Your name:

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Midterm exam
CPSC+ECE 3220, Prof. Brygg Ullmer
September 29, 2020

Please confirm you have 6 midterm pages (10 multi-part questions); and one two-page scenario (for question 8). This is an **open-book** exam; but you *must not engage **with any form of notes** (including, but not limited to, previous exams) or **with any human**, other than your instructor, **for any form of collaboration or assistance**, per Clemson's academic integrity policy.*

1. Ch. 1: Referee, Illusionist, Glue (10pts)
In Chapter 1, beginning 13.5% into the chapter and spanning 33% of the chapter, the authors consider three primary roles for operating systems: as referee, illusionist, and glue.

a) The authors give 7 examples of the OS as referee, illusionist, and glue (abbreviated CC, WB, MP, MG, MUD, PA, I). Name one of these book examples. In one sentence apiece, argue how the OS serves as referee, illusionist, and glue (three sentences total). (3pts)
Example: A web browser
Web browsers serve as a referee by ensuring that multiple tabs of a browser are responsive and that each script for the tabs are running properly. Web browsers can serve as illusionists through server connections, i.e. background servers dropping and the web browsers automatically connecting to a new server without the user seeing impact. Web browsers may also serve as glue by providing the user with an environment that can execute scripts across operating systems and other hardware platforms.

b) In your first project, you considered campus-scale lighting, South Carolina-scale dam, wearable computing, or irrigation examples. Pick one (be explicit). In one sentence apiece, argue how the OS serves as referee, illusionist, and glue for your chosen project example (three sentences total). (7pts)
I chose wearable computing, which can be argued as a referee by showcasing that all information collected through the wearable is processed as separate collection methods which are all then turned into one data field. As for illusionist, the wearer of the computer need not worry about the device not collecting data properly or a function not working, the device will automatically upload its data to the server and continue collection without the user's awareness. Lastly, the wearable computing works as glue by facilitating the sharing of data across the different facets of the OS; the OS will collect data that can be compared to similar data from another section of the OS and placed together in one data collection.

2. (10 points) a) In two sentences, contrast kernel and user mode in an operating system. (5pts)
Kernel mode is when an operating system takes control of the system due to an interrupt, a processor exception, or system call and begins taking action itself. User mode is when the user selects the input or makes an action call.

b) Per chapter 2 and our in-class S11 discussion, in one to two sentences, briefly explain the implications of user-mode writeable access to the master interrupt vector table. (5pts)
When the OS is in user mode, its kernel stack is empty, meaning the user has full writeable access to the master interrupt vector table that will inform the system of any actions that the user wishes to take place immediately.

3. (11 points) a) Per our S10 and S11 slides and discussion, please identify two specific kinds of information that commonly appear within process control blocks (PCBs). Also, choose and name any computer process or application of your choice. You will probably wish to read (b) before making your selections. (3 points).
Information kinds: process state, memory management information.
Computer process/application: google chrome

b) Under certain circumstances, alpha and gamma radiation, EMP (electromagnetic pulses), and other electromagnetic phenomena may change the state of computer RAM, cache, etc. For random errors impacting your two chosen PCB fields, in one sentence apiece, please identify a possible (a) best case and (b) worst case scenario. Four sentences total (best and worst case for each of your two chosen PCB fields.) (8 points).
Best case for process state of google chrome is that the process continues to run and no tabs/information is lost. Worst case is that the process stops responding, all current information is inaccessible, and the process closes. Best case for memory management of google chrome during an error is that the process continues using a normal amount of memory and there are no impacts on the process. Worst case is that memory overloads or corrupts and the process begins to quit responding or close.

4. Batch vs. time-share computing (10pts)
Volume 1 of your textbook makes 12 references to time-sharing operating systems; and 10 references to batch operating systems.

a) You are most likely a regular user of an operating system on a computer costing less than ~$20. Please identify one such example and, in one sentence, support your answer.
One example of an operating system costing less than $20 would be through the use of a raspberry pi machine that has minimal cost yet the entire functionality of a computer in one tiny system.

b) You are most likely a regular user of a ~computer costing more than $1 billion running a ~batch operating system. Please identify one such example and, in one sentence, support your answer.
One example of running a computer costing more than $1 billion yet using a batch operating system would be an original-themed computer that takes up an entire room, costs millions of dollars, and could only be used by one person at a time yet the OS could load only one program, maybe a few at a time.

