Homework 2

Name: Nachiket Kelkar Date: 9th 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/HW2$ 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, 0Input a string to add to file:Nachiket
)                                                                  = 1
fprintf(0x55cf8efd5260, "\n%s", "Nachiket")                                             = 9
fflush(0x55cf8efd5260)                                                                  = 0
fclose(0x55cf8efd5260)                                                                  = 0
fopen("test.txt", "r")                                                                  = 0x55cf8efd5260
printf("\nValue of a = %c", 'n'
)                                                                  = 15
_IO_getc(0x55cf8efd5260)                                                                = 'n'
printf("\nCharacter is: %c\n", 'n'Value of a = n
Character is: n
)                                                                  = 17
fgets("\n", 20, 0x55cf8efd5260)                                                         = 0x7ffd38997e80
__isoc99_fscanf(0x55cf8efd5260, 0x55cf8dc65dac, 0x7ffd38997e80, 10)                     = 1
printf("String is: %s\n", "Nachiket"String is: Nachiket
)                                                                  = 20
fclose(0x55cf8efd5260)                                                                  = 0
free(0x55cf8efd58a0)                                                                    = <void>
+++ exited (status 0) +++
nachiket@nachiket-VirtualBox:~/AESD/HW2$ S
```

2) Strace(tracing system calls) on the host

```
nachiket@nachiket-VirtualBox:~/AESD/HW2$ strace ./track_calls
execve("./track_calls", ["./track_calls"], 0x7ffe610eb320 /* 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\1\3\0\0\0\0\0\0\0\0\3\0>\0\1\0\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", 24Its a sunny day outside
) = 24
write(1, "File created\n", 13File 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:", 30Input 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
fstat(3, {st_mode=S_IFREG|0600, st_size=10, ...}) = 0
read(3, "n\nNachiket", 4096)            = 10
```

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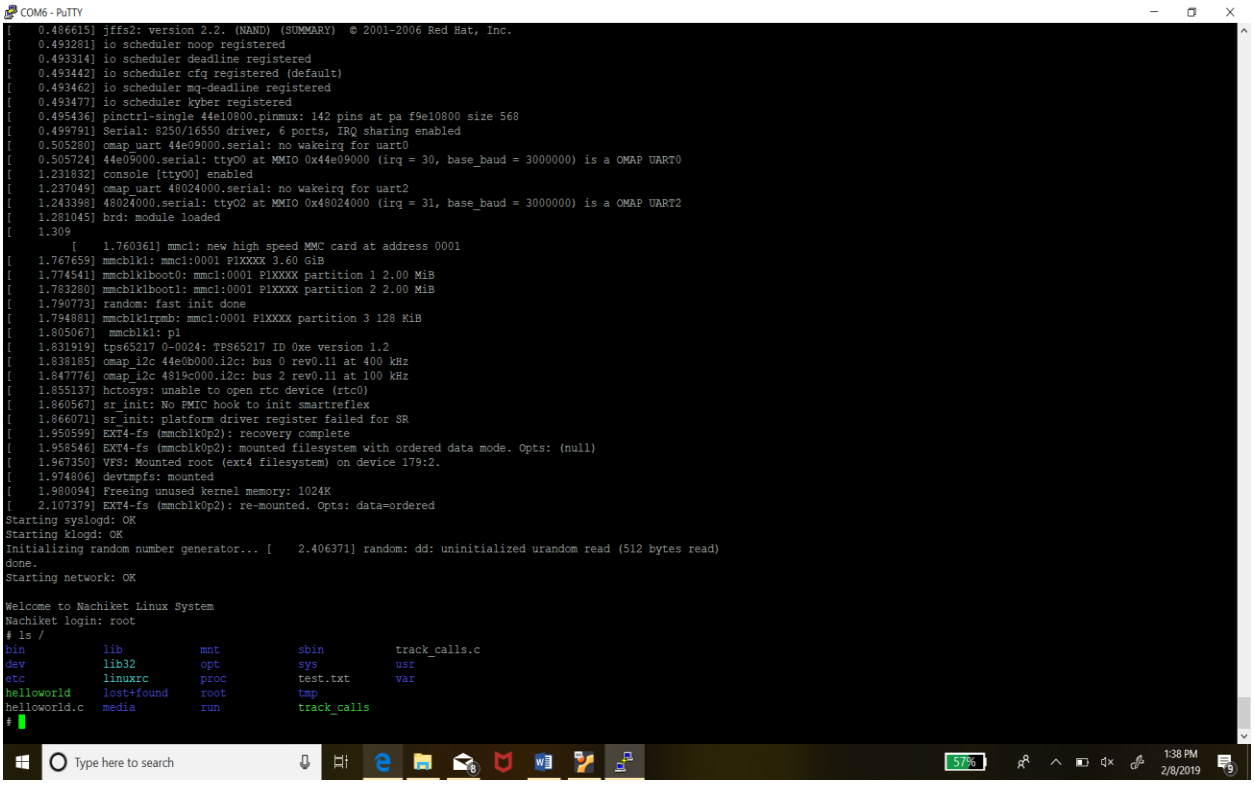
```
write(1, "Value of a = n\n", 15Value of a = n
)        = 15
write(1, "Character is: n\n", 16Character is: n
)    = 16
read(3, "", 4096)                       = 0
```

3) perf stat (performance statistics) on the host

