

Operating System

Lab Assignment 2

Synchronization in Linux

Kernel

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code organization:

the code consist of three class (mod.c & leds.c & user.c) .

leds.c : consist of main function and other function , the main function get input from user then call the other function to execute this instruction , the other function call the the function in class mod.c which included in the kernel .

Function in the mod.c execute this instruction and turn the caps on or off or get state can user user.c and follow the steps that shown.

main functions:

leds.c:

main() : call the other function and determine if we in get instruction or set instruction.

Get_led(int led): using system to get the state store in led's file that store in /sys/ directory.

Set_Led (int led , int state): using system to set store in led's file that store in /sys/ directory.

mod.c:

Store and Show : three function to read state stored in (num , caps or scroll)'s files or write new state in it .

set_led_state(int led,int state) :

to change the global varriable led_status_word and call update function to update new states

get_led_state(int led):

get led state on or off using global varriable led_status_word.

kbd_read_data(void):

check the output buffer of full read from it other wise wait to be full.

kbd_write_data(unsigned char data):

check the input buffer if clear write data using outb() other wise wait to be clear.

update_ leds(unsigned char led_status_word):

update new states and call kbd_read_data() and kbd_write_data().

how to compile and run the code:

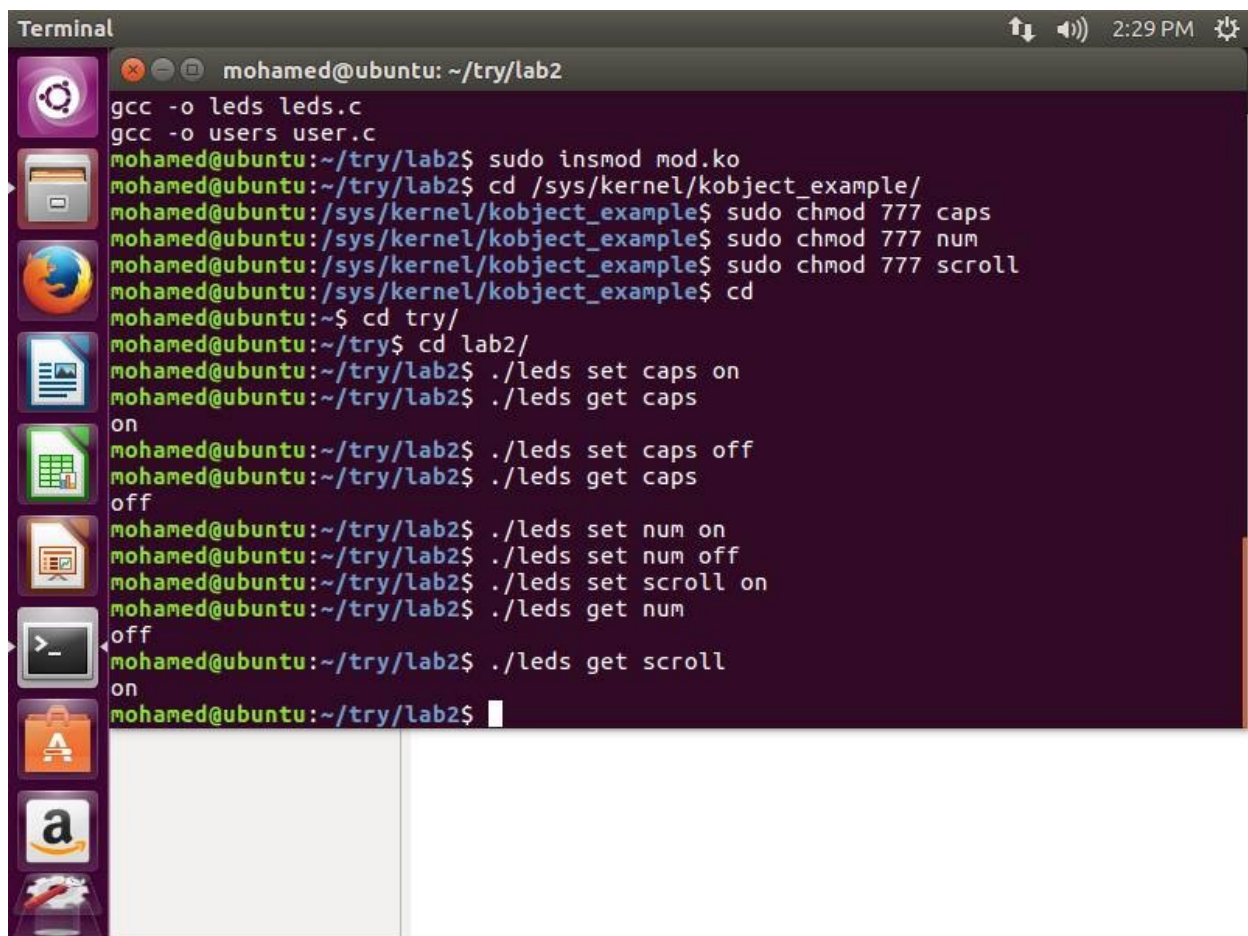
- Open the terminal and go to the project directory.
- write make in terminal.
- go to the file director by write
cd /sys/kernel/kobject.example in terminal then
make the file writable by write :
 - > sudo chmod 777 caps
 - > sudo chmod 777 num
 - > sudo chmod 777 scroll
- then go to last director and using ./leds to turn on
and off led such that :
 - > ./leds set caps on
 - > ./leds set caps off
 - > ./led get caps

and so on.

