Report

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Environment Setup:

Since I need to operate with linux system, we need to use virtual machine which can provide me with another computer system, so I install VirtualBox and vagrant first. Besides some extensions for C is necessary because we need to write code in C. Then since the goal of the assignment is to simulate the user mode and kernel mode in operating system, I need to use some functions in linux kernel archives, so I download and compile the kernel. At first, I need to turn on the virtual machine, upload the linux kernel archive to the virtual machine. Next, decompress the file through linux command ($sudo tar xvf linux-5.10.147.tar.xz). And I change the directory to kernel file and clean the previous setting so that my previous setting won't affect this assignment (make mrproper and make clean). Then I use "ll | grep config" in boot to check my config version and copy the version to the directory of kernel file. After this step, when I type "ll | grep .config" under kernel file directory, it will return three files end with "config" which can show whether my last step running successfully. Then type "make menuconfig". A blue page will exist. I choose load, save and exit to save the config. Then build kernel Image and modules in root with "make -j$(nproc)". It takes about an hour and a half. The last few steps help us install kernel modules and kernel. Reboot will load the kernel which I compile. Besides, I need to find the function and use "EXPORT_SYMBOL()" function to export them so that I can use these functions in my program. Sometimes, people may need to re-executing the “make” commands to activate exported functions.

Task 1 design:

Fork a child process from the parent process and get the process ID separately.

Child process need to execute a file (“execve”) and the file will raise signal to show its running status.

Parent process need to wait for the child process until the child process finishes running. Then the parent process check the running status of the file by WIFEITED, WIFSIGNALED and WIFSTOPPED and receive and recognize the signal by WTERMSIG. We use WIFEITED to test whether the file executed normally, WIFSIGNALED to test whether the file terminates because of signal, and WIFSTOPPED to test whether the file stopped. If the file terminates because of signal, we can use WTERMSIG to check the type of signal.

Task 2 design:

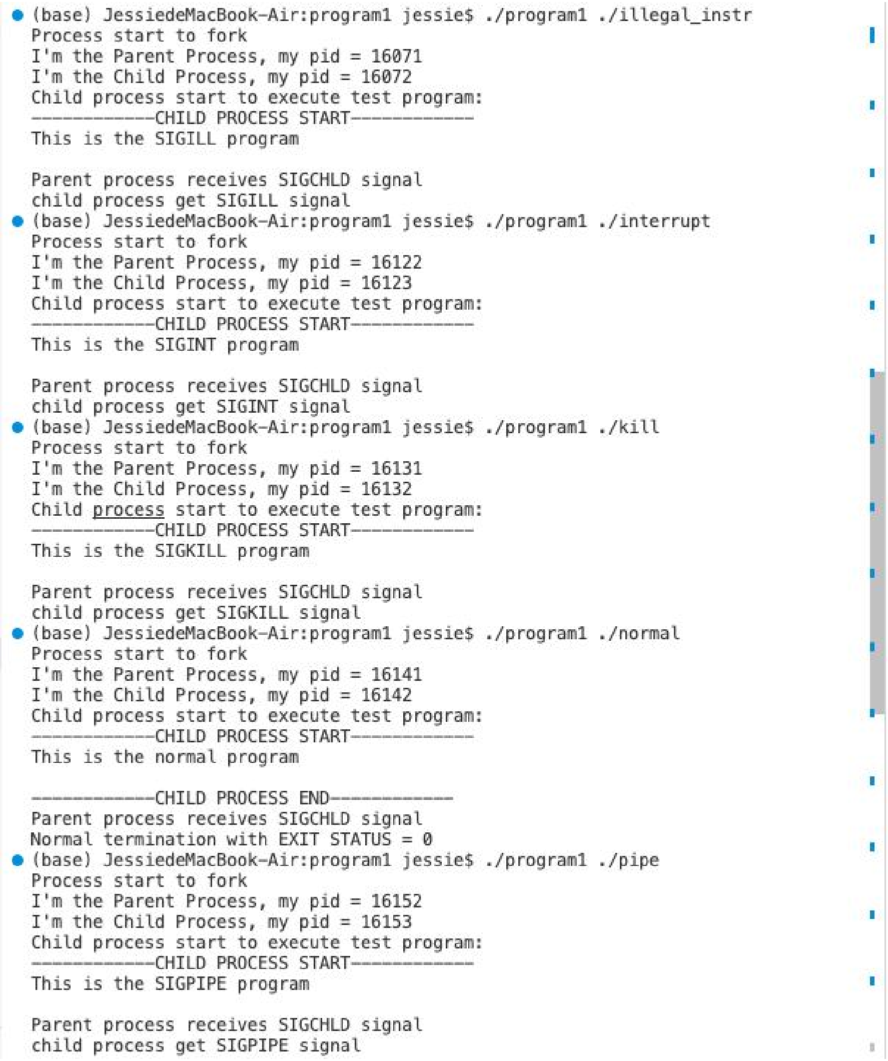
First, I create a kernel thread to run my_fork which is used to fork a child process by kernel_clone function. Then the child process executes the test file by getname_kernel and do_execve. getname_kernel will return the name of the file to do_execve by checking the file path. kernel_clone will return the process ID of child process and I can also get parent process ID by using child process ID. Then let parent process wait until the child process finishes. Parent process receive ID by a reference parameter through do_wait function. Then we can define macros like task 1 to recognize the returned value of signal or just do the operation &0x7f manually.

