

## Homework 2

Name: Nachiket Kelkar

Date: 9<sup>th</sup> Feb 2019

**Github repository:-** <https://github.com/NachiketKelkar/AESD-5013-HW2>

## Problem 2: Tracking system and library calls

1) Ltrace(tracing library calls) on the host

```
nachiket@nachiket-VirtualBox:~/AESD/HM2$ ltrace ./track_calls
fopen("test.txt", "w") = 0x55cf8efd5260
puts("Its a sunny day outside" "Its a sunny day outside" = 24
)
puts("File created" "File created" = 13
)
fclose(0x55cf8efd5260) = 0
chmod("test.txt", 0600) = 0
fopen("test.txt", "w") = 0x55cf8efd5260
fputc('n', 0x55cf8efd5260) = 110
fclose(0x55cf8efd5260) = 0
fopen("test.txt", "a") = 0x55cf8efd5260
malloc(20) = 0x55cf8efd58a0
printf("Input a string to add to file:") = 30
_isoc99_scanf(0x55cf8dc65d7f, 0x55cf8efd58a0, 0, %Input a string to add to file:Nachiket
) = 1
fprintf(0x55cf8efd5260, "%Ns", "Nachiket") = 9
fflush(0x55cf8efd5260) = 0
fclose(0x55cf8efd5260) = 0
fopen("test.txt", "r") = 0x55cf8efd5260
printf("\nValue of a = %c", 'n' = 15
) = 'n'
_IO_getc(0x55cf8efd5260)
printf("\nCharacter is: %c\n", 'n'Value of a = n
Character is: n
) = 17
fgets("\n", 20, 0x55cf8efd5260) = 0x7ffd3b997e80
_isoc99_fscanf(0x55cf8efd5260, 0x55cf8dc65dac, 0x7ffd3b997e80, 10) = 1
printf("String is: %s\n", "Nachiket"String is: Nachiket
) = 20
fclose(0x55cf8efd5260) = 0
free(0x55cf8efd58a0) = 0
+++ exited (status 0) +++ = <void>
nachiket@nachiket-VirtualBox:~/AESD/HM2$ S
```

2) Strace(tracing system calls) on the host

```

nachiket@nachiket-VirtualBox:~/AES0/HW2$ strace ./track_calls
execve("./track_calls", ["/track_calls"], 0x7ff6e10eb320 /* 57 vars */) = 0
brk(NULL)                                = 0x559a6ea3c000
access("/etc/ld.so.nohwcap", F_OK)       = -1 ENOENT (No such file or directory)
access("/etc/ld.so.preload", R_OK)       = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=86160, ...}) = 0
mmap(NULL, 86160, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7fdba5afd000
close(3)                                 = 0
access("/etc/ld.so.nohwcap", F_OK)       = -1 ENOENT (No such file or directory)
openat(AT_FDCWD, "/lib/x86_64-linux-gnu/libc.so.6", O_RDONLY|O_CLOEXEC) = 3
read(3, "\177ELF\2\1\3\0\0\0\0\0\0\0\3\0-\0\1\0\0\260\34\2\0\0\0\0...", 832) = 832
fstat(3, {st_mode=S_IFREG|0755, st_size=2030544, ...}) = 0
mmap(NULL, 8192, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0x7fdba5afb000
mmap(NULL, 4131552, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_DENYWRITE, 3, 0) = 0x7fdba54fb000
mprotect(0x7fdba56e2000, 2097152, PROT_NONE) = 0
mmap(0x7fdba58e2000, 24576, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_DENYWRITE, 3, 0x1e7000) = 0x7fdba58e2000
mmap(0x7fdba58e8000, 15072, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0x7fdba58e8000
close(3)                                 = 0
arch_prctl(ARCH_SET_FS, 0x7fdba5afc500) = 0
mprotect(0x7fdba58e2000, 16384, PROT_READ) = 0
mprotect(0x559a6d3d1000, 4096, PROT_READ) = 0
mprotect(0x7fdba5b13000, 4096, PROT_READ) = 0
munmap(0x7fdba5afd000, 86160)            = 0
brk(NULL)                                = 0x559a6ea3c000
brk(0x559a6ea5d000)                      = 0x559a6ea5d000
openat(AT_FDCWD, "test.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 3
fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(136, 0), ...}) = 0
write(1, "Its a sunny day outside\n", 24)Its a sunny day outside
) = 24
write(1, "File created\n", 13)File created
) = 13
close(3)                                 = 0
chmod("test.txt", 0600)                  = 0
openat(AT_FDCWD, "test.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 3
fstat(3, {st_mode=S_IFREG|0600, st_size=0, ...}) = 0
write(3, "n", 1)                         = 1
close(3)                                 = 0
openat(AT_FDCWD, "test.txt", O_WRONLY|O_CREAT|O_APPEND, 0666) = 3
lseek(3, 0, SEEK_END)                    = 1
fstat(0, {st_mode=S_IFCHR|0620, st_rdev=makedev(136, 0), ...}) = 0
write(1, "Input a string to add to file:", 30)Input a string to add to file:) = 30
read(0, Nachiket
"Nachiket\n", 1024)                      = 9
fstat(3, {st_mode=S_IFREG|0600, st_size=1, ...}) = 0
write(3, "\nNachiket", 9)                = 9
close(3)                                 = 0
openat(AT_FDCWD, "test.txt", O_RDONLY) = 3
write(1, "\n", 1)                        = 1
) = 1
fstat(3, {st_mode=S_IFREG|0600, st_size=10, ...}) = 0
read(3, "n\nNachiket", 4096)            = 10

