

哈尔滨工业大学

实验报告

实验（七）

题 目 TinyShell

微壳

专 业 计算机类

学 号 1170300821

班 级 1703008

学 生 罗瑞欣

指 导 教 师 郑贵滨

实 验 地 点 G712

实 验 日 期 _____

计算机科学与技术学院

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第 1 章 实验基本信息

1.1 实验目的

理解现代计算机系统进程与并发的基本知识
掌握 linux 异常控制流和信号机制的基本原理和相关系统函数
掌握 shell 的基本原理和实现方法
深入理解 Linux 信号响应可能导致的并发冲突及解决方法
培养 Linux 下的软件系统开发与测试能力

1.2 实验环境与工具

1.2.1 硬件环境

X64 CPU; 2GHz; 2G RAM; 256GHD Disk 以上

1.2.2 软件环境

Windows7 64 位以上; VirtualBox/Vmware 11 以上

1.2.3 开发工具

Ubuntu 16.04 LTS 64 位/优麒麟 64 位

1.3 实验预习

上实验课前, 必须认真预习实验指导书 (PPT 或 PDF)
了解实验的目的、实验环境与软硬件工具、实验操作步骤, 复习与实验有关的理论知识。
了解进程、作业、信号的基本概念和原理
了解 shell 的基本原理
熟知进程创建、回收的方法和相关系统函数
熟知信号机制和信号处理相关的系统函数

第 2 章 实验预习

总分 20 分

2.1 进程的概念、创建和回收方法（5 分）

在现代系统上运行一个程序是，我们会得到一个假象，就好像我们的程序是系统中当前运行的唯一的程序一样。我们的程序好像是独占地使用处理器和内存。处理器就好像是无间断地一条接一条地执行我们程序中的指令。最后，我们成徐中的代码和数据就好像是系统内存中唯一的对象。这些假象都是通过进程的概念提供给我们的。

进程的经典定义就是一个执行中程序的水里。系统中的每个程序都运行在某个进程中的上下文中。上下文是由程序正确运行所需的状态组成的。这个状态就包括存放在内存中的程序总的代码和数据，它的栈，通用目的寄存器的内容、程序计数器、环境变量以及打开文件描述符的集合。

每次用户通过向 shell 输入一个可知性目标文件的名字，运行程序是，shell 就会创建一个新的进程，然后在这个新进程的上下文中运行这个可执行文件。应用成徐也能欧创建新锦成，并且在这个新进程的上下文中运行它们自己的代码或其他应用程序。

可以通过调用 `fork()` 函数的方法来实现创建新进程。该函数返回值为若在子进程中则返回 0，父进程则返回子进程的 PID，如果出现错误就返回 -1。

可以通过调用 `waitpid()` 函数的方法来实现回收进程，当然，一个子进程可通过它的父进程回收也可通过内核安排 `init` 进程来回收。

2.2 信号的机制、种类（5 分）

在软件形式的层面上，存在 Linux 信号这一软件形式的异常。它允许进程和内核终端其他进程。一个信号就是一条小信息，它通知进程系统中发生了一个某种类型的事件。每种信号类型都对应于某种系统事件。低层的硬件异常是由内核异常处理程序处理的，正常情况下，对用户进程而言是不可见的。信号提供了一种机制，通知用户进程发生了这些异常。

1) SIGHUP 2) SIGINT 3) SIGQUIT 4) SIGILL 5) SIGTRAP

6) SIGABRT 7) SIGBUS 8) SIGFPE 9) SIGKILL 10) SIGUSR1
 11) SIGSEGV 12) SIGUSR2 13) SIGPIPE 14) SIGALRM 15) SIGTERM
 16) SIGSTKFLT 17) SIGCHLD 18) SIGCONT 19) SIGSTOP 20) SIGTSTP
 21) SIGTTIN 22) SIGTTOU 23) SIGURG 24) SIGXCPU 25) SIGXFSZ
 26) SIGVTALRM 27) SIGPROF 28) SIGWINCH 29) SIGIO 30) SIGPWR
 31) SIGSYS 34) SIGRTMIN 35) SIGRTMIN+1 36) SIGRTMIN+2
 37) SIGRTMIN+3
 38) SIGRTMIN+4 39) SIGRTMIN+5 40) SIGRTMIN+6 41) SIGRTMIN+7 42) SIGRTMIN+8
 43) SIGRTMIN+9 44) SIGRTMIN+10 45) SIGRTMIN+11 46) SIGRTMIN+12
 47) SIGRTMIN+13
 48) SIGRTMIN+14 49) SIGRTMIN+15 50) SIGRTMAX-14 51) SIGRTMAX-13
 52) SIGRTMAX-12
 53) SIGRTMAX-11 54) SIGRTMAX-10 55) SIGRTMAX-9 56) SIGRTMAX-8
 57) SIGRTMAX-7
 58) SIGRTMAX-6 59) SIGRTMAX-5 60) SIGRTMAX-4 61) SIGRTMAX-3
 62) SIGRTMAX-2
 63) SIGRTMAX-1 64) SIGRTMAX

2.3 信号的发送方法、阻塞方法、处理程序的设置方法（5分）

可以通过以下三种方式来向程序发送信号

- (1) 用/bin/kill 指令向程序发送信号
- (2) 用键盘输入来向程序发送信号。Unix Shell 使用作业这个概念来表示对一条命令行求值而创建的进程。在任何时刻，至多有一个前台作业和 0 个或多个后台作业。当用户在键盘上输入一个 Ctrl+C 或者 Ctrl+Z 将会导致内核向前台作业发送信号。
- (3) 用 kill 函数发送信号进程通过调用 kill 函数发送信号给其他进程（包括他们自己）
- (4) 进程可以通过调用 alarm 函数向他自己发送 SIGALRM 信号。

Linux 提供阻塞信号的隐式和显式的机制

- (1) 隐式阻塞机制。内核默认阻塞任何当前处理程序正在处理信号类型的待处理的信号。
- (2) 显式阻塞机制。应用程序可以使用 sigprocmask 函数和它的辅助函数明确地阻塞和解除阻塞选定的信号。

编写信号处理程序需要注重以下基本规则

(1) 处理程序尽可能简单。处理程序可能只是简单地设置全局标志并立即返回，所有与接收信号相关的处理都由主程序执行，主程序周期性检查并重置这个标志。

(2) 在处理程序中只调用异步信号安全函数。这里的异步信号安全函数指的是：要么函数可重入（如至访问局部变量），要么不能被信号处理程序后中断。

(3) 保存和恢复 `errno`。防止干扰 `errno`

2.4 什么是 shell，功能和处理流程（5 分）

Shell 是一种交互型的应用级程序，它可以代表用户执行程序。Shell 执行一系列的读/求值步骤然后终止。该步骤读取来自用户的一个命令行。求值步骤读取来自用户的一个命令行，求值步骤解析该命令行，并代表用户执行程序。在解析命令后，如果是内置命令，则解析指令并执行，否则就根据相关文件路径执行可执行目标文件。

