BLG 413E

SYSTEM PROGRAMMING

CRN: 12300

REPORT OF PROJECT #2

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1. Introduction

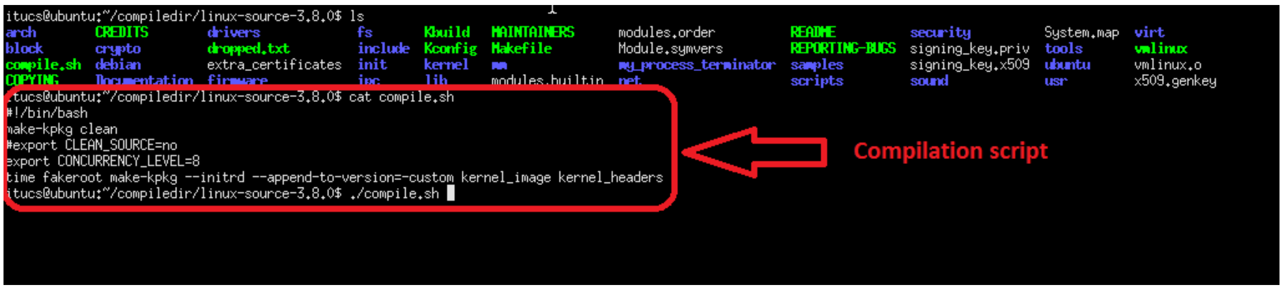
A system call which either only terminates all the children of a given process or terminates all children, all siblings and their children of a given process is written (The process itself is not terminated). Only processes having root privileges can successfully execute this system call.

The “exit” system call is also modified. If the “nice” value of the process which has executed the “exit” system call is greater than 10, then the “exit” system call also use the new system call **(my_process_terminator**) we have written with flag=0, all children of the exiting process are terminated along with the process itself. If a parent process terminated, children process of terminated process are adopted by init (pid:1) process in Linux.

2. Compilation and Installation

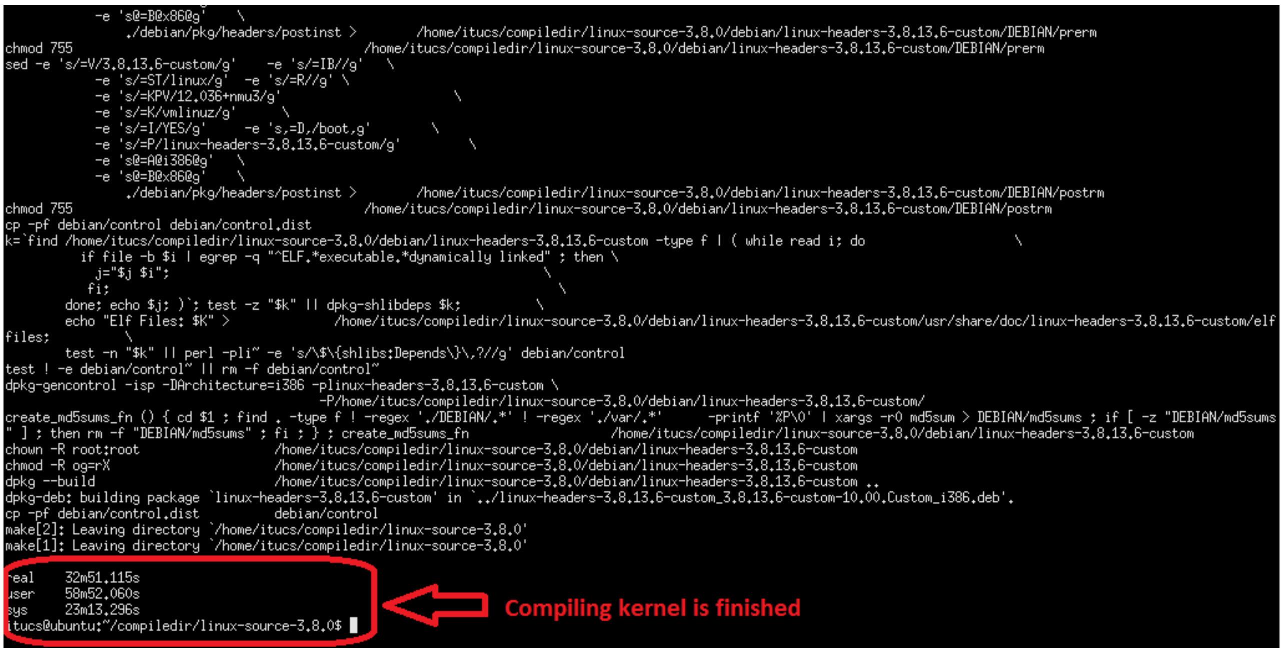
The custom kernel is compiled with a bash script with modified Makefile:

```
#!/bin/bash

make-kpkg clean

time fakeroot make-kpkg --initrd --append-to-version=-custom kernel_image kernel_headers
```



```
itucs@ubuntu:~/compiledir/linux-source-3.8.0$ ls
arch       CREDITS        drivers             fs      Kbuild   MAINTAINERS     modules.order          README          security          System.map  virt
block      crypto         dropped.txt         include Kconfig  Makefile        Module.symvers         REPORTING-BUGS  signing_key.priv  tools       vmlinux
compile.sh debian         extra_certificates  init    kernel   mm              my_process_terminator  samples         signing_key.x509  ubuntu      vmlinux.o
COPYING    Documentation  firmware            ipc     lib      modules.builtin net                    scripts         sound             usr         x509.genkey
tucs@ubuntu:~/compiledir/linux-source-3.8.0$ cat compile.sh
#!/bin/bash
ake-kpkg clean
#export CLEAN_SOURCE=no
xport CONCURRENCY_LEVEL=8
time fakeroot make-kpkg --initrd --append-to-version=-custom kernel_image kernel_headers
itucs@ubuntu:~/compiledir/linux-source-3.8.0$ ./compile.sh
```

