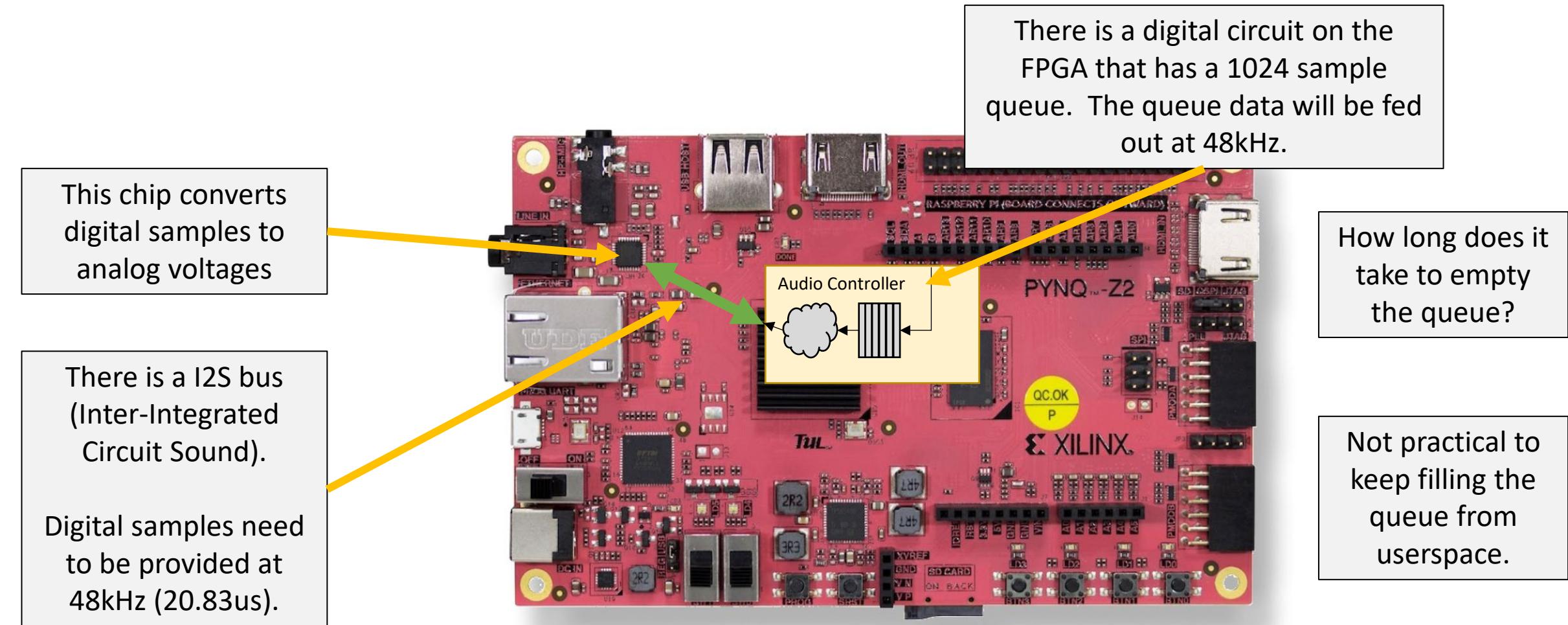


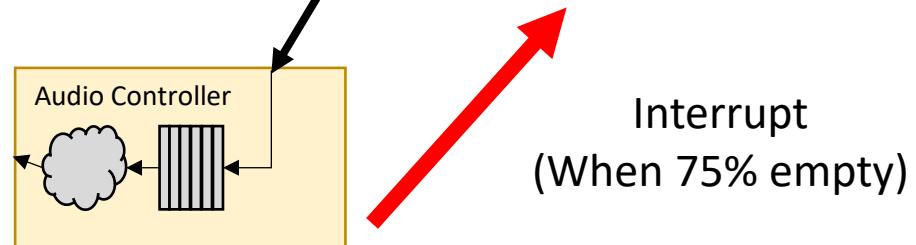
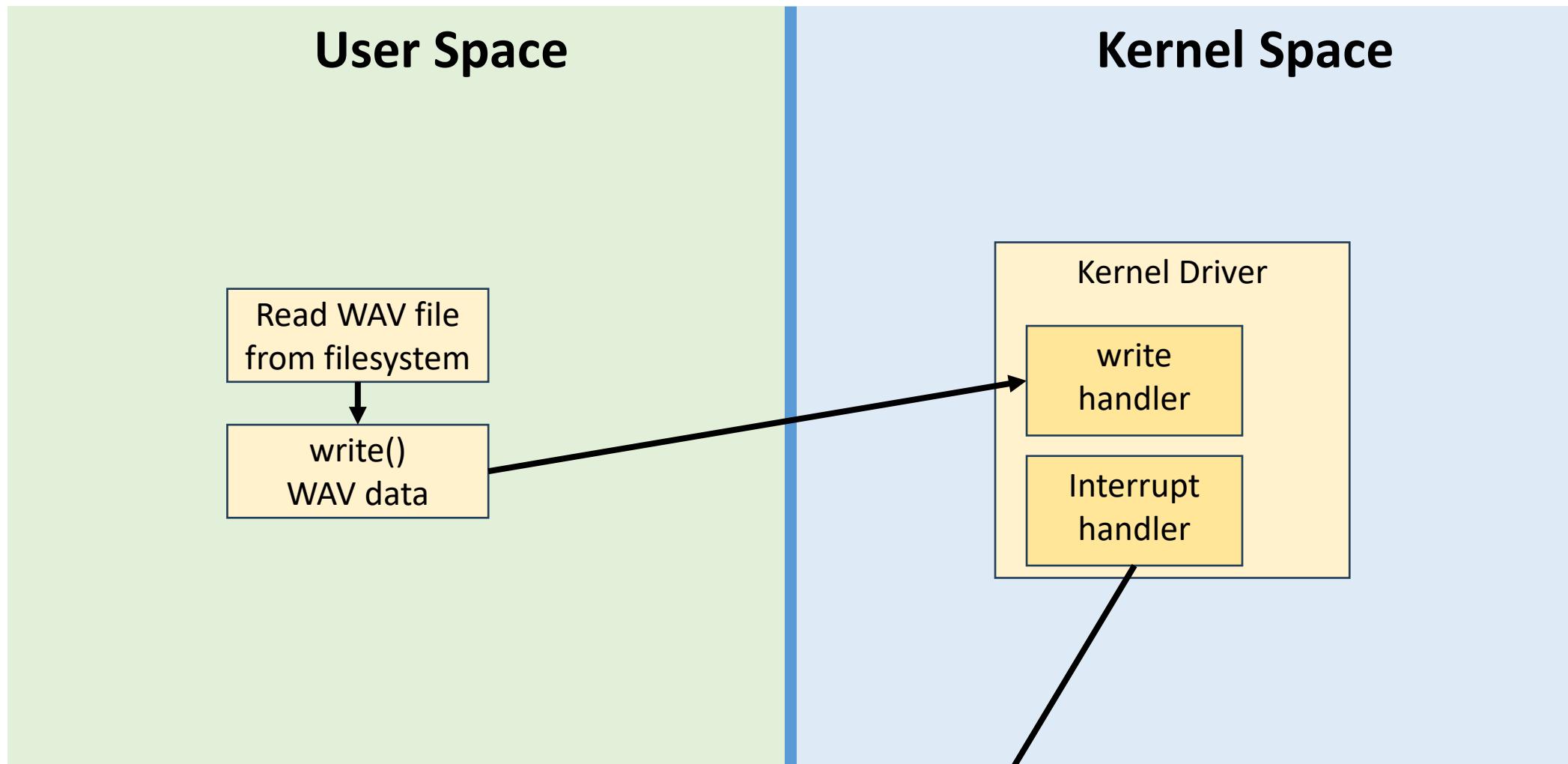
Linux Driver for Audio