第 3 章 TinyShell 的设计与实现

总分 45 分

3.1 设计

3.1.1 void eval(char *cmdline) 函数 (10 分)

函数功能：对用户输入的参数进行解析并运行计算。

参 数：命令行字符串 Char* cmdline

处理流程：

- (1) 调用函数 `parseline` 处理 `cmdline` 字符串，将其转化为参数数组 `argv`，同时函数 `parseline` 返回 `bg`，判断是否后台进行。如果该任务是前台任务那么需要等到它运行结束才返回。
- (2) 调用函数 `builtin_cmd`，判断输入是否为内建的命令行 (`quit`, `bg`, `fg`, `jobs`)，若是则立即执行
- (3) 若不是内建命令，`fork` 一个新的子进程并且将该任务在子进程的上下文中运行

要点分析：

- (1) 每个子进程必须拥有自己独一无二的进程组 ID，否则在收到 `ctrl+c` 或者 `ctrl+z` 时，子进程会被归为与 `tsh` 一个进程组中，一起被有关信号终止。
- (2) 为防止出现子进程与信号处理进程竞争 `jobs`，在 `fork` 新进程前阻塞 `SIGCHLD`、`SIGINT`、`SIGSTP` 信号。
- (3) 在父进程创建子进程前，用 `sigprocmask` 阻塞，在父进程创建子进程并 `addjob` 记录后，用 `sigprocmask` 解除阻塞。

3.1.2 int builtin_cmd(char **argv) 函数 (5 分)

函数功能：判断当前函数是否是内置函数，如果是则立即执行

参 数：命令行参数 `char **argv`

处理流程：

- (1) 判断 `argv` 是否为 `quit`，若是则调用 `exit(0)`。
- (2) 判断 `argv` 是否为 `bg` 或 `fg`，若是则调用函数 `do_fgbg`，返回 1。
- (3) 判断 `argv` 是否为 `jobs`，若是则调用函数 `listjobs`，返回 1。
- (4) 若都不是，则返回 0。

要点分析：

此函数针对三种调用情况有三种返回情况，利用返回值判断是否为内置命令。

3. 1.3 void do_bgfg(char **argv) 函数 (5 分)

函数功能：执行 bg、fg 的函数功能

参 数：命令行参数 char **argv

处理流程：

- (1) 解析传入命令行参数，判断 bg、fg 后读入 jobpid，调用 getjobpid 获得 job。
- (2) 若为 bg，将该作业的状态修改为 BG，向进程组发送 SIGCONT 信号。
- (3) 若为 fg，将该进程的状态修改为 FG，并调用 waitfg () 函数执行前台指令。

要点分析：

- (1) 判断指令是否合法，检查输入合法性。包括：命令为空、命令不符合 bgfg 格式、命令不是 bgfg、无法找到 PID 的 job。
- (2) 需要实时修改进程作业状态，向目标进程所在的进程组发送 SIGCONT 信号。
- (3) 在 fg 命令中，需要调用 waitfg 阻塞 tsh 进行，使前台一直都是该进程

3. 1.4 void waitfg(pid_t pid) 函数 (5 分)

函数功能：在 eval 函数中调用，用来等待前台子进程的完成。

参 数：前台运行的作业进程的 pid_t pid

处理流程：

利用 fgpid 函数查找到当前在前台运行的作业进程的 pid，并与传入的 pid 进行比较，代表传入的作业程序是否在前台执行，如果结果为真，则进行循环，并调用 sleep 函数达到等待的效果。

要点分析：

不要同时在 SIGCHLD 和 waitfg 函数中使用 waitpid ()

3. 1.5 void sigchld_handler(int sig) 函数 (10 分)

函数功能：SIGCHLD 信号的响应函数

参 数：传入信号 int sig

处理流程：

- (1) 保存当前的 errno
- (2) 处理停止或终止的子进程。如果子进程正常终止，则先阻塞信号，删除进程，再恢复信号。
- (3) 如果子进程已经停止则打印信息。
- (4) 如果子进程是因一个信号终止，信号未被捕获，则打印信息，阻塞信号，删除进程后恢复信号。
- (5) 恢复 (1) 中保存的 errno

要点分析：

- (1) 运用 waitpid () 函数并且用 WNOHANG|WUNTRACED 参数，该参数的作

用是判断当前进程中是否存在已经停止或者终止的进程，如果存在则返回 pid，不存在则立即返回。

- (2) 通过 waitpid 传入的 status，分别调用 WIFEXITED，WIFSTOPPED，WIFSIGNALED，判断子进程不同的返回状态。
- (3) 保存恢复 errno

3.2 程序实现（tsh.c 的全部内容）（10 分）

重点检查代码风格：

- (1) 用较好的代码注释说明——5 分
- (2) 检查每个系统调用的返回值——5 分

第 4 章 TinyShell 测试

总分 15 分

4.1 测试方法

针对 tsh 和参考 shell 程序 tshref, 完成测试项目 4.1-4.15 的对比测试, 并将测试结果截图或者通过重定向保存到文本文件(例如: ./sdriver.pl -t trace01.txt -s ./tsh -a "-p" > tshresult01.txt)。

4.2 测试结果评价

tsh 与 tshref 的输出在一下两个方面可以不同:

(1) PID

(2)测试文件 trace11.txt, trace12.txt 和 trace13.txt 中的/bin/ps 命令, 每次运行的输出都会不同, 但每个 mysplrit 进程的运行状态应该相同。

除了上述两方面允许的差异, tsh 与 tshref 的输出相同则判为正确, 如不同则给出原因分析。

4.3 自测试结果

4.3.1 测试用例 trace01.txt 的输出截图 (1 分)

tsh 测试结果		tshref 测试结果	
<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace01.txt -s ./tsh -a "-p" # # trace01.txt - Properly terminate on EOF. # 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$</pre>		<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace01.txt -s ./tshref -a "-p" # # trace01.txt - Properly terminate on EOF. # 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$</pre>	
测试结论	相同		

4.3.2 测试用例 trace02.txt 的输出截图 (1 分)

tsh 测试结果	tshref 测试结果
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<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$./sdriver.pl -t trace02.txt -s ./tsh -a "-p" # # trace02.txt - Process builtin quit command. # 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$ █</pre>	<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$./sdriver.pl -t trace02.txt -s ./tshref -a "-p" # # trace02.txt - Process builtin quit command. # 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$ █</pre>
测试结论	相同

4.3.3 测试用例 trace03.txt 的输出截图（1 分）

tsh 测试结果	tshref 测试结果
<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$./sdriver.pl -t trace03.txt -s ./tsh -a "-p" # # trace03.txt - Run a foreground job. # tsh> quit 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$ █</pre>	<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$./sdriver.pl -t trace03.txt -s ./tshref -a "-p" # # trace03.txt - Run a foreground job. # tsh> quit 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$ █</pre>
测试结论	相同

