

UNIVERSITY OF DUBLIN

TRINITY COLLEGE

Faculty of Engineering, Mathematics & Science

School of Computer Science and Statistics

Integrated Computer Science Programme

Trinity Term 2012

SENIOR FRESHMAN EXAMINATION

BA (Mod) Business and Computing

Junior Sophister EXAMINATION

Annual Examination

Telecommunications and Information Management

Friday 4th May 2012

Main Hall

ICS Students: 14:00 – 17:00

RDS

B&C Students 14:00 – 15:30

Stefan Weber, Declan O'Sullivan

For students taking:

CS2031 Telecommunications II /CS2041 Information Management (180 minutes)

Integrated Computer Science (Year 2)

Answer **two** questions from **each** section in **180** minutes.

or

CS2031 Telecommunications II (90 minutes)

Business and Computing (Year 3)

Answer **two** questions from **section A** in **90** minutes.

All questions carry equal marks (25 marks).

Use separate answer books for each QUESTION.

Materials permitted for this examination:

Calculator (non-programmable)

Materials omitted from the front page of an examination paper will not be permitted during an examination.

SECTION A

Question 1

(1a)

- Demonstrate the use of 2-dimensional parity and Hamming code on the following bit-sequence "1011011 0101110 1000011"
- Discuss the difference of the two error detection schemes.

(10 marks)

(1b) The High-Level Data Link Control (HDLC) protocol defines a number of types of frames shown in figure 1). Explain

- the general layout of HDLC frames,
- the use of the frame types to implement flow control concepts such as Stop-and-Wait ARQ and Selective Repeat ARQ
- the terms piggybacking and bit stuffing.

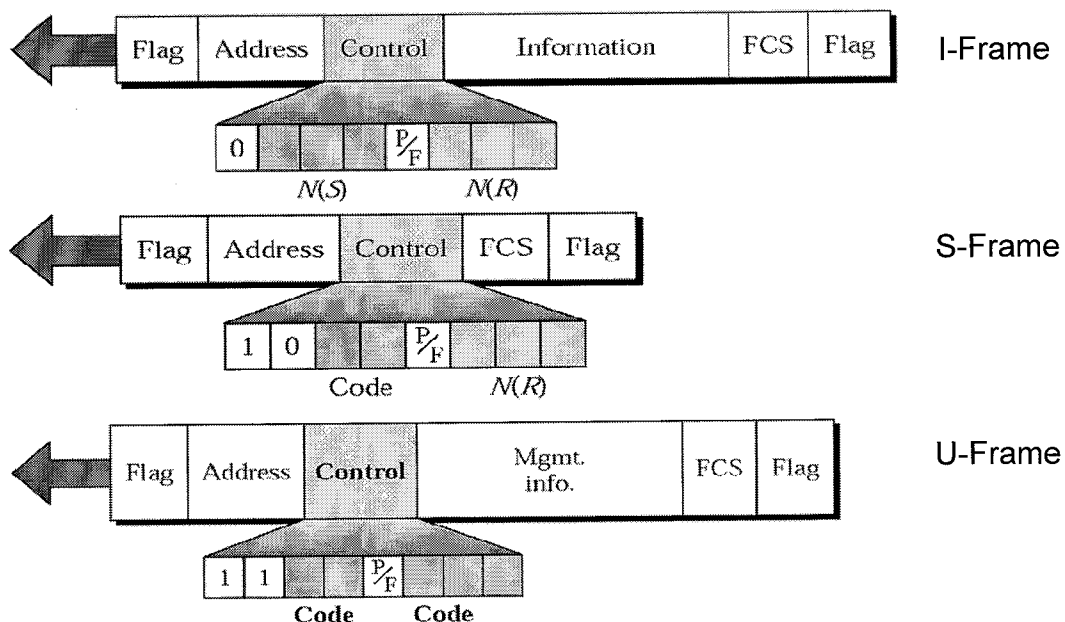


Figure 1: Types of HDLC frames

(15 marks)

(Total 25 marks)

Question 2

- (2a)** Assume that four stations use a wireless medium to communicate. All stations are within coverage of each other and a station may attempt to transmit data at the same time as all other stations. The access to the wireless medium is controlled by a Carrier Sense Multiple Access (CSMA) scheme with Collision Avoidance (CA). Assume that at least a number of transmission attempts lead to collisions.

Describe the process that a station follows to transmit a frame. Use diagrams to visualize the chronological exchange of the frames and the reaction to collisions.

(10 marks)

- (2b)** Assume that four stations use a wired medium to communicate. All stations may intend to transmit data at the same time as all other stations. The access to the medium is controlled by a Carrier Sense Multiple Access (CSMA) scheme with Collision Detection (CD) or a Time Division Multiple Access (TDMA) scheme with a reservation protocol. For the CSMA/CD approach, assume times as you see fit. For the TDMA approach, assume that every reservation slot is 10ms long and every contention free slot is 100ms. Contrast the two access control schemes with each other considering 2 scenarios:

- i) High network load i.e. every station would like to send data at any given time.
- ii) Low network load i.e. stations only have data to be transmitted every few seconds.