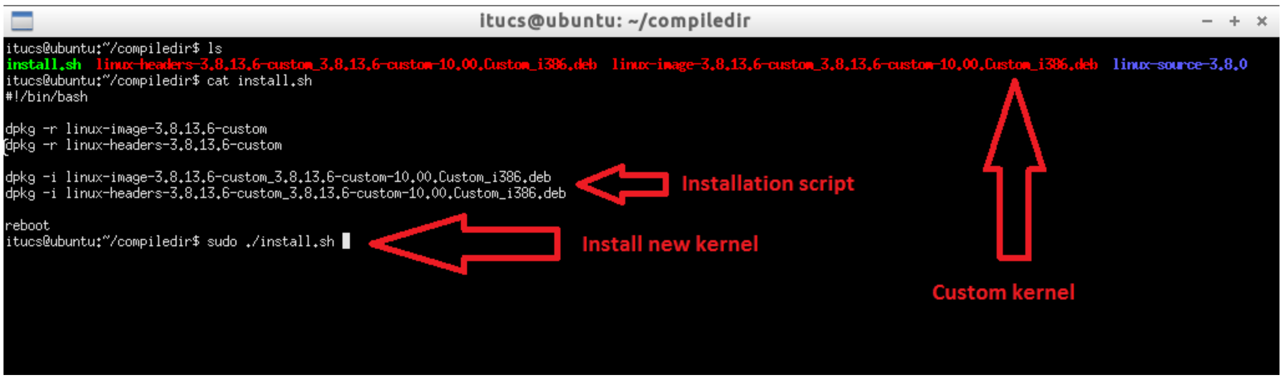
Compilation finished about half an hour:



```
            -e 's@=B@x86@g'     \
                ./debian/pkg/headers/postinst >        /home/itucs/compiledir/linux-source-3.8.0/debian/linux-headers-3.8.13.6-custom/DEBIAN/prerm
chmod 755                                       /home/itucs/compiledir/linux-source-3.8.0/debian/linux-headers-3.8.13.6-custom/DEBIAN/prerm
sed -e 's/=V/3.8.13.6-custom/g'    -e 's/=IB//g'   \
            -e 's/=ST/linux/g'  -e 's/=R//g' \
            -e 's/=KPV/12.036+nmu3/g'                    \
            -e 's/=K/vmlinuz/g'      \
            -e 's/=I/YES/g'     -e 's,=D,/boot,g'        \
            -e 's/=P/linux-headers-3.8.13.6-custom/g'         \
            -e 's@=A@i386@g'    \
            -e 's@=B@x86@g'     \
                ./debian/pkg/headers/postinst >        /home/itucs/compiledir/linux-source-3.8.0/debian/linux-headers-3.8.13.6-custom/DEBIAN/postrm
chmod 755                                       /home/itucs/compiledir/linux-source-3.8.0/debian/linux-headers-3.8.13.6-custom/DEBIAN/postrm
cp -pf debian/control debian/control.dist
k=`find /home/itucs/compiledir/linux-source-3.8.0/debian/linux-headers-3.8.13.6-custom -type f | ( while read i; do                   \
          if file -b $i | egrep -q "^ELF.*executable.*dynamically linked" ; then \
            j="$j $i";                                                \
           fi;                                                         \
        done; echo $j; )`; test -z "$k" || dpkg-shlibdeps $k;          \
        echo "Elf Files: $K" >             /home/itucs/compiledir/linux-source-3.8.0/debian/linux-headers-3.8.13.6-custom/usr/share/doc/linux-headers-3.8.13.6-custom/elf
files;          \
        test -n "$k" || perl -pli~ -e 's/\$\{shlibs:Depends\}\,?//g' debian/control
test ! -e debian/control~ || rm -f debian/control~
dpkg-gencontrol -isp -DArchitecture=i386 -plinux-headers-3.8.13.6-custom \
                                        -P/home/itucs/compiledir/linux-source-3.8.0/debian/linux-headers-3.8.13.6-custom/
create_md5sums_fn () { cd $1 ; find . -type f ! -regex './DEBIAN/.*' ! -regex './var/.*'      -printf '%P\0' | xargs -r0 md5sum > DEBIAN/md5sums ; if [ -z "DEBIAN/md5sums
" ] ; then rm -f "DEBIAN/md5sums" ; fi ; } ; create_md5sums_fn                 /home/itucs/compiledir/linux-source-3.8.0/debian/linux-headers-3.8.13.6-custom
chown -R root:root                  /home/itucs/compiledir/linux-source-3.8.0/debian/linux-headers-3.8.13.6-custom
chmod -R og=rX                      /home/itucs/compiledir/linux-source-3.8.0/debian/linux-headers-3.8.13.6-custom
dpkg --build                        /home/itucs/compiledir/linux-source-3.8.0/debian/linux-headers-3.8.13.6-custom ..
dpkg-deb: building package `linux-headers-3.8.13.6-custom' in `../linux-headers-3.8.13.6-custom_3.8.13.6-custom-10.00.Custom_i386.deb'.
cp -pf debian/control.dist          debian/control
make[2]: Leaving directory `/home/itucs/compiledir/linux-source-3.8.0'
make[1]: Leaving directory `/home/itucs/compiledir/linux-source-3.8.0'

eal     32m51.115s
user    58m52.060s
sys     23m13.296s
itucs@ubuntu:~/compiledir/linux-source-3.8.0$
```

The new kernel installed with a bash script:

```
#!/bin/bash
dpkg -r linux-image-3.8.13.6-custom
dpkg -r linux-headers-3.8.13.6-custom
dpkg -i linux-image-3.8.13.6-custom_3.8.13.6-custom-10.00.Custom_i386.deb
dpkg -i linux-headers-3.8.13.6-custom_3.8.13.6-custom-10.00.Custom_i386.deb
reboot
```



```
itucs@ubuntu:~/compiledir$ ls
install.sh  linux-headers-3.8.13.6-custom_3.8.13.6-custom-10.00.Custom_i386.deb  linux-image-3.8.13.6-custom_3.8.13.6-custom-10.00.Custom_i386.deb  linux-source-3.8.0
itucs@ubuntu:~/compiledir$ cat install.sh
#!/bin/bash

dpkg -r linux-image-3.8.13.6-custom
dpkg -r linux-headers-3.8.13.6-custom

dpkg -i linux-image-3.8.13.6-custom_3.8.13.6-custom-10.00.Custom_i386.deb
dpkg -i linux-headers-3.8.13.6-custom_3.8.13.6-custom-10.00.Custom_i386.deb

reboot
itucs@ubuntu:~/compiledir$ sudo ./install.sh
```

After reboot, now we are working on new kernel.