4.3.4 测试用例 trace04.txt 的输出截图（1 分）

tsh 测试结果	tshref 测试结果
<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$./sdriver.pl -t trace04.txt -s ./tsh -a "-p" # # trace04.txt - Run a background job. # tsh> ./myspin 1 & [1] (2097) ./myspin 1 & 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$ █</pre>	<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$./sdriver.pl -t trace04.txt -s ./tshref -a "-p" # # trace04.txt - Run a background job. # tsh> ./myspin 1 & [1] (2101) ./myspin 1 & 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$ █</pre>
测试结论	相同

4.3.5 测试用例 trace05.txt 的输出截图（1 分）

tsh 测试结果	tshref 测试结果
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<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$./sdriver.pl -t trace05.txt -s ./tsh -a "-p" # # trace05.txt - Process jobs builtin command. # tsh> ./myspin 2 & [1] (2109) ./myspin 2 & tsh> ./myspin 3 & [2] (2111) ./myspin 3 & tsh> jobs [1] (2109) Running ./myspin 2 & [2] (2111) Running ./myspin 3 & 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit</pre>	<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$./sdriver.pl -t trace05.txt -s ./tshref -a "-p" # # trace05.txt - Process jobs builtin command. # tsh> ./myspin 2 & [1] (2116) ./myspin 2 & tsh> ./myspin 3 & [2] (2118) ./myspin 3 & tsh> jobs [1] (2116) Running ./myspin 2 & [2] (2118) Running ./myspin 3 & 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit</pre>
测试结论	相同

4.3.6 测试用例 trace06.txt 的输出截图（1 分）

tsh 测试结果	tshref 测试结果
<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$./sdriver.pl -t trace06.txt -s ./tsh -a "-p" # # trace06.txt - Forward SIGINT to foreground job. # tsh> ./myspin 4 Job [1] (2207) terminated by signal 2 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$ █</pre>	<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$./sdriver.pl -t trace06.txt -s ./tshref -a "-p" # # trace06.txt - Forward SIGINT to foreground job. # tsh> ./myspin 4 Job [1] (2222) terminated by signal 2 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit \$ █</pre>
测试结论	相同

4.3.7 测试用例 trace07.txt 的输出截图（1 分）

tsh 测试结果	tshref 测试结果
<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace07.txt -s ./tsh -a "-p" # # trace07.txt - Forward SIGINT only to foreground job. # tsh> ./myspin 4 & [1] (2229) ./myspin 4 & tsh> ./myspin 5 Job [2] (2231) terminated by signal 2 tsh> jobs</pre>	<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace07.txt -s ./tshref -a "-p" # # trace07.txt - Forward SIGINT only to foreground job. # tsh> ./myspin 4 & [1] (2236) ./myspin 4 & tsh> ./myspin 5 Job [2] (2238) terminated by signal 2 tsh> jobs</pre>
测试结论	相同

4.3.8 测试用例 trace08.txt 的输出截图（1 分）

tsh 测试结果	tshref 测试结果
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<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace08.txt -s ./tsh -a "-p" # # trace08.txt - Forward SIGTSTP only to foreground job. # tsh> ./myspin 4 & [1] (2297) ./myspin 4 & tsh> ./myspin 5 Job [2] (2299) stopped by signal 20 tsh> jobs [1] (2297) Running ./myspin 4 & [2] (2299) Stopped ./myspin 5 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$.</pre>	<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace08.txt -s ./tshref -a "-p" # # trace08.txt - Forward SIGTSTP only to foreground job. # tsh> ./myspin 4 & [1] (2268) ./myspin 4 & tsh> ./myspin 5 Job [2] (2270) stopped by signal 20 tsh> jobs [1] (2268) Running ./myspin 4 & [2] (2270) Stopped ./myspin 5 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$.</pre>
测试结论	相同

4.3.9 测试用例 trace09.txt 的输出截图（1 分）

tsh 测试结果	tshref 测试结果
<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace09.txt -s ./tsh -a "-p" # # trace09.txt - Process bg builtin command # tsh> ./myspin 4 & [1] (2333) ./myspin 4 & tsh> ./myspin 5 Job [2] (2335) stopped by signal 20 tsh> jobs [1] (2333) Running ./myspin 4 & [2] (2335) Stopped ./myspin 5 tsh> bg %2 [2] (2335) ./myspin 5 tsh> jobs [1] (2333) Running ./myspin 4 & [2] (2335) Running ./myspin 5 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$</pre>	<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace09.txt -s ./tshref -a "-p" # # trace09.txt - Process bg builtin command # tsh> ./myspin 4 & [1] (2324) ./myspin 4 & tsh> ./myspin 5 Job [2] (2326) stopped by signal 20 tsh> jobs [1] (2324) Running ./myspin 4 & [2] (2326) Stopped ./myspin 5 tsh> bg %2 [2] (2326) ./myspin 5 tsh> jobs [1] (2324) Running ./myspin 4 & [2] (2326) Running ./myspin 5 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$</pre>
测试结论	相同

4.3.10 测试用例 trace10.txt 的输出截图（1 分）

tsh 测试结果	tshref 测试结果
<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace10.txt -s ./tsh -a "-p" # # trace10.txt - Process fg builtin command. # tsh> ./myspin 4 & [1] (2361) ./myspin 4 & tsh> fg %1 Job [1] (2361) stopped by signal 20 tsh> jobs [1] (2361) Stopped ./myspin 4 & tsh> fg %1 tsh> jobs 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$</pre>	<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace10.txt -s ./tshref -a "-p" # # trace10.txt - Process fg builtin command. # tsh> ./myspin 4 & [1] (2353) ./myspin 4 & tsh> fg %1 Job [1] (2353) stopped by signal 20 tsh> jobs [1] (2353) Stopped ./myspin 4 & tsh> fg %1 tsh> jobs 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$</pre>