Your analysis should be accompanied by diagrams that visualise the behaviour of the two schemes in each of the scenarios.

(15 marks)

(Total 25 marks)

Question 3

(3a) Assume that the Transmission Control Protocol (TCP) is used to manage the communication between a client and a server. The client sends a message of 150 bytes to the server, the server responds to this with a message of 10,000 bytes – sent in 9 segments – and the client confirms the receipt of this with a message of 80 bytes. Every segment is acknowledged with an individual acknowledgement packet.

- i) Describe the sequences of packets that are exchanged
- ii) Determine the overhead that is introduced through TCP's connection management.

The explanations should be accompanied by diagrams that visualise the chronological exchange of packets.

(15 marks)

(3b) A TCP connection uses Additive Increase/Multiplicative Decrease (AIMD) for congestion control. The link over which the connection is established has a roundtrip time of 20msec and no congestion at the beginning.

Note that in the following: Each graph should be accompanied by a description that gives an analysis of the respective congestion control algorithm.

- i) Draw a graph that shows the progression of the AIMD algorithm from 0 to 500msec with timeouts for packets occurring at 200msec, 300msec, and 440msec. Discuss the graph and the advantages and disadvantages of the approach.
- ii) Consider a pure slow start algorithm for the connection described above and draw a graph for the progress of this algorithm from 0 to 500msec with timeouts for packets occurring at 100msec, 200msec, 300msec, 380msec and 460msec. Discuss the graph and the advantages and disadvantages of the approach.

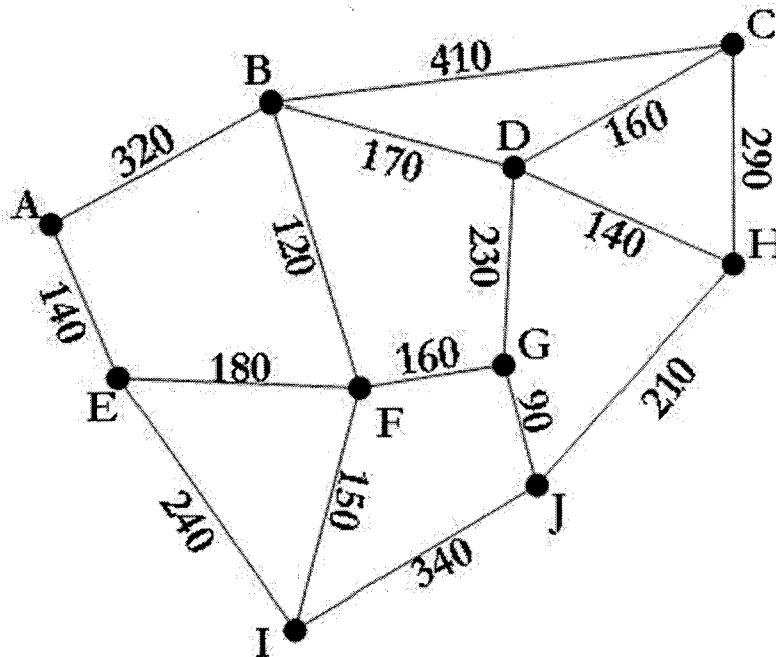
(10 marks)

(Total 25 marks)

Question 4

(4a) Link State Routing (LSR) represents one of the major routing concepts. Describe the LSR concept in your own words. The description should be accompanied by diagrams where appropriate. Dijkstra's Shortest Path algorithm is used in LSR to determine the routing table of individual nodes.

- Describe this algorithm
- Explain it with the help of the following diagram.



(10 marks)

(4b) Assume you are working for an Internet Service Provider (ISP) and have been asked to present a CIDR allocation scheme for the address block 134.226.0.0/16 that has been allocated to the provider. Customers will regularly ask the ISP to allocate them address ranges that may hold 60, 500 or 2000 addresses.

- Describe how you will split up the address block using CIDR,
- Explain how the requests for the customers will be handled,
- Describe the limitations of your approach.

(15 marks)

(Total 25 marks)

