OS Project Report

Search in File System Call

Objective:

1. Add a system call in Linux kernel.
2. System call should search for a given phrase in a file and return the first occurrence in an array or search on a specific line and return line and line number.
3. Learn about system calls, kernel space and user space.

Explanation:

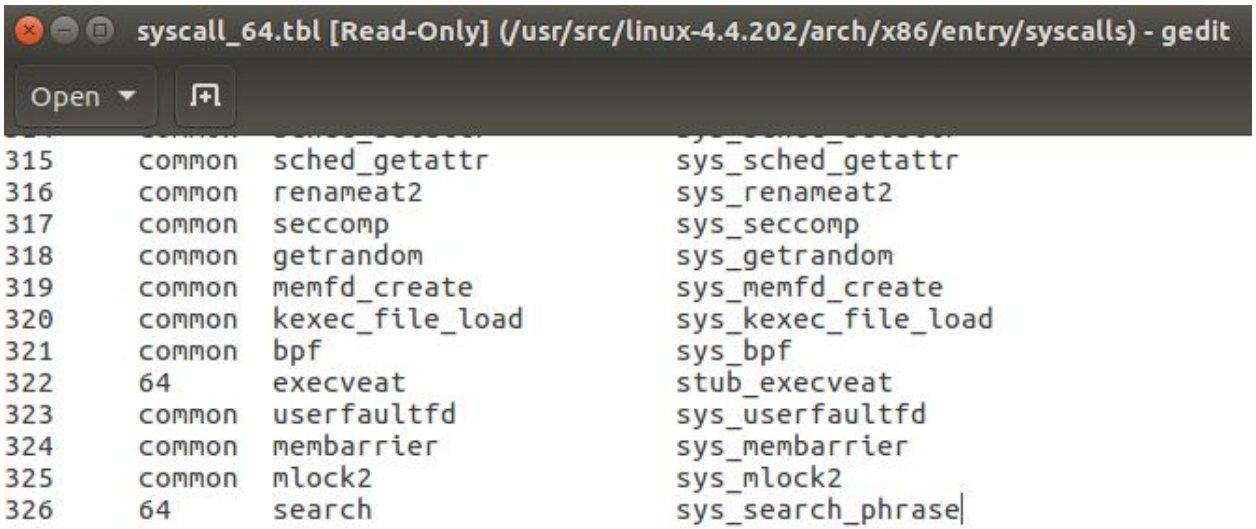
Methods in System Call:

- **int my_getLength_Fn(char * str):** This method takes a pointer to an array as an argument and returns the length of that array.
- **void my_to_lower_Fn(char * arr):** This method also takes a pointer to an array and converts every uppercase alphabet to lowercase.
- **int contains(char *container, char *query):** This method checks for the existence of query string in container string and returns 1 if query is found in container else it will return 0.
- **void copy(char *dest, char *src):** This method simply copies src string to dest string.
- **asmlinkage long sys_search_phrase(int fd, char *phrase, char *buffer, int line, int to_lower): asmlinkage** tells the compiler that the function should not expect to find any of its arguments in registers (a common optimization), but only on the CPU's stack. This method is where all of the above methods are used. It takes 5 arguments: **(1)int fd:** File descriptor. **(2)char *phrase:** The text you want to search in the file. **(3)char *buffer:** This will contain the line which has the search phrase in it. **(4)int line:** This will contain the line number you want to search on. **(5)int to_lower:** This argument is for case sensitivity. 1 is for case sensitivity on and 0 is for case sensitivity off. In this method the file is read character by character until a whole line is read and then it checks if that line contains the search phrase, if the phrase is found this method returns the number of that line and the line is saved in **char *buffer** argument. And if the

