEL: 8**
COURSE: BROADBAND NETWORKS	**COURSE CODE:** BBN810S
DATE: JULY 2023	**SESSION:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

SECOND OPPORTUNITY / SUPPLEMENTARY EXAMINATION QUESTION PAPER	
EXAMINER(S)	**PROF GUY-ALAIN LUSILAO ZODI**
MODERATOR:	**MS ESNA MANGUNDU**

INSTRUCTIONS
1. Answer ALL the questions. 2. Write clearly and neatly. 3. Number the answers clearly.

THIS QUESTION PAPER CONSISTS OF 9 PAGES (Including this front page)

QUESTION 1 [10 marks]

a) Name one advantage and one disadvantage of fixed size packets (cells) compared to variable length packets. Justify. [4 mark]

b) In Ethernet, what is the difference between a hub and a switch? [2 marks]

c) Why does the TCP congestion control mechanism have a "slow-start" and a "congestion avoidance" phase? [4 marks]

QUESTION 2 [18 marks]

We consider the following set of autonomous systems, LEVEL3, GTT, CLARANET, RENATER, INTEROUTE and IRISA as shown in figure 1. The relationships between these autonomous systems are of the peering or transit type (customer to provider). The letters U to Z represent any IP equipment on the networks of each of these autonomous systems. It is assumed that only the type of relationship between autonomous systems governs routing in this exercise: no other decision criteria are taken into account in the routing selection.

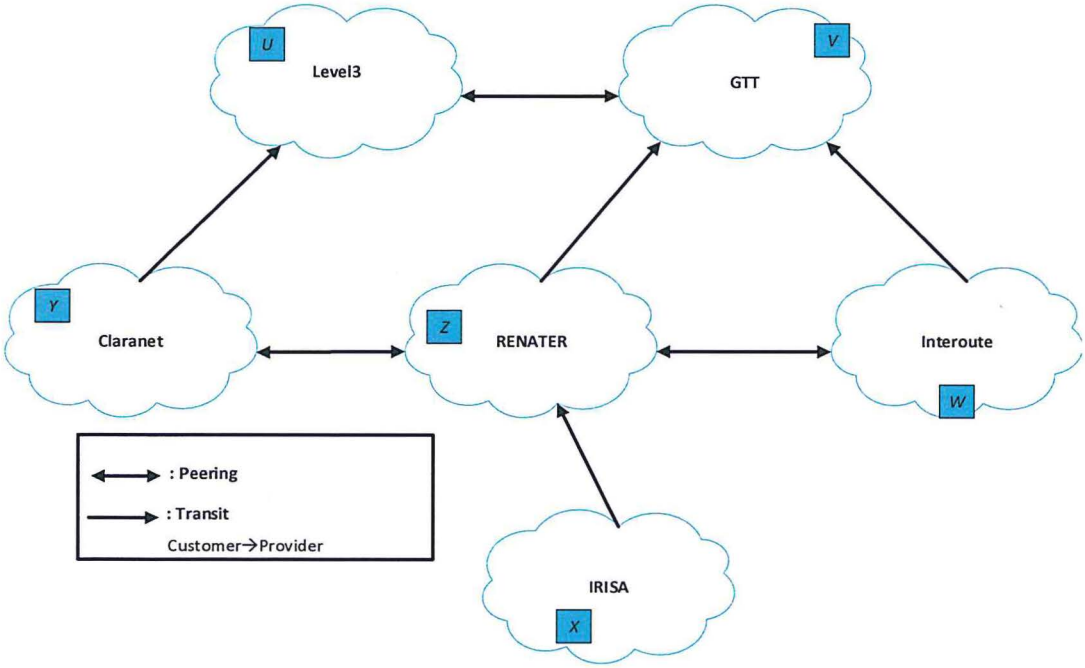


Figure 1: Autonomous Systems Relationship

Question 2.1: Looking at the topology in Figure 1 and the service agreement between autonomous systems.

a) Which autonomous carries the volume of traffic from Claranet to GTT? Explain. [2 marks]

b) Is the volume of traffic in a) carries free of charge? Explain. [2 marks]

Question 2.2: Considering the topology in Figure 1, and the service agreement between Claranet and RENATER,

a) Which autonomous system invoices the volume of traffic between Claranet and Renater on their dedicated link? [2 marks]

b) Which autonomous system charges for the volume of traffic from Irisa to Claranet? [2 marks]

Question 2.3: For a communication from Claranet to GTT, what is the path that respect the agreements between the two autonomous systems? [2 marks]

Question 2.4: For a communication from IRISA to Interoute, what are the paths that respect the service agreements between the two autonomous systems? [4 marks]