– you can user ./users that create in the director and follow the steps that shown .

Sample runs:

using ./leds:

A terminal window titled "Terminal" with the prompt "mohamed@ubuntu: ~/try/lab2". The terminal shows the following commands and output:

```
gcc -o leds leds.c
gcc -o users user.c
mohamed@ubuntu:~/try/lab2$ sudo insmod mod.ko
mohamed@ubuntu:~/try/lab2$ cd /sys/kernel/kobject_example/
mohamed@ubuntu:/sys/kernel/kobject_example$ sudo chmod 777 caps
mohamed@ubuntu:/sys/kernel/kobject_example$ sudo chmod 777 num
mohamed@ubuntu:/sys/kernel/kobject_example$ sudo chmod 777 scroll
mohamed@ubuntu:/sys/kernel/kobject_example$ cd
mohamed@ubuntu:~$ cd try/
mohamed@ubuntu:~/try$ cd lab2/
mohamed@ubuntu:~/try/lab2$ ./leds set caps on
mohamed@ubuntu:~/try/lab2$ ./leds get caps
on
mohamed@ubuntu:~/try/lab2$ ./leds set caps off
mohamed@ubuntu:~/try/lab2$ ./leds get caps
off
mohamed@ubuntu:~/try/lab2$ ./leds set num on
mohamed@ubuntu:~/try/lab2$ ./leds set num off
mohamed@ubuntu:~/try/lab2$ ./leds set scroll on
mohamed@ubuntu:~/try/lab2$ ./leds get num
off
mohamed@ubuntu:~/try/lab2$ ./leds get scroll
on
mohamed@ubuntu:~/try/lab2$
```

using ./users:

```
mohamed@ubuntu: ~/try/lab2
mohamed@ubuntu:~/try/lab2$ ./users
Hello !!!!
1- num
2- caps
3- scroll
4- exit
1
1 - num on
2 - num off
3 - get num state
1
1- num
2- caps
3- scroll
4- exit
2
1 - caps on
2 - caps off
3 - get caps state
2
1- num
2- caps
3- scroll
4- exit
2
1 - caps on
2 - caps off
3 - get caps state
3
off
1- num
2- caps
3- scroll
```

test printk in one process:

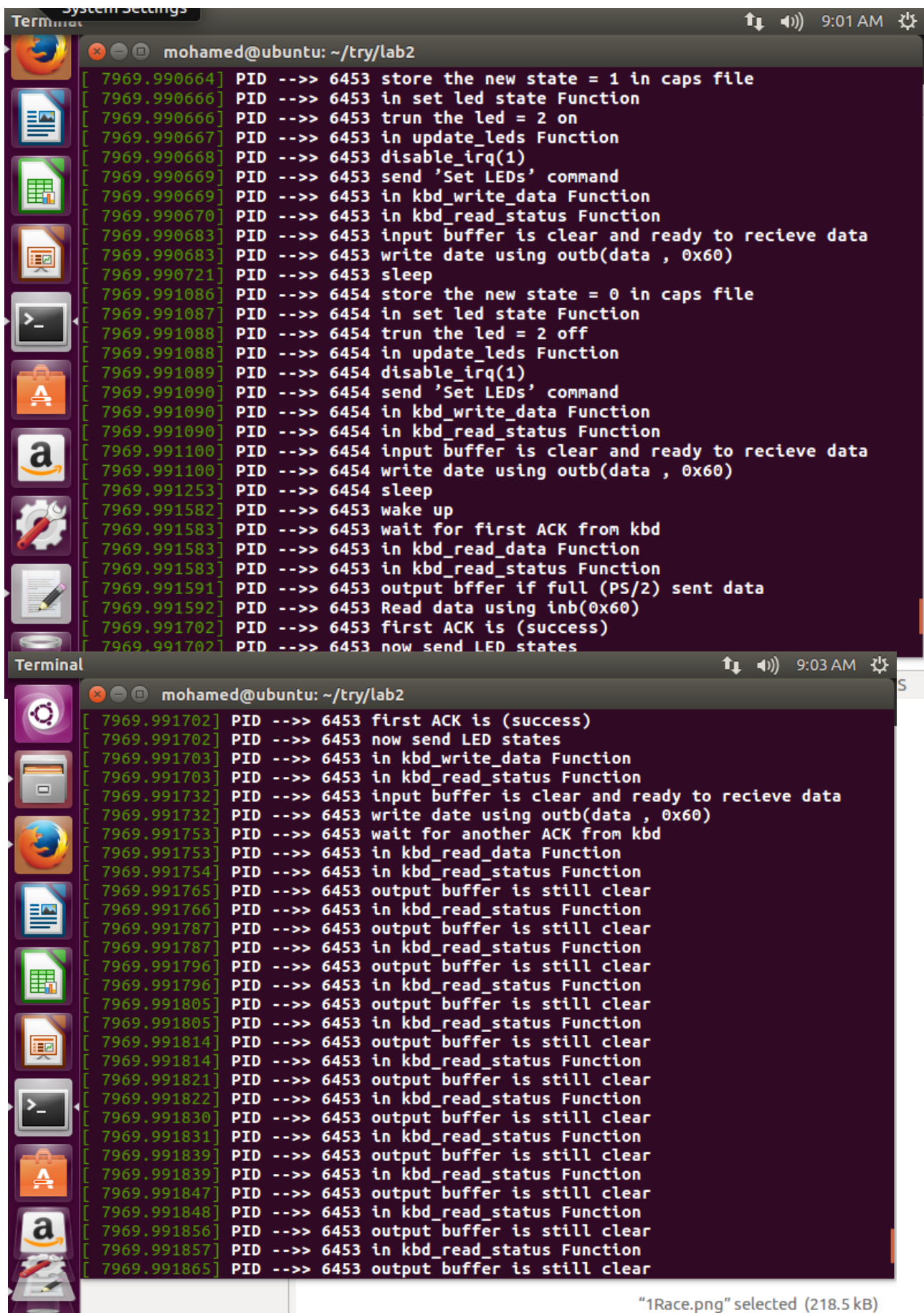
```
mohamed@ubuntu: ~/try/lab2
[ 6186.077999] module: module is already loaded
[ 6360.568228] PID --> 5774 store the new state = 1 in caps file
[ 6360.568230] PID --> 5774 in set led state Function
[ 6360.568230] PID --> 5774 trun the led = 2 on
[ 6360.568231] PID --> 5774 in update_leds Function
[ 6360.568232] PID --> 5774 disable_irq(1)
[ 6360.568233] PID --> 5774 send 'Set LEDs' command
[ 6360.568233] PID --> 5774 in kbd_write_data Function
[ 6360.568234] PID --> 5774 in kbd_read_status Function
[ 6360.568252] PID --> 5774 input buffer is clear and ready to recieve data
[ 6360.568252] PID --> 5774 write date using outb(data , 0x60)
[ 6360.568720] PID --> 5774 wait for first ACK from kbd
[ 6360.568721] PID --> 5774 in kbd_read_data Function
[ 6360.568721] PID --> 5774 in kbd_read_status Function
[ 6360.568725] PID --> 5774 output bffer if full (PS/2) sent data
[ 6360.568725] PID --> 5774 Read data using inb(0x60)
[ 6360.568746] PID --> 5774 first ACK is (success)
[ 6360.568746] PID --> 5774 now send LED states
[ 6360.568747] PID --> 5774 in kbd_write_data Function
[ 6360.568747] PID --> 5774 in kbd_read_status Function
[ 6360.568759] PID --> 5774 input buffer is clear and ready to recieve data
[ 6360.568759] PID --> 5774 write date using outb(data , 0x60)
[ 6360.568786] PID --> 5774 wait for another ACK from kbd
[ 6360.568787] PID --> 5774 in kbd_read_data Function
[ 6360.568787] PID --> 5774 in kbd_read_status Function
[ 6360.568802] PID --> 5774 output buffer is still clear
[ 6360.568803] PID --> 5774 in kbd_read_status Function
[ 6360.568839] PID --> 5774 output buffer is still clear
[ 6360.568840] PID --> 5774 in kbd_read_status Function
[ 6360.568862] PID --> 5774 output buffer is still clear
[ 6360.568863] PID --> 5774 in kbd_read_status Function
[ 6360.568873] PID --> 5774 output buffer is still clear
[ 6360.568873] PID --> 5774 in kbd_read_status Function
```

