Report of assignment 1

120090770 罗开诚

1.Develop Environment Install

First, I didn't understand how to install linux 5.10 and I did it with wrong way, installing 5.10.1-generic, founding it useless to this assignment. Then I tried the method offered in tutorial PPT. Download the .xz file, copy and unzip it to the virtual machine and follow the instruction to build the environment using the command $make -j$(nproc). It was enough to finish program1. Thus, I felt everything was done until I found some critical functions like do_execve(), kernel_clone() were unusable in program2. I looked up piazza posts and tutorial text carefully and found that I needed to change and compile the kernel. Then, I changed the kernel source file, added these functions Export_sysbol, complied the kernel and externed these fucntions in my program. I was going well after knowing the problem and how to fix it.

2.Program Design

Program1:

Task 1 is easy to finish. Fork() function forked the process in start. Parent process got the result of pid of child process, and child process got the result 0. Then I use if/else to distinguish the child process and parent process by pid. In child process with pid 0, if/else executed the test program by execve() function, while parent process waited for child process result by waitpid(). After child process raise signals, parent process using switch()/case() function to dealt with the return value and output which signal received from child process.

Program 2:

Task 2 required more time and strong learning skill to finish, especially looking up the source code, learning development of loadable kernel module and modified and recompile the kernel. In __init function, I used kthread_create to create a kernel thread to execute the myfork function, and woke up the process. In my_fork() function, I constructed a struct kernel_clone_args to use the function kernel_clone to create. Then, my_fork() printed the pid of child process and itself and wait the result of child process using my_wait().

In my_exec(), I used do_execve() function to execute the test program. In my_wait(), I builded a struct wait_opts to use function do_wait, getting the stat of child process by its pid. After do_wait function, I got the return signal of child process, but the signal was not correct. To get the correct result, I added the result "& 127", and using switch()/case() function to judge the result, outputting the corresponding signal.

3.Assignment Learning Outcome:

