

Assignment 2

Process Reporter - Linux Kernel Module

Due Date: Friday March 2nd, 2018 @ 11:59 pm
Version: 0.12

Objective

The purpose of this assignment is to create a Linux Kernel Module that generates a report describing the running processes on a Linux system. This module will traverse the list of running processes, and introspect information about them. A sample kernel module has been provided on the course web page to assist with getting started.

Key objectives of the assignment include working with the Linux Kernel linked list functions to: (1) iterate through the master process list, and (2) drill down into a process's list of child processes. In addition to working with the Linux kernel process list, a secondary objective of this assignment is to generate and provide report output to the console. Linux kernel modules and kernel routines often provide a "file" based interface to interact with users. A number of proc interfaces are found under the `/proc`. These `/proc` interfaces are dynamically generated files produced by kernel code. They can be generated by native kernel code or by kernel modules. As of Linux kernel version 4.4 the kernel API to support creation of a proc file has changed. The default Ubuntu 16.04 Linux kernel version is $\geq 4.4.x$.

It may be easier to divide and conquer the objectives. Tackling generation of the report independently (and probably before) the output part requirements of the module may be easier. Most of the credit for the assignment (75%) is weighted on setting up and producing the report, not the `/proc` output.

To support development of the report, write a function (or set of functions) to generate the report. **Report generation and process list computation should not occur in the `/proc` file output routines.** In following with good design and coding practices the report and output routines should be decoupled. To support development, debuggers can be used, or information can be written to the `/var/log/syslog` file on Ubuntu.

This file can be traced in a separate terminal window using the command:

```
sudo tail -fn 50 /var/log/syslog
```

In the kernel module here are some example print statements:

```
printk(KERN_INFO "My string=%s\n",text);  
printk(KERN_INFO "My index=%d\n",idx);  
printk(KERN_INFO "My pointer=%lu\n", (unsigned long) myptr);
```

The sample kernel module is here:

http://faculty.washington.edu/wlloyd/courses/tcss422/assignments/hello_module.tar.gz

To extract the sample kernel module:

```
tar xzf hello_module.tar.gz
```

To build the sample module:

```
cd hello_module/  
make
```

To remove a previously installed the module:

```
sudo rmmod ./helloModule.ko
```

To install a newly built module:

```
sudo insmod ./helloModule.ko
```

This sample kernel module prints messages to the kernel logs.

The “**dmesg**” command provides a command to interface with kernel log messages, but it is simple enough to just trace the output as described above.

***** THE KERNEL MODULE SHOULD BE RENAMED TO “procReport” ***
FAILURE TO RENAME THE MODULE WILL RESULT IN A 10 point deduction.**

The kernel module should produce output as below. Output should start with a line that says “PROCESS REPORTER”. Then a count of the number of unrunnable, runnable, and stopped processes should appear followed by one row of text for each running process. Here is a partial output example:

PROCESS REPORTER:

Unrunnable:0

Runnable:4

Stopped:193

Process ID=1 Name=systemd number_of_children=67 first_child_pid=495 first_child_name=systemd-journal

Process ID=2 Name=kthreadd number_of_children=86 first_child_pid=3 first_child_name=ksoftirqd/0

Process ID=3 Name=ksoftirqd/0 *No Children

Process ID=5 Name=kworker/0:0H *No Children

Process ID=7 Name=migration/0 *No Children

Process ID=8 Name=rcu_bh *No Children

Process ID=9 Name=rcuob/0 *No Children

Process ID=10 Name=rcuob/1 *No Children

Process ID=11 Name=rcuob/2 *No Children

Process ID=12 Name=rcuob/3 *No Children

Here is a verbose description of the process output row:

“Process ID=” followed by the process ID (integer) of the current process during a traversal of the process list. Then a space, followed by “Name=” and then the name of the process (string).

If the process has children first display “number_of_children=” followed by the number of children processes started by this process (integer), followed by a space, and then “first_child_pid=” followed by the process ID of the first child created (integer), followed by another space, and then “first_child_name=” followed by the name of the child process (string).

If the process does not have children, simply print “*No Children”.

IF SOME FUNCTIONALITY IS MISSING IN YOUR KERNEL MODULE, PLEASE FOLLOW THE OUTPUT FORMAT AND USE PLACEHOLDERS. For example, use a placeholder like: "number_of_children=XX"

To support development of your kernel module output, it may be helpful to begin by writing code that produces the report, and then print this report to the system log files with `printk`.

