UNIVERSITY COLLEGE DUBLIN

NATIONAL UNIVERSITY OF IRELAND, DUBLIN

An Colaiste Ollscoile Baile Atha Cliath

Ollscoil na hEireann, Baile Atha Cliath

SAMPLE EXAM

SCHDF0018 - HIGHER DIPLOMA IN COMPUTER SCIENCE EXAMINATION
ARBDF0015 – THIRD YEAR ARTS EXAMINATION

COMPUTER SCIENCE

COMPP303: Networks and Internet Systems
COMP3616: Networks and Internet Systems

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Time: 1 hour and 45 minutes

Answer Question 1 ***(COMPULSORY)*** and ***any two*** of Questions 2–5.

All questions carry equal marks.

READ EACH QUESTION CAREFULLY.

Question 1

(1-a) Three important architectural principles for computer network software are ***hierarchical modularity***, ***encapsulation***, and ***distributed scripts***. Briefly explain these principles in the context of layered computer network architectures.

(1-b) 200 nodes are connected to a 1,500 metre length of coaxial cable. Using some protocol, each node can transmit 50 frames/second, where the average frame length is 2,000 bits. The transmission rate at each node is 100 Mbps (where 1 Mbps = 1,000,000 bps). What is the ***efficiency*** of this protocol?

(1-c) The Internet was originally intended for robust transfer of computer-to-computer data over long distances. Briefly explain why connectionless packet-switching was preferred to circuit-switching in the IP layer.

(1-d) The Hamming distance between 2 Datalink layer codewords is defined to be the number of bit positions in which the codewords differ. Briefly explain how this is used in the General Parity Check error-handling scheme, mentioning the limitations of the scheme for error detection and error correction.

Question 2

(2-a) Consider a Data Link Layer with the following measured parameters:

- frame transmission time at the sender is TRANSF = 200 microseconds
- ACK or NAK transmission time at the receiver is TRANSA = 4 microseconds
- link propagation delay is PROP = 20 microseconds
- frame processing time at sender and receiver is 0 (in other words, negligible)
- overall round-trip probability of frame error on the link is r = 0.02

Assume that for both the Stop-and-wait and Go-back-n ARQ schemes, the TIMEOUT at the sender is chosen optimally. The average packet throughput in each scheme is given by the following formulas:

$$\text{throughput}_{SW} = (1-r)/(\text{TRANSF}+\text{TIMEOUT})$$

$$\text{throughput}_{GBN} = (1-r)/(\text{TRANSF}+(r\times\text{TIMEOUT}))$$

If you want to ensure an average packet throughput of at least 4,500 packets/second, which of these ARQ schemes could you use? Justify your answers mathematically.

(2-b) Draw timing diagrams to show how a Go-back-n ARQ scheme copes with

1. a damaged data frame;
2. a lost data frame; and
3. a lost ACK.

Question 3

(3-a) The throughput of an IEEE 802.5 Token Ring can be determined by the formula

$$\texttt{throughput} = 1/(\texttt{TRANSF} + (\texttt{TRANSF}/\texttt{THT}) \times \texttt{PROP})$$

where **PROP** is the one-way channel propagation delay, **TRANSF** is the average frame transmission time, and **THT** is a constant value of 10 milliseconds. Using this formula, state and explain the effect on this Token Ring's throughput of the following changes:

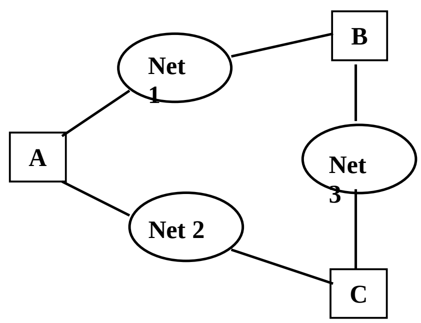
1. the length of the channel is increased (everything else held constant);

2. the average frame length is increased (everything else held constant).

(3-b) Briefly describe ***circuit switching*** and ***virtual circuit packet switching***, mentioning their principal differences.

Question 4

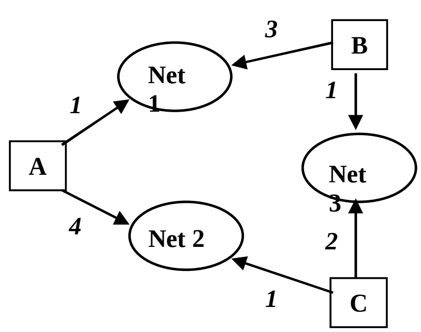
(4-a) In this diagram, A, B, and C are routers. The ovals represent LANs, labeled with their network ID. The routers are using **DISTANCE-VECTOR** routing.



1. Show the ***initial routing tables*** exchanged by the routers.

2. Show how router A ***updates*** its routing table if it first receives B's initial routing table.

(4-b) Suppose instead that **LINK-STATE** routing is being used. The following link costs have been determined:



1. Show the ***link-state packets*** each router floods to all other routers.

2. Show all the steps used by router A to determine its ***shortest-path spanning tree*** after it has received link-state packets from all other routers.

Question 5

(5-a) Consider a TCP connection using the slow-start congestion control scheme with an initial THRESHOLD value of 64 kB and a Maximum Segment Size (MSS) of 4 kB. The receiver's advertised window is initially 24 kB. The first transmission attempt is numbered 0, and all transmission attempts are successful **except** for Timeouts on attempt number 4. In the ACKs for transmission attempt number 9 and subsequently, the receiver's advertised window is **reset** to 20 kB.

Find the size in kB of the ***sender's congestion window*** for its first 11 transmission attempts (numbers 0 – 10).

(5-b) In IP-based networks, a sending host can find the physical address which corresponds to the IP address of its intended destination by using the Address Resolution Protocol (ARP). Briefly explain how ARP works.

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