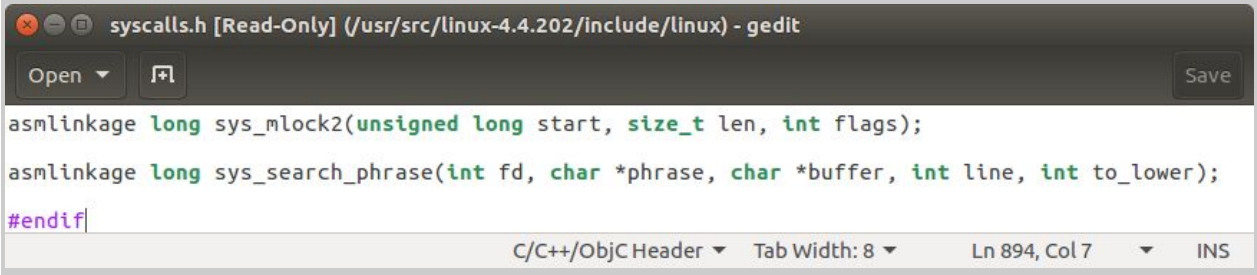
phrase is not found the function reads another line and checks again until the end of the file. If phrase does not exist in the file then system call will return -1.

How to add the system call:

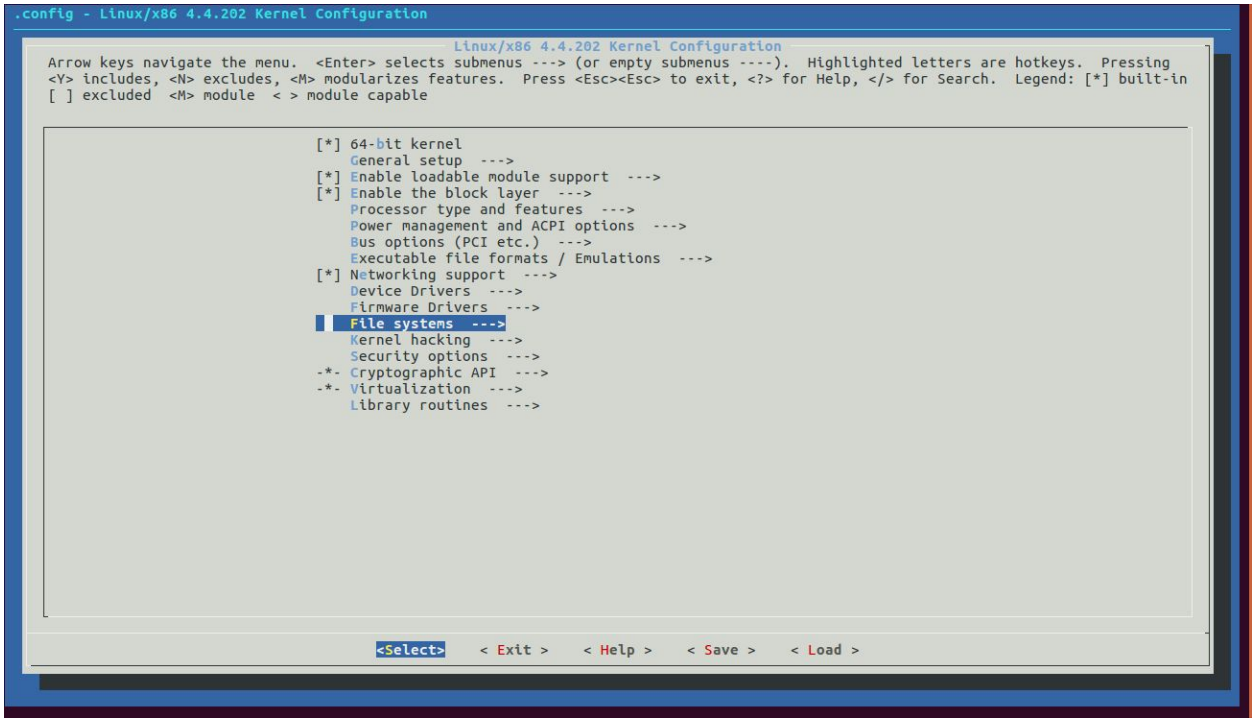
1. Go to https://www.kernel.org/ and download a stable release. A version closer to yours is preferred. To check your kernel version open terminal a type `uname -r`. I downloaded kernel version 4.4.202.
2. Open terminal and enter superuser mode:
   `sudo -s`
3. Extract the kernel source to path `/usr/src` using the following command `tar -xvf linux-4.4.202.tar.xz -C/usr/src/`.
4. Now change directory to where the files are extracted:
   `cd /usr/src/linux-4.4.202/`
5. Create a new directory:
   `mkdir search`
   `cd search`
6. Copy all files from `Code/search/` and paste into the newly created folder.
7. Go back to parent directory `cd ..`
8. Edit the Makefile of kernel to include the folder you created in the compilation process.
   Type `gedit Makefile` and edit find the following line:
   `core-y += kernel/ mm/ fs/ ipc/ security/ crypto/ block/`
   Add ‘ search/’ to the end
   `core-y += kernel/ mm/ fs/ ipc/ security/ crypto/ block/ search/`
9. Now add the new system call to the system call table:
   `cd arch/x86/entry/syscalls/`
   `gedit syscall_64.tbl`