Lab 5 Milestone 1 & 2

Lab 5

- Goal: Play sound effects in space invaders





What our driver needs to do:

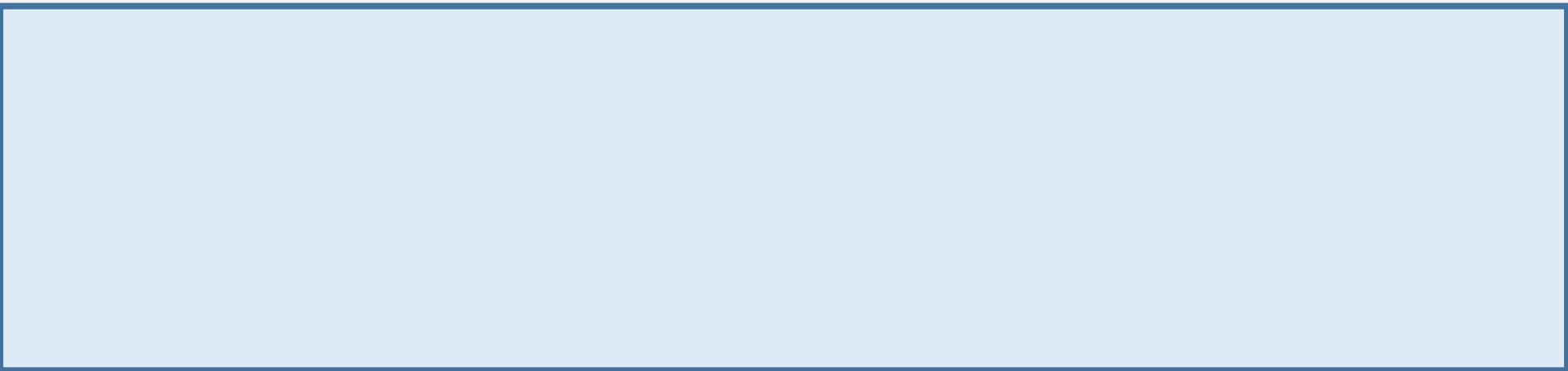
- Be notified of hardware in the system (Milestone 1)
- Allow user code to talk to the driver (Milestone 1)
- Talk to the hardware (Milestone 2)
- Handle interrupts from the hardware (Milestone 2)

Userspace

Application Code
(Space Invaders)

Kernelspace

Kernel Module



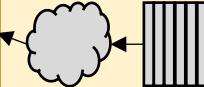
ARM CPU

Audio
CODEC

Audio Controller

Switches

Buttons



What our driver needs to do:

- Be notified of hardware in the system (Milestone 1)
- Allow user code to talk to it (Milestone 1)
- Talk to the hardware (Milestone 2)
- Handle interrupts from the hardware (Milestone 2)

Userspace

Application Code
(Space Invaders)

Kernelspace

Kernel Module

Device

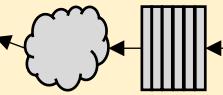
Device

Device

ARM CPU

Audio
CODEC

Audio Controller



irq

Switches

Buttons

Userspace

Application Code
(Space Invaders)

Kernelspace

Kernel Module

```
probe () {  
    ...  
    ...  
}
```

Device

Device

Device

...

Platform Driver (compatible = "byu,ecen427-audio_codec", .probe, .remove)

ARM CPU

Audio
CODEC

Audio Controller

Switches

Buttons

irq

```
platform_driver_register(struct platform_driver *)
```

What our driver needs to do:

- Be notified of hardware in the system (Milestone 1)
- Allow user code to talk to the driver (Milestone 1)
- Talk to the hardware (Milestone 2)
- Handle interrupts from the hardware (Milestone 2)

User Code Needs to Talk to Driver

End Goal: Create a device file (`/dev/xxx`) that we can `read()` and `write()` to. *(Recall how you used `/dev/uio`)*

The device file (`/dev/xxx`) is an interface to a **character device**.

Steps:

1. Create a character device
2. Create a device file

Userspace

Application Code
(Space Invaders)

Kernelspace

Kernel Module

```
int major_num;
```

```
probe () {  
    ...  
    ...  
}
```

Device

```
int minor_num;
```

Device

Device

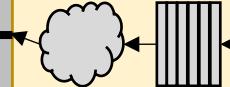
...

Platform Driver (compatible = "byu,ecen427-audio_codec", .probe, .remove)

ARM CPU

Audio
CODEC

Audio Controller



irq

Switches

Buttons

```
alloc_chrdev_region(dev_t * output, minor_start, count, MODULE_NAME)
```

Userspace

Application Code
(Space Invaders)

Kernelspace

Kernel Module

```
int major_num;  
struct file_operations fops;  
  
probe() { read() { write() {  
    ...  
    ...  
}}
```

Device

```
int minor_num;  
struct cdev cdev;
```

Device

Device

...

Device

Platform Driver (compatible = "byu,ecen427-audio_codec", .probe, .remove)

ARM CPU

Audio
CODEC

Audio Controller

Switches

Buttons

irq

```
cdev_init (struct cdev*, fops* {.read, .write})
```

Userspace

Application Code
(Space Invaders)

Kernelspace

Kernel Module

```
int major_num;
struct file_operations fops;

probe() { read() { write() {
```

...
...
}}

Character Device
(major, minor)

Char.
Device

Char.
Device

Device

```
int minor_num;
struct cdev cdev;
```

Device

Device

...

Platform Driver (compatible = "byu,ecen427-audio_codec", .probe, .remove)

ARM CPU

Audio
CODEC

Audio Controller

Switches

Buttons

irq

cdev_add (struct cdev*, dev_t, count)

User Code Needs to Talk to Driver

End Goal: Create a device file (`/dev/xxx`) that we can `read()` and `write()` to. *(Recall how you used `/dev/uio`)*

The device file (`/dev/xxx`) is an interface to a **character device**.

