Operating System DA - II

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Code

1) Program.c

```
#include<linux/module.h>
#include<linux/kernel.h>
#include<linux/kthread.h>
#include<linux/sched.h>
#include<linux/init.h>

MODULE_AUTHOR("Aadhitya Swarnesh - [redacted]");
MODULE_LICENSE("GPL");
MODULE_DESCRIPTION("A kernel program for multiplication
of two numbers and to get info on its execution.");

static void end(void);

static int __init start(void)
{
    printk(KERN_INFO "Loading Multiplication Custom
kernel module...\n");
    printk(KERN_INFO "The starting memory location of the
module is :  %p\n", (void*)start);
    int a, b, c;
    a = 10;
    b = 20;
    printk(KERN_INFO "The first number is  : %d\n", a);
    printk(KERN_INFO "The second number is  : %d\n", b);
    c = a * b;
```

```
    printk(KERN_INFO "The resultant number is  : %d\n",
c);
    int pid = task_pid_nr(current);
    printk(KERN_INFO "The pid is :  %d\n", pid);
    printk(KERN_INFO "The ending memory location of the
module is :  %p\n", (void*)end);
    return 0;
}

static void __exit end(void)
{
    printk(KERN_INFO "End of module. Bye!!!\n");
}

module_init(start);
module_exit(end);
```

2) Makefile

```
obj-m = program.o
all:
    make -C /lib/modules/$(shell uname -r)/build M=$(PWD)
modules
clean:
    make -C /lib/modules/$(shell uname -r)/build M=$(PWD)
clean
```

Output

```
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$ make
make -C /lib/modules/5.5.5/build M=/home/aadhitya/Documents/vs-code/os/da2 modules
make[1]: Entering directory '/home/aadhitya/Documents/linux-5.5.5'
  Building modules, stage 2.
  MODPOST 1 modules
WARNING: /home/aadhitya/Documents/vs-code/os/da2/program.o(.init.text+0x79): Section mismatch in reference from the function init_module() to the functio
n .exit.text:end()
The function __init init_module() references
a function __exit end().
This is often seen when error handling in the init function
uses functionality in the exit path.
The fix is often to remove the __exit annotation of
end() so it may be used outside an exit section.

make[1]: Leaving directory '/home/aadhitya/Documents/linux-5.5.5'
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$ modinfo program.ko
filename:       /home/aadhitya/Documents/vs-code/os/da2/program.ko
description:    A kernel program for multiplication of two numbers and to get info on its execution.
license:        GPL
author:         Aadhitya Swarnesh - [redacted]
srcversion:     EFECA06CFC581E7E3611122
depends:
retpoline:      Y
name:           program
vermagic:       5.5.5 SMP mod_unload
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$ sudo insmod program.ko
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$
```

```
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$ tail /var/log/kern.log
Apr 29 17:55:56 aadhitya-VirtualBox kernel: [ 4158.727129] The pid is :  9961
Apr 29 17:55:56 aadhitya-VirtualBox kernel: [ 4158.727129] The ending memory location of the module is :  0000000045ae5571
Apr 29 18:12:50 aadhitya-VirtualBox kernel: [ 5172.222412] End of module. Bye!!!
Apr 29 18:13:13 aadhitya-VirtualBox kernel: [ 5194.546436] Loading Multiplication Custom kernel module...
Apr 29 18:13:13 aadhitya-VirtualBox kernel: [ 5194.546438] The starting memory location of the module is :  000000009ae02a54
Apr 29 18:13:13 aadhitya-VirtualBox kernel: [ 5194.546439] The first number is  : 10
Apr 29 18:13:13 aadhitya-VirtualBox kernel: [ 5194.546439] The second number is  : 20
Apr 29 18:13:13 aadhitya-VirtualBox kernel: [ 5194.546440] The resultant number is  : 200
Apr 29 18:13:13 aadhitya-VirtualBox kernel: [ 5194.546440] The pid is :  11114
Apr 29 18:13:13 aadhitya-VirtualBox kernel: [ 5194.546441] The ending memory location of the module is :  0000000045ae5571
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$
```

