Term Project2:

Physical Page Map Profiling

Due:5th Dec. (TUE), 11:59 PM

Submit on I-Campus.

1. Project Introduction

You should implement a kernel module to get the physical page map of all processes via /proc.

You can refer to the data structures for the memory management in Linux Kernel.

2. Problem Specification

2.1 Environment

2.1.1 Ubuntu environment (kernel version 4.9.x)

2.1.2 You can install Ubuntu or use virtual machine for the project

2.1.3 If you use the virtual machine, allocate enough memory to the machine

2.2 Analyze the core data structures related to the projects

Your report should describe the relationship among the following kernel data structures and the management scheme of page table in Linux kernel.

: task_struct, vm_area_struct, mm_struct, file

2.3 Make physical page map

2.3.1 Implement your own loadable kernel module

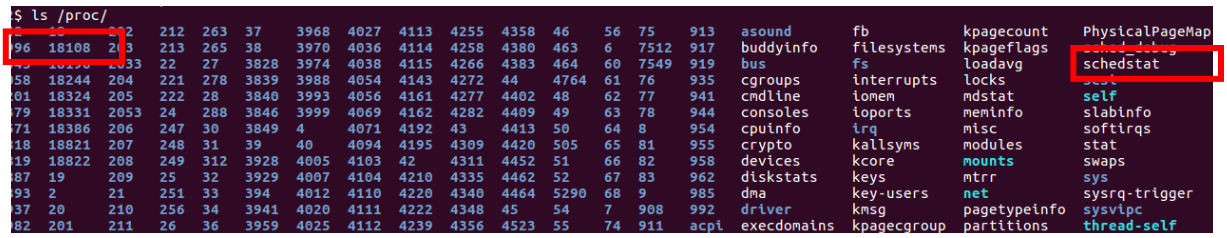

Figure 1 New node ‘PhysicalPageMap’ in proc filesystem

2.3.2 Add a file node named “PhysicalPageMap” in the /proc filesystem

2.3.3 Print the following information about a page per line for all processes within the file “PhysicalPageMap”

Process ID
Process Name
Virtual Page Address
Physical Page Frame Number (PPN)
VMA Range (start address ~ end address)

VMA Size (in Byte)

VMA Name (Classify the VMA into Heap, Stack, Data, Code, or Others[=(null)])

File Name (Mapped to the memory region)

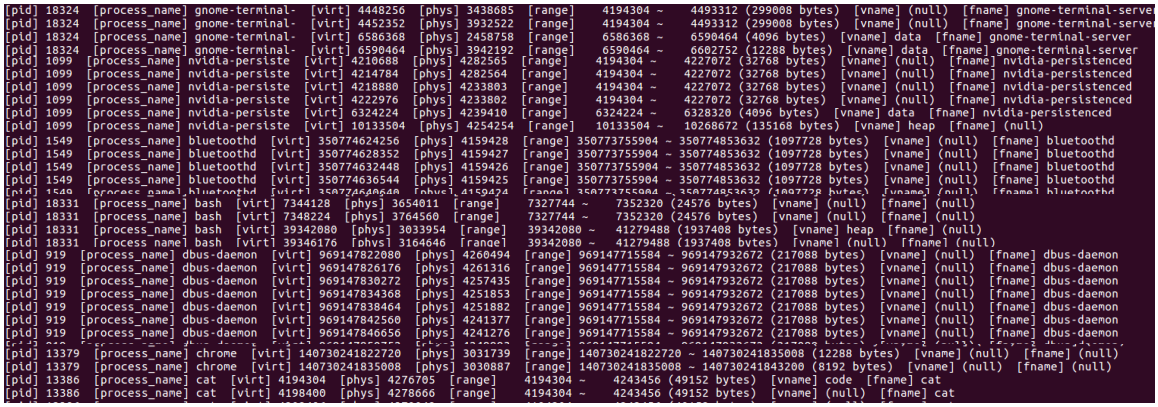

Figure 2 Page Map example

2.3.4 Reference

(fs/proc/task_mmu.c)

```
proc_pagemap_operations (pagemap_read, pagemap_open)
proc_pid_smaps_operations (pid_smaps_open)
proc_pid_smaps_op (show_pid_smap)
```

2.4 Display the Page Map and analyze the result

2.4.1 Implement your own user application which allocates at least 5MB of memory with malloc() and also maps a file into memory with mmap().

2.4.2 While running your application (2.4.1), print the file 'PhysicalPageMap' into the file 'os_pagemap.txt' like Figure 2. The result must include the information about your application.

2.4.3 Draw the memory footprint of **systemd** process (pid 1) and your application like Figure 3, and attach the graph to the report (y-axis: process ID, x-axis: PPN)

2.4.4 You can use GNU plot or Excel to draw the memory footprint.

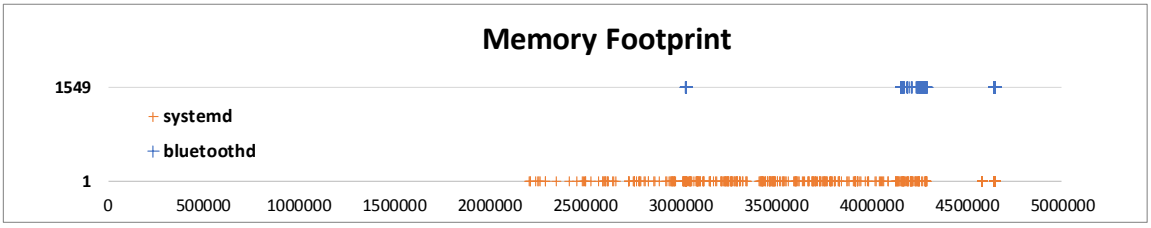

Figure 3 Memory Footprint Example

3. Evaluation Policy

3.1 Analyze the relationship among the data structures mentioned in section 2.2.1 (5 point)

3.2 Describe the management scheme of page table in Linux Kernel (10 point)

3.3 Implement Loadable Kernel Module (5 point)

3.4 Create the file node of "PhysicalPageMap" in the /proc filesystem (5 point)

3.5 Print the process IDs and process names (5 point)

3.6 Print the virtual page addresses, VMA Ranges, and VMA sizes (10 point)

3.7 Print the VMA names (10 point)

3.8 Print the Physical Page Frame Numbers (20 point)

3.9 Print the file name mapped to each memory region (10 point)

3.10 Draw the memory footprint of two processes (10 point)

3.11 Report (10 point)

Job	Data structure analysis	Page table management description	LKM impl.	New file 'PhysicalPageMap'	Process ID Process Name
Score	5	10	5	5	5

Job	Virtual Page Address VMA Range VMA Size	VMA Name	PPN	File Name	Memory Footprint	Report	Total
Score	10	10	20	10	10	10	100

4. Submission

- The final output should be a compressed zip file named **[student_id]_proj2.zip**, which includes **[student_id]_report.pdf, your_module_code.c, Makefile_for_module, your_application_code.c and os_pagemap.txt**
- Please describe the key parts of your code in the report.
  Don't attach the whole source codes in the report. Just key parts.
  (you will submit your codes too.)
- Please submit on i-Campus.

5. Notice

- You should do the term project for yourself
- If you have a question, send email to jjysienna@gmail.com with the title of [CSE3047-41] Term project1 Question, [Student ID], [Your Name]
- Your email questions should describe the problem in detail with screenshots.

- If you cheat on the project, you will finally fail this course. (F grade)
  - If I find two similar source codes or reports, both students will fail this course.
- You will get -15 points per one day delay.
- No need to submit after 3 days (We will not get more submissions after 3 days)

Have fun!