```

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```
write(1, "Value of a = n\n", 15Value of a = n
) = 15
write(1, "Character is: n\n", 16Character is: n
) = 3
Perf stat (performance statistics) on the host
read(3, "", 4096) = 0
Nachiket@Nachiket-VirtualBox:~/AESD/HW2$ sudo perf stat ./track_calls
[sudo] password for nachiket:
Sorry, try again.
[sudo] password for nachiket:
Its a sunny day outside
File created
Input a string to add to file:Nachiket

Value of a = n
Character is: n
String is: Nachiket

Performance counter stats for './track_calls':

      2.585336      task-clock (msec)      #    0.001 CPUs utilized
           2      context-switches      #    0.774 K/sec
           0      cpu-migrations      #    0.000 K/sec
          52      page-faults      #    0.020 M/sec
<not supported>      cycles
<not supported>      instructions
<not supported>      branches
<not supported>      branch-misses

      4.427680283 seconds time elapsed
```

## Problem 3: Buildroot setup and beaglebone green linux image

- 1) Boot sequence, personal greeting with name, logging in and executing first command

```
COM6 - PUTTY
[ 0.486615] jffs2: version 2.2. (NAND) (SUMMARY) © 2001-2006 Red Hat, Inc.
[ 0.493281] io scheduler noop registered
[ 0.493314] io scheduler deadline registered
[ 0.493442] io scheduler cfq registered (default)
[ 0.493462] io scheduler mq-deadline registered
[ 0.493477] io scheduler kyber registered
[ 0.495436] pinctrl-single 44e10800.pinctrl: 142 pins at pa f9e10800 size 568
[ 0.499791] Serial: 8250/16550 driver, 6 ports, IRQ sharing enabled
[ 0.505200] omap_uart 44e09000.serial: no wakeirq for uart0
[ 0.505724] 44e09000.serial: ttyO0 at MMIO 0x44e09000 (irq = 30, base_baud = 3000000) is a OMAP UART0
[ 1.231832] console [ttyO0] enabled
[ 1.237049] omap_uart 48024000.serial: no wakeirq for uart2
[ 1.243398] 48024000.serial: ttyO2 at MMIO 0x48024000 (irq = 31, base_baud = 3000000) is a OMAP UART2
[ 1.281045] brd: module loaded
[ 1.309]
[ 1.760361] mmc1: new high speed MMC card at address 0001
[ 1.767659] mmcblk1: mmc1:0001 P1XXXX 3.60 GiB
[ 1.774541] mmcblk1boot0: mmc1:0001 P1XXXX partition 1 2.00 MiB
[ 1.783280] mmcblk1boot1: mmc1:0001 P1XXXX partition 2 2.00 MiB
[ 1.790773] random: fast init done
[ 1.794881] mmcblk1rmb: mmc1:0001 P1XXXX partition 3 128 KiB
[ 1.805067] mmcblk1: p1
[ 1.831919] tps65217 0-0024: TPS65217 ID 0xe version 1.2
[ 1.838185] omap_i2c 44e0b000.i2c: bus 0 rev0.11 at 400 KHz
[ 1.847776] omap_i2c 4819c000.i2c: bus 2 rev0.11 at 100 KHz
[ 1.851377] htcosys: unable to open rtc device (rtc0)
[ 1.860567] sr_init: No PMIC hook to init smartreflex
[ 1.866071] sr_init: platform driver register failed for SR
[ 1.950599] EXT4-fs (mmcblk0p2): recovery complete
[ 1.958546] EXT4-fs (mmcblk0p2): mounted filesystem with ordered data mode. Opts: (null)
[ 1.967350] VFS: Mounted root (ext4 filesystem) on device 179:2.
[ 1.974806] devtmpfs: mounted
[ 1.980094] Freeing unused kernel memory: 1024K
[ 2.107379] EXT4-fs (mmcblk0p2): re-mounted. Opts: data=ordered
Starting syslogd: OK
Starting klogd: OK
Initializing random number generator... [ 2.406371] random: dd: uninitialized urandom read (512 bytes read)
done.
Starting network: OK

