



University
of Glasgow

Friday, 30 April 2021
Available from 09:30 BST
Expected Duration: 1 hour 30 minutes
Time Allowed: 3 hours
Timed exam within 24 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 an open book, online assessment
and is worth a total of 60 marks.**

1. (a) You have just moved home, and are looking to provision Internet access for your new apartment. Two providers offer Internet service where you live. Provider A offers you a link with average bandwidth but low latency, whereas Provider B is offering a link with average latency but much higher bandwidth. Both services are the same price. Which of the two services do you purchase? Justify your answer, stating what types of application you intend to use, their characteristics, and how those characteristics influence your choice of provider. [5]
 - (b) Because of the COVID-19 pandemic, many people are now making extensive use of video conferencing applications, such as Webex, Zoom, and Teams. Some users report that these video conferencing applications perform poorly when sharing their residential access link with other traffic, but that this problem can often be fixed by configuring their router to make less buffer space available to store packets. Explain why *reducing* the amount of memory in routers can improve performance. [10]
 - (c) TCP Reno congestion control uses 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 α and β , describe how TCP Reno senders vary the window size using the AIMD algorithm during the congestion avoidance phase of a TCP connection. Discuss why this approach is problematic for interactive video conferencing applications that share a link with such TCP flows. [5]
2. (a) The Internet is often described as a network of networks. What is the relation between a network and an Autonomous System (AS) as used in BGP (Border Gateway Protocol) routing? [2]
 - (b) The following snippet shows an example of the type of data that is stored in the Internet BGP routing table:

Prefix	Next Hop	AS Path
...		
* 12.10.231.0/24	194.68.130.254	5459 5413 5696 7369 i
*	158.43.133.48	1849 702 701 6113 5696 7369 i
*	193.0.0.242	3333 286 5696 7369 i
*	204.212.44.128	234 266 237 3561 5696 7369 i
*>	202.232.1.8	2497 5696 7369 i
*	204.70.4.89	3561 5696 7369 i
*	131.103.20.49	1225 3561 5696 7369 i
* 62.224.0.0/19	134.24.127.3	1740 3561 2578 8371 i
*	194.68.130.254	5459 2529 3561 2578 8371 i
*	158.43.133.48	1849 702 701 3216 3216 3216 8371 8371 i
*	193.0.0.242	3333 286 3561 2578 8371 i
*	144.228.240.93	1239 3561 2578 8371 i
*	204.212.44.128	234 266 237 3561 2578 8371 i
*	202.232.1.8	2497 3561 2578 8371 i
*	205.238.48.3	2914 3561 2578 8371 i
*>	204.70.4.89	3561 2578 8371 i
*	131.103.20.49	1225 3561 2578 8371 i
...		

State what is the relation between the prefixes and the AS path in BGP routing. Explain what devices are represented by the next hop IP addresses, and how these relate to the AS path. Discuss why certain AS numbers, e.g., 3216, appear duplicated in the AS path. [6]

- (c) As the Internet has grown, a number of organisations have deployed private networks on a global scale. These include Internet companies such as Apple, Facebook, Google, Netflix, and Microsoft, as well as cloud computing infrastructure providers and content distribution networks such as Amazon Web Services, Akamai, and Cloudflare, amongst others. The experience of these companies is that the latencies they measure across their private networks are often significantly lower than the latencies measured between similar sites across the public Internet. That is, the latency of intradomain paths is lower than that of the interdomain paths selected by BGP, despite both sets of paths being between data centres in the same cities. For example, the latency measured between the Amazon data centres in São Paulo, Brazil, and Dublin, Ireland, is often lower when measured through Amazon's private network than when measured across the public Internet. Discuss why this might be the case. [12]
3. (a) DNS queries were traditionally sent in UDP packets. Explain why TCP was not considered an appropriate protocol for transporting queries in the original design of DNS. Discuss what has changed that makes modern DNS resolvers increasingly use TCP for transport DNS queries. [8]
- (b) There are two aspects to DNS security: transport security and record security. Briefly explain what type of threat each of these protects against, and discuss which aspect of DNS security is likely to give the biggest improvement to Internet security today. [4]
- (c) Two methods of providing DNS transport security are to run DNS over TLS or to run DNS over HTTPS. Running DNS over TLS is widely accepted, while running DNS over HTTPS has proven to be controversial with operators and governments. Considering technical differences between these transports, operational differences in how they are used, any legal constraints, and business considerations of the operators, explain why DNS over HTTPS is controversial and DNS over TLS is not, and discuss whether you think the concerns about DNS over HTTPS are valid. Justify your answer. [8]