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Sen Lin was in our group and did not contribute to any part of this project even though they were contacted multiple times, that is why their name is not on this document.

## **EGR 226 Midterm**

**Benjamin Sanders, MS** March 11, 2021

### **1 Introduction**

In this assignment, you will have three Operating Systems (OS) options to choose from.

1. You can take the *mission control* path, in which you research, design and implement operating systems that could best be specialized for the management of individual, highly specialized projects.
2. You can take the *cyber defense* path, in which you research, design and implement operating systems that could best be used in the protection of sensitive data.
3. You can take the *project management* path, in which you research, design and implement operating systems that could best be used to manage operations over large, distributed ventures.

This is a group assignment. Turn in your work on or before the deadline on Blackboard to receive credit.

### **2 Approved Example Contexts**

1. If you choose option *mission control*, you are interested in:
  - (a) an operating system that exists at the core of a Mars Rover
  - (b) an operating system on the spacecraft flown during an Apollo mission
  - (c) an operating system that runs on a Phantom v2512 camera
  - (d) an operating system that runs on the Artec Space Spider
  - (e) an operating system that runs on a Leica Microsystem microscope
2. If you choose option *cyber defense*, you are interested in:
  - (a) an operating system that is used by the UBS Swiss Bank vault
  - (b) an operating system that is used for making secure phone calls via voice scrambler / descrambler
  - (c) an operating system that is used for hosting secure servers: designated by https
  - (d) an operating system used in servers that exhibit onion routing
3. If you choose option *project management*, you are interested in:
  - (a) an operating system that is used to manage warehouse inventory
  - (b) an operating system that is used for stock market trades
  - (c) an operating system that is used to manage large quantities of servers, such as those owned by Google
  - (d) an operating system that is used to manage a University scheduling system of classes
  - (e) an operating system that is used to manage train schedules for a given station

### **3 Research Component**

1. Indicate your choice here: *mission control*, *cyber defense*, or *project management*.

**Mission Control**

2. Identify and name a real example context from the list above that demonstrates your choice. Note: if you would like to find your own example that is not on the above list, you must get this example approved by the instructor, in writing over email, prior to proceeding with the rest of this project. Once approved in writing, or chosen from the above list, write that example here.

### **Mars Rover**

3. Next, you are to research, and provide credible online sources for, the real operating system that is used for this specific purpose. In other words, you may use Wikipedia as a starting point, but then you will need to verify the sources you actually report here as being credible. Upon finding this answer, write that operating system here, along with the links for at least two credible online sources that confirm its use in this purpose.

Operating System: Wind River Systems, Linux

Source 1 Link:

<https://www.pcmag.com/news/linux-is-now-on-mars-thanks-to-nasas-perseverance-rover#:~:text=Previous%20NASA%20Mars%20rovers%20mostly,for%20Perseverance's%20Ingenuity%20helicopter%20drone.&text=When%20NASA's%20Perseverance%20rover%20landed,system%20to%20the%20Red%20Planet.>

Source 2 Link:

<https://www.datamachines.io/blog/linux-on-mars-how-the-operating-system-will-support-ingenuitys-first-flight-on-mars>

4. Explain why this operating system is used for this specific purpose. Give one historical reason, one financial reason, one hardware reason, and one purposeful reason, and provide one or more credible online source links that confirm these reasons.

Historical Reason: Trusted, reliable open source, 30+ year use

Financial Reason: Low to no cost to use

Hardware Reason: High uptime, very stable platform, flexible and easy to customize

Purposeful Reason: automated photography, open source coding to fix software if

needed from earth, controlled flight,

Source Link:

<https://www.datamachines.io/blog/linux-on-mars-how-the-operating-system-will-support-ingenuitys-first-flight-on-mars>

5. Now that you understand why this operating system was chosen for this specific purpose, you must identify the name and version number of operating systems that exist in four categories, that have the potential to be related to the specific purpose you have chosen.

(a) Windows, Name / Version Number: Windows 10/Pro 10.0.19044

(b) Macintosh, Name / Version Number: macOS Catalina 10.15

(c) Linux, Name / Version Number: F Prime Linux 11.10

(d) Other, Name / Version Number: Ubuntu 20.04.4 LTS

6. For each of the above operating systems, provide one reason why it is related to the purpose. Indicate whether this is a historical, financial, hardware or purposeful reason, along with a new, credible online source link for each. For each source, this must be a new link, not being the same base website or quoted material as any previous link.

