IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2013

BEng Honours Degree in Information Systems Engineering Part II
MEng Honours Degree in Information Systems Engineering Part II
BSc Honours Degree in Mathematics and Computer Science Part III
MSci Honours Degree in Mathematics and Computer Science Part III
MSc in Computing Science
for Internal Students of the Imperial College of Science, Technology and Medicine

This paper is also taken for the relevant examinations for the Associateship of the City and Guilds of London Institute
This paper is also taken for the relevant examinations for the Associateship of the Royal College of Science

PAPER C527

COMPUTER NETWORKS AND DISTRIBUTED SYSTEMS

Friday 3 May 2013, 10:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators required

1 a Explain the acronyms CSMA/CD and CSMA/CA in detail and outline the main differences between them. In which circumstances are each used and why.

b Explain why in a CSMA/CD protocol an *inter-frame gap* is necessary and list the factors influencing the choice of the gap duration.

c Some manufacturers have attempted to provide better throughput efficiency by reducing the inter-frame gap in their implementations. Explain what happens in networks where computers using these implementations co-exist with those using a standard inter-frame gap.

d Do you agree with the statement that Ethernet is a fair medium access control protocol? Consider the case when two computers A and B are connected to the same Ethernet segment where A has substantially more data to transmit than B, for example a large video stream. Using a diagram of the frames exchanged, explain carefully what happens to justify your answer.

e List the advantages and disadvantages of re-transmitting lost and/or corrupted data at the data link, transport and application layers.

The five parts carry, respectively, 20%, 15%, 15%, 20%, and 30% of the marks.

2a Explain what *backward learning* is and how it is used in the context of Layer 2 switching.

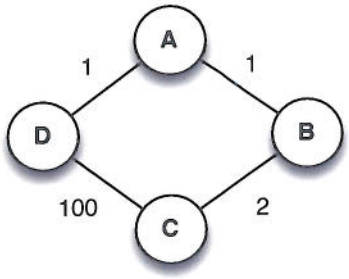
b A backward learning algorithm has been proposed as a means of routing in Layer 3. In this method the identity of the source node is included in each packet, together with a hop counter that is incremented at each hop the packet traverses from the source. This information can then be used by a router receiving a packet to update its routing tables.

i) Explain in detail how this method would work using an example.

ii) Compare this method with *distance vector routing* and *link-state routing*.

iii) List the advantages and the disadvantages of this method.

c Consider the network shown in the figure below, which uses distance vector routing.



i) Give the routing tables for each of the nodes after steady state has been reached i.e., when they no longer change.

ii) Assuming that the link between A and B breaks, approximately, after how many messages do the routing tables stabilise again? Briefly justify your answer.

The three parts carry, respectively, 20%, 60%, and 20% of the marks.

3 a Explain what is meant by *at least once* and *at most once* call semantics for remote procedure calls, what is required to implement them and give examples of when each is useful.

b A building security system has a controller for every room with integrated switch and display. Each room also has a motion detector. The switch can be used to enable or disable alarms being generated from the local motion detector. The display indicates a *disabled*, *enabled* or *alarm* condition. Each room-controller communicates with the motion detector and a centralised operator via object invocation over a network. The current state of every room is indicated on the operator's display. The operator has a keyboard to enter room numbers and commands to clear an alarm for a particular room. The room-controller sends state information every 5 seconds to the operator, and receives a return value to indicate whether an alarm condition has been cleared.

Give a diagram indicating all the objects needed to model this security system and the operation invocations between the objects (only a single room system plus the operator need to be shown).

c For the system described in part b above, give a pseudocode outline for the *operator* as a remote object i.e., a server, and for the *room-controller* as a client. The client takes two parameters, the first indicating the room number and the second the name of the operator server.

Assume a Java RMI object invocation system for implementation, and that local objects implementing the switch, keyboard and display are available. Use the following interface specifications.

```
public interface MotionDetector extends Remote {
  public boolean detect ( );  }
  // assume detect resets motion detector

public interface iOperator extends Remote {
   public boolean  report  (int room, int status);
  // true response clears alarm

int  disabled = 0; enabled =1; alarm = 2; // status values
```

Strict Java syntax is not required.

The three parts carry, respectively, 20%, 20%, and 60% of the marks.

4a What are the similarities and differences between *Kerberos* and the use of *X.509* certificates?

b The Domain Name System (DNS) is a distributed service for the resolution of host names and IP addresses. DNS translates host names to IP addresses and IP addresses to host names. DNS clients (any program that needs a host name to IP address translation) normally query their local DNS server which may forward the request to other DNS servers. DNS servers know the host names and corresponding IP addresses in their local domain. A DNS server uses port 53 as server port for both TCP and UDP. DNS queries are normally done using UDP but may also be done using TCP in case of failures. Some servers use port 53 as the source port for their queries whilst others use any port above 1023.

In a *screened subnet* firewall architecture, discuss the advantages and disadvantages of placing the DNS server:

1) outside the external packet filtering router (PFR),

2) in the perimeter network (between the external and the internal PFR),

3) inside the internal network.

c A company called *DoC* uses a screened subnet firewall architecture and provides an ftp server (port 21) on host *ftp* and an HTTP server (port 80) on host *www* to external users. DoC's DNS server, named *dns0*, is in the perimeter network and uses ports above 1023 as source ports in requests. The connections used by DNS are described in part b above.

Give a possible set of rules for configuring the external packet filtering router, which separates DoC's perimeter network from the external networks. The rules should be given in the format below, and you must explain what each rule does. Assume the direction of the traffic can be *in*, *out* or *any* (both directions).

Rule No.	Protocol	Dir.	Source Address	Src. Port	Dest. Address	Dest. Port	TCP Flags	Action

The three parts carry, respectively, 15%, 25%, and 60% of the marks.