Embedded Systems Programming

Work Queue and Input Processing in Linux (Module 16)

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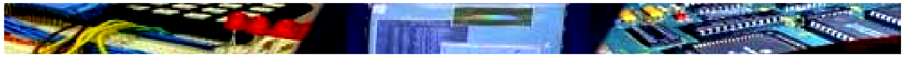


Example of Work Structure and Handler

```
#include <linux/kernel.h>
#include <linux/module.h>
#include <linux/workqueue.h>
MODULE_LICENSE("GPL");

static struct workqueue_struct *my_wq;                       // work queue
typedef struct {                                             // work
        struct work_struct  my_work;
        int x;
} my_work_t;

my_work_t  *work, *work2;

static void my_wq_function( struct work_struct *work)  // function to be call
{
        my_work_t  *my_work = (my_work_t *)work;
        printk( "my_work.x %d\n", my_work->x );
        kfree( (void *)work );
        return;
}
```

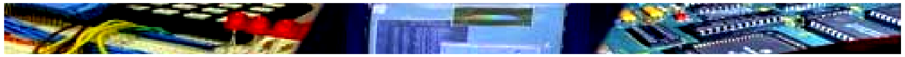
(http://www.ibm.com/developerworks/linux/library/l-tasklets/index.html)

Example of Work and WorkQueue Creation

```
int init_module( void )
{
    int ret;
    my_wq = create_workqueue("my_queue");        // create work queue
    if (my_wq) {
        work = (my_work_t *)kmalloc(sizeof(my_work_t), GFP_KERNEL);
        if (work) {                                      // Queue work (item 1)
            INIT_WORK( (struct work_struct *)work, my_wq_function );
            work->x = 1;
            ret = queue_work( my_wq, (struct work_struct *)work );
        }

        work2 = (my_work_t *)kmalloc(sizeof(my_work_t), GFP_KERNEL);
        if (work2) {                         // Queue work (item 2)
            INIT_WORK( (struct work_struct *)work2, my_wq_function );
            work2->x = 2;
            ret = queue_work( my_wq, (struct work_struct *)work2 );
        }
    }
    return 0;   }
```

(http://www.ibm.com/developerworks/linux/library/l-tasklets/index.html)