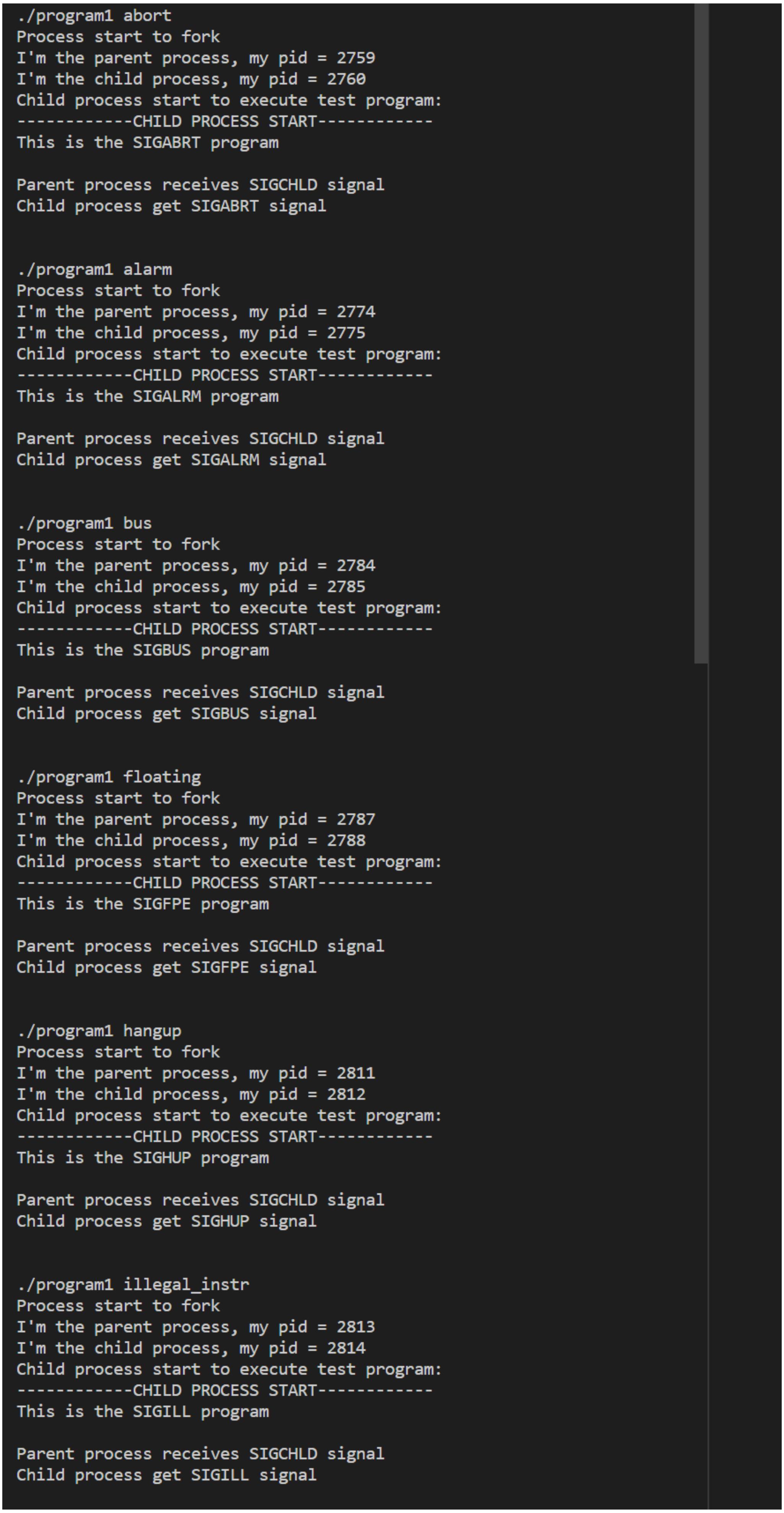
In this assignment, I learned

- Difference between user mode and kernel mode with the aspects of execution, function, development and output

