

CS60038: Assignment 2

(Handling Syscalls using LKM)

This assignment is a continuation of Assignment 1. In this assignment, you now need to develop an LKM that supports various `ioctl` calls to set and retrieve various configurations and internal information respectively. The following table describes the `ioctl` commands and their task. Here, upon insertion of this LKM, it will create a file at the path `/proc/cs60038_a2_<roll no>`. This path will be world-readable and writable. A userspace program will interact with the LKM through this file. A userspace program can fire an `ioctl` system call any time it wants.

Command	Description
PB2_SET_CAPACITY	This command initializes the LKM with the maximum priority-queue capacity. LKM is already initialized for the current process, this command resets the LKM and reinitializes again. It expects a pointer to a 32-bit integer. The value must be in the range between 1 and 100 (both inclusive). Invalid value or inaccessible pointer causes an error and sets the error number to <code>EINVAL</code> . On success, it returns 0. No other operation can be performed (including read or write) before performing this system call. Every other system call on the LKM returns an error (-1) with code <code>EACCES</code> .
PB2_INSERT_INT	This command inserts an integer into the priority-queue. It takes a pointer to an integer as the input value. Invalid value causes an error in LKM and sets error number to <code>EINVAL</code> . On success, it returns 0. This command is followed by the <code>PB2_INSERT_PRIO</code> command at the userspace process.
PB2_INSERT_PRIO	This command inserts the priority into the priority-queue. It takes a pointer to an integer as the input value. Invalid value causes an error in LKM and sets error number to <code>EINVAL</code> . On success, this command returns 0. If the priority-queue is full, it returns an error (-1) with code <code>EACCES</code> .
PB2_GET_INFO	This command returns the information about the priority-queue. <code>PB2_GET_INFO</code> command expects a pointer to a structure object of type <code>struct obj_info</code> as the value. On success, LKM returns 0 and fills the various fields of the pointer passed by the process. On error, LKM sets appropriate error no and returns -1.
PB2_GET_MIN	This extracts the element with minimum priority from the priority-queue (Element having lowest integer value as priority, should be considered as minimum priority element). This function returns 0 on success and -1 on error.
PB2_GET_MAX	This extracts the element with maximum priority from the priority-queue. This function returns 0 on success and -1 on error.

The definition of ioctl commands are as follows:

```
#define PB2_SET_CAPACITY
#define PB2_INSERT_INT                _IOW(0x10, 0x31, int32_t*)
#define PB2_INSERT_PRIO                _IOW(0x10, 0x32, int32_t*)
#define PB2_GET_INFO                    _IOW(0x10, 0x33, int32_t*)
#define PB2_GET_MIN                     _IOW(0x10, 0x33, int32_t*)
#define PB2_GET_MAX                     _IOR(0x10, 0x34, int32_t*)
                                         _IOR(0x10, 0x35, int32_t*)
                                         _IOR(0x10, 0x36, int32_t*)
```

The definition of structures are as follows:

```
struct obj_info {
    int32_t prio_queue_size; // current number of elements in priority-queue
    int32_t capacity;        // maximum capacity of priority-queue
};
```

A userspace process interacts with the LKM in the following manner only.

1. It will open the file (**/proc/cs60038_a2_<roll no>**) in read-write mode and obtain the file descriptor.
2. Userspace process calls the ioctl system call with command PB2_SET_CAPACITY and appropriate value to set the maximum capacity of the priority-queue in the kernel.
3. Insert elements using the ioctl system call with commands PB2_INSERT_INT and PB2_INSERT_PRIO as many times as you want. However, there is no bound on the number of times the user program can call this insert operation. LKM verifies the arguments in the system call and inserts the input into the priority-queue. In case the priority-queue is full, an appropriate error is returned.
4. To perform read/ extract data from priority-queue, the userspace program uses ioctl system call with command PB2_GET_MIN or PB2_GET_MAX. The system call returns 0 in case of successful execution and populates the result, whose pointer is passed while making the call.
5. When all the operations are done, the userspace process closes the file and LKM releases all the resources allocated for the process.
6. In between the userspace program can call the ioctl system call with command PB2_GET_INFO to retrieve information and the current state of the priority-queue.

LKM should be able to handle concurrency and separate data from multiple processes. Also, no userspace program should be able to open the file more than once simultaneously. However, the userspace process should be able to reset the LKM (for the said process) by reopening the file.

Submission Details:

- Students have to submit the LKM Code and the corresponding Makefile.
- In every source code file write your Roll no in the comments at the top.
- Compress these files into a zip file and name the zip file: **ASGN2_<ROLL_NO>.zip**.