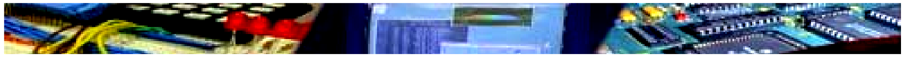


Linux Kernel Thread

- **A way to implement background tasks inside the kernel**

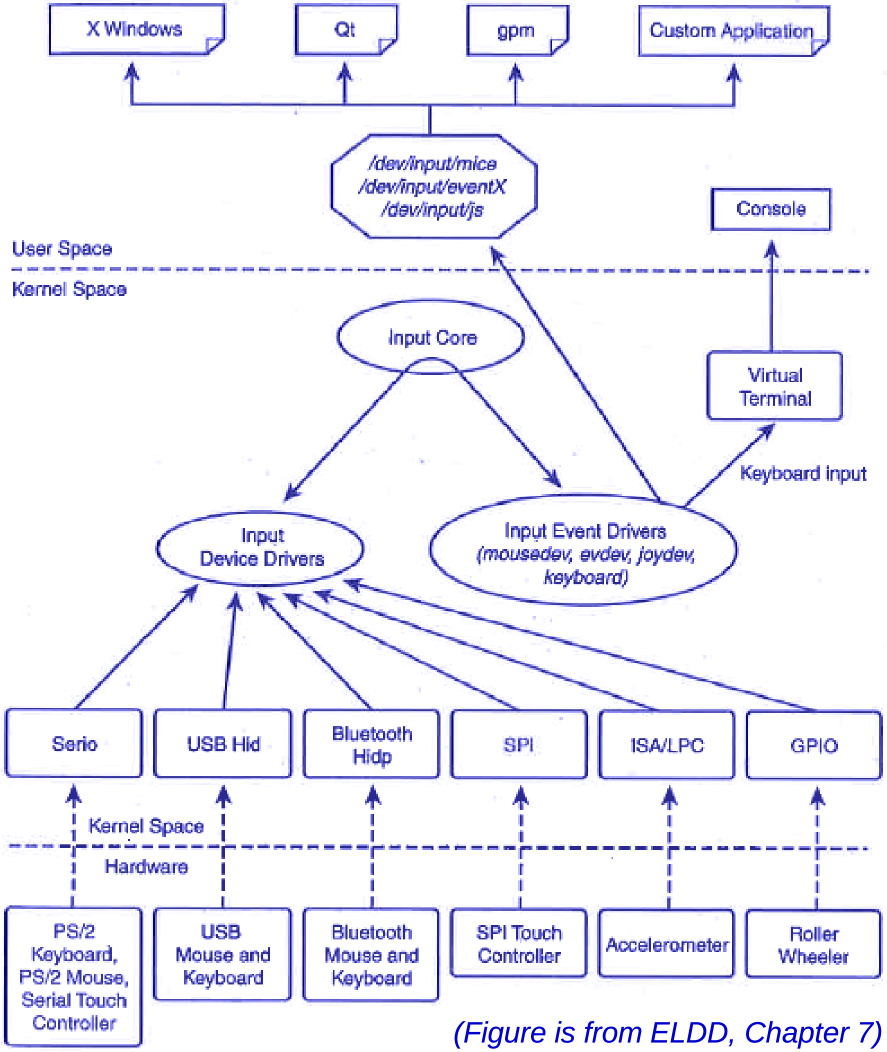
```
static struct task_struct *tsk;
static int thread_function(void *data) {
    int time_count = 0;
    do {
        printk(KERN_INFO "thread_function: %d times", ++time_count);
        msleep(1000);
     }while(!kthread_should_stop() && time_count<=30);
return time_count;
}

static int hello_init(void)  {
tsk = kthread_run(thread_function, NULL, "mythread%d", 1);
if (IS_ERR(tsk)) {  …. }
}
```

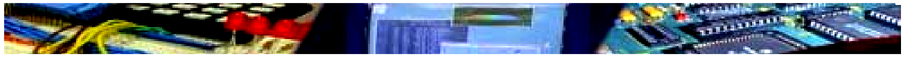


Linux Input Systems

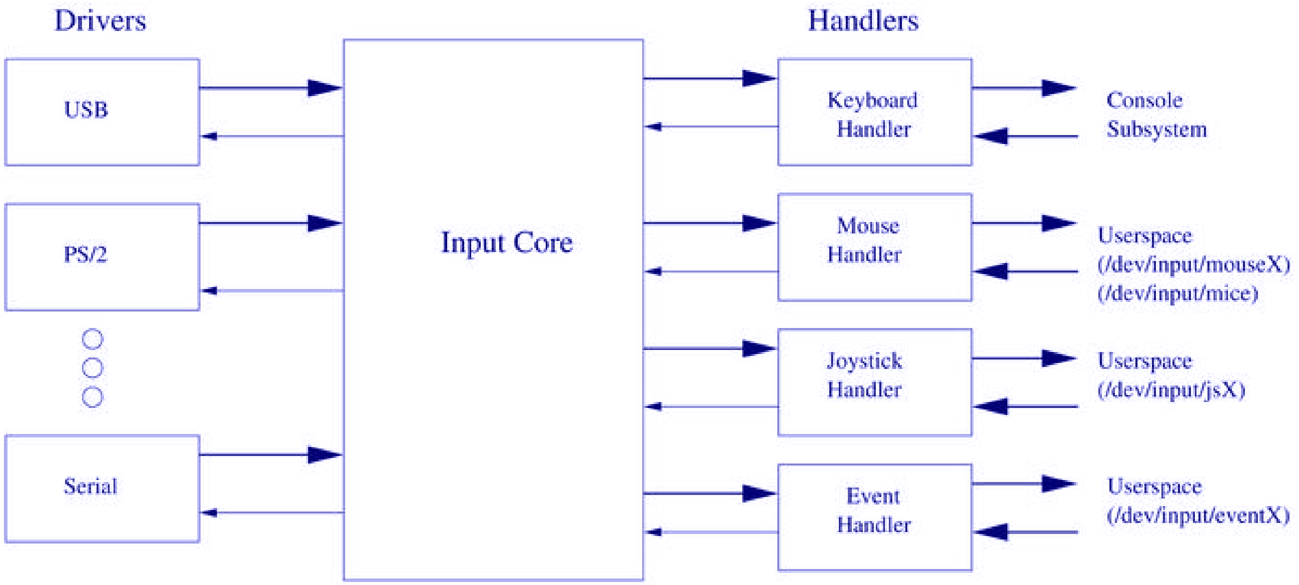
- ❑ **An option: each attached input device is handled by a driver with the details of input port and protocol the device used.**
- ❑ **The other one -- Layers**
  - adapter (controller) and port
  - device and driver
  - event interface