Welcome to Nachiket Linux System
Nachiket login: root
# ls /
bin          lib          mnt          sbin          track_calls.c
dev          lib32        opt          sys           usr
etc          linuxrc     proc        test.txt      var
helloworld  lost+found  root         tmp
helloworld.c media       run          track_calls
#
```

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### Problem 4: Porting File IO program to the beaglebone green

- 1) Ltrace(tracing library calls) on the target

```

COM6 - PuTTY
[ 2.122471] devtmpfs: mounted
[ 2.127610] Freeing unused kernel memory: 1024K
[ 2.262278] EXT4-fs (mmcblk0p2): re-mounted. Opts: data=ordered
[ 2.558208] random: dd: uninitialized urandom read (512 bytes read)
# ls
bin      lib      mnt     /sbin      track_calls.c
dev      lib32    opt      sys       usr
etc      linuxrc  proc     test.txt  var
helloworld  lost+found  root     tmp
helloworld.c  media      run      track_calls
# ltrace ./track_calls
dwarf report elf track_calls@0x10000 (/track_calls) 104: address range overlaps an existing module
Backend initialization failed.
Couldn't load ELF object /lib/ld-uClibc.so.0: Success
uClibc main(0x10738, 1, 0xbdc6e44, 0x10518 <unfinished ...>
fopen("test.txt", "w") = 0x22008
puts("Its a sunny day outside"Its a sunny day outside
) = 24
puts("File created"File created
) = 13
fclose(0x22008) = 0
fopen("test.txt", "w") = 0x22008
fputc('n', 0x22008) = 110
fclose(0x22008) = 0
fopen("test.txt", "a") = 0x22008
malloc(20) = 0x23058
printf("Input a string to add to file:") = 30
scanf(0x10a24, 0x23058, 1, 1Input a string to add to file:Nachiket
) = 1
printf(0x22008, "\n%s", "Nachiket") = 9
fflush(0x22008) = 0
fclose(0x22008) = 0
fopen("test.txt", "r") = 0x22008
printf("\nValue of a = %c", 'n'
Value of a = ) = 15
fgetc(0x22008) = 'n'
printf("\nCharacter is: %c\n", 'n\n
Character is: n
) = 17
fgets("\n", 20, 0x22008) = 0xbdc6ccc
fscanf(0x22008, 0x10a58, 0xbdc6cccc, 0xbdc6ccc) = 1
printf("String is: %s\n", "Nachiket"String is: Nachiket
) = 20
fclose(0x22008) = 0
free(0x23058) = <void>
+++ exited (status 0) +++
# [ 452.079864] random: crng init done
#

```

2) Strace(tracing system calls) on the target