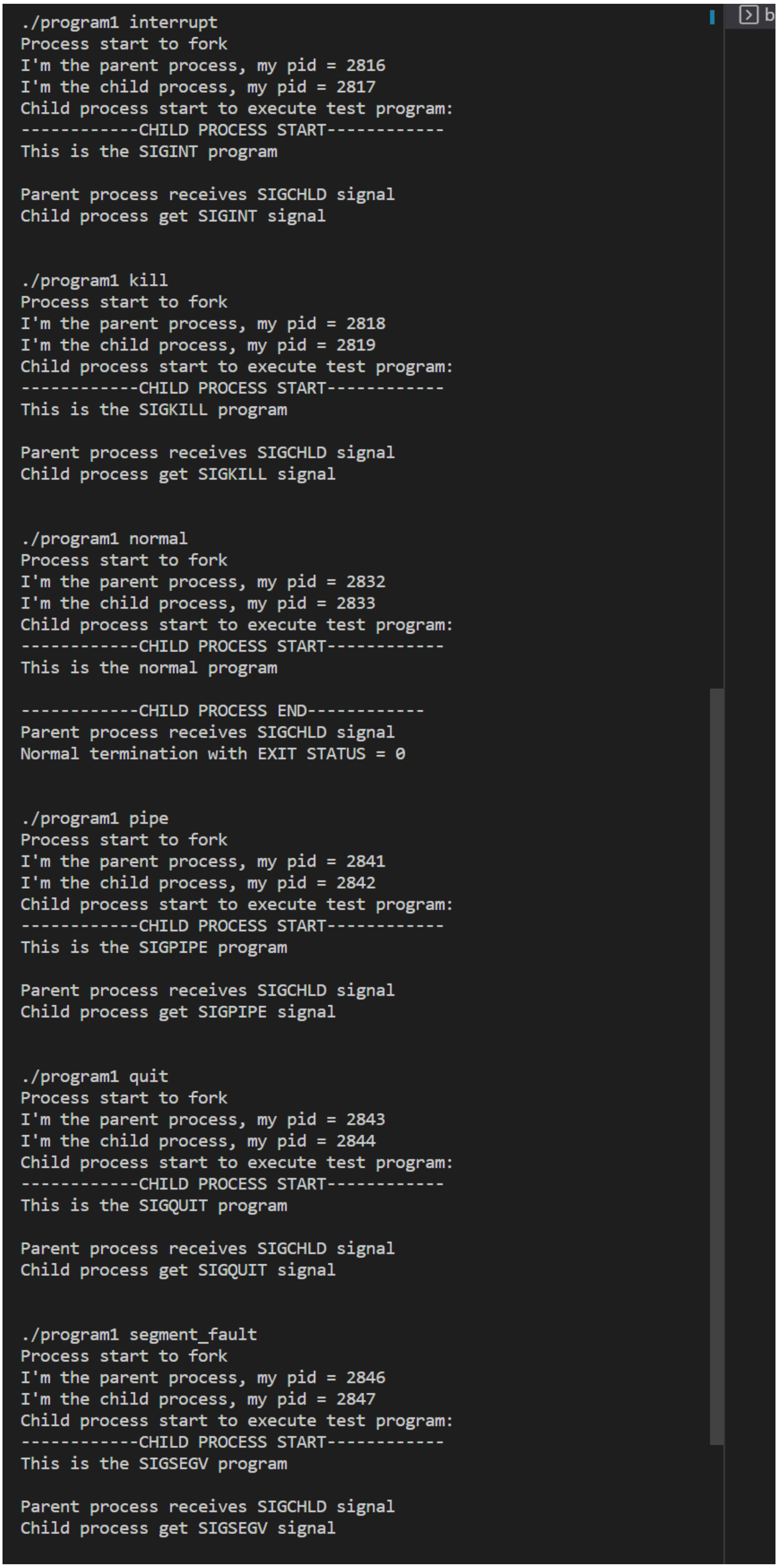
- Install and compile of Linux kernel
- Linux document looking up skill
- Clang-format usage
- Virtual machine install using vagrant
- Basic Linux command
- Basic knowledge of loadable kernel module
- Compile, modify Linux kernel and export the source function
- Makefile creating

