THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

2006 A SEMESTER EXAMINATIONS

DEPARTMENT:	Computer Science
PAPER TITLE:	Communications and Systems Software
TIME ALLOWED:	Three Hours
NUMBER OF QUESTIONS IN PAPER:	Five
NUMBER OF QUESTIONS TO BE ANSWERED:	Five
VALUE OF EACH QUESTION:	All questions are of equal value except where noted.
GENERAL INSTRUCTIONS:	Answer ALL FIVE questions.
SPECIAL INSTRUCTIONS:	NIL.
CALCULATORS PERMITTED:	Yes

1. Physical Layer

(a) Transmission Media

i. What is the difference between *multi-mode* and *single mode* optical fibre? Which provides the greatest data rate carrying capacity?

ii. Explain how an antenna can provide *gain* without electrically amplifying a signal.

(5 marks)

(b) An engineer is designing a digital modulation scheme for a 40 kHz channel

i. What is the maximum rate of symbols that may be transmitted over this channel?

ii. If the signal to noise ratio is 30dB, what is the maximum capacity of this channel? (Hint $SNR_{dB} = 10log_{10}(SNR)$.)

iii. How many bits per symbol would be required to transmit 160kb/s on this channel?

iv. What names are given to the two theories required in the first two parts of this question?

(8 marks)

(c) Fourier Analysis

i. Explain what is meant by the term *Fourier* analysis of signals.

ii. What algorithm(s) are normally used when implementing Fourier analysis in a digital system?

(3 marks)

(d) Error Detection and Correction

i. Describe the process of *error detection* when applied to coding of digital signals.

ii. How is this process extended to provide *error correction*?

(4 marks)

2. Link Layer

(a) Multiplexing

For each of the following acronyms, give the full expression and an example system that uses the technique

i. FDM
ii. TDM
iii. WDM
iv. CDMA
v. CSMA-CA
vi. CSMA-CD

(6 marks)

(b) Ethernet Frames

Properly assigned Ethernet addresses are globally unique, yet cannot be used for global routing.

i. Explain how Ethernet addresses are assigned in a way that makes them globally unique.
ii. Explain why they cannot be used for routing.

(6 marks)

(c) Ethernet Operation

i. Explain what VLAN's are and how they are implemented.
ii. Explain how bridges "learn" the topology of a network.
iii. Explain why bridged loops present a potential problem and what the solution is.

(8 marks)

3. Internet Protocol

(a) Draw the Internet protocol stack. Briefly state how this differs from the OSI protocol model

(4 marks)

(b) Consider the IP network address `186.43.176.0/20`.

i. This address is used in a *CIDR* routing table. What is CIDR and what advantage does it bring to IP?

ii. What *netmask* is associated with this network address?

iii. What is the broadcast address for hosts on this network?

iv. How many individual hosts may be connected to this network?

v. Before CIDR was introduced, what *class* would this address have belonged to?

(6 marks)

(c) The standard IPv4 Header format is shown in figure 1.

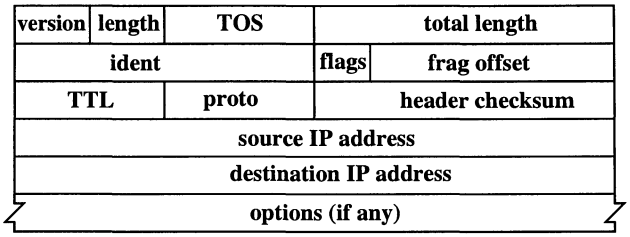

Figure 1: IPv4 Header format.

i. Which fields are altered when a datagram is fragmented?

ii. Which fields are not commonly used?

iii. What is the purpose of the *TTL* field and how is it used?

iv. Why are there two length fields?

(6 marks)

(d) Consider the IPv6 Address: `8000:0045:0000:0000:0123:0067:0000:00AB / 32`

i. Using standard techniques, rewrite the address into the shortest acceptable form.

ii. What is the Host ID portion of the address?

iii. IPv6 interfaces will generally have multiple addresses. List two types of address that Internet connected IPv6 nodes will normally have.

(4 marks)

4. Packet Forwarding

(a) Address Resolution

An internet host has matched a packet to a routing table entry for interface *eth1*:

i. How does it determine which IP address to ARP for destination Ethernet address?

ii. Where is the first place it tries to find that Ethernet address?

iii. How is the source Ethernet address for the packet chosen?

(4 marks)

(b) Routing protocols

i. What is the difference between *packet forwarding* and *routing*? Describe the interaction of each with the *route table*?

ii. Give example *routing protocols* that meet each of the following criteria:

A. Uses the Bellman-Ford algorithm.

B. An IGP.

C. Proprietry to a specific vendor.

D. Does not use IPv4 or IPv6 at the network layer.

E. Uses path-vector routing.

F. A Link-state protocol.

(8 marks)

(c) Route Aggregation

i. Give an example of a pair of routing table route entries that can be *aggregated.*

ii. Give an example of a pair of routing table route entries that cannot be aggregated.

iii. Explain what advantage *route aggregation* provides to routing tables.

(6 marks)

5. Transport Layer

(a) Explain in detail how the buffer space allocated on a TCP reciever affects the throughput on the connection.

(4 marks)

(b) Explain in detail how the buffer space allocated on a TCP sender affects the throughput on the connection.

(2 marks)

(c) Describe the differences between *slow start* and *congestion avoidance* in terms of the congestion window size and rate of increase.

(4 marks)

(d) Describe two ways in which TCP can detect lost packets.

(4 marks)

(e) For the following equation, name the terms and describe how they are measured:

$$RTO(k) = SRTT(k) + f * SRTTVar(k)$$

(4 marks)

(f) TCP is the most commonly used transport protocol on the Internet, but it is not appropriate for all applications. Describe what features of TCP are inappropriate for the following applications.

i. DNS queries

ii. Real-time voice

(2 marks)