University of Glasgow

Wednesday 18 May 2011
9.30 am – 11.00 am
(Duration: 1 hour 30 minutes)

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 45 marks

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

Section A

1. **(a)** Traditional analogue telephones use circuit-switched connections, with filters on the local loop limiting the available bandwidth to approximately 4,000 Hz. In a modern telephone exchange, the analogue signal from the local loop is digitized for onward transmission to the destination exchange. The data rate of that digital signal is 64,000 bits per second. What are the sampling rate and number of bits per sample used in the digitization process? Why was this sampling rate chosen?

[4]

(b) Dial-up modems running on analogue voice lines are limited to 56kbps operation, and often run much slower. Explain where this limit comes from, and why it is rarely reached in practice.

[4]

(c) Residential Internet connections are often provisioned using ADSL technology, using the same physical cable as the traditional analogue voice telephone service. ADSL gives a much higher bandwidth data connection than is possible using a dial-up modem on the voice line, and gives the ability to make phone calls while the data connection is in use. Describe how it is possible to run ADSL and voice telephony on the same physical cable at the same time, highlighting what changes or additions must be made to the local loop in the customer premises and in the telephone exchange to support this operation.

[5]

(d) Why does ADSL achieve much higher data rates than a dial-up modem using the same cable?

[2]

2. **(a)** TCP is a sliding window protocol with positive acknowledgments for received data segments. Briefly describe how such a sliding window protocol works, and explain how to calculate the optimal size of the window based on characteristics of the network.

[5]

(b) A TCP sender cannot start a connection using the optimal window size, since it has no way of knowing the parameters of the network path between itself and the receiver. Instead, the sender will use the slow start algorithm to estimate the path parameters, and hence the window size. Describe how the window size varies when the slow start algorithm is in operation.

[3]

(c) The sliding window algorithm provides TCP with flow control. TCP senders also implement congestion control using an additive increase multiplicative decrease (AIMD) algorithm to vary the window size during the congestion avoidance phase of a connection. With reference to the AIMD parameters α and β, describe how the TCP window size varies under the AIMD algorithm. Discuss why these particular values of α and β were chosen.

[4]

(d) The Internet Engineering Task Force (IETF)–the standards body that maintains the TCP specification–has recently received a proposal from Google to increase the size of the initial window used by TCP from 3-4 segments to around 10 segments. Discuss the potential advantages and disadvantages of such an increase.

[3]

3. **(a)** A common problem that occurs with network code written in C is vulnerability to a buffer overflow attack. Using a combination of C-like pseudo-code, and a diagram of the function call stack, describe one way in which a buffer overflow attack can be conducted, and explain why the attack works.

[10]

(b) Another frequently reported security problem with the Internet is the *distributed denial of service* (DDoS) attack, where a large number of attackers conspire to send unwanted traffic to the victim at the same time. This massively overloads the victim's network connection, making it difficult, if not impossible, for them to conduct their usual business. In the long-term, such attacks are resolved by the actions of the law enforcement officials. Discuss how, in the short-term, the victim and its Internet Service Provider (ISP) can cooperate to reduce the effects of a DDoS attack?

[5]