测试结论

相同

4.3.11 测试用例 trace11.txt 的输出截图（1 分）

tsh 测试结果

```
1170300821@luoruixin:~/hitcs/lab7/shlab-handout-hit$ ./sdriver.pl -t trace11.txt -s ./tsh -a "-p"
#
# trace11.txt - Forward SIGINT to every process in foreground process group
#
tsh> ./mysplit 4
Job [1] (2402) terminated by signal 2
tsh> /bin/ps a

PID TTY STAT TIME COMMAND
1100 tty1 Ssl+ 0:00 /usr/lib/gdm3/gdm-wayland-session gnome-session --autostart /usr/share/gdm/greeter/autostart
1104 tty1 Sl+ 0:00 /usr/lib/gnome-session/gnome-session-binary --autostart /usr/share/gdm/greeter/autostart
1110 tty1 Sl+ 0:10 /usr/bin/gnome-shell
1222 tty1 Sl+ 0:00 /usr/bin/wayland-1804 -rootless -terminate -accessx -core -listen 4 -listen 5 -displayfd 6
1256 tty1 Sl 0:00ibus-daemon -xln -panel disable
1259 tty1 Sl 0:00 /usr/lib/ibus/ibus-dconf
1262 tty1 Sl 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon
1278 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings
1283 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-a11y-settings
1284 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-clippboard
1285 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color
1287 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime
1289 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping
1292 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard
1298 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys
1299 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse
1301 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power
1304 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications
1306 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill
1307 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy
1310 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing
1315 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard
1317 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound
1321 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom
1333 tty1 Sl 0:00 /usr/lib/ibus/engine-simple
1417 tty2 Ssl+ 0:00 /usr/lib/gdm3/gdm-x-session --run-script env GNOME_SHELL_SESSION_MODE=ubuntu gnome-session --session=ubuntu
1419 tty2 Rl+ 0:15 /usr/lib/xorg/hwrt2 -displayfd 3 -auth /run/user/1000/gdm/Authority -background none --noret -keeppty -verbose 3
1430 tty2 Sl+ 0:00 /usr/lib/gnome-session/gnome-session-binary --session=ubuntu
1537 tty2 Sl+ 0:00 /usr/bin/gnome-shell
1575 tty2 Sl 0:00ibus-daemon -xln -panel disable
1579 tty2 Sl 0:00 /usr/lib/ibus/ibus-dconf
1581 tty2 Sl 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon
1653 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power
1657 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications
1658 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill
1659 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy
1663 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing
1668 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard
1674 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound
1678 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings
1680 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom
1686 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-a11y-settings
1687 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-clippboard
1692 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime
1693 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping
1696 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color
1701 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys
1705 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard
1739 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-printer
1752 tty2 Sl+ 0:05 /usr/bin/vmtoolsd -n vmusr -blockfd 3
1755 tty2 Sl+ 0:00 /usr/lib/gnome-disk-utility/gsd-disk-utility-notify
1756 tty2 Sl 0:00 nautilus-desktop
1798 tty2 Sl 0:02 /usr/lib/ibus/ibus-engine-ltbpinyin -ibus
1878 pts/0 Ss 0:00 bash
1897 tty2 Sl+ 0:00 update-notifier
1900 tty2 Sl+ 0:07 /usr/bin/gnome-software --application-service
1906 tty2 Z+ 0:00 [livespatch-notif] <defunct>
1996 tty2 Sl+ 0:00 /usr/lib/deja-dup/deja-dup-monitor
2399 pts/0 S+ 0:00 /usr/bin/perl ./sdriver.pl -t trace11.txt -s ./tsh -a -p
2400 pts/0 S+ 0:00 /tsh -p
2403 pts/0 S 0:00 /mysplit 4
2405 pts/0 R 0:00 /bin/ps a
```

tshref 测试结果

```
1170300821@luoruixin:~/hitcs/lab7/shlab-handout-hit$ ./sdriver.pl -t trace11.txt -s ./tshref -a "-p"
#
# trace11.txt - Forward SIGINT to every process in foreground process group
#
tsh> ./mysplit 4
Job [1] (2371) terminated by signal 2
tsh> /bin/ps a

PID TTY STAT TIME COMMAND
1100 tty1 Ssl+ 0:00 /usr/lib/gdm3/gdm-wayland-session gnome-session --autostart /usr/share/gdm/greeter/autostart
1104 tty1 Sl+ 0:00 /usr/lib/gnome-session/gnome-session-binary --autostart /usr/share/gdm/greeter/autostart
1110 tty1 Sl+ 0:09 /usr/bin/gnome-shell
1222 tty1 Sl+ 0:00 /usr/bin/wayland-1804 -rootless -terminate -accessx -core -listen 4 -listen 5 -displayfd 6
1256 tty1 Sl 0:00ibus-daemon -xln -panel disable
1259 tty1 Sl 0:00 /usr/lib/ibus/ibus-dconf
1262 tty1 Sl 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon
1278 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings
1283 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-a11y-settings
1284 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-clippboard
1285 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color
1287 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime
1289 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping
1292 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard
1298 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys
1299 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse
1301 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power
1304 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications
1306 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill
1307 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy
1310 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing
1315 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard
1317 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound
1321 tty1 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom
1333 tty1 Sl 0:00 /usr/lib/ibus/engine-simple
1417 tty2 Ssl+ 0:00 /usr/lib/gdm3/gdm-x-session --run-script env GNOME_SHELL_SESSION_MODE=ubuntu gnome-session --session=ubuntu
1419 tty2 Rl+ 0:20 /usr/lib/xorg/hwrt2 -displayfd 3 -auth /run/user/1000/gdm/Authority -background none --noret -keeppty -verbose 3
1430 tty2 Sl+ 0:00 /usr/lib/gnome-session/gnome-session-binary --session=ubuntu
1537 tty2 Sl+ 0:00 /usr/bin/gnome-shell
1575 tty2 Sl 0:00ibus-daemon -xln -panel disable
1579 tty2 Sl 0:00 /usr/lib/ibus/ibus-dconf
1581 tty2 Sl 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon
1653 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power
1657 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications
1658 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill
1659 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy
1663 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing
1668 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard
1674 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound
1678 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings
1680 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom
1686 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-a11y-settings
1687 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-clippboard
1692 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime
1693 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping
1696 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color
1701 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys
1705 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard
1739 tty2 Sl+ 0:00 /usr/lib/gnome-settings-daemon/gsd-printer
1752 tty2 Sl+ 0:04 /usr/bin/vmtoolsd -n vmusr -blockfd 3
1755 tty2 Sl+ 0:00 /usr/lib/gnome-disk-utility/gsd-disk-utility-notify
1756 tty2 Sl 0:03 nautilus-desktop
1798 tty2 Sl 0:02 /usr/lib/ibus/ibus-engine-ltbpinyin -ibus
1878 pts/0 Ss 0:00 bash
1897 tty2 Sl+ 0:00 update-notifier
1900 tty2 Sl+ 0:07 /usr/bin/gnome-software --application-service
1906 tty2 Z+ 0:00 [livespatch-notif] <defunct>
1996 tty2 Sl+ 0:00 /usr/lib/deja-dup/deja-dup-monitor
2399 pts/0 S+ 0:00 /usr/bin/perl ./sdriver.pl -t trace11.txt -s ./tshref -a -p
2400 pts/0 S+ 0:00 /tshref -a -p
2403 pts/0 S 0:00 /mysplit 4
2405 pts/0 R 0:00 /bin/ps a
```