For c) and d), consider the following scenario. A "once per 1,000 year" flooding event is threatening Charleston. You accept responsibility for coordinating SC's computational engagement with this threat. For the duration of the threat, you have full authority for managing Clemson's 23,072 CPU core Palmetto resource. Assume that Palmetto has been priorly instrumented to allow immediate transition to either a batch or time-share operating system; but that a choice between the two must be made. (This was the case for the 1958 TX-2 computer, "known for its role in advancing both artificial intelligence and human-computer interaction").

c) Assume that for the duration of the Charleston threat, you decide to operate Palmetto with the batch operating system. In one to two sentences, argue your choice.
We will use the batch operating method to help quickly analyze individual scenarios at speeds unheard of in the time-sharing method. While we load the next scenario, we can have scientists and analysts go over the first scenario and begin charting data.

d) Assume that for the duration of the Charleston threat, you decide to operate Palmetto with the timeshare operating system. In one to two sentences, argue your choice.
We will use the time-sharing operating method so that we can run many scenarios side by side and reduce the time it takes to compare data that has been collected. Using this method, we do not need to run individual scenarios and can have analysts look over all the data being run at once.

5. Processes. (10 points) If you submitted HW1, and if it is technically possible to use your provided figures to answer the following, you must do so. If you uploaded multiple images (two were requested), please pick one of the two for your response, indicating your choice (A or B). If you did not submit HW1, please use this image:
https://clemson.instructure.com/courses/111290/files/folder/images/2020-08-25?preview=7393968

a) Please identify the visible process that is presently using the most RAM. In one to two sentences, indicate why this process, under the circumstances prospectively present during the snapshot, might be using the most RAM.
The process currently using the most RAM was named "VB-Audio Virtual Audio Device…" and was using 34.1 MB of my RAM. Under this circumstance, I was listening to music and the virtual audio process was most likely simultaneously processing the audio through the process in order to have an output that the program desires. This caused the use of a good portion of memory through the RAM.

b) You are interviewing for a senior computing position with cybersecurity implications. (One could argue that every such position has cybersecurity implications.) Toward this, you are reviewing your chosen process listing snapshot with a cybersecurity expert. She asks which of the visible processes you view as the greatest vulnerability, and why. In one to two sentences, what is your response?
My first implication would be to name Google Chrome as the most vulnerable process. Chrome runs with multiple instances of the process open and is constantly accessing and loading information from various sites that may be malicious. If an instance of the process loads malicious information and it is one of the many background instances, a user may not notice it or may never receive warning of it, leading to negative impact on the OS.

6. PR1: Command-line reading (10 pts)
Imagine you are at the Linux command line, in a directory containing one file for each college and university in the USA. (In practice, it would be preferred to divide these files into some form of hierarchy; but that could slightly complicate our command-line interaction).

Imagine that each file contains a single line for each student, faculty, and staff at said institution; reverse DNS naming convention, `edu-xxx.txt`. Imagine that each line consists of a series of space-separated fields. Each field contains no spaces and is strictly alphanumeric. The fields in this file are: `firstname lastname role age gender affiliation`

To consider several example entries in the file `edu-clemson.txt` (with student names redacted in all master files for confidentiality):

```
Brygg      Ullmer      faculty-fullprof     47    M    CECAS-SoC-HCC
Kimiko     Oshima      faculty-assocprof    38    F    CECAS-SoC-CS
Jorge      Rodriguez   faculty-asstprof     29    M    CECAS-SoC-VC
Helga      Helgadottir faculty-instructor   29    F    CECAS-SoC-FOI
NA         NA          student-undergrad    20    F    CECAS-SoC-CS
NA         NA          student-undergrad    18    M    CECAS-SoC-CS
```

Please consider the following commands and output. In one sentence apiece, please interpret the meaning of each command to a member of the general public.

```
# cat edu*txt | grep 'faculty-' | wc -l
1573653
```
This command searches all university lists and outputs the number of times “faculty-“ is located.

```
# cat edu*txt | grep undergrad- | awk ‘{if ($4==18) print}| wc -l
2106000
```
This command searches all university lists and prints the number of lines where “undergrad-“ that are 18 years old is found.

```
# cat edu-clemson.txt | awk '{print $3 $6}' | grep prof | grep CECAS-SoC >
foo; wc -l foo
52
```
This command searches only clemson’s list and prints the number of times a “prof” of the group “CECAS-SoC” is located in the list.

```
# cat foo | awk '{print $2}' | sort | uniq -c
CECAS-SoC-CS   18
CECAS-SoC-HCC  10
CECAS-SoC-VC   12
CECAS-SoC-FOI  12
```
This command searches all lists and prints each unique instance of a different department of “CECAS-SoC” and the amount of times that it is found, as well as sorting it alphabetically.