My thought:

From these tasks, I can have a better understanding on the relationship between parent process and child process. And I learn much knowledge about using virtual machine, kernel symbols, C language. Reading the original code of the modules and packages help me study the implementation of them. Based on these, they become much more handy for me.

Screenshot:

Task1



```
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./illegal_instr
  Process start to fork
  I'm the Parent Process, my pid = 16071
  I'm the Child Process, my pid = 16072
  Child process start to execute test program:
  ------------CHILD PROCESS START------------
  This is the SIGILL program

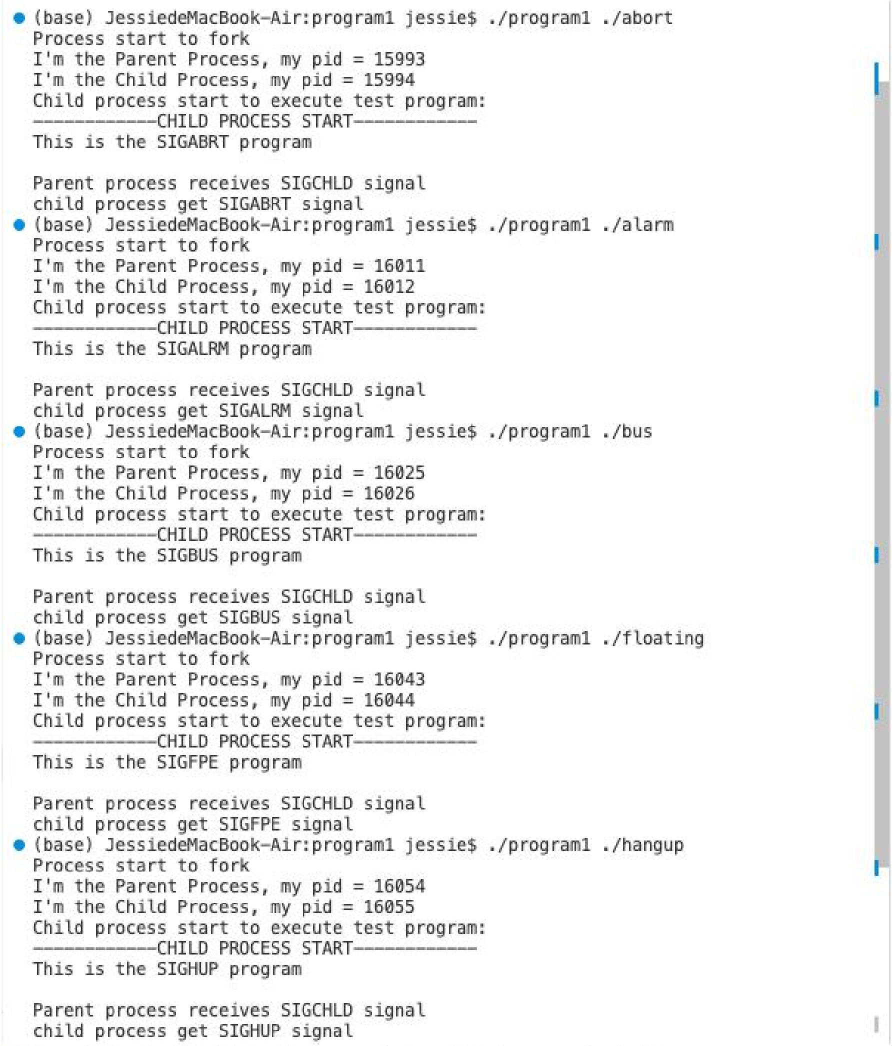
  Parent process receives SIGCHLD signal
  child process get SIGILL signal
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./interrupt
  Process start to fork
  I'm the Parent Process, my pid = 16122
  I'm the Child Process, my pid = 16123
  Child process start to execute test program:
  ------------CHILD PROCESS START------------
  This is the SIGINT program

  Parent process receives SIGCHLD signal
  child process get SIGINT signal
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./kill
  Process start to fork
  I'm the Parent Process, my pid = 16131
  I'm the Child Process, my pid = 16132
  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
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./normal
  Process start to fork
  I'm the Parent Process, my pid = 16141
  I'm the Child Process, my pid = 16142
  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
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./pipe
  Process start to fork
  I'm the Parent Process, my pid = 16152
  I'm the Child Process, my pid = 16153
  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
```



```
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./abort
  Process start to fork