4. Output Screenshot

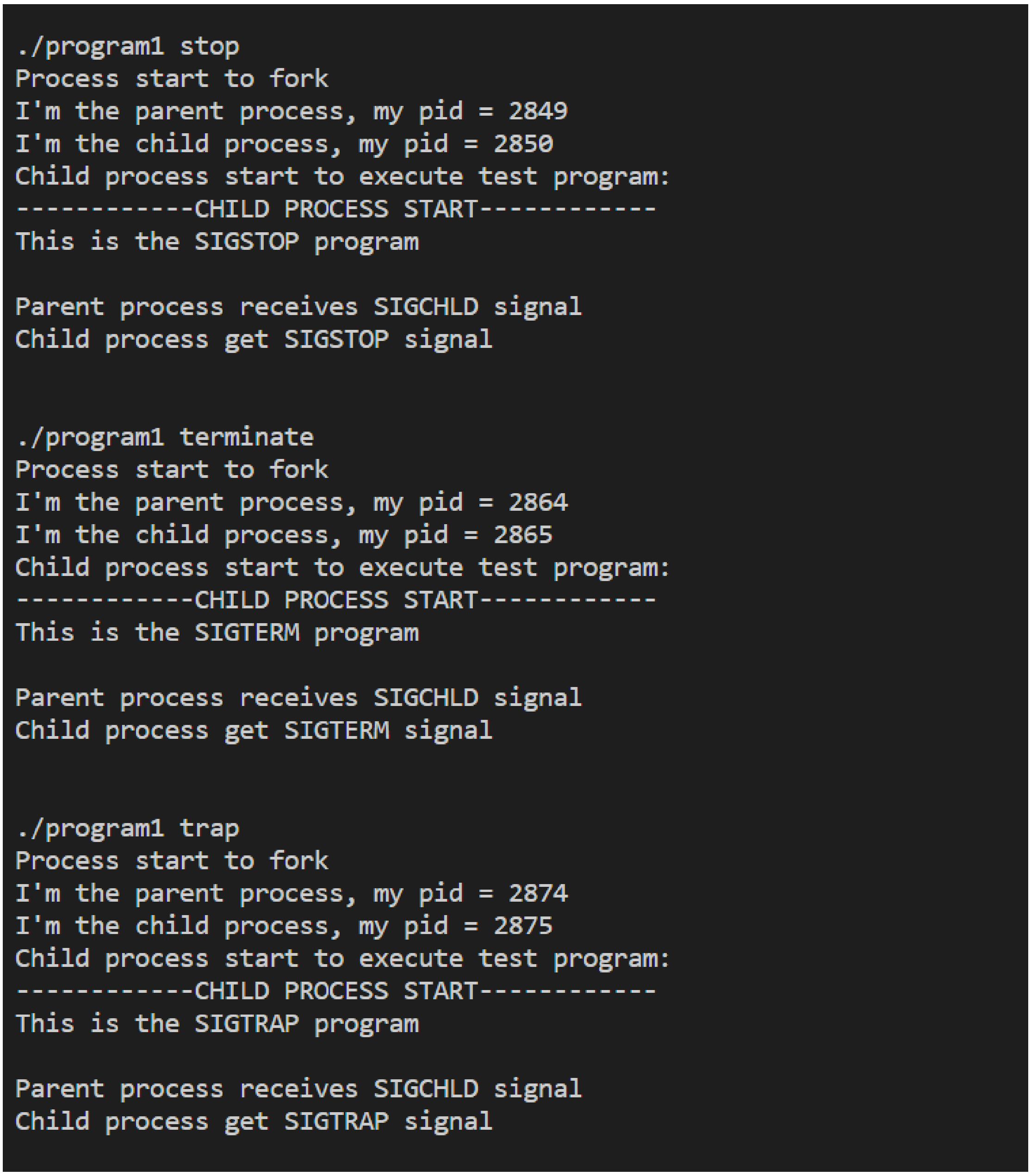
Program 1：



```
./program1 abort
Process start to fork
I'm the parent process, my pid = 2759
I'm the child process, my pid = 2760
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGABRT program

Parent process receives SIGCHLD signal
Child process get SIGABRT signal


./program1 alarm
Process start to fork
I'm the parent process, my pid = 2774
I'm the child process, my pid = 2775
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGALRM program

Parent process receives SIGCHLD signal
Child process get SIGALRM signal


./program1 bus
Process start to fork
I'm the parent process, my pid = 2784
I'm the child process, my pid = 2785
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGBUS program

Parent process receives SIGCHLD signal
Child process get SIGBUS signal


./program1 floating
Process start to fork
I'm the parent process, my pid = 2787
I'm the child process, my pid = 2788
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGFPE program

Parent process receives SIGCHLD signal
Child process get SIGFPE signal


./program1 hangup
Process start to fork
I'm the parent process, my pid = 2811
I'm the child process, my pid = 2812
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGHUP program

Parent process receives SIGCHLD signal
Child process get SIGHUP signal


./program1 illegal_instr
Process start to fork
I'm the parent process, my pid = 2813
I'm the child process, my pid = 2814
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGILL program

Parent process receives SIGCHLD signal
Child process get SIGILL signal
```