测试结论

相同

4.3.12 测试用例 trace12.txt 的输出截图（1 分）

tsh 测试结果

```
1170300821@luoruixin:~/hitcs/lab7/shlab-handout-hit$ ./sdriver.pl -t trace12.txt -s ./tsh -a "-p"
#
# trace12.txt - Forward SIGTSTP to every process in foreground process group
#
tsh> ./mysplit 4
Job [1] (2461) stopped by signal 20
tsh> jobs
[1] (2461) Stopped ./mysplit 4
tsh> /bin/ps a
```

tshref 测试结果

```
1170300821@luoruixin:~/hitcs/lab7/shlab-handout-hit$ ./sdriver.pl -t trace12.txt -s ./tshref -a "-p"
#
# trace12.txt - Forward SIGTSTP to every process in foreground process group
#
tsh> ./mysplit 4
Job [1] (2452) stopped by signal 20
tsh> jobs
[1] (2452) Stopped ./mysplit 4
tsh> /bin/ps a
```

计算机系统实验报告

<pre>1170300821@luorutxlin:~/httics/lab7/shlab-handout-hits\$./driver.pl -t trace12.txt -s ./tshref -a "-p" # trace12.txt - Forward SIGTSTP to every process in foreground process group tsh> ./mysplit 4 Job [1] (2461) stopped by signal 20 tsh> jobs [1] (2461) Stopped ./mysplit 4 tsh> /bin/ps a PID TTY STAT TIME COMMAND 1100 tty1 Ss+ 0:00 /usr/lib/gdm3/gdm-wayland-session gnome-session --autostart /usr/share/gdm/greeter/autostart 1104 tty1 S+ 0:00 /usr/lib/gnome-session/gnome-session-binary --autostart /usr/share/gdm/greeter/autostart 1110 tty1 S+ 0:10 /usr/bin/gnome-shell 1222 tty1 S+ 0:00 /usr/bin/wayland-1024 -rootless -terminate -accessx -core -listen 4 -listen 5 -displayfd 6 1226 tty1 S+ 0:00 dbus-daemon -xln -panel disable 1229 tty1 S+ 0:00 /usr/lib/ibus/ibus-dconf 1262 tty1 S+ 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon 1278 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings 1283 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-aiis-settings 1284 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-cllboard 1285 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color 1287 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime 1289 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping 1292 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard 1298 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys 1299 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse 1301 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power 1304 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications 1306 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill 1307 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy 1310 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing 1315 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard 1317 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound 1321 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom 1333 tty1 S+ 0:00 /usr/lib/ibus/ibus-engine-simple 1417 tty2 Ss+ 0:00 /usr/lib/gdm3/gdm-x-session -run-script env GNOME_SHELL_SESSION_MODE=ubuntu gnome-session --session=ubuntu 1419 tty2 S+ 0:45 /usr/lib/org/korg vt2 -displayfd 3 -auth /run/user/1000/gdm/Authority -background none -norest -keeppty -verbose 3 1430 tty2 S+ 0:00 /usr/lib/gnome-session/gnome-session-binary -session=ubuntu 1537 tty2 S+ 3:47 /usr/bin/gnome-shell 1575 tty2 S+ 0:06 dbus-daemon -xln -panel disable 1579 tty2 S+ 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon 1581 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power 1553 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications 1657 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill 1658 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy 1659 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing 1660 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard 1674 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound 1676 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings 1680 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom 1686 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-aiis-settings 1687 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-cllboard 1692 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime 1693 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping 1696 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color 1699 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys 1701 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse 1705 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard 1739 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-printer 1752 tty2 S+ 0:00 /usr/bin/vmtoolsd -n vmusr -blockfd 3 1755 tty2 S+ 0:00 /usr/lib/gnome-disk-utility/gsd-disk-utility-notifty 1756 tty2 S+ 0:04 nautilus-desktop 1790 tty2 S+ 0:02 /usr/lib/ibus/ibus-engine-ltbginyin -ibus 1870 pts/B Ss 0:00 bash 1897 tty2 S+ 0:00 update-notifier 1900 tty2 Ss+ 0:07 /usr/bin/gnome-software --application-service 1906 tty2 Z+ 0:00 [lvsatch-notify] <defunct> 1910 tty2 S+ 0:00 /usr/lib/je-dev/je-dup-monitor 2449 pts/B S+ 0:00 /usr/bin/perl ./driver.pl -t trace12.txt -s ./tshref -a "-p" 2450 pts/B S+ 0:00 ./tshref -p 2461 pts/B T 0:00 ./mysplit 4 1170300821@luorutxlin:~/httics/lab7/shlab-handout-hits\$</pre>	<pre>1170300821@luorutxlin:~/httics/lab7/shlab-handout-hits\$./driver.pl -t trace12.txt -s ./tshrefref -a "-p" # trace12.txt - Forward SIGTSTP to every process in foreground process group tsh> ./mysplit 4 Job [1] (2452) stopped by signal 20 tsh> jobs [1] (2452) Stopped ./mysplit 4 tsh> /bin/ps a PID TTY STAT TIME COMMAND 1100 tty1 Ss+ 0:00 /usr/lib/gdm3/gdm-wayland-session gnome-session --autostart /usr/share/gdm/greeter/autostart 1104 tty1 S+ 0:00 /usr/lib/gnome-session/gnome-session-binary --autostart /usr/share/gdm/greeter/autostart 1110 tty1 S+ 0:10 /usr/bin/gnome-shell 1222 tty1 S+ 0:00 /usr/bin/wayland-1024 -rootless -terminate -accessx -core -listen 4 -listen 5 -displayfd 6 1256 tty1 S+ 0:00 dbus-daemon -xln -panel disable 1259 tty1 S+ 0:00 /usr/lib/ibus/ibus-dconf 1262 tty1 S+ 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon 1278 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings 1283 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-aiis-settings 1284 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-cllboard 1285 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color 1287 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime 1289 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping 1292 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard 1298 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys 1299 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse 1301 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power 1304 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications 1306 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill 1307 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy 1310 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing 1315 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard 1317 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound 1321 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom 1333 tty1 S+ 0:00 /usr/lib/ibus/ibus-engine-simple 1417 tty2 Ss+ 0:00 /usr/lib/gdm3/gdm-x-session -run-script env GNOME_SHELL_SESSION_MODE=ubuntu gnome-session --session=ubuntu 1419 tty2 S+ 0:44 /usr/lib/org/korg vt2 -displayfd 3 -auth /run/user/1000/gdm/Authority -background none -norest -keeppty -verbose 3 1430 tty2 S+ 0:00 /usr/lib/gnome-session/gnome-session-binary -session=ubuntu 1537 tty2 S+ 3:39 /usr/bin/gnome-shell 1575 tty2 S+ 0:06 dbus-daemon -xln -panel disable 1579 tty2 S+ 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon 1581 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power 1657 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications 1658 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill 1659 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy 1663 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing 1668 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard 1674 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound 1676 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings 1680 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom 1686 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-aiis-settings 1687 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-cllboard 1692 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime 1693 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping 1696 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color 1699 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys 1701 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse 1705 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard 1739 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-printer 1752 tty2 S+ 0:00 /usr/bin/vmtoolsd -n vmusr -blockfd 3 1755 tty2 S+ 0:00 /usr/lib/gnome-disk-utility/gsd-disk-utility-notifty 1756 tty2 S+ 0:04 nautilus-desktop 1790 tty2 S+ 0:02 /usr/lib/ibus/ibus-engine-ltbginyin -ibus 1870 pts/B Ss 0:00 bash 1897 tty2 S+ 0:00 update-notifier 1900 tty2 Ss+ 0:07 /usr/bin/gnome-software --application-service 1906 tty2 Z+ 0:00 [lvsatch-notify] <defunct> 1910 tty2 S+ 0:00 /usr/lib/je-dev/je-dup-monitor 2449 pts/B S+ 0:00 /usr/bin/perl ./driver.pl -t trace12.txt -s ./tshrefref -a "-p" 2450 pts/B S+ 0:00 ./tshrefref -p 2452 pts/B T 0:00 ./mysplit 4 2453 pts/B S+ 0:00 ./mysplit 4 1170300821@luorutxlin:~/httics/lab7/shlab-handout-hits\$</pre>
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测试结论

