Program Report

# The Lunar Land Controller

(a) A discussion of the threads and semaphores you used within your code. What could be used in code as an alternative to semaphores and threads? What are the advantages and disadvantages of using them in fulfilling the functional requirements of the program? How has the program managed user input (6 marks)

(b) Instead of UDP, write another code, in the report, related to communication between controller and the server via TCP, assuming that server listens to TCP packets (the communications protocol is described in detail in Section 1.3.1). What could be the advantages and disadvantages of using UDP instead of TCP for the lunar lander code? (7 marks)

(c) A description of the data logging that you have planned. What data should the program log and why? What could be the advantages and disadvantages of logging data five times per second? How often would you be logging data if you weren't assigned a fixed interval and why? At what rate does the size of the file grow while the lander is being controlled? How have you determined this? (7 marks)

You have to include the following three parts for Network and Operating Systems Programming (50%) in your submission:

(1) Please compress all your codes to an archive file (such as a zip file) and upload it to the blackboard Assessment -> Program. More details can be found in Section 1.6.

(2) You must include your codes as appendix 1 in your report. More details can be found in Section 1.6.

(3) The first section entitled ‘The lunar lander controller’. More details can be found in Section 1.8.

# Operating Systems Theory and Concepts

## Advantages of a Command Line in Linux OS

The main advantage of using a command line is its greater speed of performing many (in particular complex) actions, some of which cannot be even achieved through a graphical user interface (GUI). On top of that, additional functionality can be added through scripting. The user can for example quickly move through the computer’s filesystem, compile and run code, edit (text-based) documents or even create short applications to automate tasks.

Another advantage of the command line is that it is lightweight - it uses less processing power and memory compared to a GUI. This makes it perfect in situations in which such things are limited, such as server-side programming, or in less-powerful machines.

The third advantage is that a command line can be used even when GUI is not present or not necessary. For example in hardware-related or server-side applications.

## Processes and Threads

Process (sometimes referred to as “task”) is an instance of a program scheduled for execution by the operating system. It includes all the necessary information needed for running that particular program, such as the process ID, the program’s code and its environment variables, virtual address space and its size. A process can be in several different states depending on the execution circumstance it is currently in – new, ready, running, blocked (waiting for interrupt or other process), terminated. A process can create child processes; they can either share all, some, or no resources. A process is isolated from other processes – it does not share memory with other processes. The creation, termination and execution of processes are usually handled by the operating system itself.

Thread is a segment of a process. All threads belonging to a process share common system resources and each thread has a subset of its process’s address space. A process may have one or multiple threads. Threads of a process may share some resources, however since they may run in parallel, such resources must be carefully managed to ensure a proper execution of the program. The creation, termination and execution of threads is usually handled by their corresponding process.

Scenario 1: Use of multiple threads (multiple windows of a web browser)

Scenario 2: Use of multiple processes (text editor and a web browser)

## Context Switching in an Operating System

Since most machines use only a single CPU, but still need to run several processes at the same time, the operating system must perform a context switch, such that the CPU may be used by multiple processes. A context switch is also used between threads.

Context switch simply means changing from one currently executed process to another. During a context switch, the old process’s state must be saved to the Process Control Block (PCB) (this will ensure that once resumed, the paused process will start executing from the same point at which it ended) and its state updated to blocked, new process is then selected for execution and loaded into the memory and its state is changed to running.

A context switch may occur under different circumstances, these may be for example a system interrupt (the current program must wait for input/output or a server response), or a timer interrupt (at regular intervals, the operating system automatically switches between one process to another). A context switch is considered to be an expensive operation, since it uses the system’s resources, while not performing any actual task. There are several overhead costs – saving, restoring and scheduling processes and the loss of cached resources.

Ubuntu is a popular Linux operating system. Ubuntu has server versions and desktops versions. Server versions of Ubuntu are headless, which means users can only use terminals to operate computers in which a server version of Ubuntu is installed. For example, you can use Nano or Vim to edit documents, and use gcc command to compile your c code. Additional to the terminal based interfaces, desktop versions of Ubuntu have Graphical User Interfaces (GUI), which is more user friendly in some ways. For example, you can use a Chrome Web browser with multiple windows. You can also use text editors (such as LibreOffice Writer, an MS word document editor in Ubuntu) when you use the Chrome web browser.

(a) Please list three advantages of command line in Linux Operating Systems and give one example for each advantage. (9 marks)

(b) Please describe the difference between the processes and threads (6 marks). In the introduction of application scenario of Ubuntu, the following two scenarios are mentioned: [Scenario 1]: you can use a Chrome Web browser with multiple windows; [Scenario 2]: You can also use text editors (such as LibreOffice Writer, an MS word document editor in Ubuntu) when you use the Chrome web browser. Which scenario is the use of multiple threads (1 mark)? Which scenario is the use of multiple processes (1 mark)?

(c) Context switch happens between processes in Ubuntu. Describe in detail the actions taken by an operating system to achieve a context switch between processes. Illustrate your answer with diagrams. Please draw diagrams according to your own understanding and do not copy them from other sources. (8 marks)

# Security

An important requirement of many operating systems is to provide a secure communication function between processes. One approach to the provision of such a function is the Secure Socket Layer (SSL).

(a) Explain in detail how SSL offers protection for operating systems both for inter-processes and also intra-processes. Also explain how SSL can be used for server to browser transactions. (8 marks)

(b) SSL makes use of both symmetric and public-key cryptography. Explain these concepts (i.e. symmetric cryptography and public-key cryptography), distinguishing clearly between them. Give examples of applications of each cryptography method to show how each of these cryptographic techniques is used in SSL, explaining the reasons for the choice of technique in each case. (8 marks)

(c) Explain if SSL is susceptible to DDOS attacks. Explain the nature of this attack. Illustrate your answer with one diagram. Identify the precise vulnerability of SSL to this attack and discuss how users of SSL can protect themselves against it. Please draw diagrams according to your own understanding and do not copy them from other sources. (9 marks)