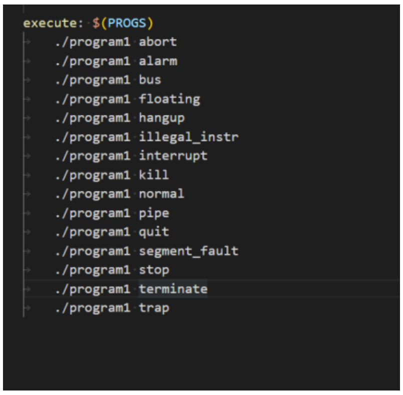


```
./program1 interrupt
Process start to fork
I'm the parent process, my pid = 2816
I'm the child process, my pid = 2817
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGINT program

Parent process receives SIGCHLD signal
Child process get SIGINT signal


./program1 kill
Process start to fork
I'm the parent process, my pid = 2818
I'm the child process, my pid = 2819
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGKILL program

Parent process receives SIGCHLD signal
Child process get SIGKILL signal


./program1 normal
Process start to fork
I'm the parent process, my pid = 2832
I'm the child process, my pid = 2833
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the normal program

------------CHILD PROCESS END------------
Parent process receives SIGCHLD signal
Normal termination with EXIT STATUS = 0


./program1 pipe
Process start to fork
I'm the parent process, my pid = 2841
I'm the child process, my pid = 2842
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGPIPE program

Parent process receives SIGCHLD signal
Child process get SIGPIPE signal


./program1 quit
Process start to fork
I'm the parent process, my pid = 2843
I'm the child process, my pid = 2844
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGQUIT program

Parent process receives SIGCHLD signal
Child process get SIGQUIT signal


./program1 segment_fault
Process start to fork
I'm the parent process, my pid = 2846
I'm the child process, my pid = 2847
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGSEGV program

Parent process receives SIGCHLD signal
Child process get SIGSEGV signal
```



```
./program1 stop
Process start to fork
I'm the parent process, my pid = 2849
I'm the child process, my pid = 2850
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGSTOP program

Parent process receives SIGCHLD signal
Child process get SIGSTOP signal


./program1 terminate
Process start to fork
I'm the parent process, my pid = 2864
I'm the child process, my pid = 2865
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGTERM program

Parent process receives SIGCHLD signal
Child process get SIGTERM signal


./program1 trap
Process start to fork
I'm the parent process, my pid = 2874
I'm the child process, my pid = 2875
Child process start to execute test program:
------------CHILD PROCESS START------------
This is the SIGTRAP program

Parent process receives SIGCHLD signal
Child process get SIGTRAP signal
```

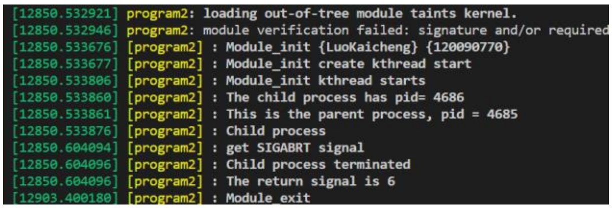
I changed the makefile to execute the program easily



```
execute: $(PROGS)
	./program1 abort
	./program1 alarm
	./program1 bus
	./program1 floating
	./program1 hangup
	./program1 illegal_instr
	./program1 interrupt
	./program1 kill
	./program1 normal
	./program1 pipe
	./program1 quit
	./program1 segment_fault
	./program1 stop
	./program1 terminate
	./program1 trap
```

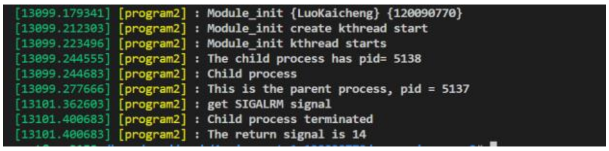
Program2:

Abort.c



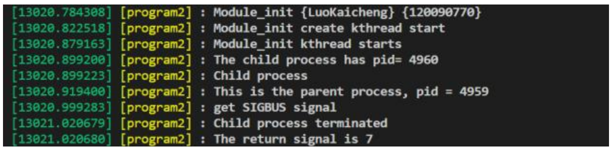
```
[12850.532921] program2: loading out-of-tree module taints kernel.
[12850.532946] program2: module verification failed: signature and/or required
[12850.533676] [program2] : Module_init {LuoKaicheng} {120090770}
[12850.533677] [program2] : Module_init create kthread start
[12850.533806] [program2] : Module_init kthread starts
[12850.533860] [program2] : The child process has pid= 4686
[12850.533861] [program2] : This is the parent process, pid = 4685
[12850.533876] [program2] : Child process
[12850.604094] [program2] : get SIGABRT signal
[12850.604096] [program2] : Child process terminated
[12850.604096] [program2] : The return signal is 6
[12903.400180] [program2] : Module_exit
```