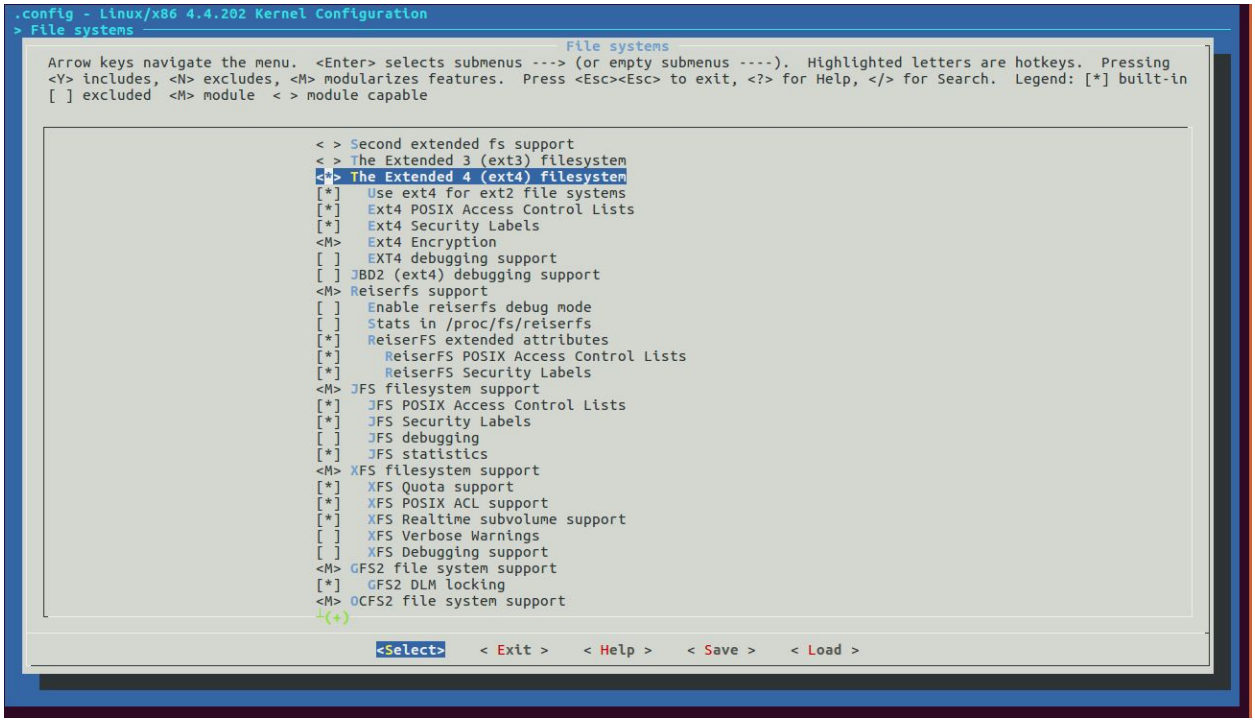
10. Also add your system call to the system call header file:
    cd /usr/src/linux-4.4.202/include/linux
    gedit syscalls.h
    Declare your method at the end of the file just before #endif



11. Finally compile the kernel.
12. Install the dependencies first:
    sudo apt-get install gcc
    sudo apt-get install libncurses5-dev
    sudo apt-get install bison
    sudo apt-get install flex
    sudo apt-get install libssl-dev
    sudo apt-get install libelf-dev
    sudo apt-get update
    sudo apt-get upgrade
13. Change directory to /usr/src/linux-4.4.202 and type make menuconfig then you will get a menu like this:



Select File systems and press enter then select The Extended 4 (ext4) filesystem



Then save and exit the configuration menu.