test two process but with out sleep:

```
mohamed@ubuntu: ~/try/lab2 8:30 AM
[ 7111.961667] PID --> 5897 update is successed is (success)
[ 7141.317975] PID --> 5922 store the new state = 1 in caps file
[ 7141.317977] PID --> 5922 in set led state Function
[ 7141.317978] PID --> 5922 trun the led = 2 on
[ 7141.317979] PID --> 5922 in update_leds Function
[ 7141.317980] PID --> 5922 disable_irq(1)
[ 7141.317980] PID --> 5922 send 'Set LEDs' command
[ 7141.317981] PID --> 5922 in kbd_write_data Function
[ 7141.317981] PID --> 5922 in kbd_read_status Function
[ 7141.317983] PID --> 5922 input buffer is clear and ready to recieve data
[ 7141.317984] PID --> 5922 write date using outb(data , 0x60)
[ 7141.318212] PID --> 5922 wait for first ACK from kbd
[ 7141.318213] PID --> 5922 in kbd_read_data Function
[ 7141.318213] PID --> 5922 in kbd_read_status Function
[ 7141.318214] PID --> 5922 output bffer if full (PS/2) sent data
[ 7141.318215] PID --> 5922 Read data using inb(0x60)
[ 7141.318230] PID --> 5922 first ACK is (success)
[ 7141.318231] PID --> 5922 now send LED states
[ 7141.318231] PID --> 5922 in kbd_write_data Function
[ 7141.318231] PID --> 5922 in kbd_read_status Function
[ 7141.318240] PID --> 5922 input buffer is clear and ready to recieve data
[ 7141.318241] PID --> 5922 write date using outb(data , 0x60)
[ 7141.318264] PID --> 5922 wait for another ACK from kbd
[ 7141.318265] PID --> 5922 in kbd_read_data Function
[ 7141.318265] PID --> 5922 in kbd_read_status Function
[ 7141.318276] PID --> 5922 output buffer is still clear
[ 7141.318276] PID --> 5922 in kbd_read_status Function
[ 7141.318286] PID --> 5922 output buffer is still clear
[ 7141.318286] PID --> 5922 in kbd_read_status Function
[ 7141.318295] PID --> 5922 output buffer is still clear
[ 7141.318295] PID --> 5922 in kbd_read_status Function
[ 7141.318304] PID --> 5922 output buffer is still clear
[ 7141.318304] PID --> 5922 in kbd_read_status Function

mohamed@ubuntu: ~/try/lab2 8:30 AM
[ 7141.319171] PID --> 5923 output buffer is still clear
[ 7141.319171] PID --> 5923 in kbd_read_status Function
[ 7141.319180] PID --> 5923 output buffer is still clear
[ 7141.319180] PID --> 5923 in kbd_read_status Function
[ 7141.319191] PID --> 5923 output buffer is still clear
[ 7141.319191] PID --> 5923 in kbd_read_status Function
[ 7141.319203] PID --> 5923 output buffer is still clear
[ 7141.319203] PID --> 5923 in kbd_read_status Function
[ 7141.319215] PID --> 5923 output buffer is still clear
[ 7141.319215] PID --> 5923 in kbd_read_status Function
[ 7141.319228] PID --> 5923 output buffer is still clear
[ 7141.319229] PID --> 5923 in kbd_read_status Function
[ 7141.319239] PID --> 5923 output buffer is still clear
[ 7141.319240] PID --> 5923 in kbd_read_status Function
[ 7141.319251] PID --> 5923 output buffer is still clear
[ 7141.319251] PID --> 5923 in kbd_read_status Function
[ 7141.319263] PID --> 5923 output buffer is still clear
[ 7141.319263] PID --> 5923 in kbd_read_status Function
[ 7141.319310] PID --> 5923 output buffer is still clear
[ 7141.319310] PID --> 5923 in kbd_read_status Function
[ 7141.319321] PID --> 5923 output buffer is still clear
[ 7141.319322] PID --> 5923 in kbd_read_status Function
[ 7141.319332] PID --> 5923 output buffer is still clear
[ 7141.319332] PID --> 5923 in kbd_read_status Function
[ 7141.319341] PID --> 5923 output buffer is still clear
[ 7141.319342] PID --> 5923 in kbd_read_status Function
[ 7141.319351] PID --> 5923 output buffer is still clear
[ 7141.319351] PID --> 5923 in kbd_read_status Function
[ 7141.319361] PID --> 5923 output buffer is still clear
[ 7141.319361] PID --> 5923 in kbd_read_status Function
[ 7141.319370] PID --> 5923 output buffer is still clear
[ 7141.319370] PID --> 5923 in kbd_read_status Function
[ 7141.319387] PID --> 5923 output buffer is still clear
```


