



University
of Glasgow

Tuesday, 28 April 2015
09:30 am - 11:00 am
(1 hour 30 minutes)

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

NETWORKED SYSTEMS 3

Answer all 3 questions

This examination paper is worth a total of 60 marks.

INSTRUCTIONS TO INVIGILATORS: Please collect all exam question papers and exam answer scripts and retain for school to collect. Candidates must not remove exam question papers.

1.
 - (a) A routing algorithm is used to find the best path from a sender host to a receiver host, when those hosts are not directly connected. There are two classes of routing algorithm: intra-domain and inter-domain. Explain what is the difference between these two classes, and in what environment each would be used. [4]
 - (b) The distance vector algorithm is sometimes used for intra-domain routing. Describe what information is stored in the routing table at each host when using the distance vector algorithm. [4]
 - (c) The link-state routing algorithm is a popular alternative to the distance vector algorithm. Considering the information stored in the routing tables, and the complexity of the routing algorithm, and the convergence time, outline the advantages and disadvantages of link-state routing when compared to distance vector routing. [6]
 - (d) The Border Gateway Protocol (BGP) is used for inter-domain routing in the Internet. BGP routers build their routing tables based on exchange of Autonomous System (AS)-path vectors giving routes to destination IP address prefixes. The routing information that is exchanged is often filtered to enforce policy, with the Gao-Rexford rules filtering rules being widely used. Describe the Gao-Rexford rules, and explain why they are desirable. [6]
2.
 - (a) The Internet Assigned Numbers Authority (IANA) made the last allocations of IPv4 address space to the regional registries in 2011, and most of regional registries have now assigned their allocation to customers. The IPv4 address space is, for all practical purposes, now fully used. Discuss how you think the network layer of the Internet will continue to grow and evolve, given this constraint on address space availability. Your answer should include a discussion of possible alternatives, and should state, with justification, which you believe to be most likely. [10]
 - (b) Network Address Translation (NAT) and Protocol Translation (NAT-PT) devices are widely used in the Internet. Describe the purpose of these devices, and give four reasons why they are used in the Internet. [6]
 - (c) NAT devices need to keep state for each network flow they translate, and will eventually timeout that state if the flow becomes idle. State what is the typical timeout period for TCP flows and for UDP flows, and explain why the two protocols have different timeouts. [4]
3.
 - (a) Networked systems often follow a layered architecture. This is useful for explaining how a networked system works, and is helpful when writing protocol specifications. Discuss whether it's also a good way of implementing a networked system, or whether an alternative software architecture would be more suitable. Outline the trade-offs involved in developing software to implement a network protocol stack, giving examples of possible design decisions and their impact if appropriate. [8]
 - (b) The Open Systems Interconnection (OSI) reference model provides a standard layered system model. Name the seven layers used in the OSI reference model, in order from lowest to highest. [4]

- (c) Ethernet is an example of a network that operates at the lower two layers of the OSI model. The concept of *bridging* can be used to improve scalability of these layers, by connecting multiple segments of an Ethernet LAN together. To prevent forwarding loops, the Ethernet bridging protocol builds a spanning tree over the connected LAN segments. With the aid of an example, explain the operation of Perlmán's distributed spanning tree algorithm, as used in the Ethernet protocol. [8]