```
# COM6 - PUTTY
# Strace ./track_calls
execve("./track_calls", ["/./track_calls"], 0xbec0de50 /* 12 vars */) = 0
readlinkat(AT_FDCWD, "/proc/self/exe", "/track_calls", 4096) = 12
mmap2(NULL, 4096, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xb6f67000
open("/lib/libc.so.0", O_RDONLY) = 3
fstat(3, {st_mode=S_IFREG|0755, st_size=440148, ...}) = 0
mmap2(NULL, 4096, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xb6f66000
read(3, "\177ELF\1\1\1\0\0\0\0\0\0\0\0\0\0\0\0\0\1\0\0\0\0\0357\0\0004\0\0\0...", 4096) = 4096
mmap2(NULL, 598016, PROT_NONE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xb6ec1000
mmap2(0xb6ec1000, 435932, PROT_READ|PROT_EXEC, MAP_PRIVATE|MAP_FIXED, 3, 0) = 0xb6ec1000
mmap2(0xb6f3b000, 4852, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED, 3, 0xb6f3b000) = 0xb6f3b000
mmap2(0xb6f3d000, 89104, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_FIXED|MAP_ANONYMOUS, -1, 0) = 0xb6f3d000
close(3) = 0
munmap(0xb6f66000, 4096) = 0
stat("/lib/ld-uclibc.so.0", {st_mode=S_IFREG|0755, st_size=28516, ...}) = 0
mmap2(NULL, 4096, PROT_READ|PROT_WRITE, MAP_PRIVATE|MAP_ANONYMOUS, -1, 0) = 0xb6f66000
set_tls(0xb6f66490) = 0
mprotect(0x20000, 4096, PROT_READ) = 0
mprotect(0xb6f3b000, 4096, PROT_READ) = 0
mprotect(0xb6f66000, 4096, PROT_READ) = 0
set_tid_address(0xb6f66068) = 108
set_robust_list(0xb6f6606c, 12) = 0
rt_sigaction(SIGRTMIN, {sa_handler=0xb6ff1fc4, sa_mask=[], sa_flags=SA_RESTORER|SA_SIGINFO, sa_restorer=0xb6ed0920}, NULL, 8) = 0
rt_sigaction(SIGRT_1, {sa_handler=0xb6ff1588, sa_mask=[], sa_flags=SA_RESTORER|SA_RESTART|SA_SIGINFO, sa_restorer=0xb6ed0920}, NULL, 8) = 0
sigprocmask(SIG_UNBLOCK, [RTMIN RT_1], NULL, 8) = 0
ugrtlimit(RLIMIT_STACK, {rlim_cur=8192*1024, rlim_max=RLIM_INFINITY}) = 0
ioctl(0, TCGETS, {B115200 oposit isig icanon echo ...}) = 0
ioctl(1, TCGETS, {B115200 oposit isig icanon echo ...}) = 0
brk(NULL) = 0x22000
brk(0x23000) = 0x23000
open("test.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 3
ioctl(3, TCGETS, {0xbcd79c2c} = -1 ENOTTY (Inappropriate ioctl for device)
brk(0x24000) = 0x24000
write(1, "Its a sunny day outside\n", 24)Its a sunny day outside
) = 24
write(1, "File created\n", 13)File created
) = 13
close(3) = 0
open("test.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 3
ioctl(3, TCGETS, {0xbcd79c2c} = -1 ENOTTY (Inappropriate ioctl for device)
write(3, "\n", 1) = 1
close(3) = 0
open("test.txt", O_WRONLY|O_CREAT|O_APPEND, 0666) = 3
ioctl(3, TCGETS, {0xbcd79c2c} = -1 ENOTTY (Inappropriate ioctl for device)
write(1, "Input a string to add to file:", 30)Input a string to add to file:) = 30
read(0, Nachiket
"Nachiket\n", 4096) = 9
write(3, "\nNachiket", 9) = 9
close(3) = 0
```

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```
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set_tls(0xb6f66490) = 0
mprotect(0x20000, 4096, PROT_READ) = 0
mprotect(0xb6f38000, 4096, PROT_READ) = 0
mprotect(0xb6f68000, 4096, PROT_READ) = 0
set_tid_address(0xb6f66068) = 108
set_robust_list(0xb6f6606c, 12) = 0
rt_sigaction(SIGRTMIN, {sa_handler=0xb6f1f4c4, sa_mask=[], sa_flags=SA_RESTORER|SA_SIGINFO, sa_restorer=0xb6ed0920}, NULL, 8) = 0
rt_sigaction(SIGRT_1, {sa_handler=0xb6f1f588, sa_mask=[], sa_flags=SA_RESTORER|SA_SIGINFO, sa_restorer=0xb6ed0920}, NULL, 8) = 0
rt_sigprocmask(SIG_UNBLOCK, {RTMIN RT_1}, NULL, 0) = 0
ugetrlimit(RLIMIT_STACK, {rlim_cur=9192*1024, rlim_max=RLIM_INFINITY}) = 0
ioctl(0, TCGETS, {B115200 oposit isig icanon echo ...}) = 0
ioctl(1, TCGETS, {B115200 oposit isig icanon echo ...}) = 0
brk(NULL) = 0x22000
brk(0x23000) = 0x23000
open("test.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 3
ioctl(3, TCGETS, 0xb6d79c2c) = -1 ENOTTY (Inappropriate ioctl for device)
brk(0x24000) = 0x24000
write(1, "Its a sunny day outside\n", 24)Its a sunny day outside
) = 24
write(1, "File created\n", 13)File created
) = 13
close(3) = 0
open("test.txt", O_WRONLY|O_CREAT|O_TRUNC, 0666) = 3
ioctl(3, TCGETS, 0xb6d79c2c) = -1 ENOTTY (Inappropriate ioctl for device)
write(3, "n", 1) = 1
close(3) = 0
open("test.txt", O_WRONLY|O_CREAT|O_APPEND, 0666) = 3
ioctl(3, TCGETS, 0xb6d79c2c) = -1 ENOTTY (Inappropriate ioctl for device)
write(1, "Input a string to add to file:", 30)Input a string to add to file:) = 30
read(0, Nachiket
"Nachiket\n", 4096) = 9
write(3, "\nNachiket", 9) = 9
close(3) = 0
open("test.txt", O_RDONLY) = 3
ioctl(3, TCGETS, 0xb6d79c2c) = -1 ENOTTY (Inappropriate ioctl for device)
write(1, "\nValue of a = ", 14
Value of a = ) = 14
read(3, "n\nNachiket", 4096) = 10
write(1, "n\nCharacter is: ", 16n
Character is: ) = 16
write(1, "n\n", 2n = 2
) = 2
read(3, "", 4096) = 0
write(1, "String is: Nachiket\n", 20)String is: Nachiket
) = 20
close(3) = 0
exit_group(0) = 0
+++ exited with 0 +++
#
```