Question 2.5: For a communication from Claranet to Interoute, what are the paths that respect the service agreements between the two autonomous systems? [4 marks]

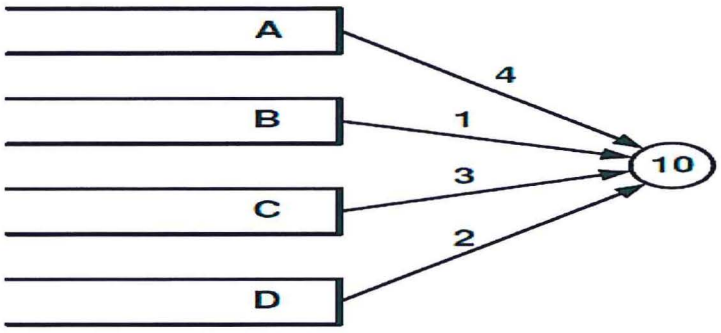
QUESTION 3 [6 marks]

Suppose every link in the network carries two classes of traffic – telephone calls and e-mail messages, with a separate queue for each class. When deciding which packet to send next, the router first selects the head of the queue containing the voice traffic, and only sends an e-mail packet if the voice queue is empty. Does the e-mail traffic have *any* effect on the performance experienced by the telephone calls? If so, what can be done to minimize the effects? [6 marks]

QUESTION 4 [12 marks]

Suppose that a router has four input flows being serviced according to a Weighted Fair Queueing (WFQ) scheduling policy. The weights given to the four queues (A,

B, C, D) are 4, 1, 3, and 2 respectively. They are being serviced by a router at the rate of 10 Mbps.



The table below gives a list of different input traffic rates (in Mbps) at the four input queues. Fill in the resultant output rates for each these four queues. We have filled in the first two rows to get you started. Each row [2 marks] [12 marks]

.

Table 1. Weighting Fair Queuing Router

Input Rates				Received Rates			
Link A	Link B	Link C	Link D	Link A	Link B	Link C	Link D
1	1	1	1	1	1	1	1
10	10	10	10	4	1	3	2
6	6	2	2	4.8	1.2	2	2
8	0	0	8	6.67	0	0	3.33
1	5	3	5	1	2	3	4

QUESTION 5 [6 marks]

In an ATM Adaptation, what percentage of the total bandwidth do all non-payload bits consume when a user transmits a cell? [4 marks]

QUESTION 6 [12 marks]

Consider the IP network shown in Figure 1. Routers R1 to R6 belong to a MPLS network where R1 to R6 are LSRs. These routers connect networks A, B, C and D. The topology links, whether internal to the MPLS network or external, have a capacity of 1 Gb/s.

We are interested in communications to C and D.

We have the following information:
R1 has announced to R2 and R3 that it can route packets but only to network D;
R2 has announced to R4 that it can route packets to C and D;
R3 has announced to R4 that it can route packets to network D;
R4 has announced to R5 and R6 that it can route packets to C and D.

We know the routing tables of routers R1 to R6.

R1 Routing Table		
Dest.	NH	Cost
R1	-	-
R2	R2	10
R3	R3	10
R4	R2	10
R5	R2	10
R6	R2	10
A	R2	10
B	R2	10
C	R2	10
D	D	10
Default	R2	10

R2 Routing Table		
Dest.	NH	Cost
R1	R1	10
R2	-	-
R3	R4	20
R4	R4	10
R5	R4	20
R6	R4	20
A	R4	30
B	R4	30
C	C	10
D	R1	20
Default	R4	10

R3 Routing Table		
Dest.	NH	Cost
R1	R1	10
R2	R4	20
R3	-	-
R4	R4	10
R5	R4	20
R6	R4	20
A	R1	30
B	R4	30
C	R4	30
D	R1	20
Default	R4	10

R4 Routing Table		
Dest.	NH	Cost
R1	R3	20
R2	R2	10
R3	R3	10
R4	-	-
R5	R5	10
R6	R6	10
A	R6	20
B	R5	20
C	R2	20
D	R3	20
Default	R2	10

R5 Routing Table		
Dest.	NH	Cost
R1	R4	30
R2	R4	20
R3	R4	20
R4	R4	10
R5	-	-
R6	R4	20
A	R4	20
B	B	10
C	R4	30
D	R4	40
Default	R4	10

R6 Routing Table		
Dest.	NH	Cost
R1	R4	30
R2	R4	20
R3	R4	20
R4	R4	10
R5	R4	20
R6	-	-
A	A	10
B	R4	30
C	R4	30
D	R4	40
Default	R4	10

We have several information on the labels used:

R4 switching table:

(FEC)	***Label IN***	***Label OUT***	***Next Hop***
(FEC A)	6	1	R6
(FEC B)	2	5	R5
(FEC C)	7	8	R2
(FEC D)	3	10	R3

Hypotheses : It is sought to minimize the number of labels used and to group streams having the same FEC as much as possible by assigning them the same label when possible.