Steps:

1. Create a character device
2. Create a device file

Userspace

Application Code
(Space Invaders)

Kernelspace

Kernel Module

```
int major_num;
struct file_operations fops;
struct class * class
probe() { ... }
read() { ... }
write() { ... }
```

Character Device
(major, minor)

Char.
Device

Char.
Device

Device

```
int minor_num;
struct cdev cdev;
```

Device

Device

Platform Driver (compatible = "byu,ecen427-audio_codec", .probe, .remove)

ARM CPU

Audio
CODEC

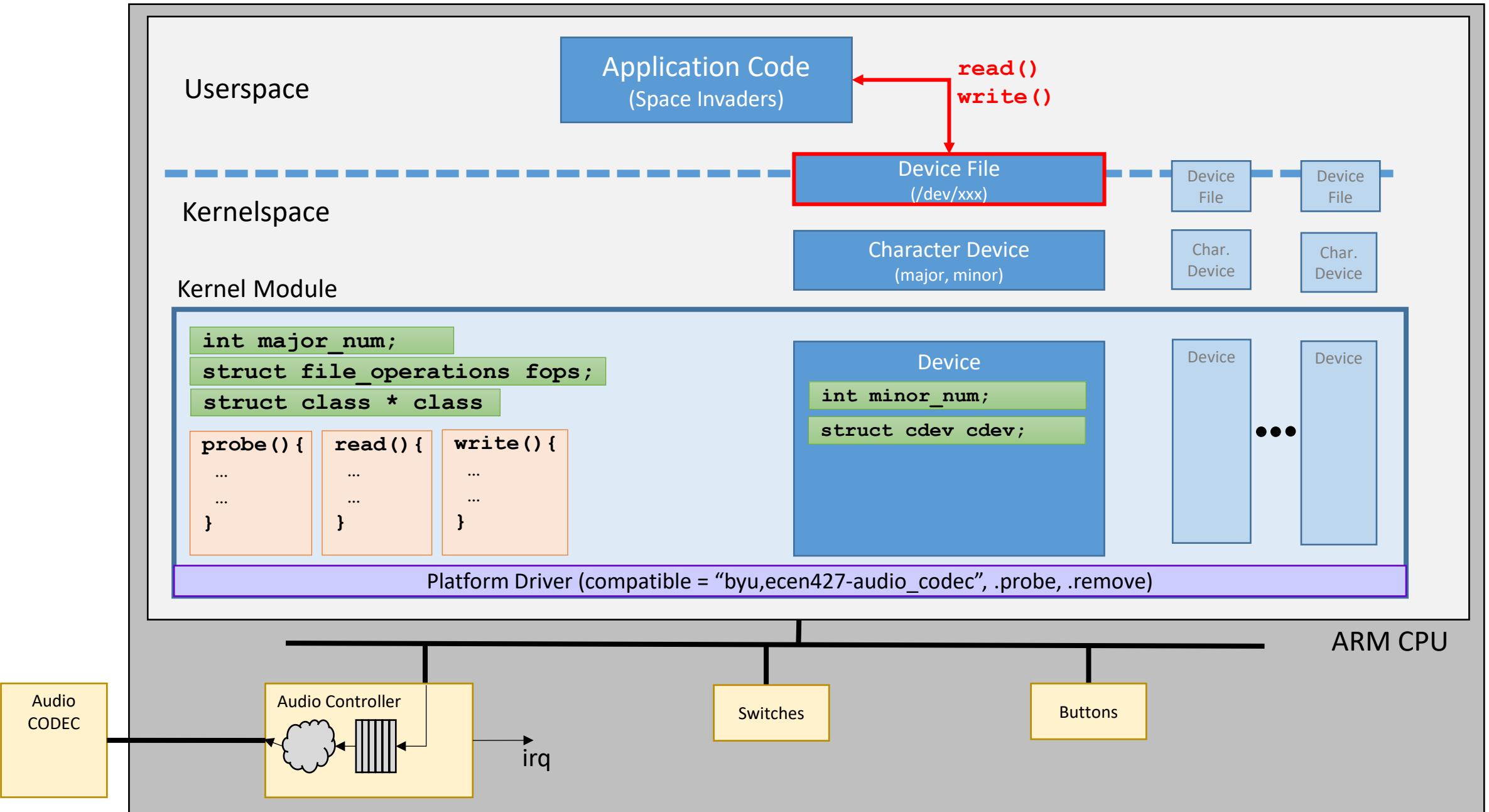
Audio Controller

Switches

Buttons

irq

```
class_create(owner = THIS_MODULE, "my class name")
```



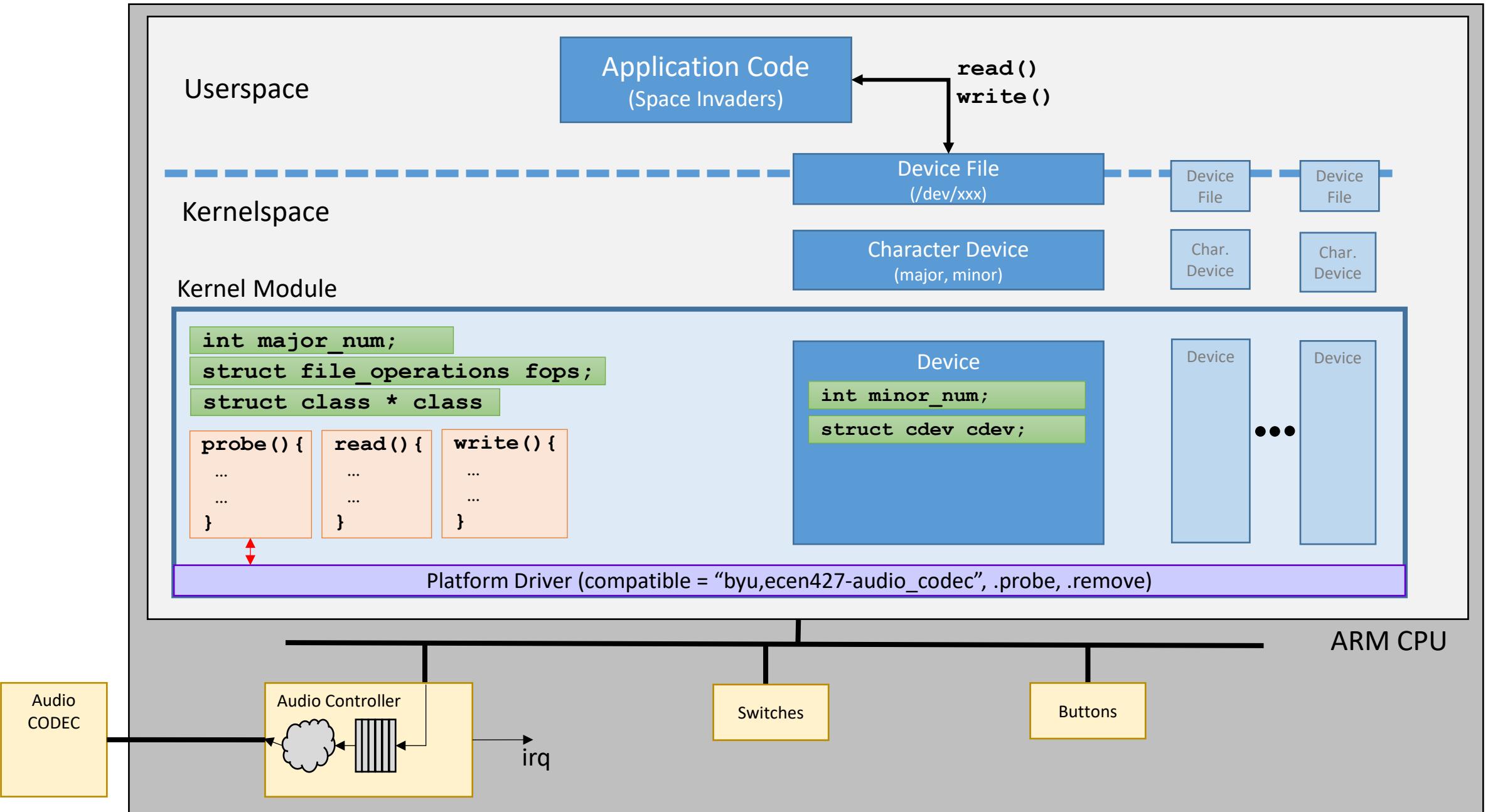
```
device_create (struct class*, parent = NULL, dev_t, "your device name")
```

