COMPSCI 314 S1 C Assignment 3

Department of Computer Science

The University of Auckland

Due Wednesday 18 May 05, 11:59 pm

This assignment will contribute 40/300 = 13.3% to your coursework mark, and 4% to your overall course mark.

Submit your assignment via the DropBox, either in PDF (preferred), or in MS Word format.

1. **LLC and Ethernet** [15 marks]

   (a) What is meant by an Ethernet 'group' MAC address? Which bit in an Ethernet MAC address indicates that it is a group address? [2 marks]

   A group MAC address is one which several hosts will respond to. Those hosts form the group. Note that a host may have a list of MAC addresses, not just one. [1 mark]

   The first bit on the wire is the 'group address' bit. The low-order bit is sent first, that's the rightmost bit of the first byte. [1 mark]

   (b) Describe one widely-used example of an Ethernet group MAC address (i.e. explain what it is, and how it is used). [3 marks]

   The 'broadcast' MAC address is the obvious example. [1 mark]

   Its value is FF-FF-FF-FF-FF-FF (all bits on). [1 mark]

   Every host on an Ethernet segment responds to messages sent to the broadcast MAC address. [1 mark]

   Another example is 01-80-C2-00-00-00 $\Rightarrow$ all bridges, used for Spanning Tree BPDUs

(c) Explain briefly what an LLC (Link Layer Control) protocol does. [4 marks]

Logical Link Control provides an interface between the *Network* and *Physical* layers in the networking stack. It takes Link *Service* Data Requests (LSDUs) and passes them to the MAC layer as Link *Protocol* Data Requests. [2 marks]

An LLC *Protocol* (which is what this question asked about) provides connection services, allowing an application to pass messages between hosts without them having to know any detail of the lower layers. In other words, an LLC protocol allows an application to work between hosts on various different types of MAC layers. [2 marks]

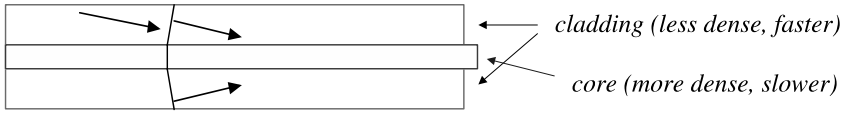
In lectures we discussed the *Unacknowledged Connectionless Service*. That's the simplest connection service; message requests in to the LLC produce message indications out to the MAC layer, and no message confirmations are generated.
LLC is the acronym for Logical Link Control, rather than Link Layer control, some students may have been confused by this typo. If they do, be generous in marking their answers!

(d) Describe the layout for a packet carrying an AppleTalk PDU over an IEEE 802.3 LAN. *(Do this by writing a brief description for each field in the overall packet. Indicate which fields are part of the various encapsulation headers.)* [6 marks]

Ethernet header	*Moves packet between hosts*
6 bytes	Destination Address
6 bytes	Source Address
2 bytes	Packet length *excluding Ethernet header* [1 mark]
LLC header	*Moves datagrams between higher-layer users*
0xAA	Destination Service Access Point
0xAA	Source Service Access Point
0x03	Control: Unacknowledged Connectionless Service [2 marks]
SNAP header	*Provides more LL information*
0x008-00-07 80-9B	SNAP header for AppleTalk [2 marks]
AppleTalk PDU	*The user's AppleTalk datagram* [1 mark]
Ethernet Frame Checksum	*For MAC layer integrity*

2. **Physical Transmission** [13 marks]

(a) Draw a diagram of an optical fibre, and explain briefly how signals are transmitted through it. [3 marks]



[1 mark]

As light travels perpendicular to the wave front, it focuses around the core. Light travels slower in the optically denser core ($\mu_{core} > \mu_{cladding}$) the wave front becomes concave. Light keeps away from the surface of the cladding (and from scratches etc.)
or light suffers internal reflection from cladding/core boundary; this is the usual explanation and the effect is the same.
The result is that light is guided along the fibre core, with very low attenuation, over long distances. [2 marks]

(b) List some differences between single-mode and multi-mode fibre. Give examples of situations where one of these is more suitable than the other. [4 marks]

	Multi-Mode	Single Mode
Core Diameter	50μ or more	1.5 to 5μ
Attenuation	Medium	Low
Application	LANs	Long distance communications
Light Source	LED or Laser	Laser only

2 marks for any reasonable difference, max 4
The lecture slides used m instead of μ for core diameter!