**SOME QUESTIONS REFER TO THE FOLLOWING
FIGURE A:**

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<news>
<news_item timestamp='1'>
  <title> Gorilla Corporation acquires YouNameItWeIntegrateIt.com </title>
  <content>
    <par> Today, Gorilla Corporation announced that it will purchase
YouNameItWeIntegrateIt.com. The shares of YouNameItWeIntegrateIt.com dropped $3.00
as a result of this announcement. </par>
    <par> As a result of this acquisition, the CEO of YouNameItWeIntegrateIt.com Bill
Smarts resigned. He did not announce what he will do next.</par>
    <par>YouNameItWeIntegrateIt.com is a leading systems integrator that enables
<quote>brick and mortar</quote> companies to have a presence on the web. </par>
  </content>
  <date>1-20-2000</date>
  <author>Mark Davis</author>
  <author>John Smith</author>
  <news_agent>News Online</news_agent>
</news_item>
<news_item timestamp='2'>
  <title>Foobar Corporation releases its new line of Foo products today</title>
  <content>
    <par> Foobar Corporation releases the 20.9 version of its Foo products. </par>
    <par> The President of Foobar Corporation announced that they were proud to release
20.9 version of Foo products
  </par>
  <figure>
    <title>Presidents of Foobar Corporation and TheAppCompany
Inc. Shake Hands</title> <image source='handshake.jpg' />
  </figure>
  </content>
  <date>1-20-2000</date>
  <news_agent>Foobar Corporation</news_agent>
</news_item>
<news_item >
<title>Foobar Corporation is suing Gorilla Corporation for patent infringement </title>
  <content>
    <par> In surprising developments today, Foobar Corporation announced that it is suing
Gorilla Corporation for patent infringement. </par>
    <par>The tension between Foobar and Gorilla Corporations has been increasing ever
since the Gorilla Corporation acquired more than 40 engineers who have left Foobar
Corporation, TheAppCompany Inc. and YouNameItWeIntegrateIt.com over the past 3
months. </par>
  </content>
  <date>1-20-2000</date></news_item></news>
```

Section B
Question 5

- a) Compare the advantages and disadvantages of the following types of secondary storage for storing data: magnetic hard disks; optical disks; solid state drives.
(4 Marks)
- b) Describe in detail how hard disks works both from a physical perspective (e.g. how data is encoded) and from a logical perspective (e.g. concepts such as track). **Use diagrams to illustrate your description.**
(8 Marks)
- c) A file has $r=20000$ STUDENT records of fixed length. Each record has the following fields: NAME (30bytes), SSN (9bytes), ADDRESS (40bytes), PHONE (9bytes), BIRTHDATE (8bytes), SEX (1byte), MAJORDEPTCODE (4bytes), MINORDEPTCODE (4bytes), CLASSCODE (4 bytes) and DEGREEPROGRAM (3bytes). An additional byte is used as a deletion marker. Block size $B = 512$ bytes; Block Transfer Time = 1 msec; Rotational Delay = 12.5 msec; Seek time = 30 msec.
- i) Calculate the record size R in bytes
- ii) Calculate the blocking factor bfr and the number of blocks b assuming an unspanned organisation
- iii) Calculate the average time it takes to find a record by doing a linear search on the file if (i) the file blocks are stored contiguously and double buffering is used and (ii) the file blocks are not stored contiguously.
- iv) Assume the file is ordered by SSN; calculate the time it takes to search for a record given its SSN value by doing a binary search

(13 Marks)

Question 6

- a) What is XML Schema and what is it used for? Describe at least two of the statements in XML Schema that have no equivalence in DTDs.

(4 Marks)

- b) Describe the relationship between the “XML tree model” and XPath expressions. List and describe the different types of nodes (e.g. comment node) possible in an XML tree model. Draw a diagram showing the nodes representing the subtree of element `<news_item timestamp='2'>` from the document shown in Figure A.

(8 Marks)

- c) Describe what is meant when describing XQuery as consisting of “FLWOR” expressions. In addition, **define and explain XQuery statements** for each of the following queries posed over the document in Figure A. **Also show expected results and explain your design decisions.**

- i) Return those `news_item` elements that have a `timestamp` attribute
- ii) Return the second `<par>` element for each `news_item`
- iii) Return in one element called `<summary>`, summary information about each individual `news_item` which has a named author(s). The summary should include a `news_item` element with `timestamp`, `title`, `date` and `news_agent` subelements for each individual `news_item`

(13 Marks)

Question 7

a) Explain the difference between a B-Tree, B+Tree and B*Tree.

(4 Marks)

b) Explain how indexing can lead to performance gain in information processing.

Describe in detail at least 2 indexing approaches, using diagrams to illustrate how they work.

(8 Marks)

c) Given the B-Tree in Figure B (with $m=5$), show the growth of the B-Tree as you add the keys in the following order

18, 20, 23, 5, 24, 27, 16, 32, 37, 44, 55, 25, 57, 69, 72

- i. Show the tree at each stage and provide an explanation for any splits
- ii. What is the average number of node splits per new key inserted?
- iii. What is the average search time?

(13 Marks)

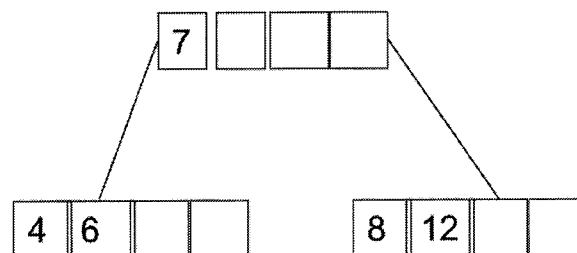


FIGURE B

Question 8

The introduction of the "semantic web" will radically change the effectiveness of searching on the web. Discuss this statement. Include at least in your answer: how Information Retrieval on the web is currently organised, using diagrams to illustrate; how effectiveness of information retrieval is currently measured; the idea behind the "semantic web" itself; the role of the XML RDF vocabulary and illustrate its usage; outline at least three advantages of the semantic web and three obstacles to the introduction of the semantic web.

(25 Marks)

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