Here are some references describing how to create the proc file kernel module interface:

URL may be offline:

<http://www.crashcourse.ca/introduction-linux-kernel-programming/lesson-11-adding-proc-files-your-modules-part-1>

<https://linux.die.net/lkmpg/>

<https://linux.die.net/lkmpg/x769.html>

<http://tuxthink.blogspot.ch/2013/10/creating-read-write-proc-entry-in.html>

<http://stackoverflow.com/questions/8516021/proc-create-example-for-kernel-module/>

Your proc file in the `/proc` directory should be called: "**proc_report**".

*****Failure to follow the naming convention will result in a loss of 10 points.*****

Grading

This assignment will be scored out of 100* points. (100/100)=100%

** If necessary the total points scored from may be lowered, while the total available points remains 100.*

Rubric:

105 possible points: (Currently 5 extra credit points are available)

Report Toal:	60 points
5 points	Output of the PID of each running process
10 points	Reporting the total count of unrunnable, runnable, and stopped processes
5 points	Output of the program name of each running process
10 points	Output of the number of children processes started by every process
	>>> 5 points for the count,
	>>> 5 points for reporting when there are No Children
10 points	Output of the PID of the first child process for every process having children
10 points	Output of the program name of the first child for every process having children
10 points	The ability to generate and provide output of the report multiple times:
	>>> 5 points – reloading your kernel module
	>>> 5 points – crashing the machine
Output Total:	20 points
20 points	Report output uses the Linux <code>/proc</code>
	>>> 10 points - decoupling output routines from report generation

Miscellaneous: 15 points

5 points	Kernel module builds and installs
5 points	Coding style, formatting, and comments
5 points	Following the Output requirements as described above (even without any output)

WARNING!

10 points	Automatic deduction if your kernel module is not called "procReport"
10 points	Automatic deduction if your /proc directory entry is called something other than "proc_report"

What to Submit

For this assignment, submit a tar gzip archive as a single file upload to Canvas.

Tar archive files can be created by going back one directory from the kernel module code with "cd ..", then issue the command "tar czf hello_module.tar.gz hello_module". Name the file the same as the directory where the kernel module was developed but with ".tar.gz" appended at the end: tar czf <module_dir>.tar.gz <module_dir>.

When developing code from the sample, please rename the source directory to procReport.

To rename a directory in Linux use: "mv hello_module procReport".

Pair Programming (optional)

Optionally, this programming assignment can be completed with two person teams.

If choosing to work in pairs, **only one** person should submit the team's tar gzip archive to Canvas.

Additionally, **EACH** member of a pair programming team must provide an **effort report** of team members to quantify team contributions for the overall project. **Effort reports** must be submitted INDEPENDENTLY and in confidence (i.e. not shared) by each team member to capture each person's overall view of the teamwork and outcome of the programming assignment. Effort reports are not used to directly numerically weight assignment grades.

Effort reports should be submitted in confidence to Canvas as a PDF file named: "effort_report.pdf". Google Docs and recent versions of MS Word provide the ability to save or export a document in PDF format.

Distribute 100 points for category to reflect each teammate's contribution for: research, design, coding, testing. Effort scores should add up to 100 for each category. Even effort 50%-50% is reported as 50 and 50. **Please do not submit 50-50 scores for all categories.** Ratings should reflect an honest confidential assessment of team member contributions. ***50-50 ratings and non-confidential scorings run the risk of an honor code violation.***

Here is an **effort report** for a pair programming team (written from the point of view of Jane Smith):

1. John Doe
Research 24
Design 33
Coding 71
Testing 29
2. Jane Smith
Research 76
Design 67
Coding 29
Testing 71

Team members may not share their **effort reports**, but should submit them independently in Canvas as a PDF file. Failure of one or both members to submit the **effort report** will result in both members receiving NO GRADE on the assignment... *(considered late until both are submitted)*

Disclaimer regarding pair programming:

The purpose of TCSS 422 is for everyone to gain experience programming in C while working with operating system and parallel coding. Pair programming is provided as an opportunity to harness teamwork to tackle programming challenges. But this does not mean that teams consist of one champion programmer, and a second observer simply watching the champion! The tasks and challenges should be shared as equally as possible.