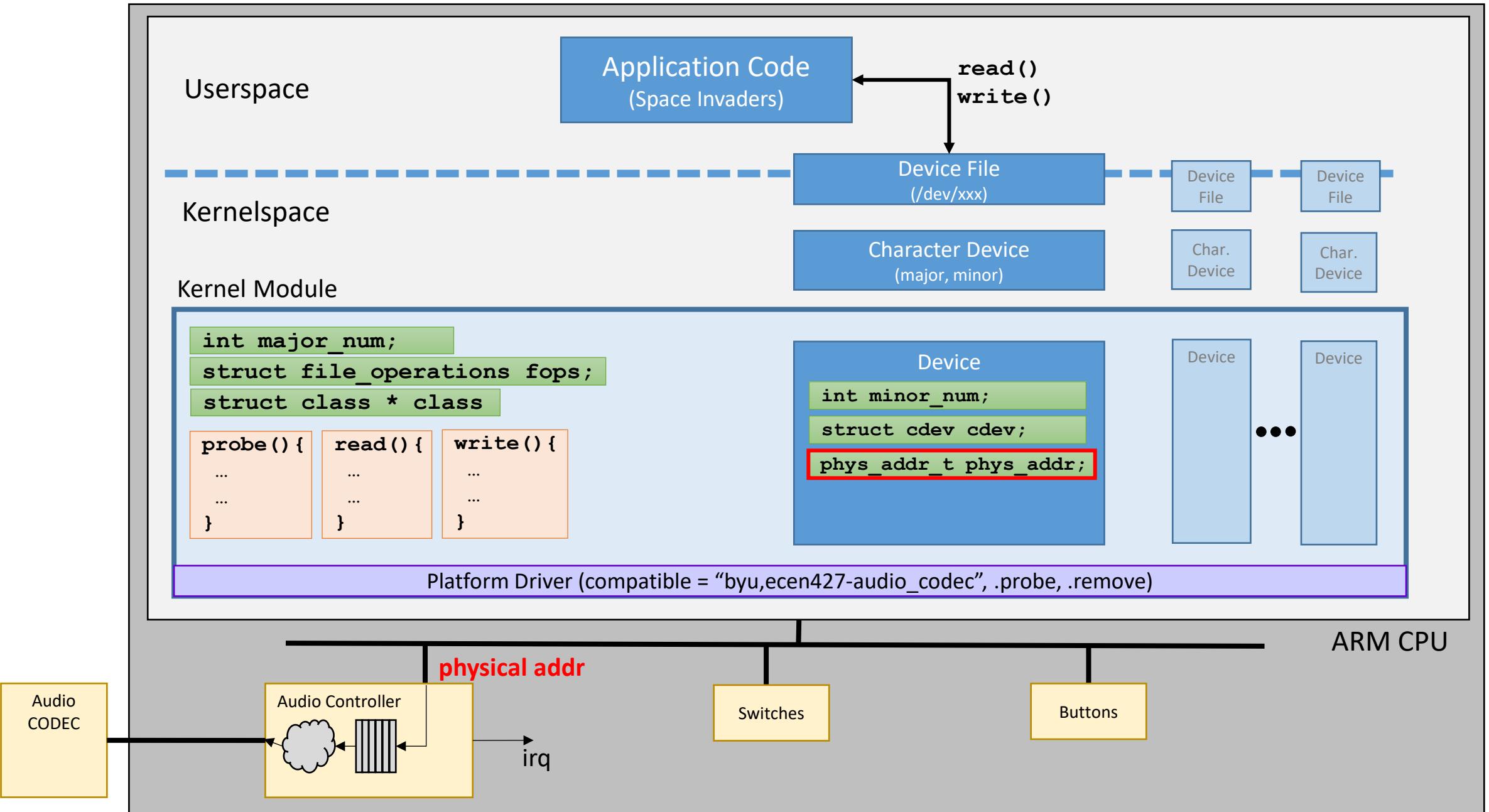
What our driver needs to do:

- Be notified of hardware in the system (Milestone 1)
- Allow user code to talk to it (Milestone 1)
- **Talk to the hardware (Milestone 2)**
- Handle interrupts from the hardware (Milestone 2)