  I'm the Parent Process, my pid = 15993
  I'm the Child Process, my pid = 15994
  Child process start to execute test program:
  ------------CHILD PROCESS START------------
  This is the SIGABRT program

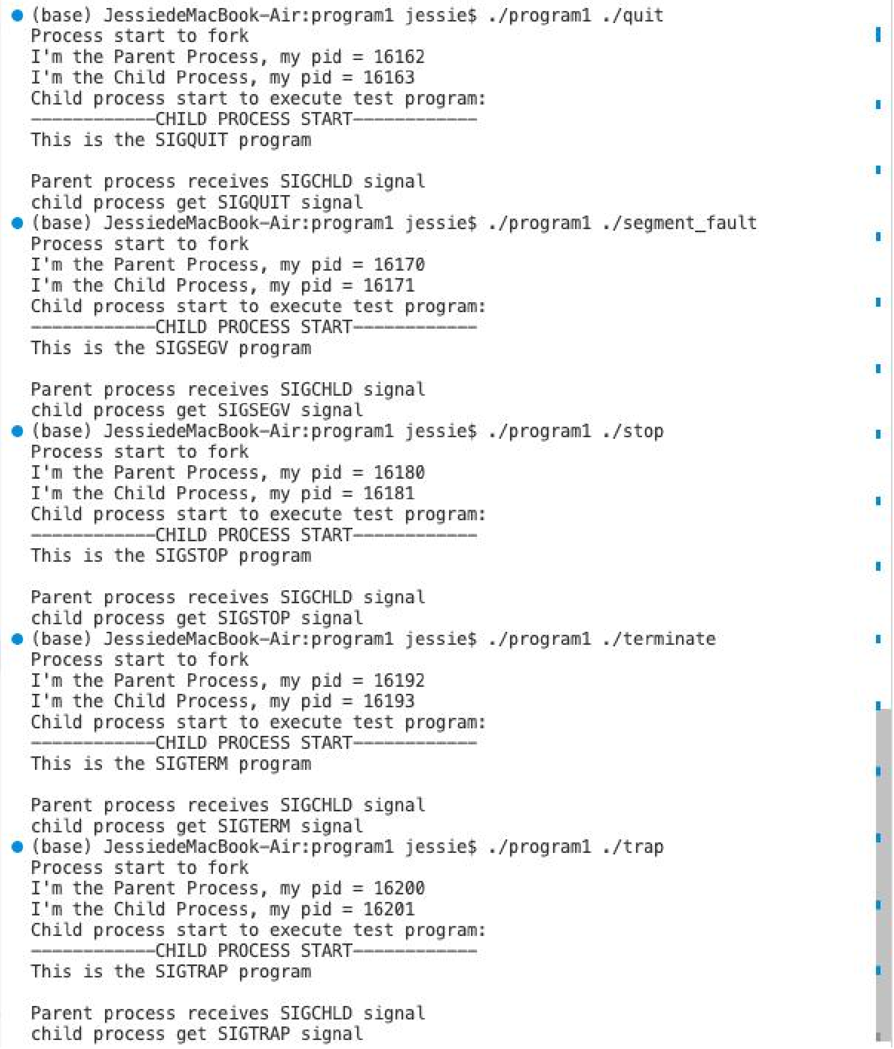
  Parent process receives SIGCHLD signal
  child process get SIGABRT signal
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./alarm
  Process start to fork
  I'm the Parent Process, my pid = 16011
  I'm the Child Process, my pid = 16012
  Child process start to execute test program:
  ------------CHILD PROCESS START------------
  This is the SIGALRM program

  Parent process receives SIGCHLD signal
  child process get SIGALRM signal
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./bus
  Process start to fork
  I'm the Parent Process, my pid = 16025
  I'm the Child Process, my pid = 16026
  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
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./floating
  Process start to fork
  I'm the Parent Process, my pid = 16043
  I'm the Child Process, my pid = 16044
  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
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./hangup
  Process start to fork
  I'm the Parent Process, my pid = 16054
  I'm the Child Process, my pid = 16055
  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
```



```
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./quit
  Process start to fork
  I'm the Parent Process, my pid = 16162
  I'm the Child Process, my pid = 16163
  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
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./segment_fault
  Process start to fork
  I'm the Parent Process, my pid = 16170
  I'm the Child Process, my pid = 16171
  Child process start to execute test program:
  ------------CHILD PROCESS START------------
  This is the SIGSEGV program

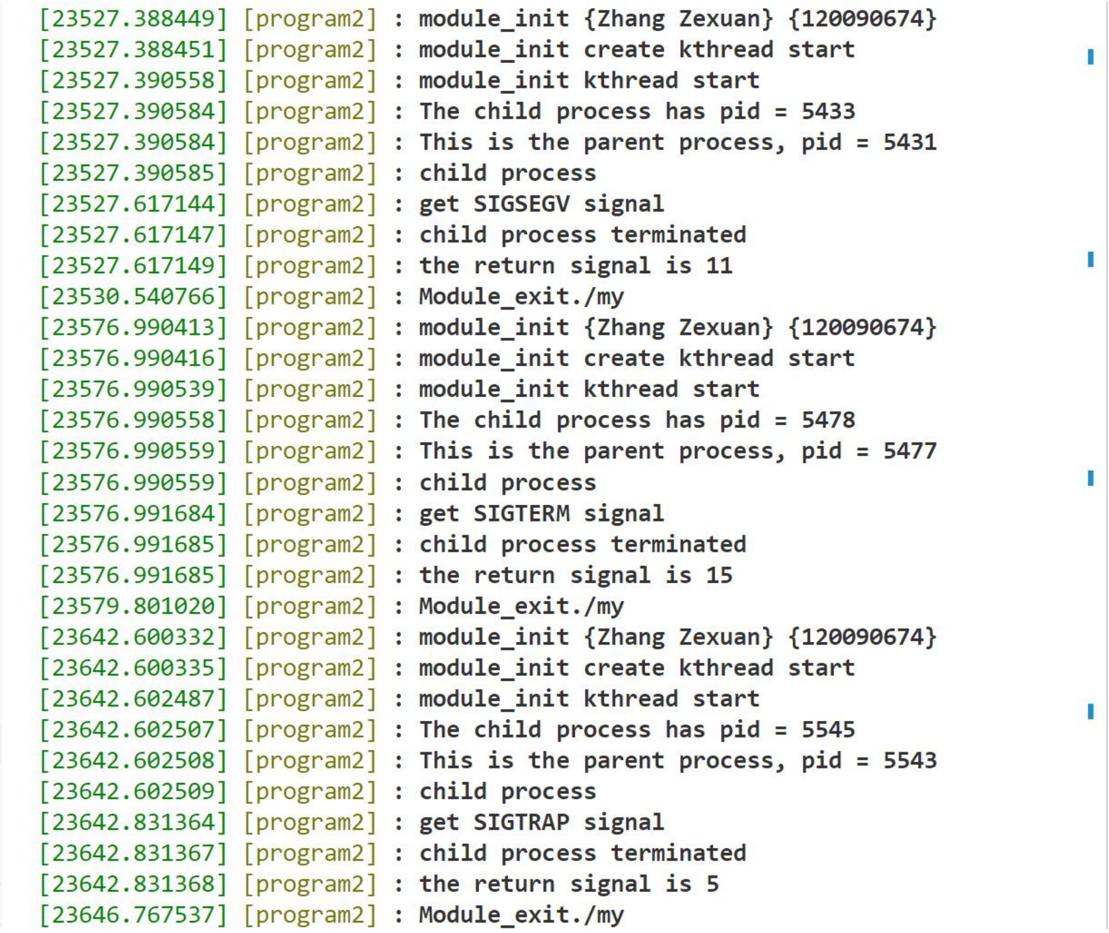