相同

4.3.13 测试用例 trace13.txt 的输出截图（1 分）

tsh 测试结果

```
1170300821@luorutxlin:~/httics/lab7/shlab-handout-hits$ ./driver.pl -t trace13.txt -s ./tshref -a "-p"
#
# trace13.txt - Restart every stopped process in process group
tsh> ./mysplit 4
Job [1] (2509) stopped by signal 20
tsh> jobs
[1] (2509) Stopped ./mysplit 4
tsh> /bin/ps a
PID TTY STAT TIME COMMAND
1100 tty1 Ss+ 0:00 /usr/lib/gdm3/gdm-wayland-session gnome-session --autostart /usr/share/gdm/greeter/autostart
1104 tty1 S+ 0:00 /usr/lib/gnome-session/gnome-session-binary --autostart /usr/share/gdm/greeter/autostart
1110 tty1 S+ 0:10 /usr/bin/gnome-shell
1222 tty1 S+ 0:00 /usr/bin/wayland-1024 -rootless -terminate -accessx -core -listen 4 -listen 5 -displayfd 6
1259 tty1 S+ 0:00 /usr/lib/ibus/ibus-dconf
1262 tty1 S+ 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon
1278 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings
1283 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-aiis-settings
1284 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-cllboard
1285 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color
1287 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime
1289 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping
1292 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard
1298 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys
1299 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse
1301 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power
1304 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications
1306 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill
1307 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy
1310 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing
1315 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard
1317 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound
1321 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom
1333 tty1 S+ 0:00 /usr/lib/ibus/ibus-engine-simple
1417 tty2 Ss+ 0:00 /usr/lib/gdm3/gdm-x-session -run-script env GNOME_SHELL_SESSION_MODE=ubuntu gnome-session --session=ubuntu
1419 tty2 S+ 0:50 /usr/lib/org/korg vt2 -displayfd 3 -auth /run/user/1000/gdm/Authority -background none -norest -keeppty -verbose 3
1430 tty2 S+ 0:00 /usr/lib/gnome-session/gnome-session-binary -session=ubuntu
1537 tty2 S+ 4:20 /usr/bin/gnome-shell
1575 tty2 S+ 0:06 dbus-daemon -xln -panel disable
1579 tty2 S+ 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon
1581 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power
1657 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications
1658 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill
1659 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy
1660 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing
1663 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard
1674 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound
1676 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings
```

tshref 测试结果

```
1170300821@luorutxlin:~/httics/lab7/shlab-handout-hits$ ./driver.pl -t trace13.txt -s ./tshrefref -a "-p"
#
# trace13.txt - Restart every stopped process in process group
tsh> ./mysplit 4
Job [1] (2486) stopped by signal 20
tsh> jobs
[1] (2486) Stopped ./mysplit 4
tsh> /bin/ps a
PID TTY STAT TIME COMMAND
1100 tty1 Ss+ 0:00 /usr/lib/gdm3/gdm-wayland-session gnome-session --autostart /usr/share/gdm/greeter/autostart
1104 tty1 S+ 0:00 /usr/lib/gnome-session/gnome-session-binary --autostart /usr/share/gdm/greeter/autostart
1110 tty1 S+ 0:10 /usr/bin/gnome-shell
1222 tty1 S+ 0:00 /usr/bin/wayland-1024 -rootless -terminate -accessx -core -listen 4 -listen 5 -displayfd 6
1256 tty1 S+ 0:00 dbus-daemon -xln -panel disable
1259 tty1 S+ 0:00 /usr/lib/ibus/ibus-dconf
1262 tty1 S+ 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon
1278 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings
1283 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-aiis-settings
1284 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-cllboard
1285 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color
1287 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime
1289 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping
1292 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard
1298 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys
1299 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse
1301 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power
1304 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications
1306 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill
1307 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy
1310 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing
1315 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard
1317 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound
1321 tty1 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom
1333 tty1 S+ 0:00 /usr/lib/ibus/ibus-engine-simple
1417 tty2 Ss+ 0:00 /usr/lib/gdm3/gdm-x-session -run-script env GNOME_SHELL_SESSION_MODE=ubuntu gnome-session --session=ubuntu
1419 tty2 S+ 0:48 /usr/lib/org/korg vt2 -displayfd 3 -auth /run/user/1000/gdm/Authority -background none -norest -keeppty -verbose 3
1430 tty2 S+ 0:00 /usr/lib/gnome-session/gnome-session-binary -session=ubuntu
1537 tty2 S+ 1:53 /usr/bin/gnome-shell
1575 tty2 S+ 0:06 dbus-daemon -xln -panel disable
1579 tty2 S+ 0:00 /usr/lib/ibus/ibus-dconf
1581 tty2 S+ 0:00 /usr/lib/ibus/ibus-x11 -kill-daemon
1657 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power
1658 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications
1659 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill
1660 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy
1663 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing
1668 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard
1674 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound
1676 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom
1680 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-aiis-settings
1687 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-cllboard
1692 tty2 S+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime
```