3. Running

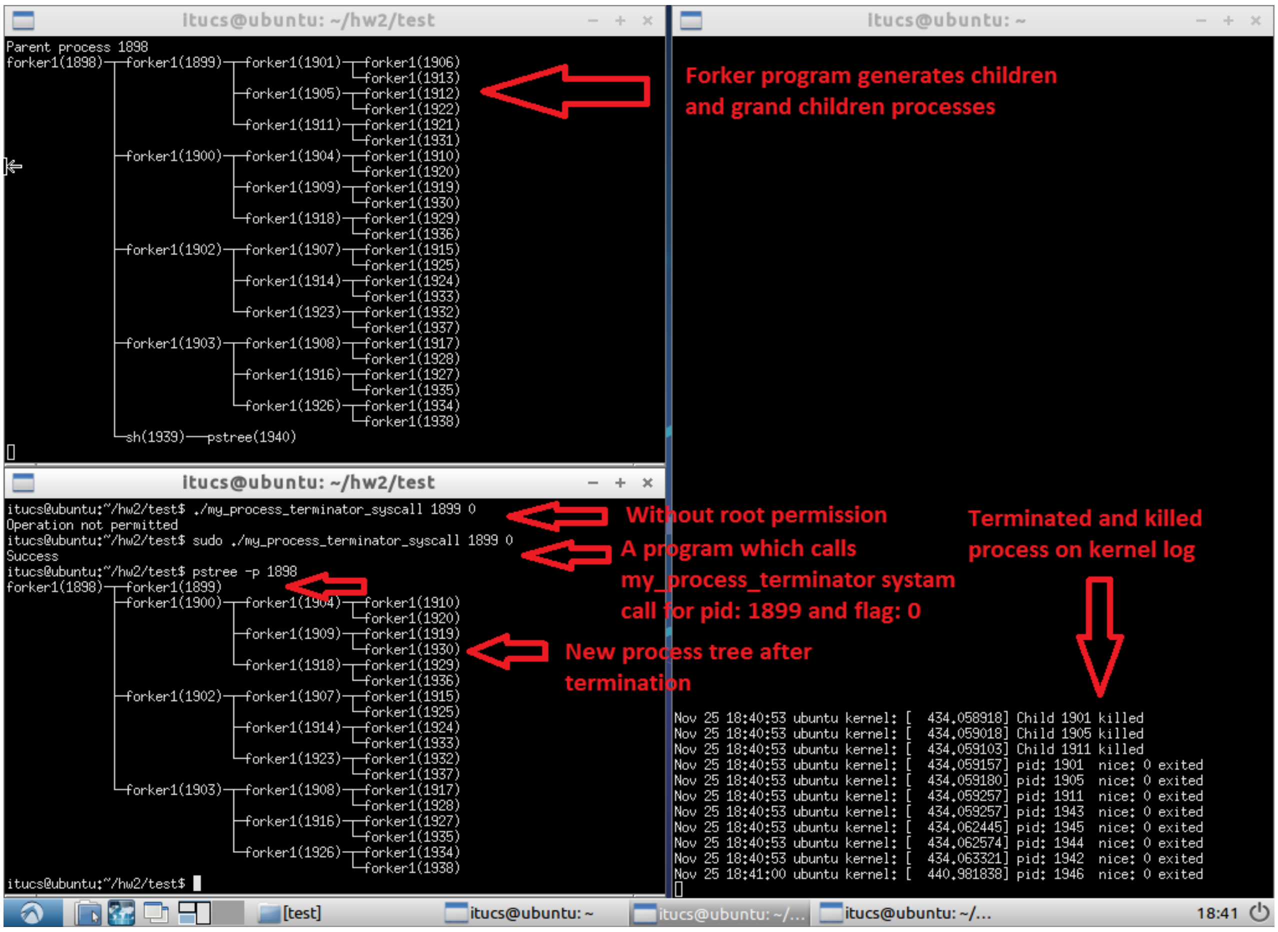
a. New Process Terminator System Call

New system call can be tested by our test programs. First program (**forker1**) generates children and grandchildren processes with fork system call, second program (**my_process_terminator_syscall**) calls new **my_process_terminator** system call with parameters PID and flag.

System calls tested with and without root permission. New process tree is shown after termination.

i. Flag 0

Firstly, **my_process_terminator** system call called with flag 0 in test program (**my_process_terminator_syscall**):


itucs@ubuntu: ~/hw2/test
itucs@ubuntu: ~
Forker program generates children and grand children processes
Without root permission
A program which calls my_process_terminator systam call for pid: 1899 and flag: 0
New process tree after termination
Terminated and killed process on kernel log
[test]
itucs@ubuntu: ~
itucs@ubuntu: ~/...
itucs@ubuntu: ~/...
18:41

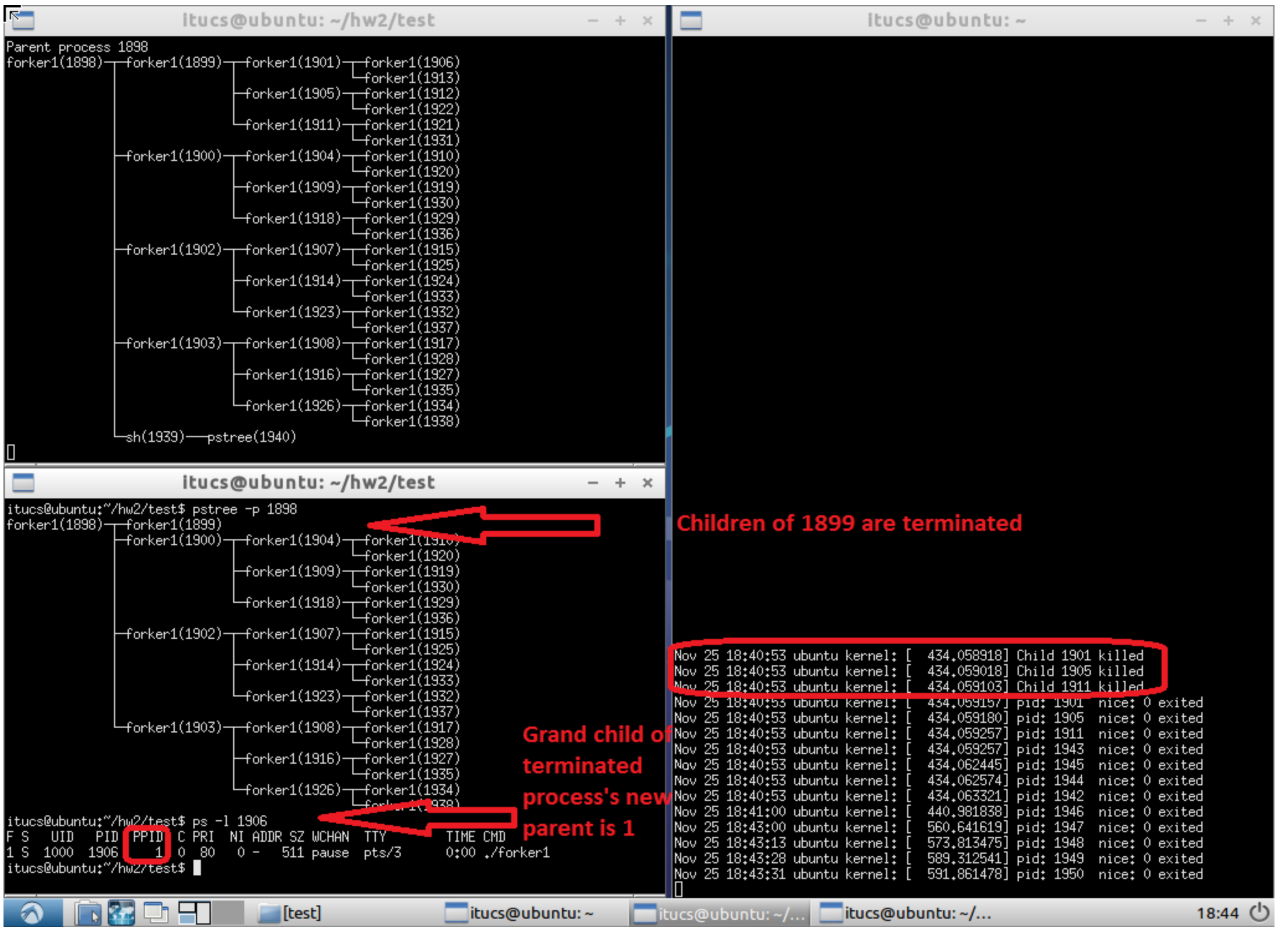
```
Parent process 1898
forker1(1898)─┬─forker1(1899)─┬─forker1(1901)─┬─forker1(1906)
              │               │               └─forker1(1913)
              │               ├─forker1(1905)─┬─forker1(1912)
              │               │               └─forker1(1922)
              │               └─forker1(1911)─┬─forker1(1921)
              │                               └─forker1(1931)
              ├─forker1(1900)─┬─forker1(1904)─┬─forker1(1910)
              │               │               └─forker1(1920)
              │               ├─forker1(1909)─┬─forker1(1919)
              │               │               └─forker1(1930)
              │               └─forker1(1918)─┬─forker1(1929)
              │                               └─forker1(1936)
              ├─forker1(1902)─┬─forker1(1907)─┬─forker1(1915)
              │               │               └─forker1(1925)
              │               ├─forker1(1914)─┬─forker1(1924)
              │               │               └─forker1(1933)
              │               └─forker1(1923)─┬─forker1(1932)
              │                               └─forker1(1937)
              ├─forker1(1903)─┬─forker1(1908)─┬─forker1(1917)
              │               │               └─forker1(1928)
              │               ├─forker1(1916)─┬─forker1(1927)
              │               │               └─forker1(1935)
              │               └─forker1(1926)─┬─forker1(1934)
              │                               └─forker1(1938)
              └─sh(1939)───pstree(1940)
```

```
itucs@ubuntu:~/hw2/test$ ./my_process_terminator_syscall 1899 0
Operation not permitted
itucs@ubuntu:~/hw2/test$ sudo ./my_process_terminator_syscall 1899 0
Success
itucs@ubuntu:~/hw2/test$ pstree -p 1898
forker1(1898)─┬─forker1(1899)
              ├─forker1(1900)─┬─forker1(1904)─┬─forker1(1910)
              │               │               └─forker1(1920)
              │               ├─forker1(1909)─┬─forker1(1919)
              │               │               └─forker1(1930)
              │               └─forker1(1918)─┬─forker1(1929)
              │                               └─forker1(1936)
              ├─forker1(1902)─┬─forker1(1907)─┬─forker1(1915)
              │               │               └─forker1(1925)
              │               ├─forker1(1914)─┬─forker1(1924)
              │               │               └─forker1(1933)
              │               └─forker1(1923)─┬─forker1(1932)
              │                               └─forker1(1937)
              └─forker1(1903)─┬─forker1(1908)─┬─forker1(1917)
                              │               └─forker1(1928)
                              ├─forker1(1916)─┬─forker1(1927)
                              │               └─forker1(1935)
                              └─forker1(1926)─┬─forker1(1934)
                                              └─forker1(1938)
itucs@ubuntu:~/hw2/test$
```

```
Nov 25 18:40:53 ubuntu kernel: [  434.058918] Child 1901 killed
Nov 25 18:40:53 ubuntu kernel: [  434.059018] Child 1905 killed
Nov 25 18:40:53 ubuntu kernel: [  434.059103] Child 1911 killed
Nov 25 18:40:53 ubuntu kernel: [  434.059157] pid: 1901  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.059180] pid: 1905  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.059257] pid: 1911  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.059257] pid: 1943  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.062445] pid: 1945  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.062574] pid: 1944  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.063321] pid: 1942  nice: 0 exited
Nov 25 18:41:00 ubuntu kernel: [  440.981838] pid: 1946  nice: 0 exited
```