test race condtions 1 as shown in code(send 0xED):



```
System Settings
Terminal
mohamed@ubuntu: ~/try/lab2
[ 7969.990664] PID --> 6453 store the new state = 1 in caps file
[ 7969.990666] PID --> 6453 in set led state Function
[ 7969.990666] PID --> 6453 trun the led = 2 on
[ 7969.990667] PID --> 6453 in update_leds Function
[ 7969.990668] PID --> 6453 disable_irq(1)
[ 7969.990669] PID --> 6453 send 'Set LEDs' command
[ 7969.990669] PID --> 6453 in kbd_write_data Function
[ 7969.990670] PID --> 6453 in kbd_read_status Function
[ 7969.990683] PID --> 6453 input buffer is clear and ready to recieve data
[ 7969.990683] PID --> 6453 write date using outb(data , 0x60)
[ 7969.990721] PID --> 6453 sleep
[ 7969.991086] PID --> 6454 store the new state = 0 in caps file
[ 7969.991087] PID --> 6454 in set led state Function
[ 7969.991088] PID --> 6454 trun the led = 2 off
[ 7969.991088] PID --> 6454 in update_leds Function
[ 7969.991089] PID --> 6454 disable_irq(1)
[ 7969.991090] PID --> 6454 send 'Set LEDs' command
[ 7969.991090] PID --> 6454 in kbd_write_data Function
[ 7969.991090] PID --> 6454 in kbd_read_status Function
[ 7969.991100] PID --> 6454 input buffer is clear and ready to recieve data
[ 7969.991100] PID --> 6454 write date using outb(data , 0x60)
[ 7969.991253] PID --> 6454 sleep
[ 7969.991582] PID --> 6453 wake up
[ 7969.991583] PID --> 6453 wait for first ACK from kbd
[ 7969.991583] PID --> 6453 in kbd_read_data Function
[ 7969.991583] PID --> 6453 in kbd_read_status Function
[ 7969.991591] PID --> 6453 output bffer if full (PS/2) sent data
[ 7969.991592] PID --> 6453 Read data using inb(0x60)
[ 7969.991702] PID --> 6453 first ACK is (success)
[ 7969.991702] PID --> 6453 now send LED states
[ 7969.991703] PID --> 6453 in kbd_write_data Function
[ 7969.991703] PID --> 6453 in kbd_read_status Function
[ 7969.991732] PID --> 6453 input buffer is clear and ready to recieve data
[ 7969.991732] PID --> 6453 write date using outb(data , 0x60)
[ 7969.991753] PID --> 6453 wait for another ACK from kbd
[ 7969.991753] PID --> 6453 in kbd_read_data Function
[ 7969.991754] PID --> 6453 in kbd_read_status Function
[ 7969.991765] PID --> 6453 output buffer is still clear
[ 7969.991766] PID --> 6453 in kbd_read_status Function
[ 7969.991787] PID --> 6453 output buffer is still clear
[ 7969.991787] PID --> 6453 in kbd_read_status Function
[ 7969.991796] PID --> 6453 output buffer is still clear
[ 7969.991796] PID --> 6453 in kbd_read_status Function
[ 7969.991805] PID --> 6453 output buffer is still clear
[ 7969.991805] PID --> 6453 in kbd_read_status Function
[ 7969.991814] PID --> 6453 output buffer is still clear
[ 7969.991814] PID --> 6453 in kbd_read_status Function
[ 7969.991821] PID --> 6453 output buffer is still clear
[ 7969.991822] PID --> 6453 in kbd_read_status Function
[ 7969.991830] PID --> 6453 output buffer is still clear
[ 7969.991831] PID --> 6453 in kbd_read_status Function
[ 7969.991839] PID --> 6453 output buffer is still clear
[ 7969.991839] PID --> 6453 in kbd_read_status Function
[ 7969.991847] PID --> 6453 output buffer is still clear
[ 7969.991848] PID --> 6453 in kbd_read_status Function
[ 7969.991856] PID --> 6453 output buffer is still clear
[ 7969.991857] PID --> 6453 in kbd_read_status Function
[ 7969.991865] PID --> 6453 output buffer is still clear

Terminal
mohamed@ubuntu: ~/try/lab2
[ 7969.991702] PID --> 6453 first ACK is (success)
[ 7969.991702] PID --> 6453 now send LED states
[ 7969.991703] PID --> 6453 in kbd_write_data Function
[ 7969.991703] PID --> 6453 in kbd_read_status Function
[ 7969.991732] PID --> 6453 input buffer is clear and ready to recieve data
[ 7969.991732] PID --> 6453 write date using outb(data , 0x60)
[ 7969.991753] PID --> 6453 wait for another ACK from kbd
[ 7969.991753] PID --> 6453 in kbd_read_data Function
[ 7969.991754] PID --> 6453 in kbd_read_status Function
[ 7969.991765] PID --> 6453 output buffer is still clear
[ 7969.991766] PID --> 6453 in kbd_read_status Function
[ 7969.991787] PID --> 6453 output buffer is still clear
[ 7969.991787] PID --> 6453 in kbd_read_status Function
[ 7969.991796] PID --> 6453 output buffer is still clear
[ 7969.991796] PID --> 6453 in kbd_read_status Function
[ 7969.991805] PID --> 6453 output buffer is still clear
[ 7969.991805] PID --> 6453 in kbd_read_status Function
[ 7969.991814] PID --> 6453 output buffer is still clear
[ 7969.991814] PID --> 6453 in kbd_read_status Function
[ 7969.991821] PID --> 6453 output buffer is still clear
[ 7969.991822] PID --> 6453 in kbd_read_status Function
[ 7969.991830] PID --> 6453 output buffer is still clear
[ 7969.991831] PID --> 6453 in kbd_read_status Function
[ 7969.991839] PID --> 6453 output buffer is still clear
[ 7969.991839] PID --> 6453 in kbd_read_status Function
[ 7969.991847] PID --> 6453 output buffer is still clear
[ 7969.991848] PID --> 6453 in kbd_read_status Function
[ 7969.991856] PID --> 6453 output buffer is still clear
[ 7969.991857] PID --> 6453 in kbd_read_status Function
[ 7969.991865] PID --> 6453 output buffer is still clear
```