  Parent process receives SIGCHLD signal
  child process get SIGSEGV signal
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./stop
  Process start to fork
  I'm the Parent Process, my pid = 16180
  I'm the Child Process, my pid = 16181
  Child process start to execute test program:
  ------------CHILD PROCESS START------------
  This is the SIGSTOP program

  Parent process receives SIGCHLD signal
  child process get SIGSTOP signal
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./terminate
  Process start to fork
  I'm the Parent Process, my pid = 16192
  I'm the Child Process, my pid = 16193
  Child process start to execute test program:
  ------------CHILD PROCESS START------------
  This is the SIGTERM program

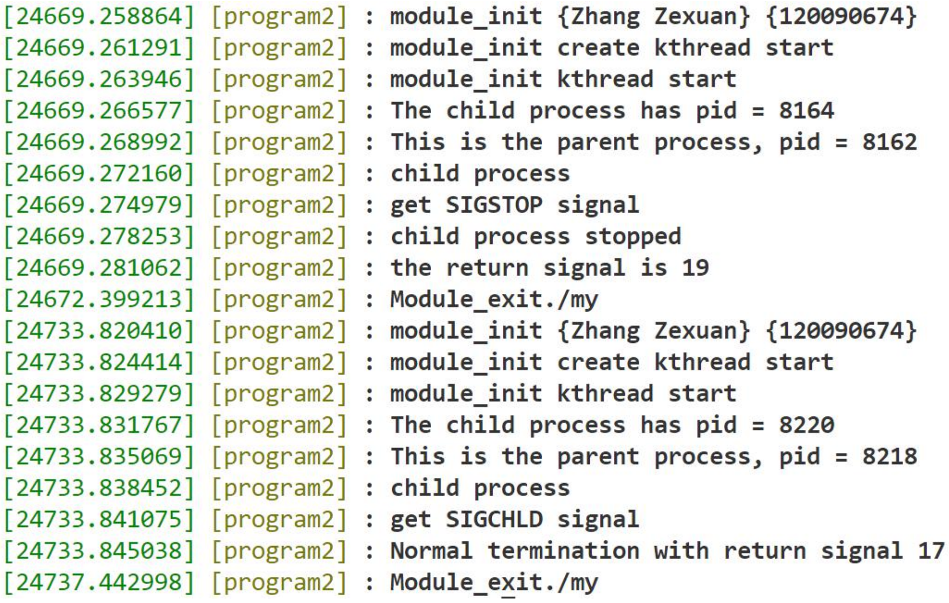
  Parent process receives SIGCHLD signal
  child process get SIGTERM signal
● (base) JessiedeMacBook-Air:program1 jessie$ ./program1 ./trap
  Process start to fork
  I'm the Parent Process, my pid = 16200
  I'm the Child Process, my pid = 16201
  Child process start to execute test program:
  ------------CHILD PROCESS START------------
  This is the SIGTRAP program

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

Task2



```
[23527.388449] [program2] : module_init {Zhang Zexuan} {120090674}
[23527.388451] [program2] : module_init create kthread start
[23527.390558] [program2] : module_init kthread start
[23527.390584] [program2] : The child process has pid = 5433
[23527.390584] [program2] : This is the parent process, pid = 5431
[23527.390585] [program2] : child process
[23527.617144] [program2] : get SIGSEGV signal
[23527.617147] [program2] : child process terminated
[23527.617149] [program2] : the return signal is 11
[23530.540766] [program2] : Module_exit./my
[23576.990413] [program2] : module_init {Zhang Zexuan} {120090674}
[23576.990416] [program2] : module_init create kthread start
[23576.990539] [program2] : module_init kthread start