The edge LSRs do the POPs.

The packets destined for A received by R2 carry a label equal to 12.

The packets destined for B received by R2 carry a label equal to 5.

The packets destined for C received by R2 carry a label equal to 8.

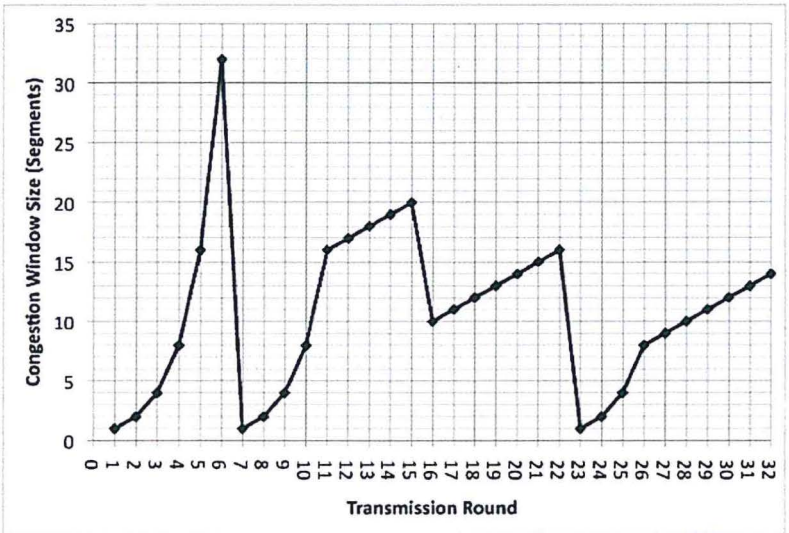
The packets destined for D received by R2 carry a label equal to 10.

When R1 receives a packet with an MPLS label equal to 6, it is bound for D.

Complete the commutation table of R6. [12 marks]

QUESTION 7 [14 marks]

The Transmission Control Protocol uses a method called congestion control to regulate the traffic entering the network. The behavior of TCP congestion control can be represented as a graph in which the x-axis indicates the time, and the y-axis indicates congestion window size. Please use the graph shown below to answer the following questions. Note that the graph does not explicitly show timeouts, but you should be able to figure out when timeouts happened based on the events shown.



a) *Give two reasons why slow start is used, and explain why it does a better job than congestion avoidance for that function.* [2 marks]

b) *Identify the intervals of time when TCP slow start is operating. For each interval, identify which of the above reasons apply and do not apply and explain why.* [2 marks]

c) *Identify the intervals of time when TCP congestion avoidance is operating. Why congestion avoidance should be used instead of slow Start during these intervals. Please clearly identify one specific reason* [2 marks]

d) *Identify the intervals of time when TCP fast retransmission is used. Please explain what fast retransmission does and how it is triggered.* [2 marks]

e) *Identify the intervals of time when TCP fast recovery is operating. What does fast recovery do and explain why is it beneficial?* [2 marks]

f) *Identify the interval(s) of time when fast recovery could have happened, but did not. Identify one specific example of a circumstance that may prevent fast recovery from happening.* [2 marks]

[2 marks]

g) *Which version of TCP is represented in this Figure?*

QUESTION 8 [10 marks]

Suppose you are designing a sliding window protocol for a 1 Mbps p-to-p link to the moon, which has a one-way latency of 1.25 seconds. Assuming that each frame carries 1 KB of data.

a) *Find the window size of the protocol based on the bandwidth-delay product.* [6 marks]

b) *What is the minimum number of bits you need for the sequence number field?* [4 marks]

QUESTION 9 [10 marks]

Consider a VC network with a 2-bit filed for the VC number. Suppose that the network wants to set up a virtual circuit over four links: link A, link B, link C and link D. Suppose that each of those links is currently carrying two other virtual circuits, and the VC numbers of these other VCs are as follows:

Link A	Link B	Link C	Link D
00	01	10	11
01	10	11	00

Assume that each of the existing VCs may only traverse one of the four links.

1) If each VC is required to use the same VC number on all the four links along its path, what VC number could be assigned to the new VC?) [5 marks]

2) If each VC is permitted to have a different VC number in the different links along its path, how many different combinations of four VC numbers (one for each of the four links) could be used? [5 marks]

==========**End of Examination**==========