"1Race.png" selected (218.5 kB)

test race condntions as shown in (change 0xED

data on >> off , off >> on):

```
Terminal
mohamed@ubuntu: ~/try/lab2
[ 9942.687665] PID -->> 7071 store the new state = 0 in caps file
[ 9942.687667] PID -->> 7071 in set led state Function
[ 9942.687668] PID -->> 7071 trun the led = 2 off
[ 9942.687668] PID -->> 7071 in update_leds Function
[ 9942.687705] PID -->> 7071 disable_irq(1)
[ 9942.687705] PID -->> 7071 send 'Set LEDs' command
[ 9942.687706] PID -->> 7071 in kbd_write_data Function
[ 9942.687706] PID -->> 7071 in kbd_read_status Function
[ 9942.687729] PID -->> 7071 input buffer is clear and ready to recieve data
[ 9942.687729] PID -->> 7071 write date using outb(data , 0x60)
[ 9942.687768] PID -->> 7071 wait for first ACK from kbd
[ 9942.687783] PID -->> 7071 in kbd_read_data Function
[ 9942.687784] PID -->> 7071 in kbd_read_status Function
[ 9942.687796] PID -->> 7071 output bffer if full (PS/2) sent data
[ 9942.687796] PID -->> 7071 Read data using inb(0x60)
[ 9942.687824] PID -->> 7071 first ACK is (success)
[ 9942.687824] PID -->> 7071 sleep
[ 9942.688139] PID -->> 7072 store the new state = 1 in caps file
[ 9942.688140] PID -->> 7072 in set led state Function
[ 9942.688140] PID -->> 7072 trun the led = 2 on
[ 9942.688141] PID -->> 7072 in update_leds Function
[ 9942.688141] PID -->> 7072 disable_irq(1)
[ 9942.688142] PID -->> 7072 send 'Set LEDs' command
[ 9942.688142] PID -->> 7072 in kbd_write_data Function
[ 9942.688143] PID -->> 7072 in kbd_read_status Function
[ 9942.688144] PID -->> 7072 input buffer is clear and ready to recieve data
[ 9942.688145] PID -->> 7072 write date using outb(data , 0x60)
[ 9942.688215] PID -->> 7072 wait for first ACK from kbd
[ 9942.688216] PID -->> 7072 in kbd_read_data Function
[ 9942.688216] PID -->> 7072 in kbd_read_status Function
[ 9942.688217] PID -->> 7072 output bffer if full (PS/2) sent data
[ 9942.688218] PID -->> 7072 Read data using inb(0x60)
[ 9942.688233] PID -->> 7072 first ACK is (success)
[ 9942.688233] PID -->> 7072 sleep
[ 9942.691542] PID -->> 7071 wake up
[ 9942.691544] PID -->> 7071 now send LED states
[ 9942.691545] PID -->> 7071 in kbd_write_data Function
[ 9942.691546] PID -->> 7071 in kbd_read_status Function
[ 9942.691549] PID -->> 7071 input buffer is clear and ready to recieve data
[ 9942.691550] PID -->> 7071 write date using outb(data , 0x60)
[ 9942.691697] PID -->> 7071 wait for another ACK from kbd
[ 9942.691698] PID -->> 7071 in kbd_read_data Function
[ 9942.691698] PID -->> 7071 in kbd_read_status Function
[ 9942.691700] PID -->> 7071 output bffer if full (PS/2) sent data
[ 9942.691701] PID -->> 7071 Read data using inb(0x60)
[ 9942.691724] PID -->> 7071 another ACK is (success)
[ 9942.691726] PID -->> 7071 enable_irq(1)
[ 9942.691727] PID -->> 7071 update is successed is (success)
[ 9942.692222] PID -->> 7072 wake up
[ 9942.692223] PID -->> 7072 now send LED states
[ 9942.692224] PID -->> 7072 in kbd_write_data Function
[ 9942.692224] PID -->> 7072 in kbd_read_status Function
[ 9942.692226] PID -->> 7072 input buffer is clear and ready to recieve data
[ 9942.692227] PID -->> 7072 write date using outb(data , 0x60)
[ 9942.692335] PID -->> 7072 wait for another ACK from kbd
[ 9942.692335] PID -->> 7072 in kbd_read_data Function
[ 9942.692336] PID -->> 7072 in kbd_read_status Function
[ 9942.692337] PID -->> 7072 output bffer if full (PS/2) sent data
[ 9942.692337] PID -->> 7072 Read data using inb(0x60)
[ 9942.692349] PID -->> 7072 another ACK is (success)
[ 9942.692353] PID -->> 7072 enable_irq(1)
```