Alarm.c



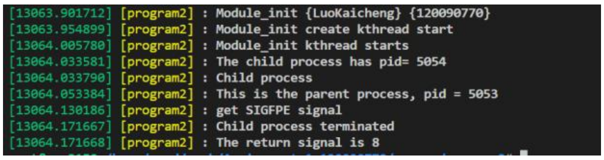
```
[13099.179341] [program2] : Module_init {LuoKaicheng} {120090770}
[13099.212303] [program2] : Module_init create kthread start
[13099.223496] [program2] : Module_init kthread starts
[13099.244555] [program2] : The child process has pid= 5138
[13099.244683] [program2] : Child process
[13099.277666] [program2] : This is the parent process, pid = 5137
[13101.362603] [program2] : get SIGALRM signal
[13101.400683] [program2] : Child process terminated
[13101.400683] [program2] : The return signal is 14
```

Bus.c



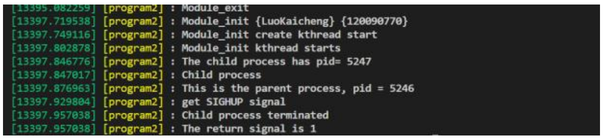
```
[13020.784308] [program2] : Module_init {LuoKaicheng} {120090770}
[13020.822518] [program2] : Module_init create kthread start
[13020.879163] [program2] : Module_init kthread starts
[13020.899200] [program2] : The child process has pid= 4960
[13020.899223] [program2] : Child process
[13020.919400] [program2] : This is the parent process, pid = 4959
[13020.999283] [program2] : get SIGBUS signal
[13021.020679] [program2] : Child process terminated
[13021.020680] [program2] : The return signal is 7
```

Float.c



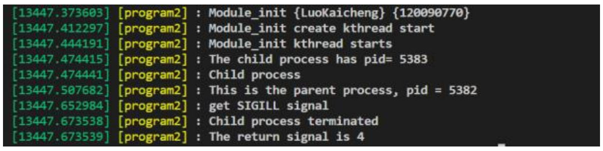
```
[13063.901712] [program2] : Module_init {LuoKaicheng} {120090770}
[13063.954899] [program2] : Module_init create kthread start
[13064.005780] [program2] : Module_init kthread starts
[13064.033581] [program2] : The child process has pid= 5054
[13064.033790] [program2] : Child process
[13064.053384] [program2] : This is the parent process, pid = 5053
[13064.130186] [program2] : get SIGFPE signal
[13064.171667] [program2] : Child process terminated
[13064.171668] [program2] : The return signal is 8
```

Hangup.c



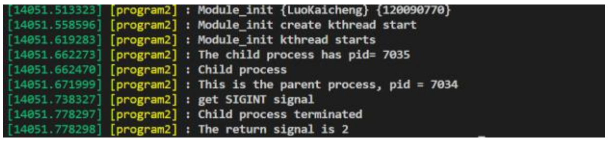
```
[13395.082259] [program2] : Module_exit
[13397.719538] [program2] : Module_init {LuoKaicheng} {120090770}
[13397.749116] [program2] : Module_init create kthread start
[13397.802878] [program2] : Module_init kthread starts
[13397.846776] [program2] : The child process has pid= 5247
[13397.847017] [program2] : Child process
[13397.876963] [program2] : This is the parent process, pid = 5246
[13397.929804] [program2] : get SIGHUP signal
[13397.957038] [program2] : Child process terminated
[13397.957038] [program2] : The return signal is 1
```

