

Section A

1.

a) TCP already has a sophisticated congestion control and avoidance scheme. However, Explicit Congestion Notification (ECN) is being proposed to enhance this existing scheme. Give a description of the existing scheme of **slow-start** and **congestion avoidance** and say how ECN would improve on it. Your answer should include a note of the role of network routers in both the normal and the ECN schemes.

(15 marks)

b) *While ECN may seem a useful scheme to use for TCP traffic, it may not be suitable for real-time traffic.*

Assuming you are working within a best-effort network only, give explanations for this statement, highlighting:

i) Why ECN would be useful for real-time applications.

ii) The difficulties that might be faced by real-time applications when trying to use ECN.

(10 marks)

[Total 25 marks]

2.

a) Outline the main components of a QoS Routing Architecture.

(10 marks)

b) Give a brief overview of the mechanisms that the Protocol Independent Multicast routing protocol provides for Multicast.

(10 marks)

c) Speculate on what might be done to support a network service that combined together the requirements for QoS Routing and Multicast Routing.

(5 marks)

Note in all the above, note form answers are acceptable.

[Total 25 marks]

3.

a) What are the main components in the Differentiated Services architecture for providing Class of Service. (A picture is often a good idea for illustrating this.)

(10 marks)

b) Recently in the Internet standards community, there was a debate between two differing views on what was required for expedited forwarding.

On the one hand, it was asserted that a bounded delay was required by applications, even though this can only be achieved for very low utilisation (on the order of $1/h$, where h is the hop count). On the other hand, it was proposed that a guaranteed rate was more useful, even if sometimes this might mean that a delay bound could not be given.

Thinking about applications that you have heard of or read about, can you make a list of points for and against each side of the debate.

(15 marks)

[Total 25 marks]