University of Glasgow

Thursday 14 May 2009
9:30 am – 11.30 pm
(Duration: 2 hours)

DEGREES OF MSci, MEng, BEng, BSc, MA and MA (Social Sciences)

COMPUTING SCIENCE 3T: NETWORKED SYSTEMS 3

(Answer all 3 questions.)

This examination paper is worth a total of 60 marks

You must not leave the examination room within the first hour or the last half-hour of the examination.

1. **(a)** A large Ethernet network will comprise a number of hosts, connected together using one or more *hubs* or *bridges*. With reference to the OSI reference model, describe what is the difference between a hub and a bridge.

[2]

(b) In a bridged Ethernet, the bridges snoop on traffic to determine the location of each host. This allows them to directly forward data destined to hosts that have previously sent a packet, since they know where such hosts are located. If a packet is sent to a host that has not previously sent any data itself, though, the bridges will not know its location, and so must flood that packet throughout the network to ensure it's delivered. To make sure this flooding operation doesn't cause packets to circle forever, the bridges build a loop-free *spanning tree* of the network, and flood data along that tree. With the aid of an example, explain how Radia Perlman's distributed algorithm to build a loop-free spanning tree works.

[8]

(c) In contrast to local area networks, which route over the spanning tree, wide area intra-domain networks use either *distance vector* or *link state* routing algorithms. Briefly explain the operation of *distance vector* routing.

[4]

(d) A major problem with distance vector routing is the *count to infinity problem*. Discuss what is this problem, and how it can be mitigated.

[6]

2. **(a)** Communication happens when a *signal* is transported from source to destination via a communications *channel*. The signal conveys some amount of *information*, and the amount of time it takes to transmit the signal will depend on the *bandwidth* of the channel. Explain what is meant by the bandwidth of a channel, and discuss how it relates to the amount of information the channel can convey per unit time.

[5]

(b) At the physical layer, a signal with bandwidth H may be directly encoded onto a channel as a baseband signal, or it may be modulated onto some carrier wave. Explain how carrier modulation allows multiple signals to share a single channel without interfering, and why this is not possible with baseband signals.

[5]

(c) There are several different ways in which a signal may be modulated onto a carrier wave. With the aid of a diagram, briefly explain the operation of one such modulation scheme.

[3]

(d) There are also several different encoding schemes used for baseband signals, for example NRZ, NRZI, and Manchester encodings. Draw a diagram to show how the binary signal 0010111101000010 would be transmitted using each of these encoding schemes. Two problems are avoided by using Manchester encoding instead of NRZ or NRZI encoding; describe these problems, and explain why they don't occur in Manchester encoding.

[7]

3. **(a)** You have written a basic web server program in the laboratory sessions for this course, using the C programming language and the Berkeley sockets and POSIX threading APIs. Describe the design of your web server, explaining the high-level structure of your code, and highlighting how it uses the functions of the Berkeley sockets and POSIX threading APIs.

[12]

(b) Also in the laboratory sessions, you wrote a set of programs to fetch a web page, and parse the content. You saw two different ways in which the HTTP server can indicate the size of the data to be returned: using a *"Content-Length:" header*, or using *chunked transfer encoding*. Explain what is the difference between these methods of signalling the length of the content. Discuss when and why a server might prefer to use chunked transfer encoding rather than content-length.

[8]