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TECHNOLOGICAL UNIVERSITY DUBLIN

Grangegorman

TU857 – Computer Science (Infrastructure)

Year 2

SEMESTER 1 EXAMINATIONS 2023/24

CMPU 2018 Operating Systems and System Administration

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Instructions to candidates: Answer Question 1 and any 2 others. Question 1 is worth 40 marks, all others are worth 30 marks

Exam Duration: 2 hours

Question 1. General (40 marks)

(a) (18 marks) **Working with the shell:**

i. (4 marks) Explain what the following code (executed in a bash terminal) will do.

```
> echo "hello world" > test.txt
```

ii. (3 marks) Explain what the following code (executed in a bash terminal) will do.

```
apt update 2>> log.txt
```

iii. (4 marks) Explain what the command below would do on a Linux system.

```
> find . -user jack | xargs -d "\n" rm
```

iv. (3 marks) The *ps* command displays all running processes. The code below demonstrates one way of using the *grep* utility to search for any running processes whose name contains the keyword "gnome".

```
ps > running_process.txt
grep "gnome" < running_processes.txt
```

Re-write this command as a one-line command which does not rely on creating temporary files.

v. (4 marks) Explain the difference between the following two commands:

```
(a) cat etc/passwd
(b) cat /etc/passwd
```

(b) (13 marks) **Security:**

i. (4 marks) Explain what the following command (executed in a bash terminal) will do.

```
chmod 700 putty_key.ppk
```

ii. (3 marks) Explain why the */etc/passwd* file does not contain user's passwords on a modern Linux system.

iii. (6 marks) Explain the concept of password hashing and how it improves the security of a user-authentication system

(c) (9 marks) **Security (continued):**

i. (3 marks) Explain the difference between a public and private key in the context of asymmetric encryption.

ii. (6 marks) Explain how a user can authenticate using a public private keypair

Question 2. The Boot Process (30 marks)

(a) (9 marks)

i. (3 marks) Briefly describe how a standard BIOS communicates POST errors to the end-user

ii. (6 marks) Explain the role of GRUB in the boot process of a computer running Linux.

(b) (9 marks)

i. (3 marks) Where would a technician find the code for the Master Boot Record (MBR) on a hard disk?

ii. (6 marks) On a hard disk using an MBR, only primary partitions may be marked as *bootable*. Explain why this is the case.

```
01. [Unit]
02. Description=The NGINX HTTP and reverse proxy server
03. After=syslog.target network-online.target
    remote-fs.target nss-lookup.target
04. Wants=network-online.target
05.
06. [Service]
07. Type=forking
08. PIDFile=/run/nginx.pid
09. ExecStartPre=/usr/sbin/nginx -t
10. ExecStart=/usr/sbin/nginx
11. ExecReload=/usr/sbin/nginx -s reload
12. ExecStop=/bin/kill -s QUIT $MAINPID
13. PrivateTmp=true
14.
15. [Install]
16. WantedBy=multi-user.target
```

Figure 1: Contents of /etc/systemd/system/nginx.service

(c) (12 marks) Figure 1 shows the contents of a configuration file found in the */etc/systemd/service* directory.

i. (3 marks) Explain what is meant by the **After** keyword (line 3)

ii. (3 marks) State the command a user would need to run in order to start the service manually

iii. (6 marks) Explain what is meant by *multi-user.target* (line 16)

Question 3. Kernels (30 marks)

(a) (15 marks) There are three alternative approaches to Operating System kernel design, *monolithic*, *modular* and *microkernel*.

i. (12 marks) Compare and contrast the *monolithic* and *microkernal* kernel designs, highlighting the benefits and drawbacks of each approach.

ii. (3 marks) State which kernel architecture is used by modern-day Linux.

(b) (9 marks)

i. (3 marks) Briefly (1 - 2 sentences) explain why security is a particular concern for kernel code.

ii. (6 marks) Explain how the concepts of *kernel mode* and *user mode* help to increase the security of the kernel.

(c) (6 marks)

i. (3 marks) Explain the concept of drivers in the context of a Linux operating system.

ii. (3 marks) Explain why a Linux driver developer would need to be familiar with the *dmesg* command.

Question 4. Shell Scripting (30 marks)

(a) (15 marks)

i. (3 marks) In the context of BASH scripting, explain the difference between a *variable* and an *environment variable*.

ii. (3 marks) Describe the step(s) required to turn a variable into an environment variable in bash.

iii. (3 marks) A developer creates a bash script and saves it in their home directory as *script.sh*. Their attempt to run the script and the resulting error message is shown below:

```
> ./script.sh

bash: ./script.sh: Permission denied
```

The developer confirms that they are able to read and write the file. What is the most likely cause of this error?

iv. (6 marks) Explain the purpose of the */.bash_profile* and */.bashrc* files on a Linux system. Give one example of when a system administrator or developer may want to edit this file.

(b) (15 marks) The listing below shows the contents of a bash script:

```
01. #!/bin/bash
02.
03. if [ $# -lt 2 ] ; then
04.     exit 2
05. fi
06.
07. find . -user $((whoami))
08. exit $?
```

Explain what each of the following code segments do in this script

i. (3 marks) Line 1.

ii. (3 marks) Lines 3 - 5

iii. (3 marks) $((whoami)) on line 7

iv. (6 marks) Line 8