## 3) Perf stat(performance statistics) on the target

```
COM6 - PuTTY
# perf stat ./track_calls
Its a sunny day outside
File created
Input a string to add to file:Nachiket

Value of a = n
Character is: n
String is: Nachiket

Performance counter stats for './track_calls':

    11.396622 task-clock (msec)    #    0.002 CPUs utilized
         11 context-switches      #    0.965 K/sec
          0  cpu-migrations        #    0.000 K/sec
         29 page-faults           #    0.003 M/sec
    9917193 cycles                 #    0.870 GHz
    2667280 instructions           #    0.27  insn per cycle
    312610  branches               #   27.430 M/sec
     78049  branch-misses          #   24.97% of all branches

4.745509750 seconds time elapsed

#
```

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### Problem 5: Implement own system call on beaglebone green

A. Correct data is passed to system call

1) Displaying PID, Userid and current time.

```
# time ./sorting

PID is 98
Userid is 0
Current itme and date is: Thu Jan  1 00:00:43 19[ 43.944683] Data is copied from user successfully.
```

2) Buffer before the sorting system call (in user space)

The size of the array is called by random function hence it is called with 68 size as of now.

```
Size of the buffer (no of elements) is 68
[ 43.957510] kernel_unsorted[0] = 14431

unsorted[0] = 14431
unsorted[1] = 9673
unsort[ 43.957521] kernel_unsorted[1] = 9673
ed[2] = 7642
unsorted[3] = 15448
unsorted[4] =[ 43.965589] kernel_unsorted[2] = 7642
9653
unsorted[5] = 9005
unsorted[6] = 1769
u[ 43.973628] kernel_unsorted[3] = 15448
nsorted[7] = 14628
unsorted[8] = 14485
unsorte[ 43.981673] kernel_unsorted[4] = 9653
d[9] = 8843
unsorted[10] = 9823
unsorted[11] =[ 43.989816] kernel_unsorted[5] = 9005
1387
unsorted[12] = 14624
unsorted[13] = 1371[ 43.997814] kernel_unsorted[6] = 1769
3
```

