University of Glasgow

Friday, 22 May 2020, 09:30 BST
(24 hour open online assessment – Indicative duration 1.5 hours)

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

NETWORKED SYSTEMS (H)
COMPSCI 4012

Answer all 3 questions

This examination paper is worth a total of 60 marks.

1. **(a)** TLS 1.3 supports 0-RTT connection re-establishment to reduce the time it takes to connect to a previously known TLS 1.3 server. Explain how 0-RTT connection re-establishment works, and why it improves performance. State what are the risks inherent in 0-RTT connection re-establishment. Discuss whether you think the benefits of 0-RTT connection re-establishment outweigh the risks, and briefly justify your answer. [10]

(b) When using TLS 1.3 with TCP, the data sent within the TCP connection is encrypted, but the TCP headers remain unencrypted. This exposes the TCP sequence and acknowledgement numbers, control bits such as SYN and FIN, and the contents of TCP extensions such as selective acknowledgement (SACK) blocks to devices in the network. When using the QUIC transport protocol, the corresponding header information is encrypted. Discuss why the designers of QUIC chose to encrypt the transport header information. Give examples to illustrate your answer. [10]

2. **(a)** TCP packets contain a sequence number, and the receiver acknowledges the highest contiguously received sequence number in its responses. The sender retransmits a lost packet if it sees three or more consecutive duplicate acknowledgements for the same sequence number. Explain why the threshold for retransmission for TCP was chosen to be three consecutive duplicate acknowledgements of the same sequence number. Discuss what would be the effect of setting the retransmission threshold to either two or four consecutive duplicate acknowledgements instead. [6]

(b) In addition to reacting to packet loss, TCP (and QUIC) can respond to explicit congestion notification (ECN) signals. State what is ECN, and how it integrates with IP and TCP. Explain how ECN is used to signal the onset of congestion to the receiver, and how congestion is reported back to the sender. Say how the sender reacts to an ECN congestion report. [6]

(c) Video conferencing applications use the Real-time Transport Protocol (RTP), running over UDP/IP, to transmit audio-visual data. RTP sends speech and video data from sender to receiver, and returns feedback on packet loss and reception times that can be used for congestion control and to monitor reception quality. An extension to RTP lets the sender mark the packets containing audio/visual data as ECN capable, and allows the receiver to report whether the received RTP packets contained ECN congestion experienced marks. Discuss why the use of ECN is beneficial for interactive video conferencing applications. [8]

3. **(a)** Many applications use the Domain Name System (DNS) to map between host names and IP addresses. The DNS is a globally distributed database, but relies on well-known root name servers to find the top-level domains in the hierarchy. Imagine some catastrophic failure occurs, causing the DNS root name servers to fail simultaneously, and stop answering queries. Discuss how the effects of such a total DNS failure would manifest themselves, and how quickly they would become visible. [5]

(b) The DNS was originally deployed using UDP as its transport protocol. Explain why UDP used to be a good choice for DNS, and discuss why the DNS is now switching to use

alternative transport protocols. [7]

(c) Explain what is DNS-over-HTTPS, and discuss why its deployment has proven to be controversial. Discuss whether you think deployment of DNS-over-HTTPS is beneficial overall. [8]