Illegal.c



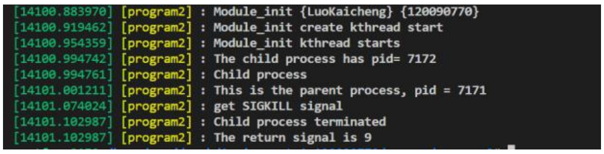
```
[13447.373603] [program2] : Module_init {LuoKaicheng} {120090770}
[13447.412297] [program2] : Module_init create kthread start
[13447.444191] [program2] : Module_init kthread starts
[13447.474415] [program2] : The child process has pid= 5383
[13447.474441] [program2] : Child process
[13447.507682] [program2] : This is the parent process, pid = 5382
[13447.652984] [program2] : get SIGILL signal
[13447.673538] [program2] : Child process terminated
[13447.673539] [program2] : The return signal is 4
```

Interrupt.c



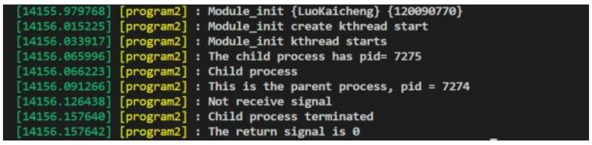
```
[14051.513323] [program2] : Module_init {LuoKaicheng} {120090770}
[14051.558596] [program2] : Module_init create kthread start
[14051.619283] [program2] : Module_init kthread starts
[14051.662273] [program2] : The child process has pid= 7035
[14051.662470] [program2] : Child process
[14051.671999] [program2] : This is the parent process, pid = 7034
[14051.738327] [program2] : get SIGINT signal
[14051.778297] [program2] : Child process terminated
[14051.778298] [program2] : The return signal is 2
```

Kill.c



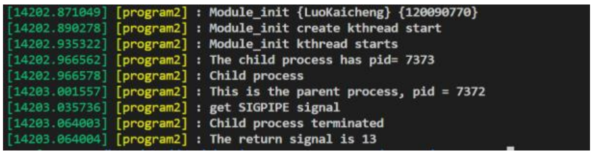
```
[14100.883970] [program2] : Module_init {LuoKaicheng} {120090770}
[14100.919462] [program2] : Module_init create kthread start
[14100.954359] [program2] : Module_init kthread starts
[14100.994742] [program2] : The child process has pid= 7172
[14100.994761] [program2] : Child process
[14101.001211] [program2] : This is the parent process, pid = 7171
[14101.074024] [program2] : get SIGKILL signal
[14101.102987] [program2] : Child process terminated
[14101.102987] [program2] : The return signal is 9
```

Normal.c



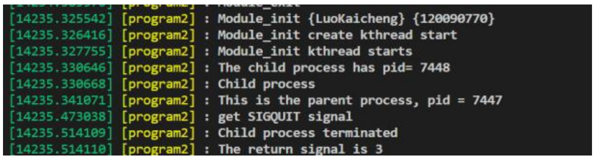
```
[14155.979768] [program2] : Module_init {LuoKaicheng} {120090770}
[14156.015225] [program2] : Module_init create kthread start
[14156.033917] [program2] : Module_init kthread starts
[14156.065996] [program2] : The child process has pid= 7275
[14156.066223] [program2] : Child process
[14156.091266] [program2] : This is the parent process, pid = 7274
[14156.126438] [program2] : Not receive signal
[14156.157640] [program2] : Child process terminated
[14156.157642] [program2] : The return signal is 0
```

Pipe.c



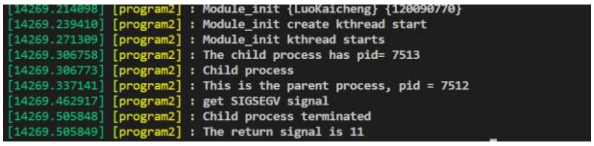
```
[14202.871049] [program2] : Module_init {LuoKaicheng} {120090770}
[14202.890278] [program2] : Module_init create kthread start
[14202.935322] [program2] : Module_init kthread starts
[14202.966562] [program2] : The child process has pid= 7373
[14202.966578] [program2] : Child process
[14203.001557] [program2] : This is the parent process, pid = 7372
[14203.035736] [program2] : get SIGPIPE signal
[14203.064003] [program2] : Child process terminated
[14203.064004] [program2] : The return signal is 13
```