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3) Buffer after copy to kernel space (in kernel space)

```
[ 44.201590] kernel_unsorted[31] = 1229
[ 44.209717] kernel_unsorted[32] = 6018
[ 44.216294] kernel_unsorted[33] = 1146
[ 44.220260] kernel_unsorted[34] = 293
[ 44.224176] kernel_unsorted[35] = 15671
[ 44.228002] kernel_unsorted[36] = 10152
[ 44.232054] kernel_unsorted[37] = 2062
[ 44.236052] kernel_unsorted[38] = 13916
[ 44.240010] kernel_unsorted[39] = 8253
[ 44.244016] kernel_unsorted[40] = 10905
[ 44.247929] kernel_unsorted[41] = 7355
[ 44.251982] kernel_unsorted[42] = 9640
[ 44.255904] kernel_unsorted[43] = 9145
[ 44.259863] kernel_unsorted[44] = 4684
[ 44.263776] kernel_unsorted[45] = 15135
[ 44.267687] kernel_unsorted[46] = 10244
[ 44.271739] kernel_unsorted[47] = 7596
[ 44.275744] kernel_unsorted[48] = 6208
[ 44.279705] kernel_unsorted[49] = 7248
[ 44.283617] kernel_unsorted[50] = 8329
[ 44.287533] kernel_unsorted[51] = 16123
[ 44.291495] kernel_unsorted[52] = 2622
[ 44.295500] kernel_unsorted[53] = 4174
[ 44.299461] kernel_unsorted[54] = 13470
[ 44.303371] kernel_unsorted[55] = 15326
[ 44.307376] kernel_unsorted[56] = 7552
[ 44.311418] kernel_unsorted[57] = 12114
[ 44.315329] kernel_unsorted[58] = 12858
[ 44.319331] kernel_unsorted[59] = 10734
[ 44.323376] kernel_unsorted[60] = 8459
```

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### 4) Buffer after sorting in system call (in kernel space)

The data is sorted in the descending order by the kernel.

```
[ 44.477424] kernel_sorted[31] = 9888
[ 44.481199] kernel_sorted[32] = 9823
[ 44.484928] kernel_sorted[33] = 9673
[ 44.488663] kernel_sorted[34] = 9653
[ 44.492444] kernel_sorted[35] = 9640
[ 44.496171] kernel_sorted[36] = 9145
[ 44.499950] kernel_sorted[37] = 9005
[ 44.503684] kernel_sorted[38] = 8843
[ 44.507415] kernel_sorted[39] = 8459
[ 44.511187] kernel_sorted[40] = 8329
[ 44.514925] kernel_sorted[41] = 8253
[ 44.518657] kernel_sorted[42] = 7642
[ 44.522436] kernel_sorted[43] = 7596
[ 44.526165] kernel_sorted[44] = 7552
[ 44.529946] kernel_sorted[45] = 7508
[ 44.533683] kernel_sorted[46] = 7456
[ 44.537420] kernel_sorted[47] = 7355
[ 44.541200] kernel_sorted[48] = 7248
[ 44.544931] kernel_sorted[49] = 6362
[ 44.548667] kernel_sorted[50] = 6208
[ 44.552444] kernel_sorted[51] = 6018
[ 44.556175] kernel_sorted[52] = 5495
[ 44.559955] kernel_sorted[53] = 4684
[ 44.563685] kernel_sorted[54] = 4174
[ 44.567415] kernel_sorted[55] = 3377
```

### 5) Buffer after copy to user space (in user space)

```
sorted_array[31] = 9888
sorted_array[32] = 9823
sorted_array[33] = 9673
sorted_array[34] = 9653
sorted_array[35] = 9640
sorted_array[36] = 9145
sorted_array[37] = 9005
sorted_array[38] = 8843
sorted_array[39] = 8459
sorted_array[40] = 8329
sorted_array[41] = 8253
sorted_array[42] = 7642
sorted_array[43] = 7596
sorted_array[44] = 7552
sorted_array[45] = 7508
sorted_array[46] = 7456
sorted_array[47] = 7355
sorted_array[48] = 7248
sorted_array[49] = 6362
sorted_array[50] = 6208
sorted_array[51] = 6018
sorted_array[52] = 5495
```

## Homework 2

Name: Nachiket Kelkar

Date: 9<sup>th</sup> Feb 2019

- B. Null pointers passed to the system call
  - 1) System call handling the null pointer

```
Passing null pointer
Invalid arguments to the call
: Bad address
```

- C. Negative size passed to the system call
  - 1) System call handling the negative size

```
Passing negative size
Invalid arguments to the call
: Bad address
```

The reported time is as below screenshot.

```
real0m 1.66s
user0m 0.00s
sys0m 0.67s
```



# Homework 2

Name: Nachiket Kelkar

Date: 9<sup>th</sup> Feb 2019

## **Problem 6: Creating a CRON task for beaglebone green**

- 1) Outputs from system call at different instance

The output is attached on the git repo