```
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



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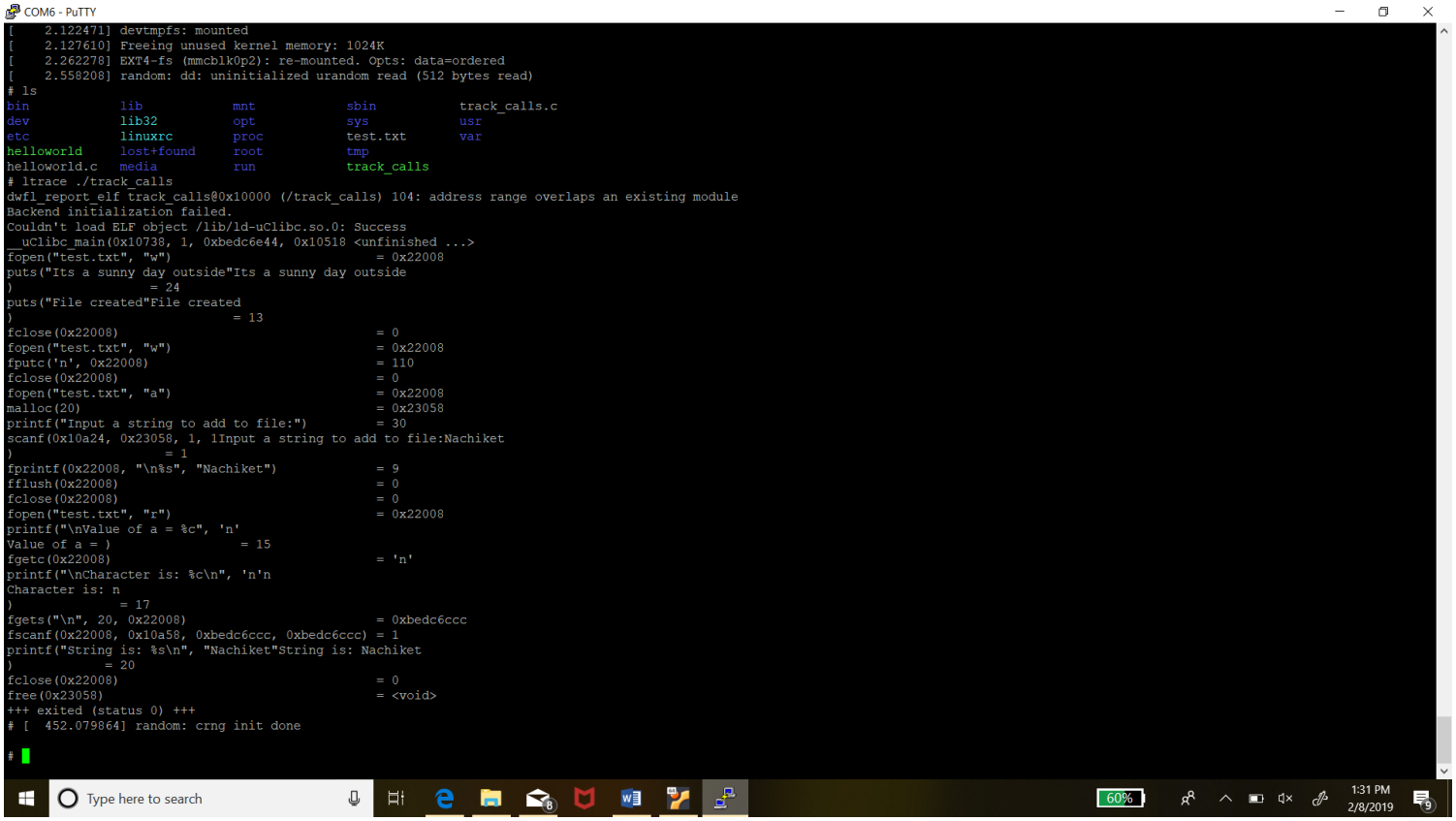
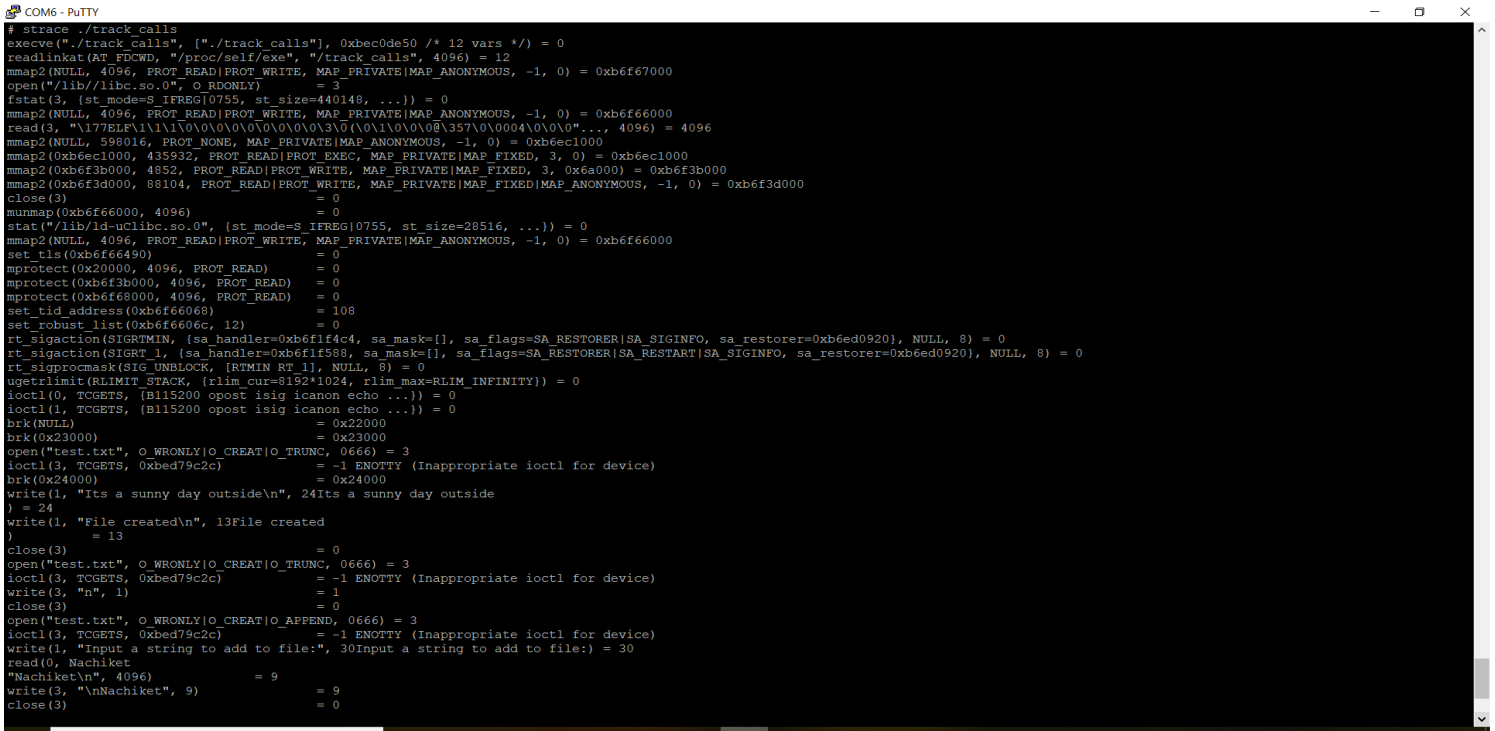
Problem 4: Porting File IO program to the beaglebone green

