

**Programming Assignment 3  
(PCI Device Driver)  
CS614: Linux Kernel Programming  
2022-23 - Semester II  
Computer Science and Engineering  
Indian Institute of Technology Kanpur**

## Design

---

- The Device Driver is implemented using mmio for allocation of 1MB region to access the device registers.
  - The Driver is the main interface for communication with the Device pci bus interface is used for the implementation.
  - By implementing a character driver with IOCTL the interface is built to send and receive messages and instructions to the driver.
  - A char device named “CryptocardChardev” is created for enabling the interface between driver and user library.
  - The user level library gives functions to set and unset various device configurations and to send input and output to the device.
  - The driver handles multithreaded environment using mutex based concurrency control exploit the tgid of the task\_struct structure to get unique thread IDs.
  - Using LinkedList of structure configuration informations are stored.
  - For Handling large size data the data is divided into chunks of size 32768 Bits.
-

- All chunk handling is done at user level library which is the encrypt and decrypt functions in user library.
- The user mmap function calls mmap and remaps the device last chunk of bar to user memory.

## Implementation details

---

Driver Kernel module, cryptocard\_mod.c -

- Task\_node: It is used for storing the config information for each thread/task.
- Add\_node : Function is used to add a new task\_node to the linkedlist structure when driver open the driver.
- Remove\_node: Function is used to remove task\_node from linkedlist structure when device releases the driver.
- Search\_node: Function used to search the Linkedlist for the current task.
- mmio: Function handles all mmio specific utilities and performs encryption based defined configuration as per the process.
- dma: Function handles all dma specific encryption based on the selected configuration given by user library.

- Set\_keys: Function is used to set the keys for encryption or decryption and is used by both mmio and dma.
- set\_mmio\_dataaddr: Function is used to set the data address for mmio and used by mmio function.
- check\_liveness: Function checks if the driver is alive or not.
- Encrypt: This user library function used to break the data into dma buffer size chunks and encrypt based on that for each of the chunks based on specified configuration.

## Test strategies

---

- Test cases provided in test-cases/ directory were used to check the correctness of the driver.

- Modified default test1.c test-case file and Used set\_config() function to check for different scenarios possible, mmio, dma, with interrupt, without interrupt.
- To check the robustness to multiprocess environment multiple instances of the same .
- Each executables was run 10 times and CPU usage was recorded with 5 MB input file.
- Tested with multiple threaded environment using pthreads.

## Benchmark Results

---

- Average CPU usage for each benchmark
-

- 5 MB memory file was created for benchmark reporting.

S.no.	config	%CPU (user)	%CPU (system)	%iowait	%CPU (total)
1	dma	0.01	0.83	0.10	0.84
2	dma_interrupt	0.50	0.75	0.50	1.25
3	mmio	0.51	9.38	0.25	9.89
4	mmio_interrupt	1.77	3.79	2.79	5.56
5	mmap	17.92	1.18	0.03	19.1
6	mmap_interrupt	2.42	0.33	0.13	2.55