test race condtions as shown in (early enable irq(1) or change send led states):

```
mohamed@ubuntu: ~/try/lab2 9:21 AM
[10287.364127] PID --> 7556 store the new state = 0 in caps file
[10287.364129] PID --> 7556 in set led state Function
[10287.364130] PID --> 7556 trun the led = 2 off
[10287.364130] PID --> 7556 in update_leds Function
[10287.364132] PID --> 7556 disable_irq(1)
[10287.364132] PID --> 7556 send 'Set LEDs' command
[10287.364133] PID --> 7556 in kbd_write_data Function
[10287.364133] PID --> 7556 in kbd_read_status Function
[10287.364155] PID --> 7556 input buffer is clear and ready to recieve data
[10287.364155] PID --> 7556 write date using outb(data , 0x60)
[10287.364203] PID --> 7556 wait for first ACK from kbd
[10287.364203] PID --> 7556 in kbd_read_data Function
[10287.364204] PID --> 7556 in kbd_read_status Function
[10287.364215] PID --> 7556 output bffer if full (PS/2) sent data
[10287.364216] PID --> 7556 Read data using inb(0x60)
[10287.364245] PID --> 7556 first ACK is (success)
[10287.364245] PID --> 7556 now send LED states
[10287.364246] PID --> 7556 in kbd_write_data Function
[10287.364270] PID --> 7556 in kbd_read_status Function
[10287.364281] PID --> 7556 input buffer is clear and ready to recieve data
[10287.364281] PID --> 7556 write date using outb(data , 0x60)
[10287.364304] PID --> 7556 sleep
[10287.364676] PID --> 7557 store the new state = 1 in caps file
[10287.364677] PID --> 7557 in set led state Function
[10287.364677] PID --> 7557 trun the led = 2 on
[10287.364678] PID --> 7557 in update_leds Function
[10287.364678] PID --> 7557 disable_irq(1)
[10287.364679] PID --> 7557 send 'Set LEDs' command
[10287.364679] PID --> 7557 in kbd_write_data Function
[10287.364680] PID --> 7557 in kbd_read_status Function
[10287.364681] PID --> 7557 input buffer is clear and ready to recieve data
[10287.364681] PID --> 7557 write date using outb(data , 0x60)
[10287.364749] PID --> 7557 wait for first ACK from kbd
[10287.364749] PID --> 7557 in kbd_read_data Function
[10287.364750] PID --> 7557 in kbd_read_status Function
[10287.364753] PID --> 7557 output bffer if full (PS/2) sent data
[10287.364753] PID --> 7557 Read data using inb(0x60)
[10287.364765] PID --> 7557 first ACK is (success)
[10287.364766] PID --> 7557 now send LED states
[10287.364766] PID --> 7557 in kbd_write_data Function
[10287.364766] PID --> 7557 in kbd_read_status Function
[10287.364775] PID --> 7557 input buffer is clear and ready to recieve data
[10287.364776] PID --> 7557 write date using outb(data , 0x60)
[10287.364795] PID --> 7557 sleep
[10287.367576] PID --> 7557 wake up
[10287.367579] PID --> 7557 wait for another ACK from kbd
[10287.367581] PID --> 7557 in kbd_read_data Function
[10287.367581] PID --> 7557 in kbd_read_status Function
```