1) Ltrace(tracing library calls) on the target



2) Strace(tracing system calls) on the target



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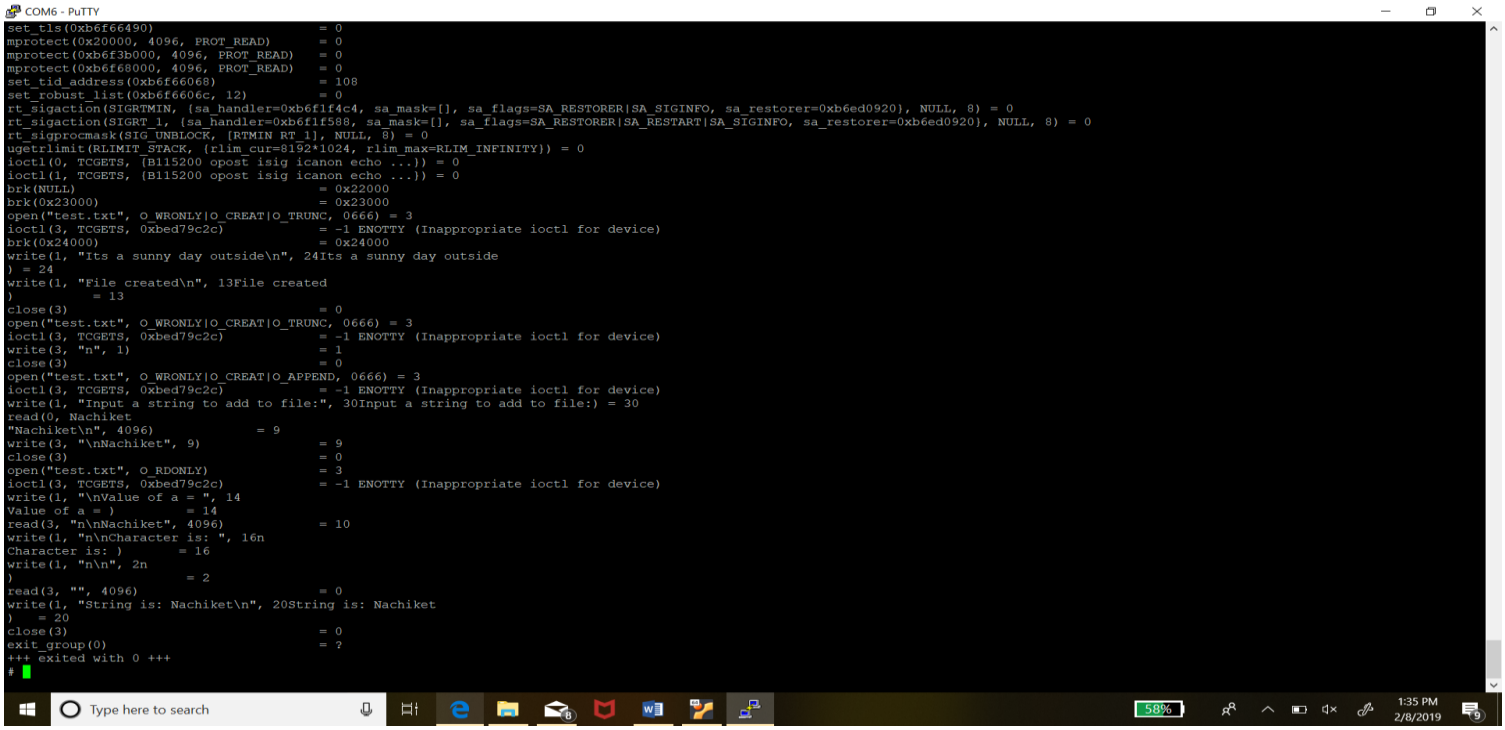
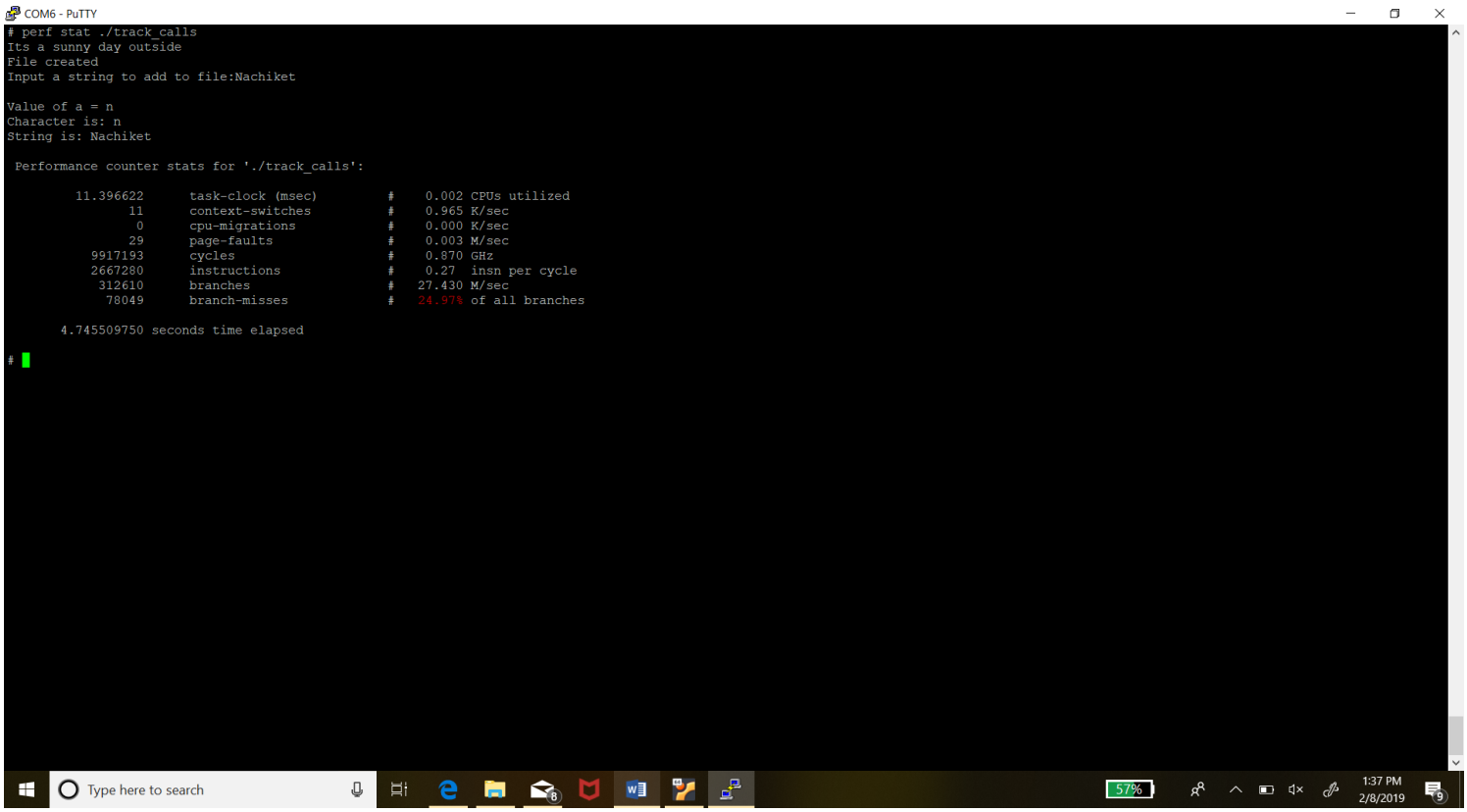


3) Perf stat(performance statistics) on the target



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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
```

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
```

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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
```

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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