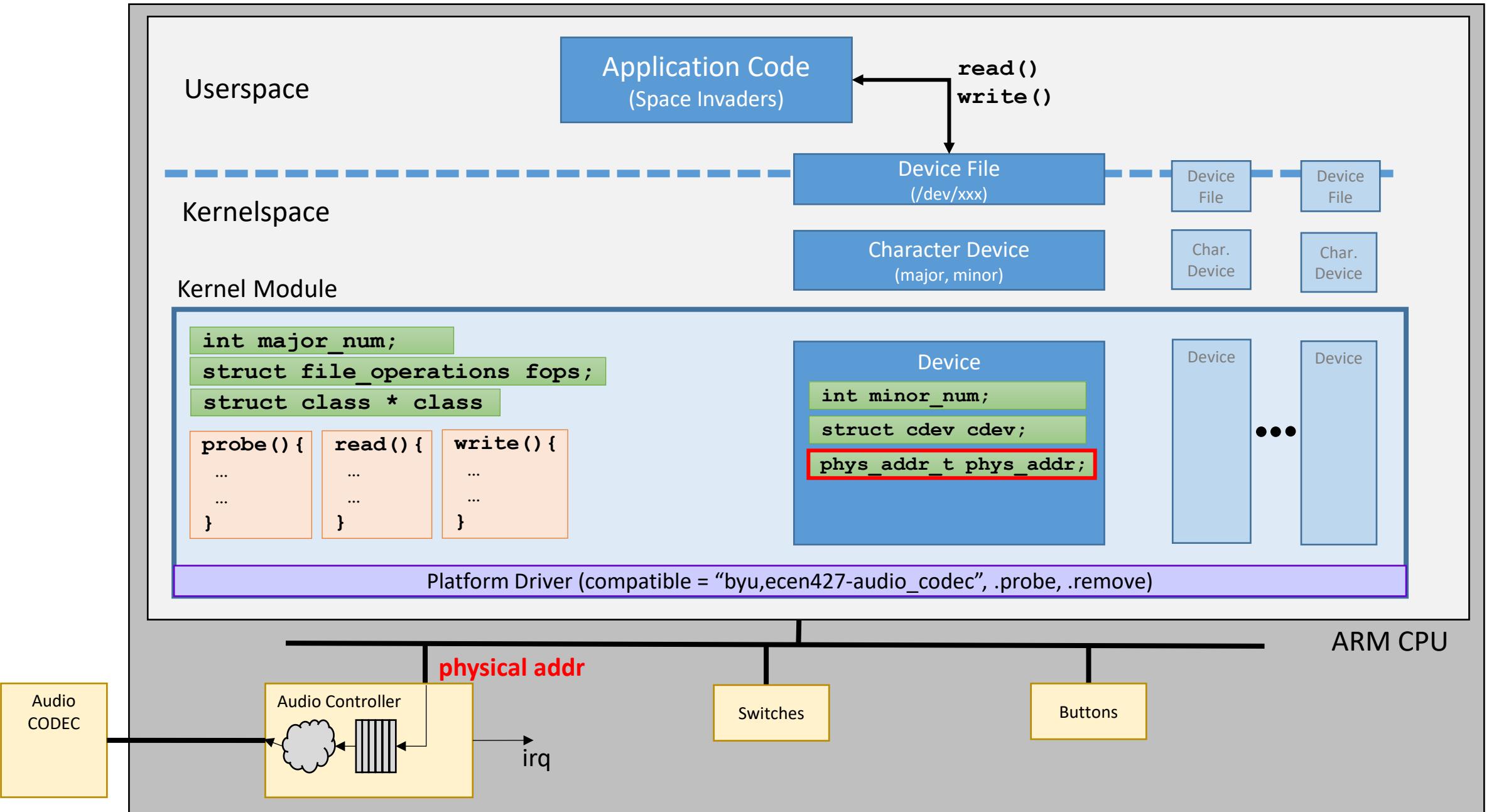
Driver needs to talk to the hardware

1. Need to figure out physical address
2. Need to reserve the physical address
3. Need to get a pointer (virtual address) to the physical address

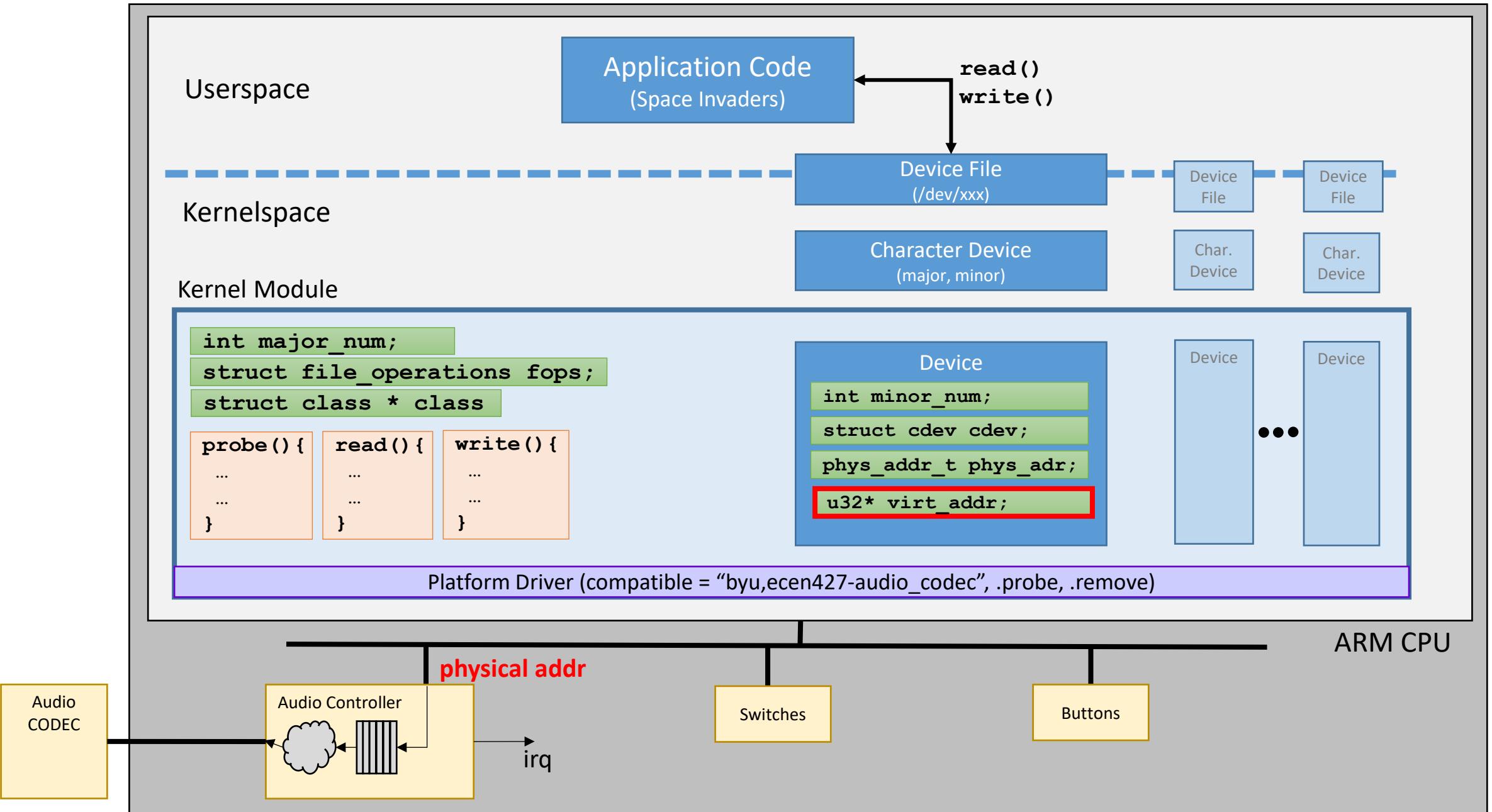




```
platform_get_resource(struct platform_device * dev, IORESOURCE_MEM, 0);
```



```
request_mem_region(phys_addr, size, MODULE_NAME);
```