After calling system call with flag 0, children processes are terminated but process itself, siblings and grandchildren processes are alive.

After termination of process with flag 0, orphan processes are adopted by init process:



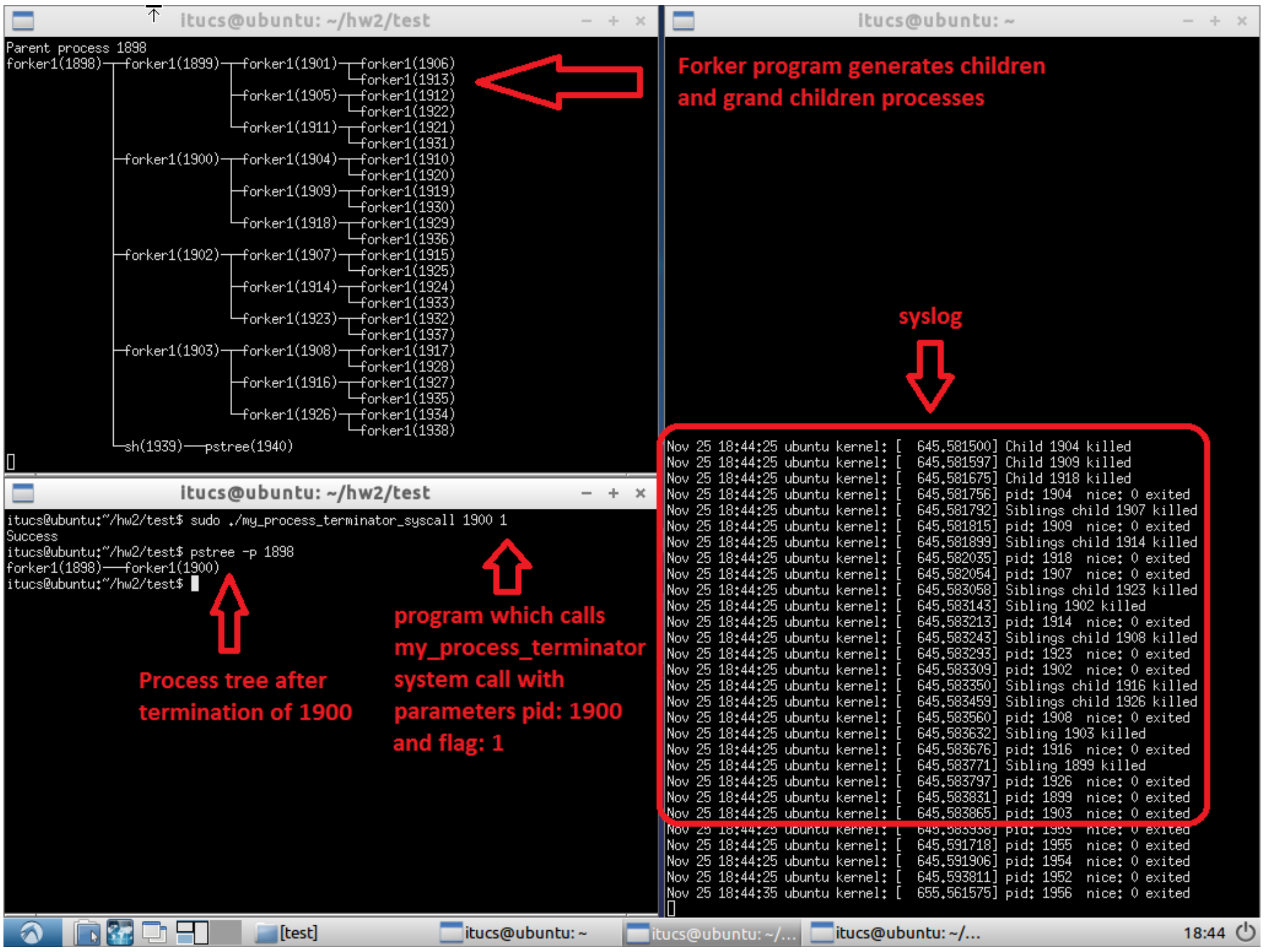
```
Parent process 1898
forker1(1898)─┬─forker1(1899)─┬─forker1(1901)─┬─forker1(1906)
              │               │               └─forker1(1913)
              │               ├─forker1(1905)─┬─forker1(1912)
              │               │               └─forker1(1922)
              │               └─forker1(1911)─┬─forker1(1921)
              │                               └─forker1(1931)
              ├─forker1(1900)─┬─forker1(1904)─┬─forker1(1910)
              │               │               └─forker1(1920)
              │               ├─forker1(1909)─┬─forker1(1919)
              │               │               └─forker1(1930)
              │               └─forker1(1918)─┬─forker1(1929)
              │                               └─forker1(1936)
              ├─forker1(1902)─┬─forker1(1907)─┬─forker1(1915)
              │               │               └─forker1(1925)
              │               ├─forker1(1914)─┬─forker1(1924)
              │               │               └─forker1(1933)
              │               └─forker1(1923)─┬─forker1(1932)
              │                               └─forker1(1937)
              ├─forker1(1903)─┬─forker1(1908)─┬─forker1(1917)
              │               │               └─forker1(1928)
              │               ├─forker1(1916)─┬─forker1(1927)
              │               │               └─forker1(1935)
              │               └─forker1(1926)─┬─forker1(1934)
              │                               └─forker1(1938)
              └─sh(1939)───pstree(1940)
```

```
itucs@ubuntu:~/hw2/test$ pstree -p 1898
forker1(1898)─┬─forker1(1899)
              ├─forker1(1900)─┬─forker1(1904)─┬─forker1(1910)
              │               │               └─forker1(1920)
              │               ├─forker1(1909)─┬─forker1(1919)
              │               │               └─forker1(1930)
              │               └─forker1(1918)─┬─forker1(1929)
              │                               └─forker1(1936)
              ├─forker1(1902)─┬─forker1(1907)─┬─forker1(1915)
              │               │               └─forker1(1925)
              │               ├─forker1(1914)─┬─forker1(1924)
              │               │               └─forker1(1933)
              │               └─forker1(1923)─┬─forker1(1932)
              │                               └─forker1(1937)
              └─forker1(1903)─┬─forker1(1908)─┬─forker1(1917)
                              │               └─forker1(1928)
                              ├─forker1(1916)─┬─forker1(1927)
                              │               └─forker1(1935)
                              └─forker1(1926)─┬─forker1(1934)
                                              └─forker1(1938)
itucs@ubuntu:~/hw2/test$ ps -l 1906
F S   UID   PID  PPID  C PRI  NI ADDR SZ WCHAN  TTY        TIME CMD
1 S  1000  1906     1  0  80   0 -   511 pause  pts/3      0:00 ./forker1
itucs@ubuntu:~/hw2/test$
```

```
Nov 25 18:40:53 ubuntu kernel: [  434.058918] Child 1901 killed
Nov 25 18:40:53 ubuntu kernel: [  434.059018] Child 1905 killed
Nov 25 18:40:53 ubuntu kernel: [  434.059103] Child 1911 killed
Nov 25 18:40:53 ubuntu kernel: [  434.059157] pid: 1901  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.059180] pid: 1905  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.059257] pid: 1911  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.059257] pid: 1943  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.062445] pid: 1945  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.062574] pid: 1944  nice: 0 exited
Nov 25 18:40:53 ubuntu kernel: [  434.063321] pid: 1942  nice: 0 exited
Nov 25 18:41:00 ubuntu kernel: [  440.981838] pid: 1946  nice: 0 exited
Nov 25 18:43:00 ubuntu kernel: [  560.641619] pid: 1947  nice: 0 exited
Nov 25 18:43:13 ubuntu kernel: [  573.813475] pid: 1948  nice: 0 exited
Nov 25 18:43:28 ubuntu kernel: [  589.312541] pid: 1949  nice: 0 exited
Nov 25 18:43:31 ubuntu kernel: [  591.861478] pid: 1950  nice: 0 exited
```

