Xi'an Jiaotong-Liverpool University

西交利物浦大学

Paper CODE	EXAMINER	DEPARTMENT	TEL
CAN201		CAN	

1st SEMESTER 2024/25 FINAL EXAMINATION

Undergraduate – Year 3

INTRODUCTION TO NETWORKING

TIME ALLOWED: 2 Hours

INSTRUCTIONS TO CANDIDATES

1. This is a closed-book examination, which is to be written without books or notes.
2. Total marks available are 100.
3. There are 5 questions. Answer all questions.
4. Answer should be written in the answer booklet(s) provided.
5. Only English solutions are accepted.
6. All materials must be returned to the exam supervisor upon completion of the exam. Failure to do so will be deemed academic misconduct and will be dealt with accordingly.

Question 1 (20 points)

Alice wants to access a webpage located at http://www.example.com/images.html. The main part of content of the HTML file is following:

```
<!DOCTYPE html>
<html>
<head>
    <meta charset="UTF-8" />
    <title>images/Europe/UK/Liverpool</title>
</head>
<body>
<h1>images/Europe/UK/Liverpool</h1>
<a href="/images/Europe/UK">Back</a><br>
<img src="/images/Europe/UK/Liverpool/IMGP2582.JPG"/><br>
<img src="/images/Europe/UK/Liverpool/IMGP2638.JPG"/><br>
<img src="/images/Europe/UK/Liverpool/IMGP2641.JPG"/><br>
<img src="/images/Europe/UK/Liverpool/IMGP2567.JPG"/><br>
<img src="/images/Europe/UK/Liverpool/IMGP2559.JPG"/><br>
<!-- A lot of pure text is skipped here. No more file link ...-->
</body>
</html>
```

The total size of this HTML file is 20 KB (kilobyte). The size of each image is 100 KB. The network conditions are:

- Bandwidth: 10 Mbps (megabit per second)
- RTT (Round Trip Time): 50 ms (millisecond)
- No congestion: RTT remains constant, and there is no network blocking.
- DNS resolution takes 2 RTTs to complete.
- TCP connection setup requires 1.5 RTTs (for the three-way handshake).
- Once the TCP connection is established, data transmission can start immediately.

Assumptions:

- Non-persistent HTTP: Each object (including the HTML file and images) requires a separate TCP connection. Each download takes 1.5 RTTs for TCP setup + 1 RTT for data transmission.
- Persistent HTTP: A single TCP connection is used for all objects. TCP setup takes 1.5 RTTs. The HTML file is transmitted immediately after setup, and each subsequent object requires 1 RTT to download.

Please answer the following questions:

1. For Non-persistent HTTP case, calculate how long it takes (in seconds) for Alice to load the entire webpage using non-persistent HTTP. (5 Points) $(2.5\times6+2)\times50ms = 0.85s$
2. For Persistent HTTP case, calculate how long it takes (in seconds) for Alice to load the entire webpage using non-persistent HTTP. (5 Points) $(2+1.5+1\times6)\times50ms = 0.475s$
3. Explain the role of DNS in Alice's attempt to access the webpage. (5 Points)
4. Why does DNS use a hierarchical and distributed system? (5 Points)

Translate the hostname to IP address. ~ To help find the IP address of the web which will be need for the TCP connection.

① single point of failure ②. Maintenance ③. Traffic Volume ④. Distant centralized Database

Question 2 (20 points)

The transport layer provides two main protocols for data transmission: Transmission Control Protocol (TCP) and User Datagram Protocol (UDP). Both protocols offer different features and are used in distinct scenarios.

1. Please Describe the key differences between TCP and UDP regarding the following aspects: (10 Points)
   - Connection establishment TCP uses three hands shaking. UDP doesn't use.
   - Reliability mechanisms TCP has. Fast retransmission. TCP will retransmit when the packet lose.
   - Data ordering TCP has sequence number.
   - Congestion control TCP has. AIMD, slow start.
   - Overhead and efficiency TCP has high overhead and low efficiency.
2. Suppose a new streaming video platform is deciding whether to use TCP or UDP for transmitting video data to users. Which protocol would you recommend, and why? In your answer, consider the trade-offs related to performance, reliability, and user experience. Provide a reasoned justification for your choice. (10 Points)

UDP. Low latency.

loss tolerant

Question 3 (20 points)

Software-Defined Networking (SDN) has emerged as a paradigm that enables the network control to become directly programmable and the underlying infrastructure to be abstracted for applications.

1. In traditional networking, each router is responsible for both routing and forwarding functions. However, in an SDN architecture, these functions are separated. Could you specify which device is responsible for the routing function and which for the forwarding function within an SDN framework? (4 points)

SDN controller, switch

2. Given that a network utilizing SDN architecture has recently been initialized and the switch is configured with a default flow entry, which option below is most likely to represent the default entry? Please provide an explanation for your choice. (8 points) c). The default entry doesn't know the source and destination, so every unknown flow should be manage. And they need to arrange by the controller to be matched and action successfully next time.
   a) source=1.2.*.*, destination=3.4.*.*, action=forward
   b) source=*.*.*.*, destination=3.4.*.*, action=drop
   c) source=*.*.*.*, destination=*.*.*.*, action=controller
3. Given a switch with three custom flow entries installed, in addition to the original default flow entry, each associated with a priority number (where a higher number signifies greater priority), please identify which flow entry will match an incoming packet with a source IP of 1.2.1.2 and a destination IP of 3.4.5.6. Provide a rationale for your selection. (8 points)

a) source =1.2.*.*, destination=3.4.5.6, action=drop, priority=3

b) source =1.2.1.2, destination =3.4.5.6, action=controller, priority=2

c) source =1.2.*.*, destination =3.4.5.6, action=forward, priority=1

Every flow entry's source and destination are matched to the packet. But ca)'s priority is the highest, so ca) will match it.