7. PR1: Command-line reading (10 pts)
For each of the below sentences, relative to the files described in Q8, please write the Linux command that would generate the requested output.

a) Please identify how many faculty-instructors are currently active in US higher education.
```
# cat edu*txt | grep 'faculty-instructor' | wc -l
```

b) Please identify how many female undergraduate students are enrolled within the United States.
```
# cat edu*txt | grep 'undergrad-' | grep ‘F’ | wc -l
```

c) Please identify how many male and females are engaged in higher education, in any role (student, staff, faculty, etc.); two numbers.
```
# cat edu*txt | grep 'faculty-' | grep ‘F’ | grep ‘M’ | awk ‘{print $2}’ | wc -l
```

d) Please identify how many US faculty are less than 24 years old. (E.g., Dr. Erik Demaine joined MIT as an asst. professor at age 20.)
```
# cat edu*txt | grep 'faculty-' | awk ‘{if $4 < 24 print}’ | wc -l
```

8. Ch. 2 and 3 meet Clemson contexts (10 pts)
In S11 and on a provided page, two road-related examples are given. (No prior reading or context is necessary; they were shared slightly in advance given their length.) For each of these, in one sentence apiece, argue how the OS in the described system is shaped by topics in (a) Chapter 2; and (b) Chapter 3. (Please do not refer to the Chapter 1 concepts of referee, illusionist, and glue). Be specific. (Two sentences for each; four sentences total).

a) Clemson crosswalk minder: (5 pts)
Ths Clemson crosswalk minder seems to be shaped around the aspect of time-sharing versus batch operating systems. The crosswalk minder leans more towards batch operating systems that process one instance of information at a time and send the signal while also touching on the kernel abstraction of “reliability” and “privacy”. This system operates for one purpose, has protection against things that could potentially harm it or the transfer of its data, and has the security and privacy of a kernel system that needs to make sure its information is collected and analyzed.

a) Emergency vehicular localization and predictive+coordinative traffic simulation: (5 pts)
The emergency vehicular location simulation is largely based on the concepts of resource sharing, portability, and the concept of adoption. The app that will locate all cars that have applied and then sharing the information with the higher ups in a time of need is an excellent form of managing potential resources. The portability of having it in an app on your phone makes it accessible for almost everyone and spreads the arms of the resource sharing to those who may not have participated beforehand.

9. Your vote matters (12 pts)

You are a member of the nonpartisan Student Voting Cybersecurity Alliance. Specifically, you are leading a 20-student team inspecting the remote management shell of SC's Scytl vote reporting deployment. (Scytl software has been used in SC since 2008; the company declared ~bankruptcy in June 2020.) Your team has noted the following shell code:

```
12020  char *prog, **args;
12021  int child_pid;
12022  // Read and parse the input a line at a time
12023  while (readAndParseCmdLine(&prog, &args)) {
12024     child_pid = fork();      // create a child process
12025      if (child_pid == 0) {
12026         exec(prog, args);       // I'm the child process.  Run program
12027        // NOT REACHED
12028      } else {
12029         wait(child_pid);       // I'm the parent, wait for child
12030         return 0;
12031      }
12032  }
```

a) Please explain the function of lines 12024-12025 to a not-particularly-computationally-literate person. (4 points)
This line of code creates a new, separate instance of the program and begins to run both this new child and the older child at the same time. This allows for the program to check two things at once or run multiple operations at one time, hence the name "fork" as it has multiple tongs.

b) Please explain the function of lines 12028-12029 to a computational expert. (4 points)
In this instance, the section of code being analyzed is under the else portion of the if statement, meaning we are not participating as the child of the fork but rather than parent. Here, we are waiting for the child process to finish running and then return a value of 0 to the top of the program.

c) The github repository indicates modifications impacting lines 12020-12032 within the past 12 months. The prior and subsequent passages have been stable since 2010. In two sentences, please indicate a possible concern regarding some specific vulnerability this might raise. (4 points.)

This snippet of code is how the process reads and understands command line code. If this portion is vulnerable or has been modified, it means there may be a security risk where unauthorized personnel may have access to command line inputs and have changed how the parsing code understands it and processes it. If it is not malicious intent, it may mean the command line code will simply not be interpreted as is expected.

10. Wider afield (7 pts)

As prize for winning an international competition, you are awarded the opportunity to spend summer 2021 as deputy CTO for your institution of choice. Name the institution. (1 pt.)
IBM

During this window, you plan to launch a project engaging a specific topic discussed in textbook chapters 2 or 3. In 3-4 sentences, please identify the OS topic; argue its relevance to your chosen institution; and summarize your initiative. (6 pts)

The project I wish to launch is the undergoing of research for a new, mainstream time-sharing operating system. This OS will have exceptional research capabilities that will allow consumers in businesses or in their homes to have access to a high-powered searching and parsing machine. These machines will give consumers the ability to process their needs at exceeding speeds and access databases for instructional research like never before.