ii. Flag 1

Secondly, **my_process_terminator** system call called with flag 1 in test program (**my_process_terminator_syscall**):


itucs@ubuntu: ~/hw2/test
itucs@ubuntu: ~
Forker program generates children and grand children processes
syslog
itucs@ubuntu: ~/hw2/test
program which calls my_process_terminator system call with parameters pid: 1900 and flag: 1
Process tree after termination of 1900
[test]
itucs@ubuntu: ~
itucs@ubuntu: ~/...
itucs@ubuntu: ~/...
18:44

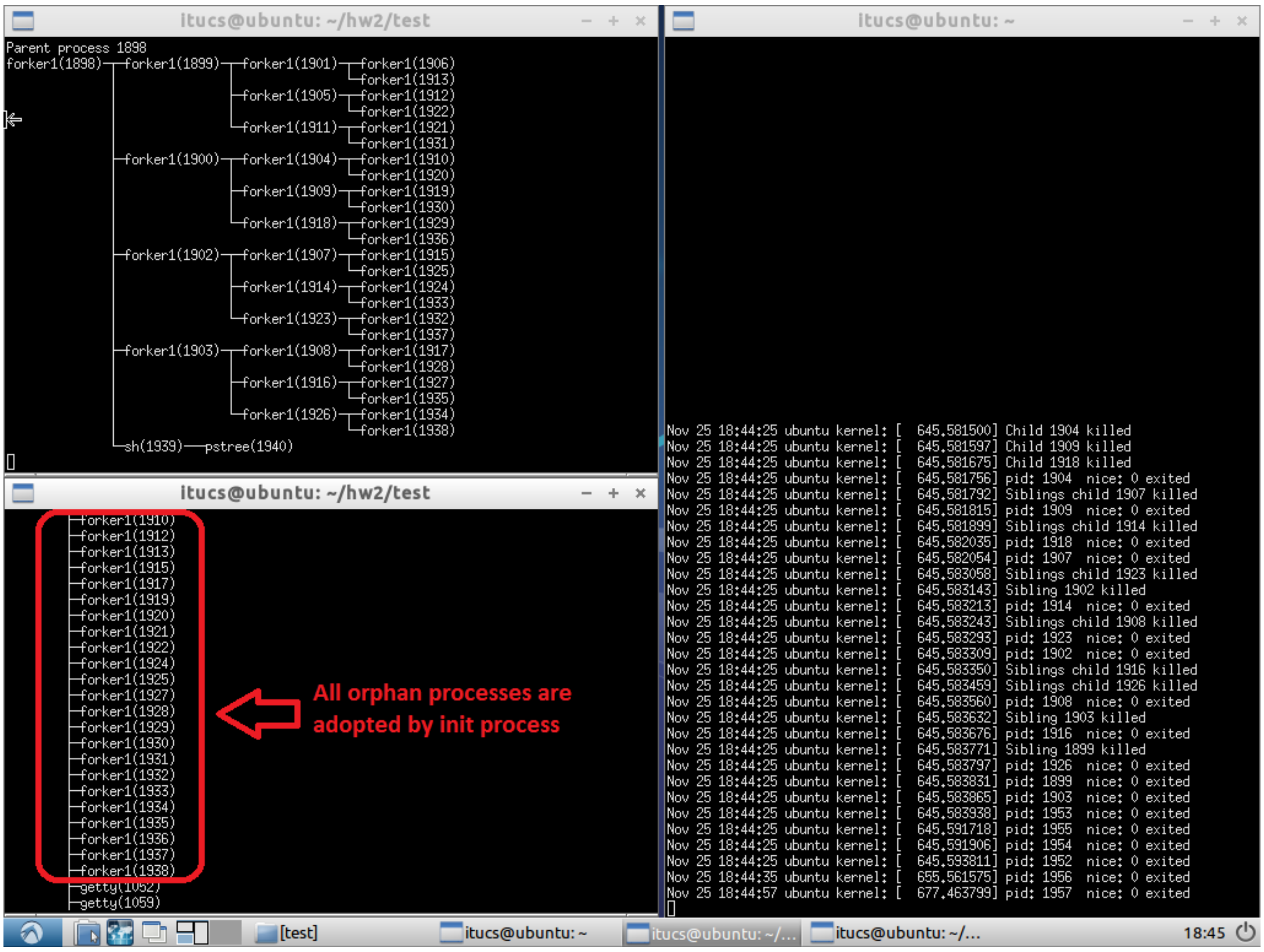
```
Parent process 1898
forker1(1898)─┬─forker1(1899)─┬─forker1(1901)─┬─forker1(1906)
              │               │               └─forker1(1913)
              │               ├─forker1(1905)─┬─forker1(1912)
              │               │               └─forker1(1922)
              │               └─forker1(1911)─┬─forker1(1921)
              │                               └─forker1(1931)
              ├─forker1(1900)─┬─forker1(1904)─┬─forker1(1910)
              │               │               └─forker1(1920)
              │               ├─forker1(1909)─┬─forker1(1919)
              │               │               └─forker1(1930)
              │               └─forker1(1918)─┬─forker1(1929)
              │                               └─forker1(1936)
              ├─forker1(1902)─┬─forker1(1907)─┬─forker1(1915)
              │               │               └─forker1(1925)
              │               ├─forker1(1914)─┬─forker1(1924)
              │               │               └─forker1(1933)
              │               └─forker1(1923)─┬─forker1(1932)
              │                               └─forker1(1937)
              ├─forker1(1903)─┬─forker1(1908)─┬─forker1(1917)
              │               │               └─forker1(1928)
              │               ├─forker1(1916)─┬─forker1(1927)
              │               │               └─forker1(1935)
              │               └─forker1(1926)─┬─forker1(1934)
              │                               └─forker1(1938)
              └─sh(1939)───pstree(1940)
```

```
itucs@ubuntu:~/hw2/test$ sudo ./my_process_terminator_syscall 1900 1
Success
itucs@ubuntu:~/hw2/test$ pstree -p 1898
forker1(1898)───forker1(1900)
itucs@ubuntu:~/hw2/test$
```

```
Nov 25 18:44:25 ubuntu kernel: [  645.581500] Child 1904 killed
Nov 25 18:44:25 ubuntu kernel: [  645.581597] Child 1909 killed
Nov 25 18:44:25 ubuntu kernel: [  645.581675] Child 1918 killed
Nov 25 18:44:25 ubuntu kernel: [  645.581756] pid: 1904  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.581792] Siblings child 1907 killed
Nov 25 18:44:25 ubuntu kernel: [  645.581815] pid: 1909  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.581899] Siblings child 1914 killed
Nov 25 18:44:25 ubuntu kernel: [  645.582035] pid: 1918  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.582054] pid: 1907  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583058] Siblings child 1923 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583143] Sibling 1902 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583213] pid: 1914  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583243] Siblings child 1908 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583293] pid: 1923  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583309] pid: 1902  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583350] Siblings child 1916 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583459] Siblings child 1926 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583560] pid: 1908  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583632] Sibling 1903 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583676] pid: 1916  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583771] Sibling 1899 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583797] pid: 1926  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583831] pid: 1899  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583865] pid: 1903  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583938] pid: 1953  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.591718] pid: 1955  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.591906] pid: 1954  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.593811] pid: 1952  nice: 0 exited
Nov 25 18:44:35 ubuntu kernel: [  655.561575] pid: 1956  nice: 0 exited
```