14. Now we can run the command to compile the kernel:
    make && make modules_install && make install
15. Now go to /boot directory and type ls. You should see four new files:
    a. System.map-4.4.202
    b. Vmlinuz-4.4.202
    c. Initrd.img-4.4.202
    d. config-4.4.202

    This means that the kernel was compiled successfully.
16. Now restart your computer and check your kernel version with uname -r.

How to use the system call:

1. In github repository go to Code/search/. The search folder contains a header file(my headers.h), a source code file(search_in_file.c) for the system call and a make file(Makefile).
2. Add the system call using the instructions given above.
3. In github repository go to Code folder there is a file named using-syscall.c which is using the system call.
4. To use the system call in any file type long int ret = search(fd, phrase, buffer, line, to_lower);. The name of the method is different than the name of the actual system call because we have include a header file search.h which is implementing a method search which is returning our system call.

```c
#include <sys/syscall.h>
#define SYS_search_phrase 326
long search(int fd, char *phrase, char *buffer, int line, int to_lower){
        return syscall(SYS_search_phrase, fd, phrase, buffer, line, to_lower);
}
```

Screenshots:

history.txt

```
total 76
drwxrwxr-x 8 compro compro 4096 Nov 28 01:28 clion-2019.2.5
drwxrwxr-x 3 compro compro 4096 Nov 28 01:45 CLionProjects
drwxr-xr-x 5 compro compro 4096 Nov 29 17:22 Desktop
drwxr-xr-x 2 compro compro 4096 Nov 24 19:58 Documents
drwxr-xr-x 3 compro compro 4096 Nov 29 17:24 Downloads
-rw-r--r-- 1 compro compro 8980 Nov 25 00:38 examples.desktop
drwxr-xr-x 2 compro compro 4096 Nov 24 19:58 Music
drwxr-xr-x 2 compro compro 4096 Nov 24 19:58 Pictures
drwxrwxr-x 3 compro compro 4096 Nov 28 21:01 Postman
drwxr-xr-x 2 compro compro 4096 Nov 24 19:58 Public
drwxr-xr-x 3 compro compro 4096 Nov 29 02:38 snap
drwxr-xr-x 2 compro compro 4096 Nov 24 19:58 Templates
-rwxrwxr-x 1 compro compro 8664 Nov 26 02:38 userspace
-rw-rw-r-- 1 compro compro  226 Nov 26 02:37 userspace.c
drwxr-xr-x 2 compro compro 4096 Nov 24 19:58 Videos
```

Note that the output will depend on how you use the system call in user space.

```
compro@ubuntu:~/Desktop/project-fall-2019-102539-62722_62462/Code$ ./using-syscall
Enter Your search phrase:
postman
Enter line No(Enter 0 to search all lines):
0
Turn case sensitivity on/off 1|0:
1
Sys call returned: -1

compro@ubuntu:~/Desktop/project-fall-2019-102539-62722_62462/Code$ ./using-syscall
Enter Your search phrase:
postman
Enter line No(Enter 0 to search all lines):
0
Turn case sensitivity on/off 1|0:
0
Sys call returned: 10
drwxrwxr-x 3 compro compro 4096 Nov 28 21:01 Postman
compro@ubuntu:~/Desktop/project-fall-2019-102539-62722_62462/Code$
```

```
compro@ubuntu:~/Desktop/project-fall-2019-102539-62722_62462/Code$ ./using-syscall
Enter Your search phrase:
Videos
Enter line No(Enter 0 to search all lines):
0
Turn case sensitivity on/off 1|0:
1
Sys call returned: 16
drwxr-xr-x 2 compro compro 4096 Nov 24 19:58 Videos
compro@ubuntu:~/Desktop/project-fall-2019-102539-62722_62462/Code$ ./using-syscall
Enter Your search phrase:
Videos
Enter line No(Enter 0 to search all lines):
0
Turn case sensitivity on/off 1|0:
0
Sys call returned: 16
drwxr-xr-x 2 compro compro 4096 Nov 24 19:58 Videos
compro@ubuntu:~/Desktop/project-fall-2019-102539-62722_62462/Code$
```