Question 4 (20 points)

Consider the following Fig. 4-1, where several subnets are interconnected.

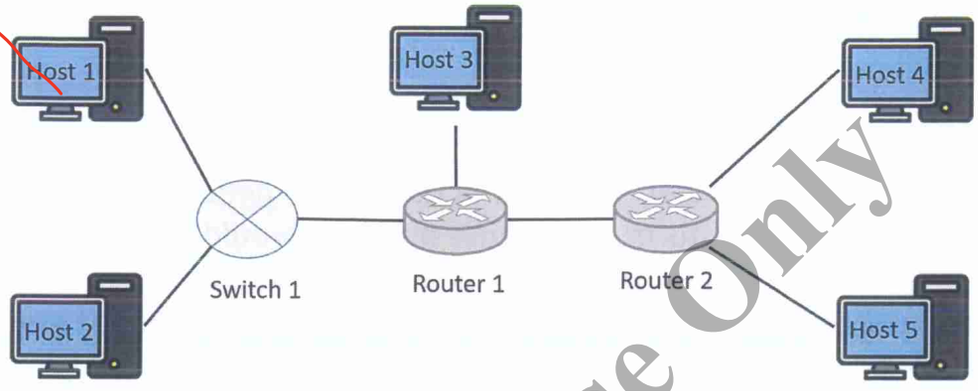

Figure 4-1: Network topology

1. Please list all the subnets in this network. Hint: list them in terms of the corresponding host and router's network interfaces. (11 points)
2. If Host 1 and Host 3 are removed, and Router 2 is replaced by a switch (Switch 2), making Host 4 and Host 5 directly linked to Switch 2, list the new subnets in terms of the corresponding host and router's network interfaces. (5 points)
3. According to the original Figure 4-1, assuming the interface of Host 1 has an IP address 10.0.1.5, and the adapter for that interface has a MAC address aa-aa-aa-aa-aa-aa; the interface of Router 1 lined with Switch 1 has an IP address 10.0.1.1, and the adapter for that interface has a MAC address 11-11-11-11-11-11.

   Now, consider sending an IP datagram from Host 1 to Host 3. Suppose Host 1 has an empty ARP table, while Router 1 has an up-to-date ARP table and routing table respectively. Describe all the steps to succeed in sending the IP datagram. (4 points)

Question 5 (20 points)

Alice and Bob are interested in secure communication, but they face potential threats from Charlie, who may attempt to compromise their communication. Figure 5-1 illustrates Charlie's capability to listen on Alice and Bob's communication channel, enabling him to conduct an eavesdropping attack. Figure 5-2 depicts Charlie executing a spoofing attack by impersonating Alice to send a malicious message to Bob. Regarding the components of the CIA triad, which include **C**onfidentiality, **I**ntegrity, and **A**vailability, given that Alice and Bob opt for **symmetric encryption** to protect their communication, and assuming the original message is M and the symmetric key is K_S, please answer the following questions.

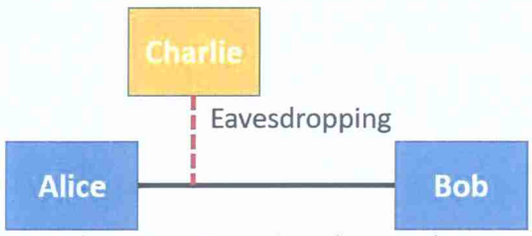

Figure 5-1: Eavesdropping attack

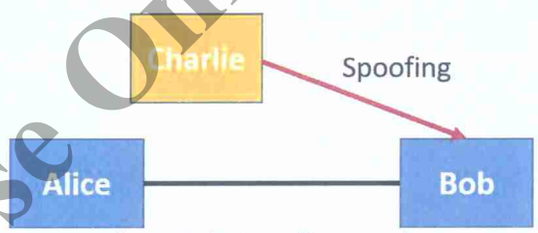

Figure 5-2: Spoofing attack

1. By conducting an eavesdropping attack (see Figure 5-1), which component of the CIA triad is compromised by Charlie? (2 points)

   To protect the communication against eavesdropping, how would Alice and Bob proceed? Describe the actions taken by them respectively. (6 points)
2. By performing a spoofing attack (see Figure 5-2), which component of the CIA triad is compromised by Charlie? (2 points)

   To protect their communication against spoofing, how would Alice and Bob proceed? Describe the actions taken by them respectively. (6 points)
3. Identify the primary challenge for the use of symmetric encryption. (4 points)

1. Confidentiality

Alice

$M \xrightarrow{K_B^+} K_B^+(M) \longrightarrow K_B^+(M) \xrightarrow{K_B^-} M.$

Bob

2. Integrity

Alice

$M \xrightarrow{H(\cdot)} H(m)$, m

$\xrightarrow{K_B^+} K_B^+(H(m), m) \xrightarrow{K_B^-} H(m)$, m

Bob

compare $H(m)$ with $H(\cdot)$

3. The key distribution. The security of sharing symmetric key at first cannot be promised.

---------- *END OF EXAM* ----------