After calling system call with flag 1, all siblings and children processes are terminated but process itself and grandchildren processes are alive.

After termination of process with flag 1, orphan processes are adopted by init process:



```
Parent process 1898
forker1(1898)─┬─forker1(1899)─┬─forker1(1901)─┬─forker1(1906)
              │               │               └─forker1(1913)
              │               ├─forker1(1905)─┬─forker1(1912)
              │               │               └─forker1(1922)
              │               └─forker1(1911)─┬─forker1(1921)
              │                               └─forker1(1931)
              ├─forker1(1900)─┬─forker1(1904)─┬─forker1(1910)
              │               │               └─forker1(1920)
              │               ├─forker1(1909)─┬─forker1(1919)
              │               │               └─forker1(1930)
              │               └─forker1(1918)─┬─forker1(1929)
              │                               └─forker1(1936)
              ├─forker1(1902)─┬─forker1(1907)─┬─forker1(1915)
              │               │               └─forker1(1925)
              │               ├─forker1(1914)─┬─forker1(1924)
              │               │               └─forker1(1933)
              │               └─forker1(1923)─┬─forker1(1932)
              │                               └─forker1(1937)
              ├─forker1(1903)─┬─forker1(1908)─┬─forker1(1917)
              │               │               └─forker1(1928)
              │               ├─forker1(1916)─┬─forker1(1927)
              │               │               └─forker1(1935)
              │               └─forker1(1926)─┬─forker1(1934)
              │                               └─forker1(1938)
              └─sh(1939)───pstree(1940)
```

```
        ├─forker1(1910)
        ├─forker1(1912)
        ├─forker1(1913)
        ├─forker1(1915)
        ├─forker1(1917)
        ├─forker1(1919)
        ├─forker1(1920)
        ├─forker1(1921)
        ├─forker1(1922)
        ├─forker1(1924)
        ├─forker1(1925)
        ├─forker1(1927)
        ├─forker1(1928)
        ├─forker1(1929)
        ├─forker1(1930)
        ├─forker1(1931)
        ├─forker1(1932)
        ├─forker1(1933)
        ├─forker1(1934)
        ├─forker1(1935)
        ├─forker1(1936)
        ├─forker1(1937)
        ├─forker1(1938)
        ├─getty(1052)
        ├─getty(1059)
```

```
Nov 25 18:44:25 ubuntu kernel: [  645.581500] Child 1904 killed
Nov 25 18:44:25 ubuntu kernel: [  645.581597] Child 1909 killed
Nov 25 18:44:25 ubuntu kernel: [  645.581675] Child 1918 killed
Nov 25 18:44:25 ubuntu kernel: [  645.581756] pid: 1904  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.581792] Siblings child 1907 killed
Nov 25 18:44:25 ubuntu kernel: [  645.581815] pid: 1909  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.581899] Siblings child 1914 killed
Nov 25 18:44:25 ubuntu kernel: [  645.582035] pid: 1918  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.582054] pid: 1907  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583058] Siblings child 1923 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583143] Sibling 1902 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583213] pid: 1914  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583243] Siblings child 1908 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583293] pid: 1923  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583309] pid: 1902  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583350] Siblings child 1916 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583459] Siblings child 1926 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583560] pid: 1908  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583632] Sibling 1903 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583676] pid: 1916  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583771] Sibling 1899 killed
Nov 25 18:44:25 ubuntu kernel: [  645.583797] pid: 1926  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583831] pid: 1899  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583865] pid: 1903  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.583938] pid: 1953  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.591718] pid: 1955  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.591906] pid: 1954  nice: 0 exited
Nov 25 18:44:25 ubuntu kernel: [  645.593811] pid: 1952  nice: 0 exited
Nov 25 18:44:35 ubuntu kernel: [  655.561575] pid: 1956  nice: 0 exited
Nov 25 18:44:57 ubuntu kernel: [  677.463799] pid: 1957  nice: 0 exited
```