Analysis

Page Swaps :

In order to get the Page swaps :

```
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$ ps -o min_flt,maj_flt 9961
 MINFL  MAJFL
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$
```

Context Switches :

```
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$ ps aux|grep 15021|awk '{print $5}'
21532
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$ ps aux|grep 15021
aadhitya 11917  0.0  0.0  21532  1088 pts/0    S+   18:21   0:00 grep --color=auto 15021
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$
```

To view all context switches taking place :

```
aadhitya@aadhitya-VirtualBox:~/Documents/vs-code/os/da2$ pidstat -w
Linux 5.5.5 (aadhitya-VirtualBox)       29/04/20        _x86_64_        (2 CPU)

18:22:45      UID       PID   cswch/s nvcswch/s  Command
18:22:45        0         1      5.93      0.59  systemd
18:22:45        0         2      0.03      0.00  kthreadd
18:22:45        0         3      0.00      0.00  rcu_gp
18:22:45        0         4      0.00      0.00  rcu_par_gp
18:22:45        0         6      0.00      0.00  kworker/0:0H-kblockd
18:22:45        0         9      0.00      0.00  mm_percpu_wq
18:22:45        0        10      1.40      0.01  ksoftirqd/0
18:22:45        0        11     35.80      0.00  rcu_sched
18:22:45        0        12      0.28      0.00  migration/0
18:22:45        0        13      0.00      0.00  idle_inject/0
18:22:45        0        14      0.00      0.00  cpuhp/0
18:22:45        0        15      0.00      0.00  cpuhp/1
18:22:45        0        16      0.00      0.00  idle_inject/1
18:22:45        0        17      0.29      0.00  migration/1
18:22:45        0        18      0.82      0.00  ksoftirqd/1
18:22:45        0        20      0.00      0.00  kworker/1:0H-kblockd
18:22:45        0        21      0.04      0.00  kdevtmpfs
18:22:45        0        22      0.00      0.00  netns
18:22:45        0        23      0.00      0.00  rcu_tasks_kthre
18:22:45        0        24      0.00      0.00  kauditd
18:22:45        0        25      0.01      0.00  khungtaskd
18:22:45        0        26      0.00      0.00  oom_reaper
18:22:45        0        27      0.00      0.00  writeback
18:22:45        0        28      0.00      0.00  kcompactd0
18:22:45        0        29      0.00      0.00  ksmd
18:22:45        0        30      0.00      0.00  khugepaged
18:22:45        0       123      0.00      0.00  kintegrityd
18:22:45        0       124      0.00      0.00  kblockd
18:22:45        0       125      0.00      0.00  blkcg_punt_bio
18:22:45        0       126      0.00      0.00  tpm_dev_wq
18:22:45        0       127      0.00      0.00  ata_sff
18:22:45        0       128      0.00      0.00  md
```

Explanation

In the kernel program written above we have initialised two numbers and have performed a simple multiplication calculation, a typical example for abstracting to as an example of a process.

We have also printed the starting and the ending location of the initialisation and the clean-up function, which marks as the starting point and the finishing point of any program respectively. Thus with these information we can get teetotal memory occupied by the program.

In the next step we have tried to get the number of page swaps, that might have occurred during the execution of the program, as we have just performed multiplication in our program, there are no page swaps as it is not a memory exhaustive program. A page swap occurs when there is a page fault and the executed command gives us the number of page faults. A page fault occurs when a program attempts to access data or code that is in its address space, but is not currently located in the system RAM. Swapping refers to copying the entire process address space, or at any rate, the non-shareable-text data segment.

MINFL- minor page faults
MAJFL-major page faults

In order to execute the required command in the terminal, we require the process id, that we obtain in the program using the **task_pid_nr(current)** command. We substitute the pid obtained here to get the page fault count.

A context switch is a procedure that a computer's CPU follows to change from one task (or process) to another while ensuring that the tasks do not conflict. We use the **pidstat -w** command to see all the context switches that are taking place currently in the system.