



University College Dublin  
An Coláiste Ollscoile, Baile Átha Cliath

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**WINTER EXAMINATIONS - 2006**

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**PROGRAMME CODE/TITLE**  
**SCHDF0018 / HIGHER DIPLOMA IN COMPUTER SCIENCE EXAMINATION**  
**ARBDF0015 / THIRD YEAR ARTS EXAMINATION**  
**SCBDF003 / SCBDF0015 / THIRD YEAR SCIENCE & B.Sc. (GENERAL)**  
**DEGREE EXAMINATION**

**Networks and Internet Systems**  
**COMP30040**

Head of School Prof Barry Smyth  
Examiner Dr John Murphy

**Time Allowed: 1 Hour 45 Minutes**

**Instructions for Candidates**

**Answer Question 1 (COMPULSORY) and any TWO of Questions 2-5.**  
**All questions carry equal marks.**  
**READ EACH QUESTION CAREFULLY.**

**Instructions for Invigilators**

**Loose Rough Work sheets are not to be distributed or used.**

## 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:

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

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

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

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

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

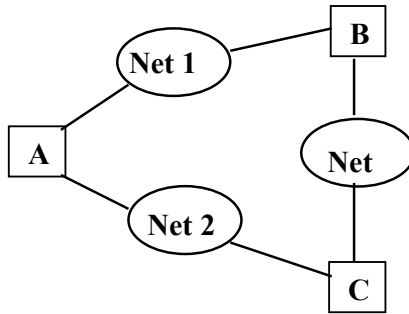
(4-a) Consider a TCP connection using the slow-start congestion control scheme with an initial THRESHOLD value of 64 kB and a Maximum Segment Size (MSS) of 4 kB. The receiver's advertised window is initially 24 kB. The first transmission attempt is numbered 0, and all transmission attempts are successful 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).

(4-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.

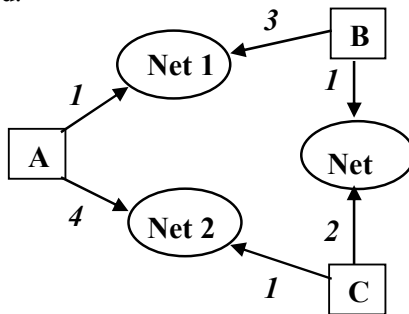
**Question 5**

(5-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.

(5-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.

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