IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE

EXAMINATIONS 2016

BEng Honours Degree in Electronic and Information Engineering Part II
MEng Honours Degree in Electronic and Information Engineering Part II
BEng Honours Degree in Mathematics and Computer Science Part III
MEng 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

PAPER C527

COMPUTER NETWORKS AND DISTRIBUTED SYSTEMS

Monday 25 April 2016, 10:00
Duration: 120 minutes

Answer THREE questions

Paper contains 4 questions
Calculators required

1 a List the advantages and disadvantages of a layered stack model architecture over a monolithic one.

b Briefly explain the main services provided by the Link Layer.

c i) Suppose the maximum diameter for a $10Mbps$ 802.3 LAN network is set by the specifications to be $2,000m$, and that the maximum length of one segment is fixed to $500m$ to ensure an acceptable signal/noise ratio. You also know that a repeater introduces a 3 μs delay (in one direction), and that the propagation delay (i.e., the signal speed on wire) is equal to $200,000,000m/s$ ($200m/\mu s$).

Calculate the minimum frame length to ensure detection of all worst-case collisions.

ii) Suppose that on an L2 network built using the specifications given above in i), node A (MAC address: `CE:46:CF:C5:08:AB`) wants to send to node B (MAC address: `CE:54:58:17:7B:99`) the following data:

```
0100 1000 0101 0111
```

Give the Layer 2 802.3 Frame of this message, by showing its fields and their values (assume the "checksum" field is set to four bytes of 0). (You can mix hexadecimal/binary/decimal notation to show the values of the fields.)

iii) Show the resulting Manchester Encoding of the data bits (using the 802.3 convention, where a 0 is represented as high-to-low transition).

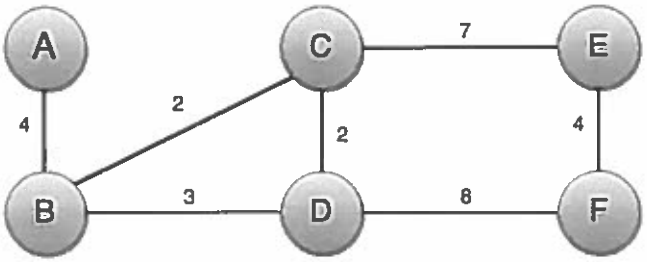
The three parts carry, respectively, 20%, 20%, and 60% of the marks.

2a i) Briefly explain the main features of the *distance vector* and *link-state* routing algorithms.

ii) If you were the administrator of a large Internet Service Provider (ISP), explain which routing algorithm you would use in the internal network and why.

iii) If you were the external consultant of a consortium of large ISPs, explain which type of routing algorithm you would suggest to be used between the ISPs and why.

b Consider the following network.



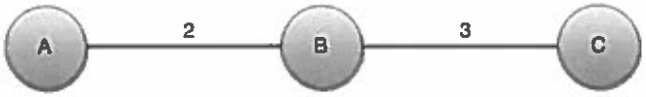
Give the global *distance vector* routing tables when:

i) Each node knows only the distances to its immediate neighbours.

ii) Each node has reported the information it had in the preceding step to its immediate neighbours.

iii) Step ii) above happens one more time.

c Consider the following network.



i) Suppose the link from B to C fails. Graphically show the first 3 iterations of the distance vector algorithm.

ii) Explain the behaviour of the distance vector algorithm in the situation occurring in i), and suggest possible modifications to improve the algorithm.

The three parts carry, respectively, 30%, 45%, and 25% of the marks.

3 A *BusBroker* system offers the cheapest bus trips for its clients from a set of bus companies that are registered with it. Bus companies register with the *BusBroker* the routes they serve by giving their name, origin and destination for each route, and URL of the Java RMI server that can be used to query the price of a booking and to make a booking. Each bus company quotes, for a booking, a price given by multiplying the number of travellers already confirmed for that route with a *PricingFactor* specific to the bus company.

Assume the interfaces to be as follows:

For the *BusBroker*:

```
1  import java.rmi.Remote;
2
3  public interface IBusBroker extends Remote {
4    boolean registerBusRoute(String bus, String from,
5                      String to, String url);
6    boolean makeCheapestBooking(String from, String to, String date);
7  }
```

For the *BusCompany*:

```
1  import java.rmi.Remote;
2
3  public interface IBusCompany extends Remote {
4    float quotePrice(String from, String to, String date);
5    void book(String from, String to, String date);
6  }
```

For simplicity assume that bus companies use an existing `IManageBookings` `booking` object, i.e. an object that implements the following interface:

```
1  public interface IManageBookings {
2      int bookings(String from, String to, String date);
3          // returns the number of bookings
4      void addbooking(String from, String to, String date);
5          // adds a booking
6  }
```

Also assume that bus companies use a *Registration* data structure:

```
1  public class Registration {
2
3      public String busCompany;
4      public Route route;
5      public String url;
6
7      public Registration(String busCompany, Route route, String url)
8      {
9          this.busCompany = busCompany;
10         this.route = route;
11         this.url = url;
12     }
13 }
```

```
1  public class Route {
2      public String from;
3      public String to;
4
```

```
5       public Route(String from, String to)
6       {
7           this.from = from;
8           this.to = to;
9       }
10  }
```

a For the system described above give a graphical representation of the interactions between the clients making the booking, the *BusBroker* and the *BusCompany*.

b Give the Java RMI implementation for the *BusBroker* server.

c Give the Java RMI implementation for the *BusCompany* server.

Strict Java syntax is not required but your answer must include all the components of the RMI invocations.

The three parts carry, respectively, 20%, 40%, and 40% of the marks.

4a Briefly describe the *screened subnet* firewall architecture. Indicate when it would be used and the typical configuration of its components.

b SoundArt is a music production company which needs to secure its network. It wishes to allow its customers to: i) access its web site (on port 80), in order to browse their catalogue, ii) download music files from an ftp server (on port 21) iii) play RealAudio files from a RealAudio server (on port 7070).

RealAudio by default uses a system where a TCP connection initiated by the client is used for session control while the data is transferred using UDP for better performance. However, it is possible to configure RealAudio to restrict UDP to use only ports in the range 6970-7170 or to use only the TCP connection (i.e. data transfer also occurs on the TCP connection).

SoundArt company users are not permitted to access external networks.

After investigating various options, SoundArt decides to employ a screened subnet firewall architecture with two bastion hosts in the perimeter network (the network segment between the inner and the outer packet filtering routers). One bastion host (B1) is dedicated to the web server and the other (B2) is dedicated to the ftp server and the RealAudio server.

Assuming the RealAudio server is used in its default configuration, give a possible set of rules for configuring the outer packet filtering router, which separates the perimeter network from the external networks. The rules should be given in the format below and you must briefly explain what each rule does. Assume the direction of the traffic can be *in*, *out*, or *any* (both directions) where in denotes incoming external traffic. Denote the internal network of SoundArt as SoundNet and the perimeter network as SoundPerim.

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

c The employees of SoundArt have convinced management to allow them to access external web sites and play RealAudio files stored on external servers. To permit this, SoundArt has installed a real audio proxy on B2 (port 4721) and an http proxy on B1 (port 4488).

i) Discuss how the RealAudio proxy should be configured with respect to connections to external servers and connections with company users assuming that they are configured separately. You must explain their security implications and choose the most appropriate configuration.

ii) Specify the additional rules needed for the outer packet filtering router.

The three parts carry, respectively, 20%, 40%, and 40% of the marks.