[23576.990558] [program2] : The child process has pid = 5478
[23576.990559] [program2] : This is the parent process, pid = 5477
[23576.990559] [program2] : child process
[23576.991684] [program2] : get SIGTERM signal
[23576.991685] [program2] : child process terminated
[23576.991685] [program2] : the return signal is 15
[23579.801020] [program2] : Module_exit./my
[23642.600332] [program2] : module_init {Zhang Zexuan} {120090674}
[23642.600335] [program2] : module_init create kthread start
[23642.602487] [program2] : module_init kthread start
[23642.602507] [program2] : The child process has pid = 5545
[23642.602508] [program2] : This is the parent process, pid = 5543
[23642.602509] [program2] : child process
[23642.831364] [program2] : get SIGTRAP signal
[23642.831367] [program2] : child process terminated
[23642.831368] [program2] : the return signal is 5
[23646.767537] [program2] : Module_exit./my
```



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[24669.258864] [program2] : module_init {Zhang Zexuan} {120090674}
[24669.261291] [program2] : module_init create kthread start
[24669.263946] [program2] : module_init kthread start
[24669.266577] [program2] : The child process has pid = 8164
[24669.268992] [program2] : This is the parent process, pid = 8162
[24669.272160] [program2] : child process
[24669.274979] [program2] : get SIGSTOP signal
[24669.278253] [program2] : child process stopped
[24669.281062] [program2] : the return signal is 19
[24672.399213] [program2] : Module_exit./my
[24733.820410] [program2] : module_init {Zhang Zexuan} {120090674}
[24733.824414] [program2] : module_init create kthread start
[24733.829279] [program2] : module_init kthread start
[24733.831767] [program2] : The child process has pid = 8220
[24733.835069] [program2] : This is the parent process, pid = 8218
[24733.838452] [program2] : child process
[24733.841075] [program2] : get SIGCHLD signal