(a) Windows Reason: widely compatible with many different softwares, supports wide variety of programs and languages, able to run in tandem with linux as well

Source Link:

<https://computerinfobits.com/is-windows-10-good-for-coding/#:~:text=Windows%2010%20is%20a%20good,10%20over%20Mac%20or%20Linux.>

(b) Macintosh Reason: cross platform compatibility, strongly connected to UNIX and Linux systems, no interruptions or bugs while working

Source Link:

<https://ourcodeworld.com/articles/read/1061/3-reasons-why-macos-is-better-than-windows-for-programming>

(c) Linux Reason: open source nature, strong security, support for most to all coding languages, creative customization, reliability, strong community support

Source Link:

<https://itsfoss.com/linux-better-than-windows/>

(d) Other Reason: support for emerging technologies, access to certified hardware, consistent experience, flexibility of upgrading hardware

Source Link:

<https://www.whizlabs.com/blog/why-ubuntu-is-best-os-for-programming/#:~:text=How%3Faudience%20with%20their%20apps%20easily.>

7. Now that you have an understanding of what reasons would be used to choose an operating system for a specific purpose, you are to design a new, very small, operating system as detailed below, for the same specific purpose.

## 4 Design Component

This design will exist in two phases: planning, and execution.

### 4.1 Planning Phase

Create an informal 'box and arrows' diagram, in which you plan out the features of your new operating system.

See the Windows, Unix, Linux, etc. operating systems 'box and arrows' diagrams at the end of Lecture 2 slides (posted on course website) to get an idea for the diagram you want to create. Remember to keep the specific purpose you have chosen in mind. You need to include the below four features from **4.2 Execution Phase** in your diagram, in addition to three custom features of your own choosing. You must include three features that are custom for the specific purpose you have been researching thus far. Write those three features here.

- Feature 1: Charge on Battery
- Feature 2: Finding Water
- Feature 3: Types of Rocks found

### 4.2 Execution Phase

Implement this plan in Java, C++, Python, or C, to be run by a user in an IDE context (IntelliJ, Visual Studio, etc). This implementation needs to include the following features:

1. User Input (keyboard, mouse, or other)
2. Load Program (transfer files from RAM to CPU)

3. Refresh RAM (transfer data from CPU to RAM)
4. User Output (text-based, visual, or audio)
  - The three custom features as detailed in the **4.1 Planning Phase**.

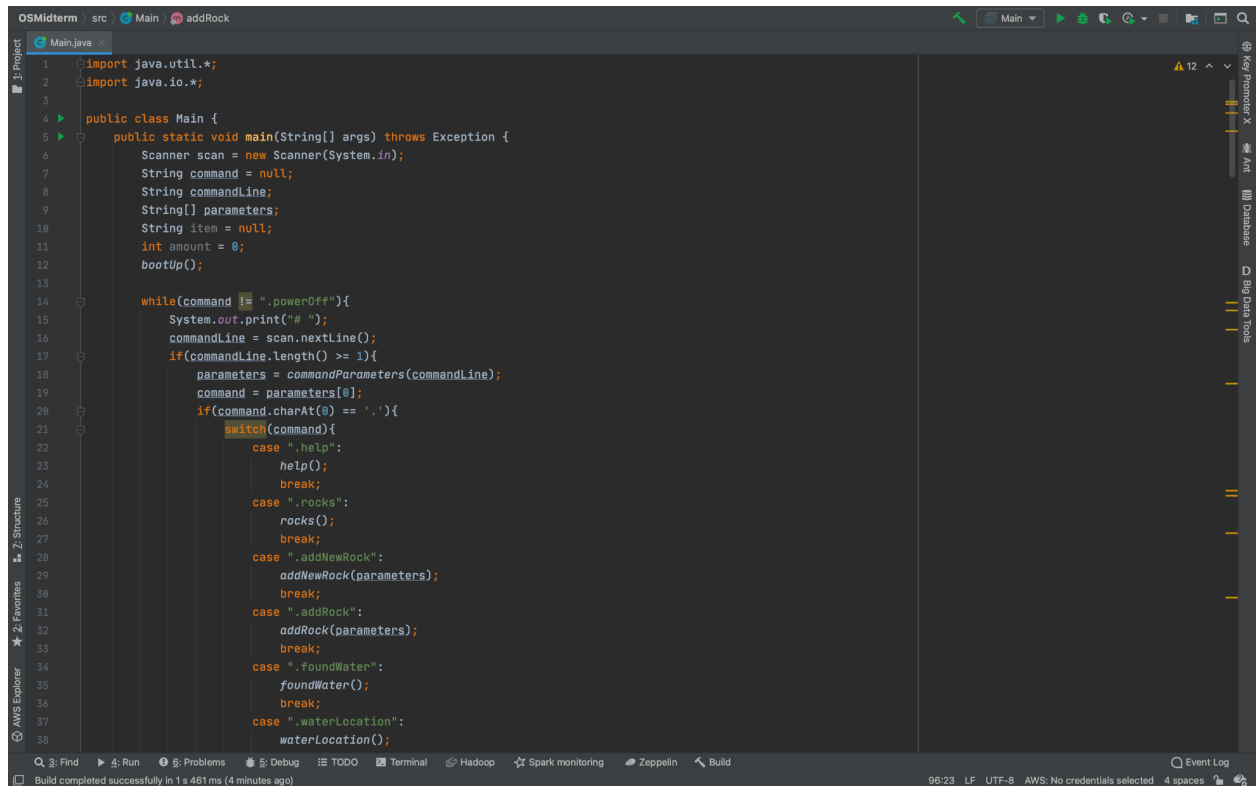
Caveat: I do not expect you to write code that truly interfaces with the drivers you would actually find in a keyboard, CPU, RAM, or monitor. You are welcome to simulate these components using hardcoded data as much as you would like. Consider the following suggestions:

- You may create a data structure called RAM (possibly composed of an ArrayList in Java) that your program can write to and read from as necessary. Perhaps this data structure stores file names of local \*.txt files that contain code that should be executed by the CPU.
- You may use System.out.println() in Java if you want to provide user output.
- You may use any number of math functions to execute CPU functions.

## 5 What to Turn In

Turn in one PDF or Word document on Blackboard, containing the following items.

1. All pages scanned or photographed of the Midterm completed document.
2. Any additional pages you used to complete the assignment.
3. All code created for the assignment, along with test cases.



The screenshot shows an IDE window titled 'OSMidterm' with a project named 'src'. The main file is 'Main.java'. The code is as follows:

```
1 import java.util.*;
2 import java.io.*;
3
4 public class Main {
5     public static void main(String[] args) throws Exception {
6         Scanner scan = new Scanner(System.in);
7         String command = null;
8         String commandLine;
9         String[] parameters;
10        String item = null;
11        int amount = 0;
12        bootUp();
13
14        while(command != ".powerOff"){
15            System.out.print("# ");
16            commandLine = scan.nextLine();
17            if(commandLine.length() >= 1){
18                parameters = commandParameters(commandLine);
19                command = parameters[0];
20                if(command.charAt(0) == '.'){
21                    switch(command){
22                        case ".help":
23                            help();
24                            break;
25                        case ".rocks":
26                            rocks();
27                            break;
28                        case ".addNewRock":
29                            addNewRock(parameters);
30                            break;
31                        case ".addRock":
32                            addRock(parameters);
33                            break;
34                        case ".foundWater":
35                            foundWater();
36                            break;
37                        case ".waterLocation":
38                            waterLocation();
39                    }
40                }
41            }
42        }
43    }
44 }
```

The IDE interface includes a sidebar with 'Project', 'Structure', 'Favorites', and 'AWS Explorer'. The bottom status bar shows 'Build completed successfully in 1 s 461 ms (4 minutes ago)' and '90:23 LF UTF-8 AWS: No credentials selected 4 spaces'.

```
DSMidterm | src | Main | addRock
Main.java
39         break;
40     case ".batteryLife":
41         batteryLife();
42         break;
43     case ".chargeBattery":
44         chargeBattery();
45         break;
46     case ".powerOff":
47         powerOff();
48         return;
49     default:
50         System.out.println("Unknown Command");
51     }
52 }
53
54 }
55 scan.close();
56 }
57
58 public static void help(){
59     System.out.println("Commands:");
60     System.out.println(".help displays what you see now");
61     System.out.println(".rocks displays what rocks the rover has found and how many");
62     System.out.println(".addNewRock <item> <amount> adds new rocks to inventory");
63     System.out.println(".addRock <item> <amount> adds more rocks to current inventory");
64     System.out.println(".foundWater creates a file stating water has been found");
65     System.out.println(".waterLocation checks to see where water was found, if water was already found.");
66     System.out.println(".batteryLife displays the charge of the battery on the rover");
67     System.out.println(".chargeBattery charges the battery to 100%");
68     System.out.println(".powerOff turns off rover");
69 }
70
71 public static void rocks() throws FileNotFoundException {
72     Scanner rocks = new Scanner(new File( pathname: "rocks.txt"));
73     String line;
74     while(rocks.hasNextLine()){
75         line = rocks.nextLine();
76         System.out.println(line);
77     }
78 }
79
80 }
```

```
77 }
78 }
79
80 public static void addNewRock(String[] parameters) throws IOException {
81     String item = item(parameters);
82     int amount = amount(parameters);
83     FileWriter rocks = new FileWriter( fileName: "rocks.txt");
84     rocks.write( str: "\n" + item + ": " + amount);
85     File newRock = new File( pathname: "rocks.txt");
86 }
87
88 public static void addRock(String[] parameters) throws IOException {
89     String item = item(parameters);
90     if (itemExists(item)){
91         Scanner rocks = new Scanner( source: "rocks.txt");
92         String rock;
93         while(rocks.hasNext()){
94             rock = rocks.next();
95             if(rock.equals(item)){
96                 rock = amount(parameters).toString();
97             }
98         }
99     }
100 }
101
102 private static boolean itemExists(String item) {
103     Scanner rocks = new Scanner( source: "rocks.txt");
104     String rock;
105     while(rocks.hasNext()){
106         rock = rocks.next();
107         if(rock.equals(item)){
108             return true;
109         }
110     }
111     return false;
112 }
113
114 public static void foundWater() throws IOException {
```

