Calculators may be used in this examination provided they are not capable of being used to store alphabetical information other than hexadecimal numbers

UNIVERSITY OF BIRMINGHAM

School of Computer Science

Advanced Networking

Main Summer Examinations 2024

Time allowed: 2 hours

[Answer all questions]

Turn Over

Note

Answer ALL questions. Each question will be marked out of 20. The paper will be marked out of 60, which will be rescaled to a mark out of 100.

Question 1

The two main user-level protocols in the IP suite are TCP and UDP. They have different attributes. It is important to choose the correct one when designing an application.

(a) If a protocol is said to offer "reliable, sequenced delivery", what does this mean? Which of UDP and TCP offer this combination of properties? Briefly explain your answers. **[4 marks]**

(b) Consider two systems A and B, 1000 kilometres apart and connected by a 1 gigabit (1×10^9 bits per second) connection. An application wishes to send a query of 1000 bytes from A to B. This will be followed by an answer of 1000 bytes from B to A. Using firstly UDP and secondly TCP, what is the minimum time this can take? **[4 marks]**

You can assume the maximum size of a packet is 1500 bytes, the speed of light is 3×10^8 metres per second, and the time taken to transmit a single packet is $10\mu s$, $10 \times 10^{-6} s$) irrespective of how much data there is in it or how much calculation is required.

(c) Rather than making a single query and receiving a single answer, instead the application wishes to send 150 megabytes (150×10^6 bytes), which will return a single packet. Again using firstly UDP and secondly TCP, what is the minimum time this can take? You can assume the availability of window scaling and other appropriate technologies for long, fast networks. **[4 marks]**

(d) Explain the concept of "latency" in the context of a wide-area network. How does latency and reliability affect the choice of protocol used for an application? You can refer to your answers in parts (b) and (c). **[8 marks]**

Question 2

The Domain Name System (DNS) is a core component of the current Internet: it is the mechanism by which keys such as hostnames are mapped to values such as IP addresses. The DNS consists of a distributed database of resource records (often called RRs), for example:

```
google.com. 300   IN AAAA 2a00:1450:4009:815::200e
```

(a) In the above example, AAAA is referred to as the record's type. Explain the meaning of the AAAA type. Give two further types, and briefly explain their purpose. **[5 marks]**

(b) Again looking at the above examples, 300 is referred to as the record's Time To Live, or TTL. Explain its use. Briefly discuss the benefits and drawbacks of using TTL values of 60 and 86400. **[4 marks]**

(c) A "recursive" DNS server is able to answer queries about any name on the connected Internet. Given this initial information:

```
.                       51987   IN      NS      a.root-servers.net.
a.root-servers.net.     77631   IN      A       198.41.0.4
```

briefly explain how a recursive server is able to translate www.google.com to an IP address. **[3 marks]**

(d) Your employer has been given the power to radically reshape the Internet overnight. You have been tasked with designing a replacement for the DNS to overcome its known security, performance and scalability problems, exploiting the vastly faster and more reliable computers of 2024. Outline an architecture and indicate where and how it solves an existin problems with the DNS. You should write approximately one page. **[8 marks]**

Question 3

A necessary task in networks is allocating addresses to devices.

(a) Compare and contrast the use of static addressing, DHCP and SLAAC. Which do you think is the preferred solution for consumer IPv6 networks? Justify your answer.
[8 marks]

(b) Subnetting is often used to improve the allocation of larger allocations of addresses, particularly for IPv4. Explain the concept of subnetting, and suggest how it could be used to allocate addresses in 147.188.0.0/16 to a hundred units with an organisation.
[4 marks]

(c) Consider again the scenario give in question 1(c). How would you design a DHCP infrastructure to ensure that addresses were handled correctly – in particular, avoiding duplicates – in the event of the link between the building breaking and reconnecting?
[8 marks]

End of Paper

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Do not complete the attendance slip, fill in the front of the answer book or turn over the question paper until you are told to do so

Important Reminders

- Coats/outwear should be placed in the designated area.
- Unauthorised materials (e.g. notes or Tippex) must be placed in the designated area.
- Check that you do not have any unauthorised materials with you (e.g. in your pockets, pencil case).
- Mobile phones and smart watches **must** be switched off and placed in the designated area or under your desk. They must not be left on your person or in your pockets.
- You are not permitted to use a mobile phone as a clock. If you have difficulty seeing a clock, please alert an Invigilator.
- You are not permitted to have writing on your hand, arm or other body part.
- Check that you do not have writing on your hand, arm or other body part – if you do, you must inform an Invigilator immediately
- Alert an Invigilator immediately if you find any unauthorised item upon you during the examination.

Any students found with non-permitted items upon their person during the examination, or who fail to comply with Examination rules may be subject to Student Conduct procedures.