[24733.845038] [program2] : Normal termination with return signal 17
[24737.442998] [program2] : Module_exit./my
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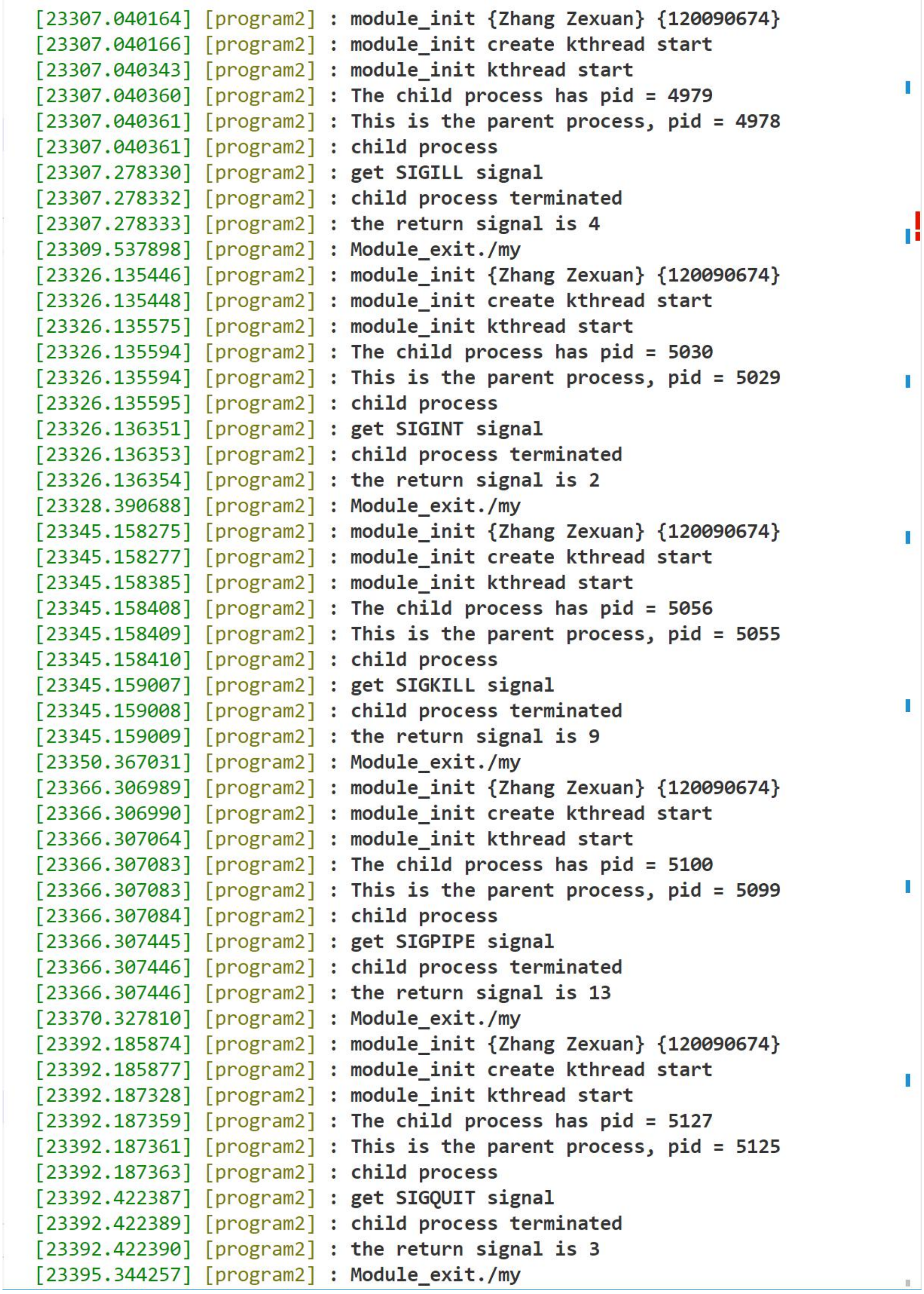

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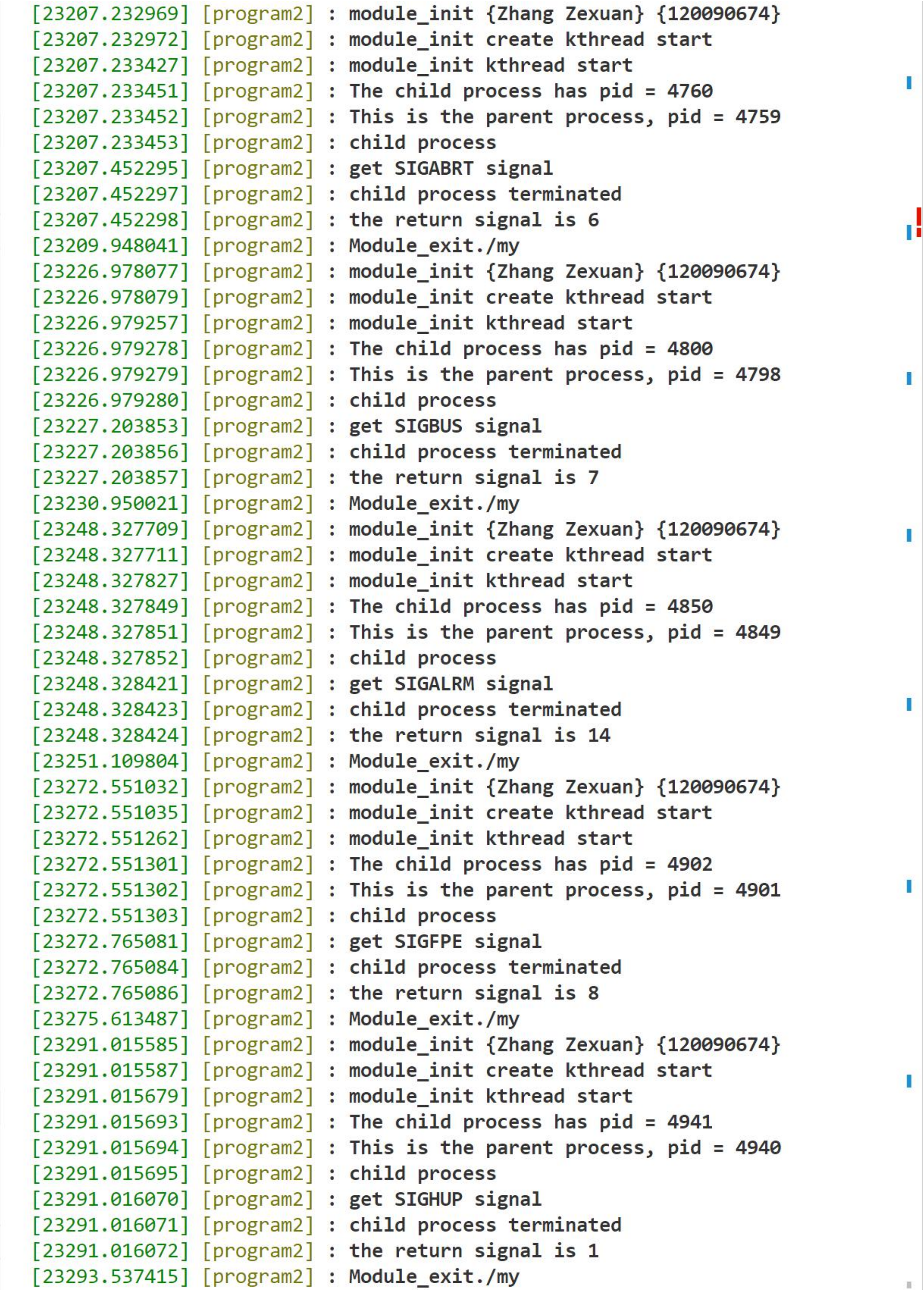
[23307.040164] [program2] : module_init {Zhang Zexuan} {120090674}
[23307.040166] [program2] : module_init create kthread start
[23307.040343] [program2] : module_init kthread start
[23307.040360] [program2] : The child process has pid = 4979
[23307.040361] [program2] : This is the parent process, pid = 4978
[23307.040361] [program2] : child process
[23307.278330] [program2] : get SIGILL signal
[23307.278332] [program2] : child process terminated
[23307.278333] [program2] : the return signal is 4
[23309.537898] [program2] : Module_exit./my
[23326.135446] [program2] : module_init {Zhang Zexuan} {120090674}
[23326.135448] [program2] : module_init create kthread start
[23326.135575] [program2] : module_init kthread start
[23326.135594] [program2] : The child process has pid = 5030
[23326.135594] [program2] : This is the parent process, pid = 5029
[23326.135595] [program2] : child process
[23326.136351] [program2] : get SIGINT signal
[23326.136353] [program2] : child process terminated
[23326.136354] [program2] : the return signal is 2
[23328.390688] [program2] : Module_exit./my
[23345.158275] [program2] : module_init {Zhang Zexuan} {120090674}
[23345.158277] [program2] : module_init create kthread start
[23345.158385] [program2] : module_init kthread start
[23345.158408] [program2] : The child process has pid = 5056
[23345.158409] [program2] : This is the parent process, pid = 5055
[23345.158410] [program2] : child process
[23345.159007] [program2] : get SIGKILL signal
[23345.159008] [program2] : child process terminated
[23345.159009] [program2] : the return signal is 9
[23350.367031] [program2] : Module_exit./my