The screenshot shows an IDE with a Java file named Main.java. The code defines several static methods. A red squiggly line is under the variable 'rock' in line 96, where it is assigned the value of 'amount(parameters).toString()'. A tooltip points to this line with the message: 'The value amount(parameters).toString() assigned to 'rock' is never used'. The IDE interface includes a sidebar with 'Project', 'Structure', 'Favorites', and 'AWS Explorer' views, and a bottom status bar with search, run, and build icons.

```
OSMidterm - src - Main - addRock
Main.java
114 public static void foundWater() throws IOException {
115     File file = new File( pathname: "water.txt");
116     FileWriter water = new FileWriter( fileName: "water.txt");
117     Random rand = new Random();
118     int x = rand.nextInt( bound: 181) - 180;
119     int y = rand.nextInt( bound: 91) - 90;
120     water.write( str: "Water was found at Latitude: " + y + " Longitude: " + x + "\n");
121     water.close();
122 }
123
124
125 public static void waterLocation() throws FileNotFoundException {
126     Scanner water = new Scanner(new File( pathname: "water.txt"));
127     String line;
128     while(water.hasNextLine()){
129         line = water.nextLine();
130         System.out.println(line);
131     }
132 }
133
134 public static void batteryLife() throws FileNotFoundException {
135     Scanner battery = new Scanner(new File( pathname: "battery.txt"));
136     String line;
137     while(battery.hasNextLine()){
138         line = battery.nextLine();
139         System.out.println(line);
140     }
141 }
142
143 public static void chargeBattery() throws Exception {
144     String battery = "battery.txt";
145     String result = fileToString(battery);
146     result = result.replaceAll( regex: "Power: 91%", replacement: "Power: 100%");
147     PrintWriter writer = new PrintWriter(new File(battery));
148     writer.append(result);
149     writer.flush();
150     Thread.sleep( millis: 3000);
151     System.out.println("Battery Fully Charged");
152 }
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OSMidterm src Main addRock
Main.java
191 private static String item (String[] s){
192     String item = "";
193     for (String value : s) {
194         if (integerCheck(value)) {
195             item += value + " ";
196         }
197     }
198     return item;
199 }
200
201 private static boolean integerCheck(String s) {
202     try {
203         Integer.parseInt(s);
204     } catch (NumberFormatException | NullPointerException e) {
205         return false;
206     }
207     return true;
208 }
209
210
211 public static void createRocks() throws IOException, InterruptedException {
212     File file = new File( pathname: "rocks.txt");
213     FileWriter rocks = new FileWriter( fileName: "rocks.txt");
214     rocks.write( str: "Basalt: 5\n");
215     rocks.write( str: "Shale: 43\n");
216     rocks.write( str: "Sandstone: 0\n");
217     rocks.write( str: "Conglomerate: 52");
218     rocks.close();
219     Thread.sleep( millis: 1000);
220     if (file.createNewFile()){
221         System.out.println("33%");
222     }
223 }
224
225 public static void createBattery() throws IOException, InterruptedException {
226     File file = new File( pathname: "battery.txt");
227     FileWriter battery = new FileWriter( fileName: "battery.txt");
228     battery.write( str: "Power: 91%");
229     battery.close();
230     Thread.sleep( millis: 1000);
231     if (file.createNewFile()){
232         System.out.println("66%");
233     }
234 }
235
236
237
238 public static void bootUp() throws IOException, InterruptedException {
239     System.out.println("Welcome to Mars Rover OS!");
240     System.out.println("Checking Rover status");
241     createRocks();
242     createBattery();
243     System.out.println();
244     System.out.println("Type .help for list of commands");
245 }
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