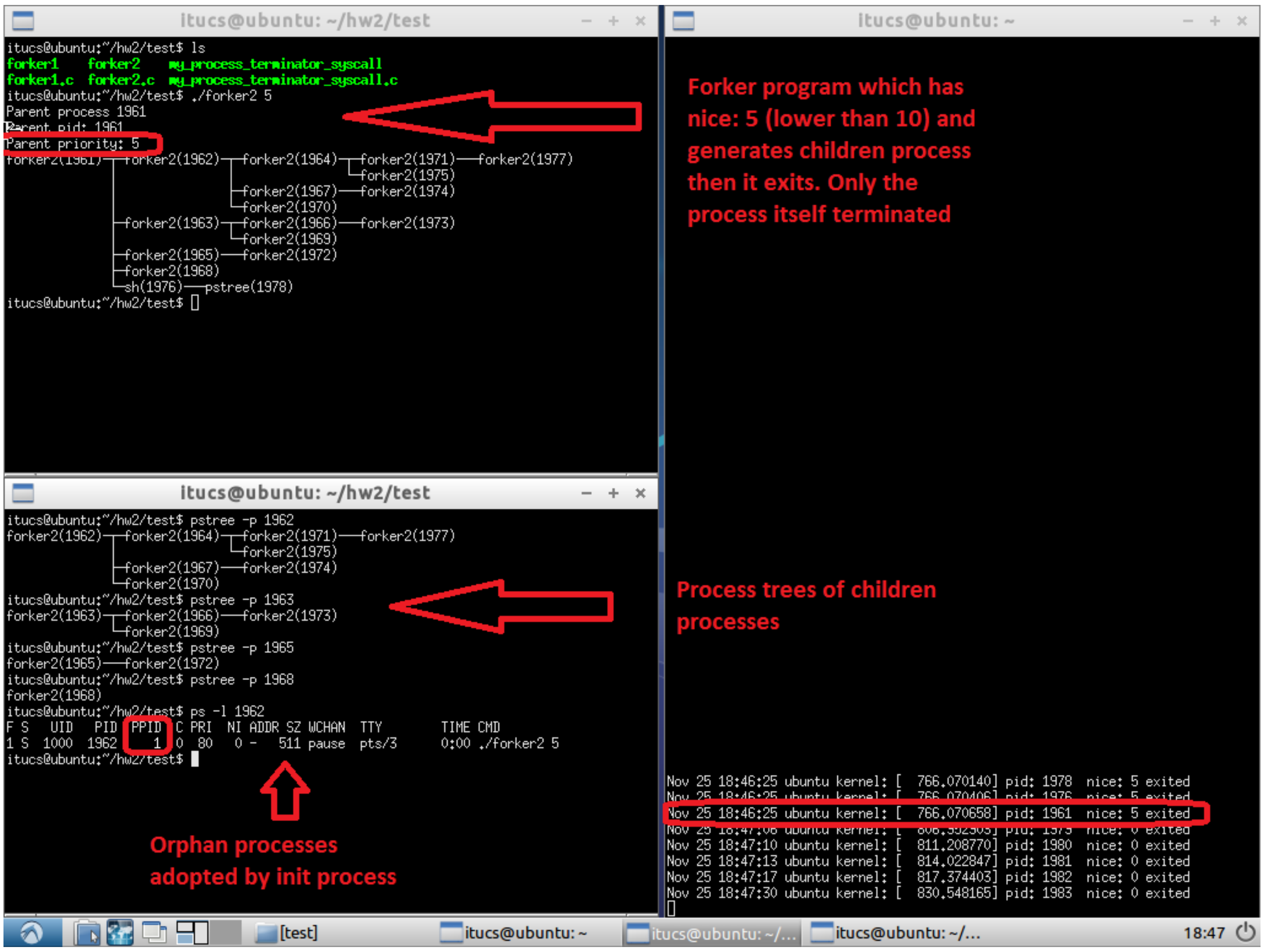
b. Modified Exit System Call

Modified exit system call can be tested by our test program (**forker2**) which generates children and grandchildren processes with fork system call. The program takes nice value as an argument.

System call tested with and without root permission. New process tree is shown after termination.

i. Nice value lower than 10

Firstly, modified **exit** system call called with nice value 5 (lower than 10) in test program (**forker2**):


itucs@ubuntu: ~/hw2/test
itucs@ubuntu: ~
Forker program which has nice: 5 (lower than 10) and generates children process then it exits. Only the process itself terminated
Process trees of children processes
Orphan processes adopted by init process
[test]
itucs@ubuntu: ~
itucs@ubuntu: ~/...
itucs@ubuntu: ~/...
18:47

```
itucs@ubuntu:~/hw2/test$ ls
forker1    forker2    my_process_terminator_syscall
forker1.c  forker2.c  my_process_terminator_syscall.c
itucs@ubuntu:~/hw2/test$ ./forker2 5
Parent process 1961
Parent pid: 1961
Parent priority: 5
forker2(1961)─┬─forker2(1962)─┬─forker2(1964)─┬─forker2(1971)───forker2(1977)
              │               │               └─forker2(1975)
              │               ├─forker2(1967)───forker2(1974)
              │               └─forker2(1970)
              ├─forker2(1963)─┬─forker2(1966)───forker2(1973)
              │               └─forker2(1969)
              ├─forker2(1965)───forker2(1972)
              ├─forker2(1968)
              └─sh(1976)───pstree(1978)
itucs@ubuntu:~/hw2/test$ 
```

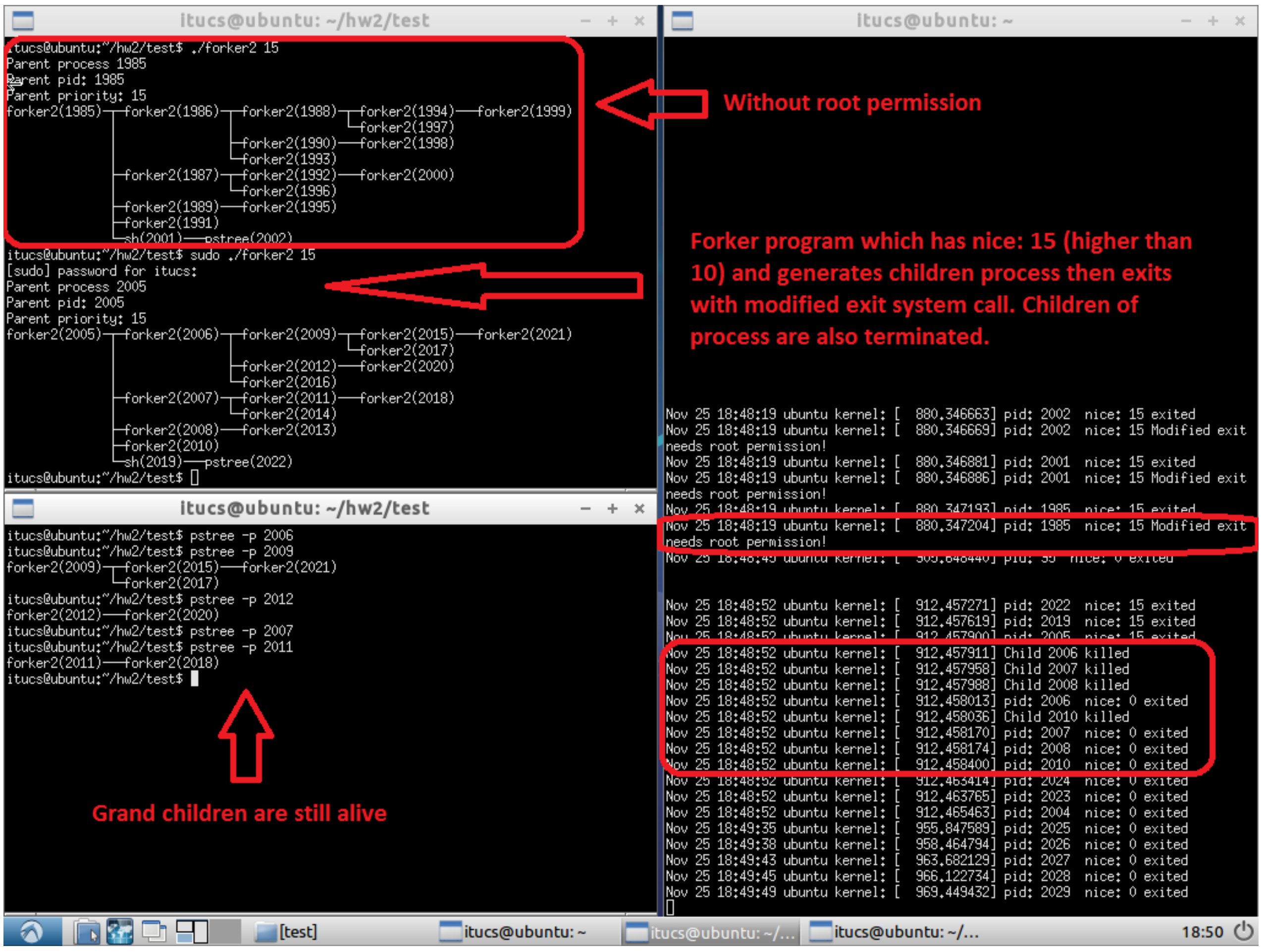
```
itucs@ubuntu:~/hw2/test$ pstree -p 1962
forker2(1962)─┬─forker2(1964)─┬─forker2(1971)───forker2(1977)
              │               └─forker2(1975)
              ├─forker2(1967)───forker2(1974)
              └─forker2(1970)
itucs@ubuntu:~/hw2/test$ pstree -p 1963
forker2(1963)─┬─forker2(1966)───forker2(1973)
              └─forker2(1969)
itucs@ubuntu:~/hw2/test$ pstree -p 1965
forker2(1965)───forker2(1972)
itucs@ubuntu:~/hw2/test$ pstree -p 1968
forker2(1968)
itucs@ubuntu:~/hw2/test$ ps -l 1962
F S   UID   PID  PPID  C PRI  NI ADDR SZ WCHAN  TTY        TIME CMD
1 S  1000  1962     1  0  80   0 -   511 pause  pts/3      0:00 ./forker2 5
itucs@ubuntu:~/hw2/test$ 
```

```
Nov 25 18:46:25 ubuntu kernel: [  766.070140] pid: 1978  nice: 5 exited
Nov 25 18:46:25 ubuntu kernel: [  766.070406] pid: 1976  nice: 5 exited
Nov 25 18:46:25 ubuntu kernel: [  766.070658] pid: 1961  nice: 5 exited
Nov 25 18:47:08 ubuntu kernel: [  808.552505] pid: 1979  nice: 0 exited
Nov 25 18:47:10 ubuntu kernel: [  811.208770] pid: 1980  nice: 0 exited
Nov 25 18:47:13 ubuntu kernel: [  814.022847] pid: 1981  nice: 0 exited
Nov 25 18:47:17 ubuntu kernel: [  817.374403] pid: 1982  nice: 0 exited
Nov 25 18:47:30 ubuntu kernel: [  830.548165] pid: 1983  nice: 0 exited
```