计算机系统实验报告

<pre>1880 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom 1880 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-ally-settings 1887 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-clipboard 1892 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime 1893 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping 1896 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color 1898 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys 1761 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse 1765 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard 1730 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-printer 1752 tty2 SL+ 0:07 /usr/bin/vmtoolsd -n vmusr --blockfd 3 1753 tty2 SL+ 0:00 /usr/lib/gnome-disk-utility/gsd-disk-utility-notify 1754 tty2 SL+ 0:04 nautilus-desktop 1798 tty2 SL 0:02 /usr/lib/ibus/ibus-engine-libpinyin -ibus 1878 pts/0 Ss 0:00 bash 1897 tty2 SL+ 0:00 update-notifier 1900 tty2 SL+ 0:07 /usr/bin/gnome-software --application-service 1900 tty2 Z+ 0:00 [livepatch-notif] <defunct> 1996 tty2 SL+ 0:00 /usr/lib/deja-dup/deja-dup-monitor 2106 pts/0 Rv 0:00 /usr/bin/perl ./driver.pl -t trace13.txt -s ./tshref -a -p 2507 pts/0 R+ 0:00 ./tsh -p 2509 pts/0 T 0:00 ./mysplit 4 2510 pts/0 S 0:00 ./mysplit 4 2513 pts/0 R 0:00 /bin/ps a tsh> fg %1 PID TTY STAT TIME COMMAND 1100 tty1 Ssl+ 0:00 /usr/lib/gdm/gdm-wayland-session gnome-session --autostart /usr/share/gdm/greeter/autostart 1104 tty1 SL+ 0:00 /usr/lib/gnome-session/gnome-session-binary --autostart /usr/share/gdm/greeter/autostart 1110 tty1 SL+ 0:10 /usr/bin/gnome-shell 1222 tty1 SL+ 0:00 /usr/bin/Xwayland :1024 -rootless -terminate -accessx -core -listen 4 -listen 5 -displayfd 6 1250 tty1 SL 0:00 dbus-daemon -x1n -panel disable 1250 tty1 SL 0:00 /usr/lib/ibus/ibus-dconf 1262 tty1 SL 0:00 /usr/lib/ibus/ibus-x11 --kill-daemon 1278 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings 1281 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-ally-settings 1284 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-clipboard 1285 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color 1287 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime 1289 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping 1292 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard 1298 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys 1299 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse 1301 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power 1304 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications 1306 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill 1307 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy 1310 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing 1315 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard 1317 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound 1321 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom 1333 tty1 SL 0:00 /usr/lib/ibus/ibus-engine-simple 1417 tty2 Ssl+ 0:00 /usr/lib/gdm/gdm-x-session -run-script env GNOME_SHELL_SESSION_MODE=ubuntu gnome-session --session=ubuntu 1419 tty2 SL+ 0:50 /usr/lib/korg/korg vt2 -displayfd 3 -auth /run/user/1000/gdm/Authority -background none -noreset -keeppty -verbose 3 1430 tty2 SL+ 0:00 /usr/lib/gnome-session/gnome-session-binary --session=ubu 1537 tty2 SL+ 4:20 /usr/bin/gnome-shell 1575 tty2 SL 0:06 dbus-daemon -x1n -panel disable 1579 tty2 SL 0:00 /usr/lib/ibus/ibus-dconf 1581 tty2 SL 0:00 /usr/lib/ibus/ibus-x11 --kill-daemon 1583 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power 1587 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications 1608 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill 1609 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy 1661 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing 1668 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard 1674 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound 1676 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings 1680 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom 1686 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-ally-settings 1687 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-clipboard 1692 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime 1693 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping 1696 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color 1698 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys 1701 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse 1765 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard 1730 tty2 SL+ 0:07 /usr/bin/vmtoolsd -n vmusr --blockfd 3 1752 tty2 SL+ 0:00 /usr/lib/gnome-disk-utility/gsd-disk-utility-notify 1754 tty2 SL+ 0:04 nautilus-desktop 1798 tty2 SL 0:02 /usr/lib/ibus/ibus-engine-libpinyin -ibus 1878 pts/0 Ss 0:00 bash 1897 tty2 SL+ 0:00 update-notifier 1900 tty2 SL+ 0:07 /usr/bin/gnome-software --application-service 1900 tty2 Z+ 0:00 [livepatch-notif] <defunct> 1996 tty2 SL+ 0:00 /usr/lib/deja-dup/deja-dup-monitor 2106 pts/0 S+ 0:00 /usr/bin/perl ./driver.pl -t trace13.txt -s ./tshref -a -p 2507 pts/0 S+ 0:00 ./tshref -p 2510 pts/0 R 0:00 /bin/ps a [119300002]@ubuntu1504:~/htts/c/ab7/shlab-handout-ht5</pre>	<pre>1893 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping 1896 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color 1898 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys 1701 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse 1705 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard 1730 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-printer 1752 tty2 SL 0:07 /usr/bin/vmtoolsd -n vmusr --blockfd 3 1753 tty2 SL+ 0:00 /usr/lib/gnome-disk-utility/gsd-disk-utility-notify 1754 tty2 SL+ 0:04 nautilus-desktop 1798 tty2 SL 0:02 /usr/lib/ibus/ibus-engine-libpinyin -ibus 1878 pts/0 Ss 0:00 bash 1897 tty2 SL+ 0:00 update-notifier 1900 tty2 SL+ 0:07 /usr/bin/gnome-software --application-service 1900 tty2 Z+ 0:00 [livepatch-notif] <defunct> 1996 tty2 SL+ 0:00 /usr/lib/deja-dup/deja-dup-monitor 2106 pts/0 S+ 0:00 /usr/bin/perl ./driver.pl -t trace13.txt -s ./tshref -a -p 2483 pts/0 S+ 0:00 ./tshref -p 2484 pts/0 T 0:00 ./mysplit 4 2487 pts/0 T 0:00 ./mysplit 4 2490 pts/0 R 0:00 /bin/ps a tsh> fg %1 PID TTY STAT TIME COMMAND 1100 tty1 Ssl+ 0:00 /usr/lib/gdm/gdm-wayland-session gnome-session --autostart /usr/share/gdm/greeter/autostart 1104 tty1 SL+ 0:00 /usr/lib/gnome-session/gnome-session-binary --autostart /usr/share/gdm/greeter/autostart 1110 tty1 SL+ 0:10 /usr/bin/gnome-shell 1222 tty1 SL+ 0:00 /usr/bin/Xwayland :1024 -rootless -terminate -accessx -core -listen 4 -listen 5 -displayfd 6 1250 tty1 SL 0:00 dbus-daemon -x1n -panel disable 1250 tty1 SL 0:00 /usr/lib/ibus/ibus-dconf 1262 tty1 SL 0:00 /usr/lib/ibus/ibus-x11 --kill-daemon 1278 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings 1281 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-ally-settings 1284 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-clipboard 1285 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color 1287 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime 1289 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping 1292 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard 1298 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys 1299 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse 1301 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power 1304 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications 1306 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill 1307 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy 1310 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing 1315 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard 1317 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound 1321 tty1 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom 1333 tty1 SL 0:00 /usr/lib/ibus/ibus-engine-simple 1417 tty2 Ssl+ 0:00 /usr/lib/gdm/gdm-x-session -run-script env GNOME_SHELL_SESSION_MODE=ubuntu gnome-session --session=ubuntu 1419 tty2 SL+ 0:50 /usr/lib/korg/korg vt2 -displayfd 3 -auth /run/user/1000/gdm/Authority -background none -noreset -keeppty -verbose 3 1430 tty2 SL+ 0:00 /usr/lib/gnome-session/gnome-session-binary --session=ubuntu 1537 tty2 SL+ 4:20 /usr/bin/gnome-shell 1575 tty2 SL 0:06 dbus-daemon -x1n -panel disable 1579 tty2 SL 0:00 /usr/lib/ibus/ibus-dconf 1581 tty2 SL 0:00 /usr/lib/ibus/ibus-x11 --kill-daemon 1583 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-power 1587 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-print-notifications 1608 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-rfkill 1609 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-screensaver-proxy 1661 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sharing 1668 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-smartcard 1674 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-sound 1676 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-xsettings 1680 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-wacom 1686 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-ally-settings 1687 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-clipboard 1692 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-datetime 1693 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-housekeeping 1696 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-color 1698 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-media-keys 1701 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-mouse 1765 tty2 SL+ 0:00 /usr/lib/gnome-settings-daemon/gsd-keyboard 1730 tty2 SL+ 0:07 /usr/bin/vmtoolsd -n vmusr --blockfd 3 1752 tty2 SL+ 0:00 /usr/lib/gnome-disk-utility/gsd-disk-utility-notify 1754 tty2 SL+ 0:04 nautilus-desktop 1798 tty2 SL 0:02 /usr/lib/ibus/ibus-engine-libpinyin -ibus 1878 pts/0 Ss 0:00 bash 1897 tty2 SL+ 0:00 update-notifier 1900 tty2 SL+ 0:07 /usr/bin/gnome-software --application-service 1900 tty2 Z+ 0:00 [livepatch-notif] <defunct> 1996 tty2 SL+ 0:00 /usr/lib/deja-dup/deja-dup-monitor 2106 pts/0 S+ 0:00 /usr/bin/perl ./driver.pl -t trace13.txt -s ./tshref -a -p 2483 pts/0 S+ 0:00 ./tshref -p 2484 pts/0 T 0:00 ./mysplit 4 2487 pts/0 T 0:00 ./mysplit 4 2490 pts/0 R 0:00 /bin/ps a [119300002]@ubuntu1504:~/htts/c/ab7/shlab-handout-ht5</pre>
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测试结论