(c) Briefly describe Wavelength-Division Multiplexing? Why is it useful? [3 marks]

WDM means using different bands of wavelengths *(e.g. different colours)* of light to carry different channels of digital data. [1 mark]

Systems which carry few channels are called *Coarse* systems, CWDM, systems with many channels are *Dense*, DWDM. CWDM systems can be made with passive optical components, so they're cheaper. [1 mark]

WDM is useful because it allows us to carry many channels of data through a single fibre, which is often cheaper than using many fibres carrying one channel each. [1 mark]

(d) What is an 'optical amplifier?' Where would you find one in use? What advantage is gained by using an optical amplifier in that situation? [3 marks]

An optical amplifier is a device which amplifies optical signals directly, i.e. with no intermediate conversion to electrical signals. [1 mark]

They are especially useful in undersea cables, e.g. the Southern Cross cable. [1 mark]

Since they have a wide bandwidth, they amplify all the channels the cable can carry. Therefore we can bring more channels into use over time without having to modify the amplifiers – that would be expensive since they're on the bottom of the sea! [1 mark]

3. **WANs, Virtual Circuits** [12 marks]

(a) Explain what is meant by 'best effort' routing; illustrate your answer by describing how IP uses best-effort routing. [2 marks]

Best Effort Routing means that:

- Each router on a packet's path maintains routing tables, so that it knows the 'best,' i.e. least cost, link on which it should forward packets for a given destination.
- Packets therefore progress through the network until they reach their destination. *No state is kept in routers,* that makes it simpler to implement best-effort routing.
- The network makes no attempt to ensure that any packet actually arrives at its destination – that's left to the higher layers

1 marks for any of these points, max 2

(b) What is the difference between a routing algorithm and a routing protocol? Briefly describe the algorithm used for 'distance vector' routing. [3 marks]

A routing *algorithm* is a method of computing routing tables. [1 mark]

A routing *protocol* is an agreed way of exchanging packets so as to carry information about links (and their endpoint nodes) between the network nodes routers (nodes). That data is used by the network's routing algorithm to compute routing tables. [1 mark]

In *Distance Vector* routing, each node copies its own routing table to its neighbouring nodes from time to time. Nodes scan those incoming tables; if they find a better route to some destination, they use it to update their own routing table. [1 mark]

(c) What is meant by a 'Virtual Circuit?' Give two examples of network technologies that support Virtual Circuits. [3 marks]

A *virtual circuit (VC)* is a *fixed* path through a network, through which a user can send *packets* between a specified pair of hosts. To the user the VC behaves as though it was a direct connection between those two hosts. [1 mark]

VCs are identified by number; those numbers can differ for each link along the path. A VC is implemented by setting up tables in switches along the path, mapping VC numbers for incoming packets on each port to outbound ports and VC numbers. [1 mark]

ATM and Frame Relay are two network technologies that support VCs. [1 mark]

(d) What advantages could Virtual Circuits provide, as compared with IP and its 'best-effort' routing? [4 marks]

Best-effort routing is simple and cheap to implement, and performs well enough for most applications. Virtual Circuits provide a fixed path, along which all packets travel. Possible advantages of VCs include:

- Dedicated use of network resources, e.g. a guaranteed bit rate
- Well-controlled quality of Service (QoS), since all packets follow the same path.

2 marks for each advantage, max 4