Quit.c



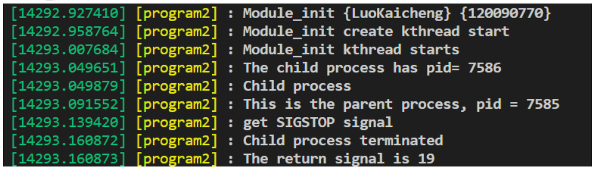
```
[14235.325542] [program2] : Module_init {LuoKaicheng} {120090770}
[14235.326416] [program2] : Module_init create kthread start
[14235.327755] [program2] : Module_init kthread starts
[14235.330646] [program2] : The child process has pid= 7448
[14235.330668] [program2] : Child process
[14235.341071] [program2] : This is the parent process, pid = 7447
[14235.473038] [program2] : get SIGQUIT signal
[14235.514109] [program2] : Child process terminated
[14235.514110] [program2] : The return signal is 3
```

Segment_fault.c



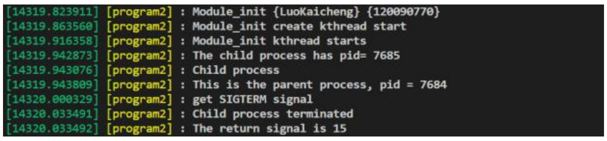
```
[14269.214098] [program2] : Module_init {LuoKaicheng} {120090770}
[14269.239410] [program2] : Module_init create kthread start
[14269.271309] [program2] : Module_init kthread starts
[14269.306758] [program2] : The child process has pid= 7513
[14269.306773] [program2] : Child process
[14269.337141] [program2] : This is the parent process, pid = 7512
[14269.462917] [program2] : get SIGSEGV signal
[14269.505848] [program2] : Child process terminated
[14269.505849] [program2] : The return signal is 11
```

Stop.c



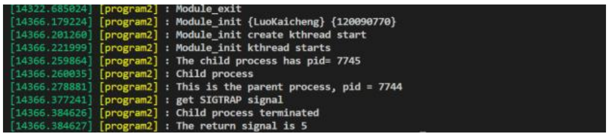
```
[14292.927410] [program2] : Module_init {LuoKaicheng} {120090770}
[14292.958764] [program2] : Module_init create kthread start
[14293.007684] [program2] : Module_init kthread starts
[14293.049651] [program2] : The child process has pid= 7586
[14293.049879] [program2] : Child process
[14293.091552] [program2] : This is the parent process, pid = 7585
[14293.139420] [program2] : get SIGSTOP signal
[14293.160872] [program2] : Child process terminated
[14293.160873] [program2] : The return signal is 19
```

Terminate.c



```
[14319.823911] [program2] : Module_init {LuoKaicheng} {120090770}
[14319.863560] [program2] : Module_init create kthread start
[14319.916358] [program2] : Module_init kthread starts
[14319.942873] [program2] : The child process has pid= 7685
[14319.943076] [program2] : Child process
[14319.943809] [program2] : This is the parent process, pid = 7684
[14320.000329] [program2] : get SIGTERM signal
[14320.033491] [program2] : Child process terminated
[14320.033492] [program2] : The return signal is 15
```

Trap.c



```
[14322.685024] [program2] : Module_exit
[14366.179224] [program2] : Module_init {LuoKaicheng} {120090770}
[14366.201260] [program2] : Module_init create kthread start
[14366.221999] [program2] : Module_init kthread starts
[14366.259864] [program2] : The child process has pid= 7745
[14366.260035] [program2] : Child process
[14366.278881] [program2] : This is the parent process, pid = 7744
[14366.377241] [program2] : get SIGTRAP signal
[14366.384626] [program2] : Child process terminated
[14366.384627] [program2] : The return signal is 5
```