UNIVERSITY OF BIRMINGHAM

School of Computer Science

Third Year – BSc Artificial Intelligence and Computer Science
First Year – UG Affiliate Computer Science/Software Engineering
Third Year – BSc Natural Sciences
Third Year – BSc Computer Science
Third Year – MSci Computer Science
Third Year – MEng Computer Science/Software Engineering
Third Year – BSc Mathematics and Computer Science
Third Year – BSc Computer Science with Business Management
Fourth Year – BSc Computer Science with Industrial Year
Third Year – MEng Computer Science/Software Engineering with Industrial Year
Fourth Year – BSc Computer Science with Business Management with Industrial Year
Third Year – MSci Computer Science with Industrial Year

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Networks

Summer Examinations 2015

Time allowed: 2 hours

[Answer ALL Questions]

No calculator

1. IPv4 uses 32-bit addresses to identify hosts and routers. There is a world-wide shortage of IP numbers.

   (a) Explain the role of a "subnet mask" in making routing decisions. **[3%]**

   (b) RFC1918 reserves the IP ranges `10.0.0.0/8`, `172.16.0.0/12` and `192.168.0.0/16`. For what purposes are they reserved? `172.16.0.0/12` specifies a range of addresses. As well as "16", which other values for the second byte are included within the range? **[4%]**

   (c) *Network Address Translation* (NAT) is one way to address the shortage of addresses. Explain its rôle, and describe its operation for both TCP and UDP. **[5%]**.

   (d) You are asked to plan the allocation of IP numbers in a business. The ISP from whom you purchase your internet connection has allocated you a "/28". Your network consists of one service running a web application for use by customers, three servers used by your own staff, twenty desktop devices and a wireless network. Sketch a network design, and indicate the addresses you would allocate to each component. **[8%]**

2. Although ethernet is a dominant low-level protocol today, other technologies have been used in local area networks. Ethernet frames are carried over a variety of wide area technologies.

   (a) Explain the difference between a *slotted ring* and a *token ring* when used as local area networks. **[5%]**

   (b) Ethernet is often carried over *wave-division multiplexed* links, because of their large capacity. Explain how WDM makes maximum use of the capacity of a fibre-optic link. **[5%]**

3. TCP uses a "Receive Window" to control how much data can be sent at any given time. Each byte of data is identified by a number in the TCP sequence space.

   (a) What is the size of the receive window field in the TCP packet header? **[1%]**

   (b) What is the size of the sequence number space in TCP? **[1%]**

   (c) In networks with a high bandwidth-delay product, what problem is caused by the limited size of the receive window? Give an example, in terms of bandwidth and either round-trip time or distance, when this problem will arise. **[4%]**

   (d) TCP has an optional feature which addresses this issue: name it and briefly describe its function. **[5%]**

   (e) In networks with a high bandwidth-delay product, what problem is caused by the limited size of the sequence number space? Give an example, in terms of bandwidth and either round-trip time or distance, when this problem will arise. **[4%]**

   (f) TCP has an optional feature which addresses this issue: name it and briefly describe its function. **[5%]**

4. *Virtual LANS* (VLANS) are a means to segregate logically distinct traffic on a shared physical infrastructure.

   (a) Briefly describe the means of operation of VLANs, explaining the rôle of "tags". **[4%]**

   (b) You are approached by a client who wishes to use VLAN tagging to separate sensitive management traffic from less sensitive bulk data in his data centre. Is this a reasonable use for VLANs? Justify your answer. **[5%]**

   (c) If the network were extended into a physically insecure area, what would your advice be? **[5%]**

5. RIP and OSPF are two routing protocols used in local area networks. RIP is an example of a distance-vector protocol; OSPF is an example of a link-state protocol.

   (a) Describe the operation of distance-vector and link-state protocols, paying particular attention to the differences between the techniques. **[10%]**

   (b) OSPF will usually *converge* faster than RIP, particularly in larger networks. Explain the meaning of convergence, and describe why link-state protocols will tend to converge faster than distance vector protocols. **[6%]**.

   (c) RIP usually implements *split horizon*. Explain the concept, and describe the problems that will arise if it is not implemented on a router. **[4%]**

6. Time synchronisation is carried out with NTP.

   (a) Assuming that a client device has only a clock which is consistent in rate and ticks roughly correct microseconds, explain how it would be brought into synchronisation with a master clock. **[6%]**

   (b) Although NTP is able to correct for network delays, it will struggle to give close synchronisation in the face of some common networking problems. State two sources of error caused by network conditions that NTP is unable to deal with, and explain why NTP's algorithms are not sufficient in these circumstances. **[5%]**

   (c) NTP is founded around the correct operation of *Stratum One* clocks, which are assumed to be exactly correct. List two problems that can reduce the accuracy of a stratum one clock, and suggest briefly how they can be mitigated. **[5%]**