相同

4.3.14 测试用例 trace14.txt 的输出截图（1 分）

tsh 测试结果

tshref 测试结果

<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace14.txt -s ./tsh -a "-p" # # trace14.txt - Simple error handling # tsh> ./bogus ./bogus: Command not found tsh> ./myspin 4 & [1] (2546) ./myspin 4 & tsh> fg fg command requires PID or %jobid argument tsh> bg bg command requires PID or %jobid argument tsh> fg a fg: argument must be a PID or %jobid tsh> bg a bg: argument must be a PID or %jobid tsh> fg 9999999 (9999999): No such process tsh> bg 9999999 (9999999): No such process tsh> fg %2 %2: No such job tsh> fg %1 Job [1] (2546) stopped by signal 20 tsh> bg %2 %2: No such job tsh> bg %1 [1] (2546) ./myspin 4 & tsh> jobs [1] (2546) Running ./myspin 4 & 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$</pre>	<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace14.txt -s ./tshref -a "-p" # # trace14.txt - Simple error handling # tsh> ./bogus ./bogus: Command not found tsh> ./myspin 4 & [1] (2526) ./myspin 4 & tsh> fg fg command requires PID or %jobid argument tsh> bg bg command requires PID or %jobid argument tsh> fg a fg: argument must be a PID or %jobid tsh> bg a bg: argument must be a PID or %jobid tsh> fg 9999999 (9999999): No such process tsh> bg 9999999 (9999999): No such process tsh> fg %2 %2: No such job tsh> fg %1 Job [1] (2526) stopped by signal 20 tsh> bg %2 %2: No such job tsh> bg %1 [1] (2526) ./myspin 4 & tsh> jobs [1] (2526) Running ./myspin 4 & 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$</pre>
测试结论	相同

4.3.15 测试用例 trace15.txt 的输出截图（1 分）

tsh 测试结果	tshref 测试结果
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<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace15.txt -s ./tsh -a "-p" # # trace15.txt - Putting it all together # tsh> ./bogus ./bogus: Command not found tsh> ./myspin 10 Job [1] (2581) terminated by signal 2 tsh> ./myspin 3 & [1] (2583) ./myspin 3 & tsh> ./myspin 4 & [2] (2585) ./myspin 4 & tsh> jobs [1] (2583) Running ./myspin 3 & [2] (2585) Running ./myspin 4 & tsh> fg %1 Job [1] (2583) stopped by signal 20 tsh> jobs [1] (2583) Stopped ./myspin 3 & [2] (2585) Running ./myspin 4 & tsh> bg %3 %3: No such job tsh> bg %1 [1] (2583) ./myspin 3 & tsh> jobs [1] (2583) Running ./myspin 3 & [2] (2585) Running ./myspin 4 & tsh> fg %1 tsh> quit 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$</pre>	<pre>1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$./sdriver.pl -t trace15.txt -s ./tshref -a "-p" # # trace15.txt - Putting it all together # tsh> ./bogus ./bogus: Command not found tsh> ./myspin 10 Job [1] (2563) terminated by signal 2 tsh> ./myspin 3 & [1] (2565) ./myspin 3 & tsh> ./myspin 4 & [2] (2567) ./myspin 4 & tsh> jobs [1] (2565) Running ./myspin 3 & [2] (2567) Running ./myspin 4 & tsh> fg %1 Job [1] (2565) stopped by signal 20 tsh> jobs [1] (2565) Stopped ./myspin 3 & [2] (2567) Running ./myspin 4 & tsh> bg %3 %3: No such job tsh> bg %1 [1] (2565) ./myspin 3 & tsh> jobs [1] (2565) Running ./myspin 3 & [2] (2567) Running ./myspin 4 & tsh> fg %1 tsh> quit 1170300821@luoruixin:~/hitics/lab7/shlab-handout-hit\$</pre>
测试结论	相同

4.4 自测试评分

根据节 4.3 的自测试结果，程序的测试评分为： 15 。

第 5 章 总结

5.1 请总结本次实验的收获

理解了现代计算机系统进程与并发的基本知识

掌握了 linux 异常控制流和信号机制的基本原理和相关系统函数

掌握了 shell 的基本原理和实现方法

深入了理解 Linux 信号响应可能导致的并发冲突及解决方法

培养了 Linux 下的软件系统开发与测试能力

5.2 请给出对本次实验内容的建议

注：本章为酌情加分项。

参考文献

为完成本次实验你翻阅的书籍与网站等

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