University of Glasgow

Monday 13 December 2021
01.30 pm - 03.00 pm
Duration: 1 hour 30 minutes
Additional time: 30 minutes
Timed exam - fixed start time

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

Networks & Operating Systems Essentials 2

COMPSCI 2024

(RUBRIC: Answer All Questions)

This examination paper is an open book, online assessment and is worth a total of 60 marks

Networked Systems

1. (a) Host A resides in a network with IP address prefix 192.0.2.0/24 and host B in a network with IP address prefix 192.1.2.0/24. Describe how host A can discover host B through the ARP protocol. [2 marks]

(b) Assuming a scenario of strolling in the city and using multiple TCP-based Internet applications on your smartphone; explain why your TCP connections usually do not fail. [4 marks]

(c) Consider the following Python code of two client-side implementations for two different clients.

```
#client1.py
from socket import *
s_name = 'hostname'
s_port = 2789
cl_socket = socket(AF_INET, SOCK_DGRAM)
message = "Hello"
m_in_bytes= str.encode(message)
cl_socket.sendto(m_in_bytes,(s_name, s_port))
n_message, s_address = cl_socket.recvfrom(2048)
print(n_message.decode())
cl_socket.close()

#client2.py
from socket import *
s_name = 'hostname'
s_port = 2000
cl_socket = socket(AF_INET, SOCK_STREAM)
cl_socket.connect((s_name, s_port))
sentence = raw_input('Input:')
cl_socket.send(sentence.encode())
n_sentence = cl_socket.recv(1024)
```

```
print('Server:', n_sentence.decode())
cl_socket.close()
```

State on which protocol each client runs and indicate the segment of code justifying your answer in each one of the servers explaining the code definition. [4 marks]

(d) Answer the following:

1. State whether client1 and client 2 send text or binary data.
2. What is the buffer size associated with the message received from a server in client1.py?
3. Provide the line of code in client2 where data is converted to String.
4. In which IP version is client1 running? Provide the line of code indicating this.
5. Which are the client socket port numbers for both client1 and client2?

[6 marks]

(e) Assume you are a video game software engineer and you need to implement functionalities within an online game engine entailing: (i) an audio/video application-layer game network protocol and (ii) interaction with an HTTP server. Describe what kind of transport layer sockets you will use and justify your design choice for both functionalities. [4 marks]

Security

2. (a) Explain how a secure HTTP (HTTPS) session is enabled and describe the steps for establishing a secure HTTP session (HTTPS) between two hosts. [4 marks]

(b) Assume you are a security architect and you are asked to design and implement the security approach to use for banking data stored locally and in the physical premises (i.e., devices, databases) of a bank. Describe what kind of encryption you would use and justify your answer. [4 marks]

(c) You are a network security architect and you are asked to propose a solution in which demanding real-time network applications require network and transport layer end-to-end encryption. The greatest majority of such applications require: (i) the full optimisation of the logical IP addressing conducted on the network layer without any additional encryption/decryption and, (ii) the full encryption of the actual payload within a packet. Discuss which security protocol(s) you will use and justify your selection. [6 marks]

(d) Alice uses a public WiFi and tries to access secure HTTP site of https://www.gla.ac.uk/myglasgow however her browser redirected her to the HTTP website http://www.gla.ac.uk/myglasgow/. In less than 200 words, describe what could have been wrong and state the steps by which her session could have been hijacked assuming an attacker is in close proximity. [6 marks]

Operating Systems

3. (a) A section of code is reserved for a process to access shared memory resources. Name that code and outline principles leading to mitigating solutions when two processes try to access shared resources at the same time. [4 marks]

(b) Consider a cache with 3 slots (e.g., 3 bits) and the following stream of requests:

A,B,C,B,D,D,C,A,A,B

Give the contents of the cache after each request and indicate cache misses if the cache is using the simple ageing algorithm. Illustrate the inner state for every access (i.e., 3-bit pattern for aging on each page).

[5 marks]

(c) Consider the following set of processes, with the length of the CPU burst given in milliseconds:

Process ID	Burst Time (ms)	Priority
P1	5	1
P2	3	2
P3	7	3
P4	4	2
P5	1	1

Assume that processes have arrived in the order P1, P2, P3, P4, P5, all at time 0. Show the order of process execution with the corresponding time intervals for each algorithm, and compute the turnaround time of each process and the average waiting time over all processes, for each of the following scheduling algorithms: First Come First Serve (FCFS), Shortest Job First (SJF), non-preemptive priority (a smaller priority number implies a higher priority), and pre-emptive Round Robin (RR) with quantum = 2.

[11 marks]