test race condtions as shown in (over write):

```
mohamed@ubuntu: ~/try/lab2 9:29 AM
[10785.919622] PID -->> 8106 store the new state = 0 in caps file
[10785.919625] PID -->> 8106 in set led state Function
[10785.919626] PID -->> 8106 trun the led = 2 off
[10785.919628] PID -->> 8106 in update_leds Function
[10785.919630] PID -->> 8106 disable_irq(1)
[10785.919631] PID -->> 8106 send 'Set LEDs' command
[10785.919632] PID -->> 8106 in kbd_write_data Function
[10785.919633] PID -->> 8106 in kbd_read_status Function
[10785.919642] PID -->> 8106 input buffer is clear and ready to recieve data
[10785.919643] PID -->> 8106 write date using outb(data , 0x60)
[10785.920362] PID -->> 8106 wait for first ACK from kbd
[10785.920363] PID -->> 8106 in kbd_read_data Function
[10785.920364] PID -->> 8106 in kbd_read_status Function
[10785.920399] PID -->> 8106 output bffer if full (PS/2) sent data
[10785.920400] PID -->> 8106 Read data using inb(0x60)
[10785.920485] PID -->> 8106 first ACK is (success)
[10785.920487] PID -->> 8106 now send LED states
[10785.920488] PID -->> 8106 in kbd_write_data Function
[10785.920489] PID -->> 8106 in kbd_read_status Function
[10785.920513] PID -->> 8106 input buffer is clear and ready to recieve data
[10785.920514] PID -->> 8106 write date using outb(data , 0x60)
[10785.920568] PID -->> 8106 wait for another ACK from kbd
[10785.920570] PID -->> 8106 in kbd_read_data Function
[10785.920572] PID -->> 8106 in kbd_read_status Function
[10785.920604] PID -->> 8106 output buffer is still clear
[10785.920606] PID -->> 8106 in kbd_read_status Function
[10785.920634] PID -->> 8106 output buffer is still clear
[10785.920636] PID -->> 8106 in kbd_read_status Function
[10785.920662] PID -->> 8106 output buffer is still clear
[10785.920663] PID -->> 8106 in kbd_read_status Function
[10785.920685] PID -->> 8106 output buffer is still clear
[10785.920687] PID -->> 8106 in kbd_read_status Function
[10785.920709] PID -->> 8106 output buffer is still clear
```


test semaphore(to handle first race condtion):

```
mohamed@ubuntu: ~/try/lab2 10:09 AM
[13150.603537] PID --> 10037 in kbd_read_status Function
[13150.603553] PID --> 10037 input buffer is clear and ready to recieve data
[13150.604071] PID --> 10037 write date using outb(data , 0x60)
[13150.604109] PID --> 10037 sleep
[13150.607437] PID --> 10037 wake up
[13150.607439] PID --> 10037 wait for first ACK from kbd
[13150.607440] PID --> 10037 in kbd_read_data Function
[13150.607441] PID --> 10037 in kbd_read_status Function
[13150.607459] PID --> 10037 output bffer if full (PS/2) sent data
[13150.607460] PID --> 10037 Read data using inb(0x60)
[13150.607511] PID --> 10037 first ACK is (success)
[13150.607512] PID --> 10037 now send LED states
[13150.607512] PID --> 10037 in kbd_write_data Function
[13150.607513] PID --> 10037 in kbd_read_status Function
[13150.607533] PID --> 10037 input buffer is clear and ready to recieve data
[13150.607534] PID --> 10037 write date using outb(data , 0x60)
[13150.607566] PID --> 10037 wait for another ACK from kbd
[13150.607567] PID --> 10037 in kbd_read_data Function
[13150.607568] PID --> 10037 in kbd_read_status Function
[13150.607594] PID --> 10037 output buffer is still clear
[13150.607595] PID --> 10037 in kbd_read_status Function
[13150.607653] PID --> 10037 output buffer is still clear
[13150.607653] PID --> 10037 in kbd_read_status Function
[13150.607668] PID --> 10037 output buffer is still clear
[13150.607669] PID --> 10037 in kbd_read_status Function
[13150.607682] PID --> 10037 output buffer is still clear
[13150.607683] PID --> 10037 in kbd_read_status Function
[13150.607697] PID --> 10037 output buffer is still clear
[13150.607699] PID --> 10037 in kbd_read_status Function
[13150.607715] PID --> 10037 output buffer is still clear
[13150.607717] PID --> 10037 in kbd_read_status Function
[13150.607735] PID --> 10037 output buffer is still clear
[13150.607736] PID --> 10037 in kbd_read_status Function
mohamed@ubuntu: ~/try/lab2 10:09 AM
[13150.607791] PID --> 10037 in kbd_read_status Function
[13150.607809] PID --> 10037 output buffer is still clear
[13150.607810] PID --> 10037 in kbd_read_status Function
[13150.607891] PID --> 10037 output bffer if full (PS/2) sent data
[13150.607892] PID --> 10037 Read data using inb(0x60)
[13150.607926] PID --> 10037 another ACK is (success)
[13150.607932] PID --> 10037 enable_irq(1)
[13150.607934] PID --> 10037 update is successed is (success)
[13150.608386] PID --> 10038 store the new state = 1 in caps file
[13150.608387] PID --> 10038 in set led state Function
[13150.608388] PID --> 10038 trun the led = 2 on
[13150.608388] PID --> 10038 in update_leds Function
[13150.608389] PID --> 10038 disable_irq(1)
[13150.608390] PID --> 10038 send 'Set LEDs' command
[13150.608390] PID --> 10038 in kbd_write_data Function
[13150.608391] PID --> 10038 in kbd_read_status Function
[13150.608407] PID --> 10038 input buffer is clear and ready to recieve data
[13150.608407] PID --> 10038 write date using outb(data , 0x60)
[13150.608512] PID --> 10038 sleep
[13150.611675] PID --> 10038 wake up
[13150.611677] PID --> 10038 wait for first ACK from kbd
[13150.611678] PID --> 10038 in kbd_read_data Function
[13150.611692] PID --> 10038 in kbd_read_status Function
[13150.611705] PID --> 10038 output bffer if full (PS/2) sent data
[13150.611706] PID --> 10038 Read data using inb(0x60)
[13150.611751] PID --> 10038 first ACK is (success)
[13150.611751] PID --> 10038 now send LED states
[13150.611752] PID --> 10038 in kbd_write_data Function
[13150.611752] PID --> 10038 in kbd_read_status Function
[13150.611763] PID --> 10038 input buffer is clear and ready to recieve data
[13150.611764] PID --> 10038 write date using outb(data , 0x60)
[13150.611777] PID --> 10038 wait for another ACK from kbd
[13150.611778] PID --> 10038 in kbd_read_data Function
```