[23366.306989] [program2] : module_init {Zhang Zexuan} {120090674}
[23366.306990] [program2] : module_init create kthread start
[23366.307064] [program2] : module_init kthread start
[23366.307083] [program2] : The child process has pid = 5100
[23366.307083] [program2] : This is the parent process, pid = 5099
[23366.307084] [program2] : child process
[23366.307445] [program2] : get SIGPIPE signal
[23366.307446] [program2] : child process terminated
[23366.307446] [program2] : the return signal is 13
[23370.327810] [program2] : Module_exit./my
[23392.185874] [program2] : module_init {Zhang Zexuan} {120090674}
[23392.185877] [program2] : module_init create kthread start
[23392.187328] [program2] : module_init kthread start
[23392.187359] [program2] : The child process has pid = 5127
[23392.187361] [program2] : This is the parent process, pid = 5125
[23392.187363] [program2] : child process
[23392.422387] [program2] : get SIGQUIT signal
[23392.422389] [program2] : child process terminated
[23392.422390] [program2] : the return signal is 3
[23395.344257] [program2] : Module_exit./my
```



```
[23207.232969] [program2] : module_init {Zhang Zexuan} {120090674}
[23207.232972] [program2] : module_init create kthread start
[23207.233427] [program2] : module_init kthread start
[23207.233451] [program2] : The child process has pid = 4760
[23207.233452] [program2] : This is the parent process, pid = 4759
[23207.233453] [program2] : child process
[23207.452295] [program2] : get SIGABRT signal
[23207.452297] [program2] : child process terminated
[23207.452298] [program2] : the return signal is 6
[23209.948041] [program2] : Module_exit./my
[23226.978077] [program2] : module_init {Zhang Zexuan} {120090674}
[23226.978079] [program2] : module_init create kthread start
[23226.979257] [program2] : module_init kthread start
[23226.979278] [program2] : The child process has pid = 4800