Only the process itself is terminated. Exit system call works as normally.

ii. Nice value greater than 10

Secondly, modified **exit** system call called with nice value 15 (greater than 10) in test program (**forker2**):



Without root permission
Forker program which has nice: 15 (higher than 10) and generates children process then exits with modified exit system call. Children of process are also terminated.
Grand children are still alive

```
itucs@ubuntu:~/hw2/test$ ./forker2 15
Parent process 1985
Parent pid: 1985
Parent priority: 15
forker2(1985)─┬─forker2(1986)─┬─forker2(1988)─┬─forker2(1994)───forker2(1999)
              │               │               └─forker2(1997)
              │               ├─forker2(1990)───forker2(1998)
              │               └─forker2(1993)
              ├─forker2(1987)─┬─forker2(1992)───forker2(2000)
              │               └─forker2(1996)
              ├─forker2(1989)───forker2(1995)
              ├─forker2(1991)
              └─sh(2001)───pstree(2002)
itucs@ubuntu:~/hw2/test$ sudo ./forker2 15
[sudo] password for itucs:
Parent process 2005
Parent pid: 2005
Parent priority: 15
forker2(2005)─┬─forker2(2006)─┬─forker2(2009)─┬─forker2(2015)───forker2(2021)
              │               │               └─forker2(2017)
              │               ├─forker2(2012)───forker2(2020)
              │               └─forker2(2016)
              ├─forker2(2007)─┬─forker2(2011)───forker2(2018)
              │               └─forker2(2014)
              ├─forker2(2008)───forker2(2013)
              ├─forker2(2010)
              └─sh(2019)───pstree(2022)
itucs@ubuntu:~/hw2/test$ 
```

```
itucs@ubuntu:~/hw2/test$ pstree -p 2006
itucs@ubuntu:~/hw2/test$ pstree -p 2009
forker2(2009)─┬─forker2(2015)───forker2(2021)
              └─forker2(2017)
itucs@ubuntu:~/hw2/test$ pstree -p 2012
forker2(2012)───forker2(2020)
itucs@ubuntu:~/hw2/test$ pstree -p 2007
itucs@ubuntu:~/hw2/test$ pstree -p 2011
forker2(2011)───forker2(2018)
itucs@ubuntu:~/hw2/test$ 
```

```
Nov 25 18:48:19 ubuntu kernel: [  880.346663] pid: 2002  nice: 15 exited
Nov 25 18:48:19 ubuntu kernel: [  880.346669] pid: 2002  nice: 15 Modified exit
needs root permission!
Nov 25 18:48:19 ubuntu kernel: [  880.346881] pid: 2001  nice: 15 exited
Nov 25 18:48:19 ubuntu kernel: [  880.346886] pid: 2001  nice: 15 Modified exit
needs root permission!
Nov 25 18:48:19 ubuntu kernel: [  880.347193] pid: 1985  nice: 15 exited
Nov 25 18:48:19 ubuntu kernel: [  880.347204] pid: 1985  nice: 15 Modified exit
needs root permission!
Nov 25 18:48:45 ubuntu kernel: [  905.848440] pid: 55  nice: 0 exited


Nov 25 18:48:52 ubuntu kernel: [  912.457271] pid: 2022  nice: 15 exited
Nov 25 18:48:52 ubuntu kernel: [  912.457619] pid: 2019  nice: 15 exited
Nov 25 18:48:52 ubuntu kernel: [  912.457900] pid: 2005  nice: 15 exited
Nov 25 18:48:52 ubuntu kernel: [  912.457911] Child 2006 killed
Nov 25 18:48:52 ubuntu kernel: [  912.457958] Child 2007 killed
Nov 25 18:48:52 ubuntu kernel: [  912.457988] Child 2008 killed
Nov 25 18:48:52 ubuntu kernel: [  912.458013] pid: 2006  nice: 0 exited
Nov 25 18:48:52 ubuntu kernel: [  912.458036] Child 2010 killed
Nov 25 18:48:52 ubuntu kernel: [  912.458170] pid: 2007  nice: 0 exited
Nov 25 18:48:52 ubuntu kernel: [  912.458174] pid: 2008  nice: 0 exited
Nov 25 18:48:52 ubuntu kernel: [  912.458400] pid: 2010  nice: 0 exited
Nov 25 18:48:52 ubuntu kernel: [  912.463414] pid: 2024  nice: 0 exited
Nov 25 18:48:52 ubuntu kernel: [  912.463765] pid: 2023  nice: 0 exited
Nov 25 18:48:52 ubuntu kernel: [  912.465463] pid: 2004  nice: 0 exited
Nov 25 18:49:35 ubuntu kernel: [  955.847589] pid: 2025  nice: 0 exited
Nov 25 18:49:38 ubuntu kernel: [  958.464794] pid: 2026  nice: 0 exited
Nov 25 18:49:43 ubuntu kernel: [  963.682129] pid: 2027  nice: 0 exited
Nov 25 18:49:45 ubuntu kernel: [  966.122734] pid: 2028  nice: 0 exited
Nov 25 18:49:49 ubuntu kernel: [  969.449432] pid: 2029  nice: 0 exited
```

The process and also children of the process are terminated. Exit system call works with new **my_process_terminator** system call.

4. Code

a. New Process Terminator System Call

Firstly root permission check is done:

```
      if(! capable(CAP_SYS_ADMIN)){

            return EPERM;

      }
```

Finding and killing child process of given PID:

```
struct task_struct *p;  // process task struct

struct task_struct *child_task;

struct list_head *children_list;

for_each_process(p){

      if(p->pid == pid){

            list_for_each(children_list, &(p->children)){

                  child_task = list_entry(children_list, struct task_struct, 
sibling);

                  printk("Child %d killed\n",child_task->pid);


                  sys_kill(child_task->pid,SIGKILL);

            }

      }

}
```

for_each_process iterates over all process in the system, **list_for_each** iterates over process’s children list and **sys_kill** kills processes with **SIGKILL** flag.

b. Modified Exit System Call

Exit system call modified with **exit.c** file under the kernel directory in Linux source code. In the **exit.c** file, only the **do_exit** function modified. These are added to head of the function:

```
printk("pid: %d  nice: %d exited\n", tsk->pid, task_nice(tsk));

if (task_nice(tsk) > 10){     // gets nice value of the process

      if(capable(CAP_SYS_ADMIN)){

            sys_my_process_terminator(tsk->pid,0);

      }

      else{

            printk("pid: %d  nice: %d Modified exit needs root permission!\n",
tsk->pid, task_nice(tsk));

      }

}
```

If nice value of process is greater than 10, modified code block runs instead of original code. **task_nice** macro gets nice value of process and then if process has permission new **sys_my_process_terminator** system call called with flag 0.