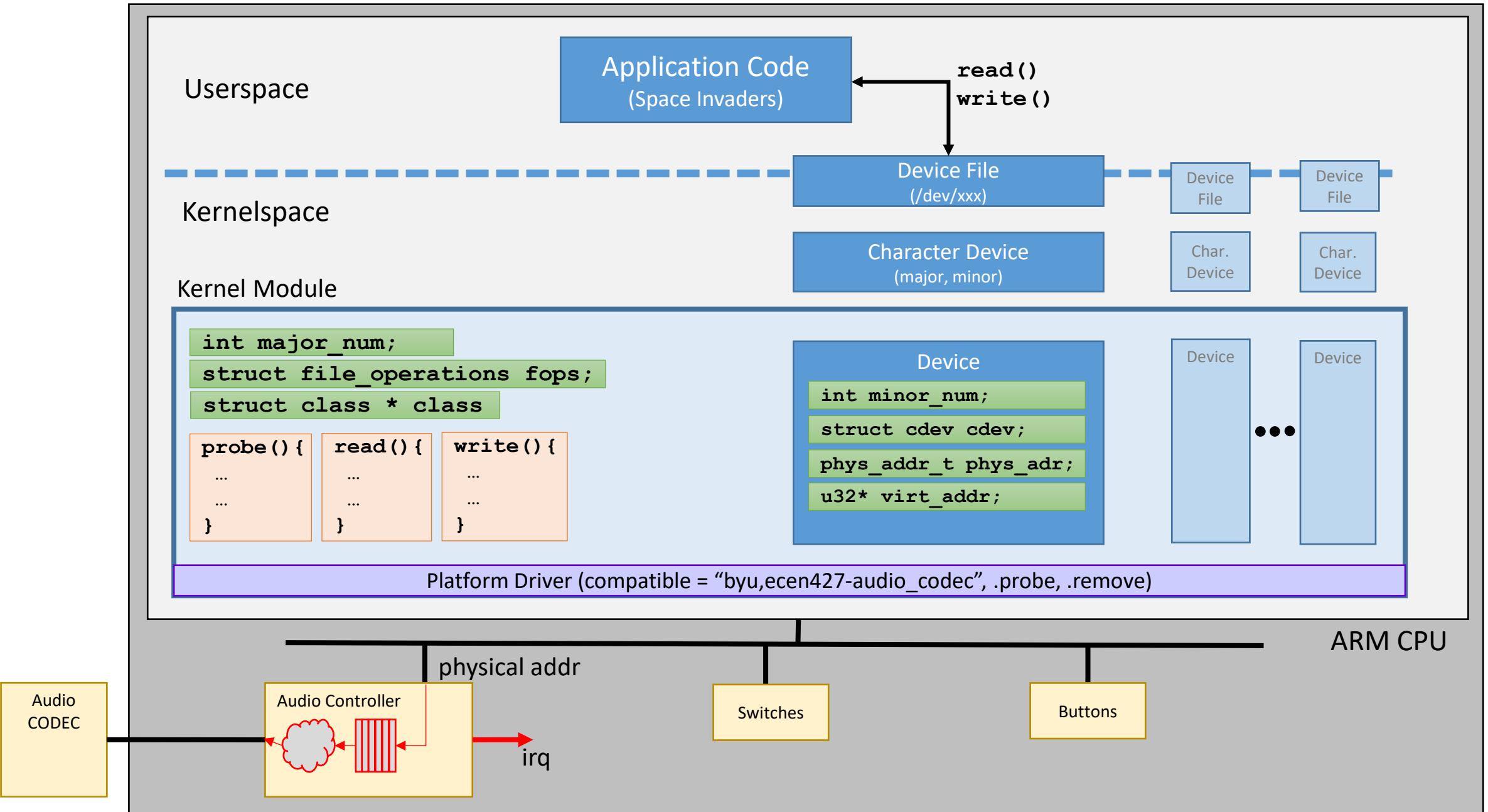


```
virt_addr = ioremap(phys_addr, size);
```

Driver needs to talk to the hardware

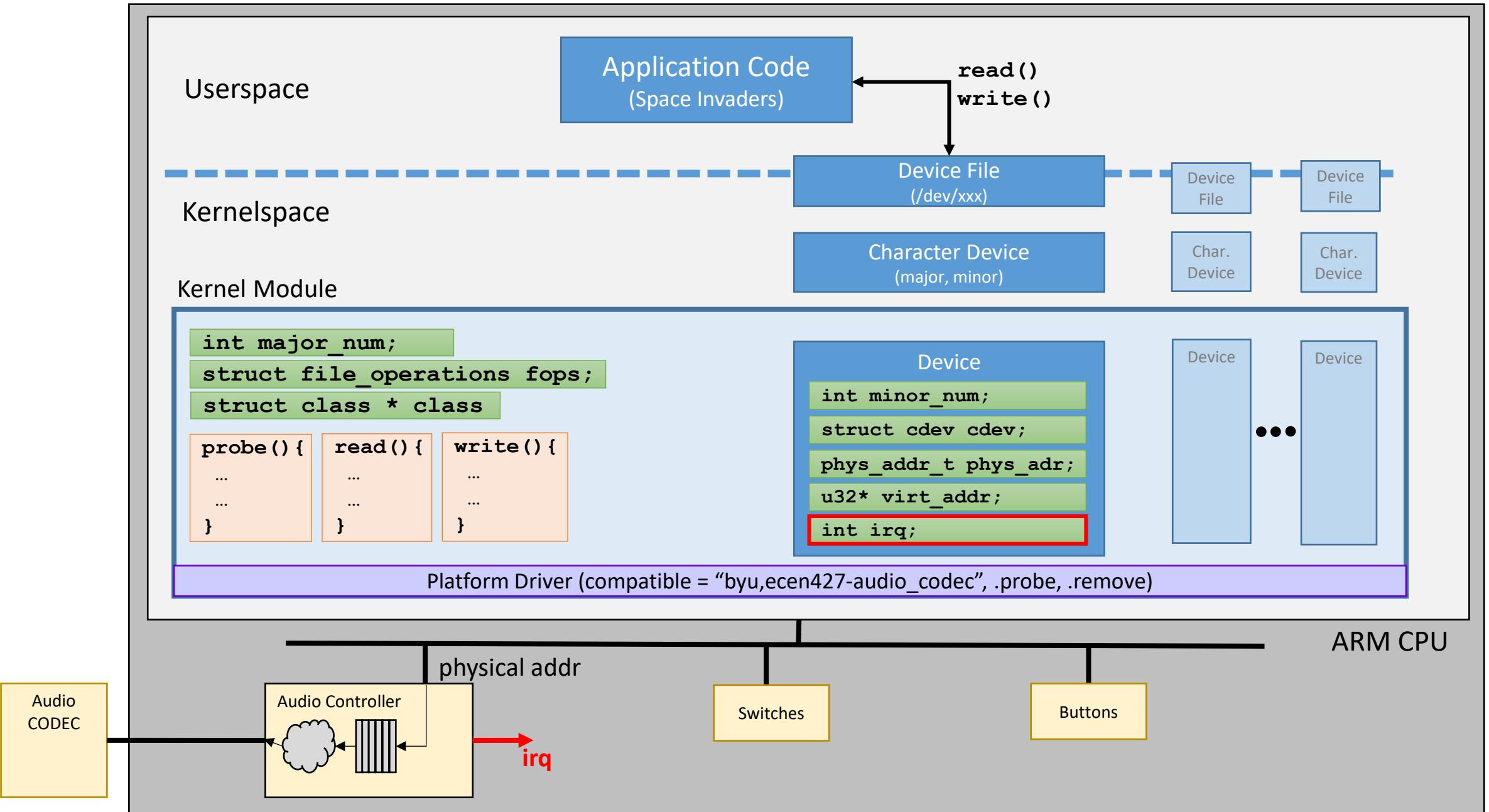
1. Need to figure out physical address
2. Need to reserve the physical address
3. Need to get a pointer (virtual address) to the physical address
4. Talk to the hardware with:
 - iowrite32 (value, virt_addr + offset)
 - ioread32(virt_addr + offset)