[23226.979279] [program2] : This is the parent process, pid = 4798
[23226.979280] [program2] : child process
[23227.203853] [program2] : get SIGBUS signal
[23227.203856] [program2] : child process terminated
[23227.203857] [program2] : the return signal is 7
[23230.950021] [program2] : Module_exit./my
[23248.327709] [program2] : module_init {Zhang Zexuan} {120090674}
[23248.327711] [program2] : module_init create kthread start
[23248.327827] [program2] : module_init kthread start
[23248.327849] [program2] : The child process has pid = 4850
[23248.327851] [program2] : This is the parent process, pid = 4849
[23248.327852] [program2] : child process
[23248.328421] [program2] : get SIGALRM signal
[23248.328423] [program2] : child process terminated
[23248.328424] [program2] : the return signal is 14
[23251.109804] [program2] : Module_exit./my
[23272.551032] [program2] : module_init {Zhang Zexuan} {120090674}
[23272.551035] [program2] : module_init create kthread start
[23272.551262] [program2] : module_init kthread start
[23272.551301] [program2] : The child process has pid = 4902
[23272.551302] [program2] : This is the parent process, pid = 4901
[23272.551303] [program2] : child process
[23272.765081] [program2] : get SIGFPE signal
[23272.765084] [program2] : child process terminated
[23272.765086] [program2] : the return signal is 8
[23275.613487] [program2] : Module_exit./my
[23291.015585] [program2] : module_init {Zhang Zexuan} {120090674}
[23291.015587] [program2] : module_init create kthread start
[23291.015679] [program2] : module_init kthread start
[23291.015693] [program2] : The child process has pid = 4941
[23291.015694] [program2] : This is the parent process, pid = 4940
[23291.015695] [program2] : child process
[23291.016070] [program2] : get SIGHUP signal
[23291.016071] [program2] : child process terminated
[23291.016072] [program2] : the return signal is 1
[23293.537415] [program2] : Module_exit./my
```