



University  
of Glasgow

Wednesday, 11 May 2016  
09:30 am - 11:00 am  
(1 hour 30 minutes)

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

## **NETWORKED SYSTEMS (H)**

Answer all 3 questions

This examination paper is worth a total of 60 marks.

The use of calculators is not permitted in this examination.

**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) Home networks often connect to the wider Internet using a network address translation (NAT) router, rather than using a standard IPv4 router. Explain how addressing and routing for a sub-network were intended to work in the Internet architecture, and how they work in a NAT-based network. [10]
  - (b) Describe the benefits that come from using network address translation in an IPv4-based network. [3]
  - (c) Describe the problems that are caused by the use of network address translation in an IPv4-based network. [5]
  - (d) Could it make sense to use network address translation in an IPv6 network? Justify your answer. [2]
  
2.
  - (a) The sliding window algorithm can be used for congestion control. Briefly describe how the sliding window algorithm operates when used as part of a network transport protocol. [4]
  - (b) In a sliding window protocol, how large should the window be to ensure full utilisation of a network path? Justify your answer. [3]
  - (c) TCP senders implement congestion control by using an additive increase multiplicative decrease (AIMD) algorithm to vary the sliding window size during the congestion avoidance phase of a connection. With reference to the AIMD parameters  $\alpha$  and  $\beta$ , describe how the TCP window size varies under the AIMD algorithm. Explain why an AIMD algorithm with these parameters was chosen for TCP congestion control. [5]
  - (d) Each TCP packet contains a sequence number to detect lost packets. The receiver includes an acknowledgement of the highest contiguously received sequence number in its responses to the sender. The sender retransmits a lost packet if it sees three or more consecutive duplicate acknowledgements for the same sequence number. With the aid of a diagram, discuss why the threshold for retransmission was chosen to be three consecutive duplicate acknowledgements of the same sequence number. Explain what would be the effect of setting the threshold to either two or four consecutive duplicate acknowledgements instead, and why a threshold of three consecutive duplicate acknowledgements was chosen for the TCP on the Internet. [8]
  
3.
  - (a) Addresses in IPv6 are divided into a network part and a local identifier part. The network part identifies the network to which the host connects, and the local identifier part identifies the host on that network. There are two options for assigning the local identifier part: it can either be derived from the link layer address of the network interface used, or it can be assigned randomly (a so-called privacy address). Explain what are the privacy concerns with using the link layer address as the local identifier part of an IPv6 address, and whether they are solved by using privacy addresses. [5]
  - (b) The Transport Layer Security (TLS) protocol, that is used to secure HTTP connections, uses a mixture of symmetric and public-key cryptography. Explain why this is done, and how it ensures both security and good performance. [5]

- (c) Many networked applications and services are written in languages, such as C and C++, that do not enforce memory safety. Programming mistakes in these languages can lead to exploitable buffer overflows, and serious security vulnerabilities. Given these potential problems, discuss why networked applications are written this way, and whether you think it is justifiable to write new networked code in memory unsafe languages. [10]