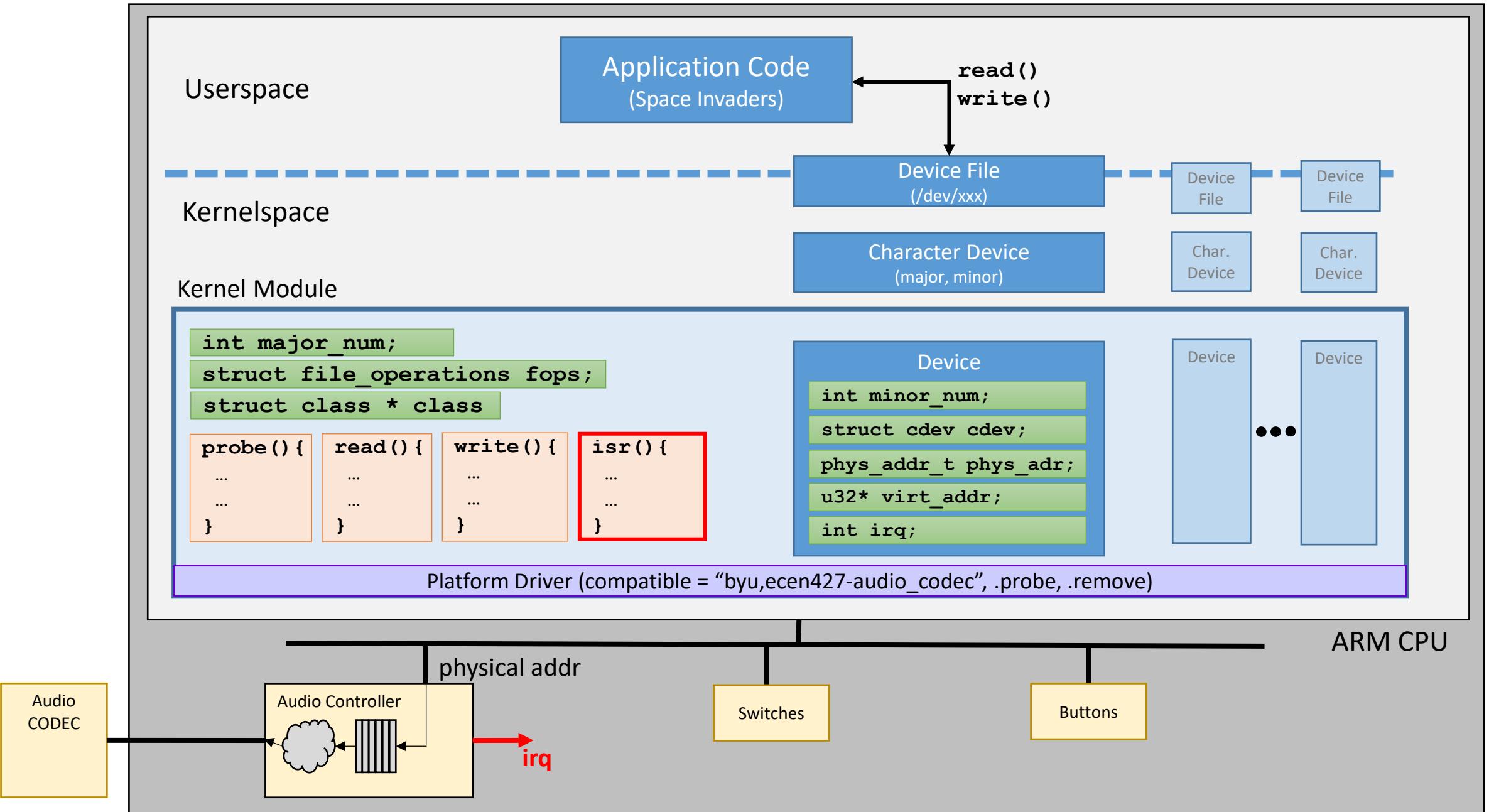
Driver Needs to Handle Interrupts



Driver Needs to Handle Interrupts

1. Get IRQ Number
2. Register Interrupt Handler with Linux

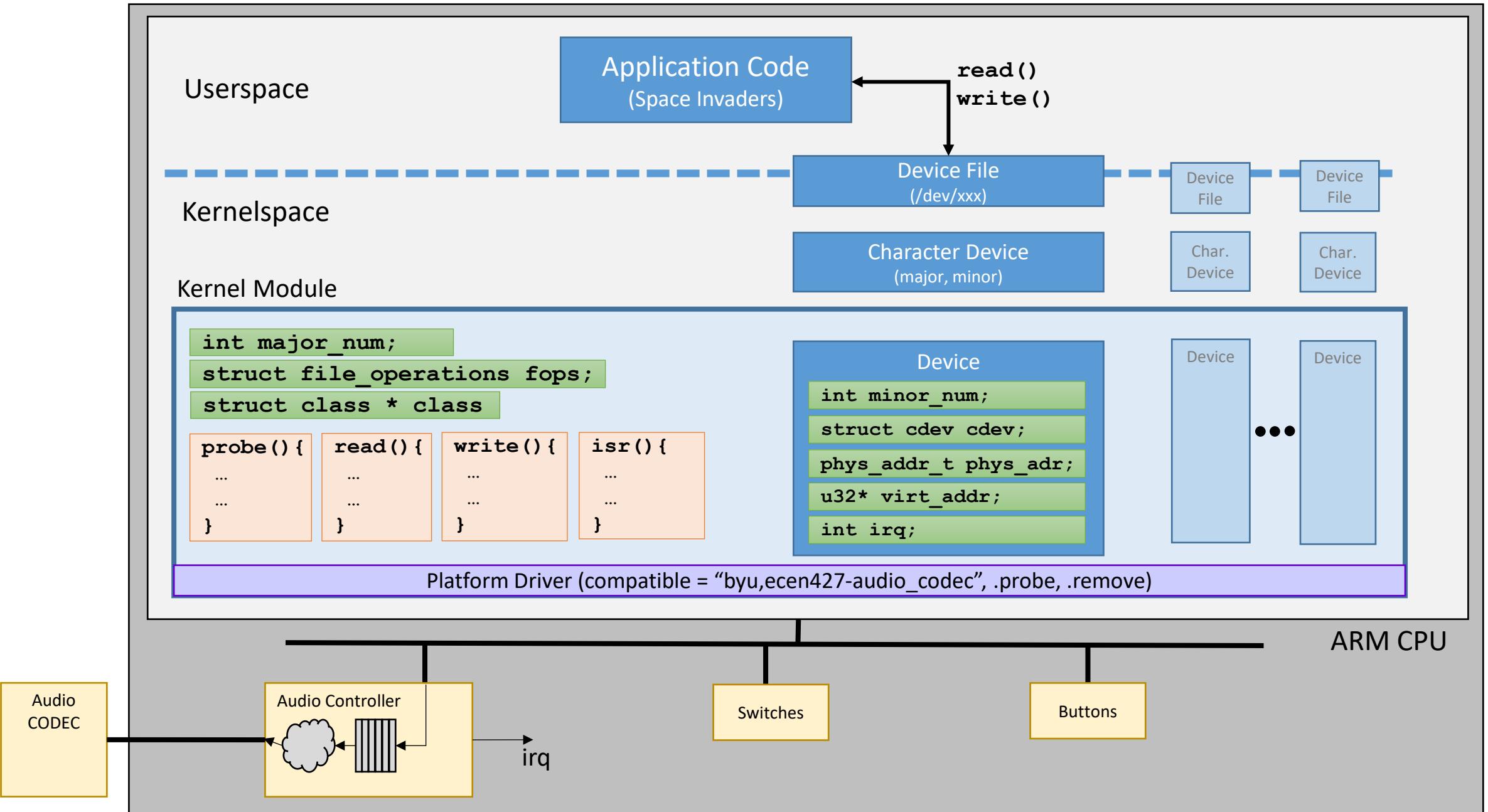




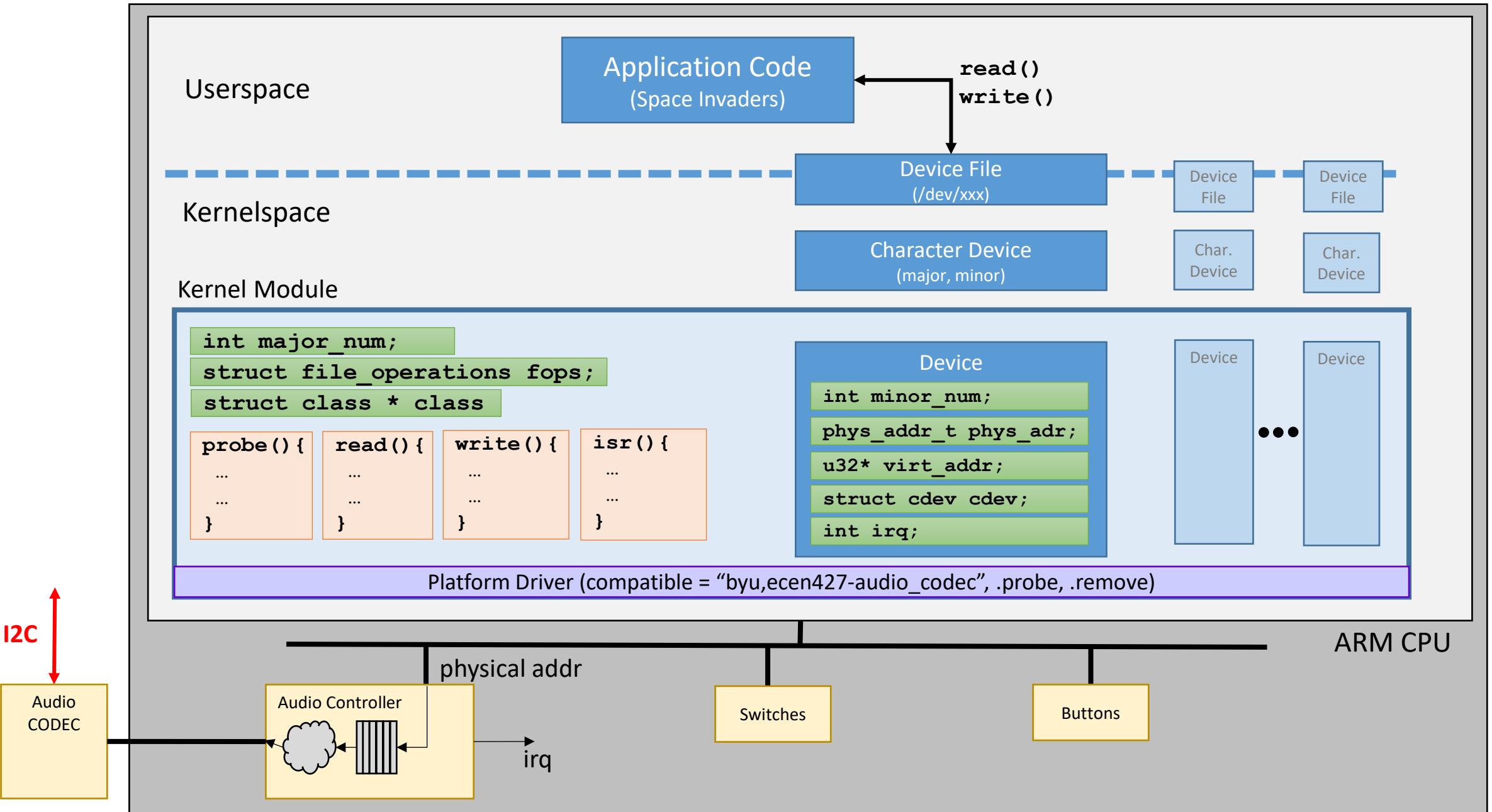
```
request_irq(irq, isr, IRQ_NO_FLAGS, MODULE_NAME, void*)
```

Driver Needs to Handle Interrupts

1. Get IRQ Number
2. Register Interrupt Handler with Linux



One last thing...



Before you actually send data to the CODEC chip, you need to configure it via I2C. I have provided you with a userspace library to do this. Run it before loading your driver.