test semaphore for all race conditions:

```
mohamed@ubuntu: ~/try/lab2 10:15 AM
[13150.612114] PID --> 10038 another ACK is (success)
[13150.612119] PID --> 10038 enable_irq(1)
[13150.612120] PID --> 10038 update is succeeded is (success)
[13364.240638] PID --> 10491 store the new state = 0 in caps file
[13364.240640] PID --> 10491 in set led state Function
[13364.240641] PID --> 10491 trun the led = 2 off
[13364.240642] PID --> 10491 in update_leds Function
[13364.240643] PID --> 10491 disable_irq(1)
[13364.240643] PID --> 10491 send 'Set LEDs' command
[13364.240644] PID --> 10491 in kbd_write_data Function
[13364.240644] PID --> 10491 in kbd_read_status Function
[13364.240660] PID --> 10491 input buffer is clear and ready to recieve data
[13364.240661] PID --> 10491 write date using outb(data , 0x60)
[13364.241108] PID --> 10491 wait for first ACK from kbd
[13364.241109] PID --> 10491 in kbd_read_data Function
[13364.241109] PID --> 10491 in kbd_read_status Function
[13364.241113] PID --> 10491 output bffer if full (PS/2) sent data
[13364.241113] PID --> 10491 Read data using inb(0x60)
[13364.241132] PID --> 10491 first ACK is (success)
[13364.241132] PID --> 10491 now send LED states
[13364.241133] PID --> 10491 in kbd_write_data Function
[13364.241133] PID --> 10491 in kbd_read_status Function
[13364.241171] PID --> 10491 input buffer is clear and ready to recieve data
[13364.241172] PID --> 10491 write date using outb(data , 0x60)
[13364.241193] PID --> 10491 sleep
[13364.242120] PID --> 10491 wake up
[13364.242121] PID --> 10491 wait for another ACK from kbd
[13364.242122] PID --> 10491 in kbd_read_data Function
[13364.242122] PID --> 10491 in kbd_read_status Function
[13364.242131] PID --> 10491 output bffer if full (PS/2) sent data
[13364.242132] PID --> 10491 Read data using inb(0x60)
[13364.242223] PID --> 10491 another ACK is (success)
[13364.242225] PID --> 10491 enable_irq(1)

mohamed@ubuntu: ~/try/lab2 10:15 AM
[13364.242225] PID --> 10491 enable_irq(1)
[13364.242226] PID --> 10491 update is succeeded is (success)
[13364.242527] PID --> 10492 store the new state = 1 in caps file
[13364.242528] PID --> 10492 in set led state Function
[13364.242529] PID --> 10492 trun the led = 2 on
[13364.242529] PID --> 10492 in update_leds Function
[13364.242530] PID --> 10492 disable_irq(1)
[13364.242531] PID --> 10492 send 'Set LEDs' command
[13364.242531] PID --> 10492 in kbd_write_data Function
[13364.242531] PID --> 10492 in kbd_read_status Function
[13364.242549] PID --> 10492 input buffer is clear and ready to recieve data
[13364.242550] PID --> 10492 write date using outb(data , 0x60)
[13364.242627] PID --> 10492 wait for first ACK from kbd
[13364.242627] PID --> 10492 in kbd_read_data Function
[13364.242628] PID --> 10492 in kbd_read_status Function
[13364.242638] PID --> 10492 output bffer if full (PS/2) sent data
[13364.242639] PID --> 10492 Read data using inb(0x60)
[13364.242664] PID --> 10492 first ACK is (success)
[13364.242665] PID --> 10492 now send LED states
[13364.242665] PID --> 10492 in kbd_write_data Function
[13364.242666] PID --> 10492 in kbd_read_status Function
[13364.242675] PID --> 10492 input buffer is clear and ready to recieve data
[13364.242675] PID --> 10492 write date using outb(data , 0x60)
[13364.242695] PID --> 10492 sleep
[13364.246245] PID --> 10492 wake up
[13364.246247] PID --> 10492 wait for another ACK from kbd
[13364.246248] PID --> 10492 in kbd_read_data Function
[13364.246249] PID --> 10492 in kbd_read_status Function
[13364.246253] PID --> 10492 output bffer if full (PS/2) sent data
[13364.246254] PID --> 10492 Read data using inb(0x60)
[13364.246443] PID --> 10492 another ACK is (success)
[13364.246449] PID --> 10492 enable_irq(1)
[13364.246450] PID --> 10492 update is succeeded is (success)
```