(Figure is from ELDD, Chapter 7)



Software Structure of Input Systems

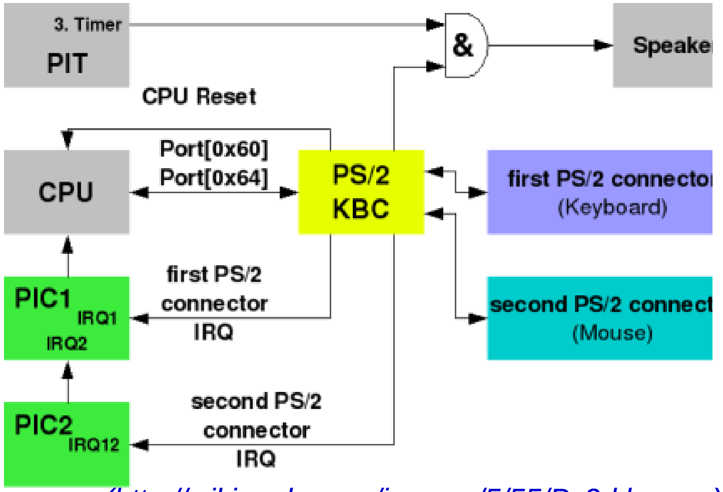


(http://www.linuxjournal.com/article/6396)

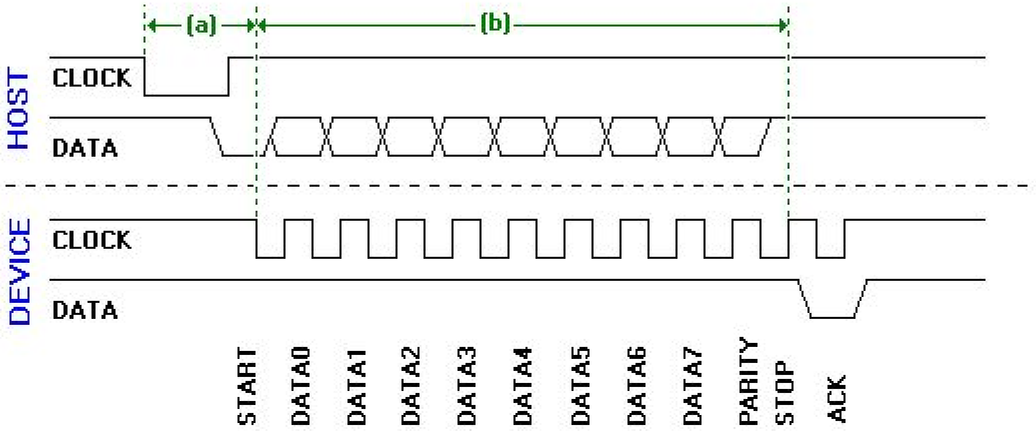
- **Device drivers, input core, and event handlers**
- **Example:**
  - i8042 is the driver for 8042 adapter
  - psmouse is the driver for ps2 mouse
  - mousedev is the event handler for all mice

Example: PS2 Mouse Driver

- **The adapter – 8042**
  - from PC-AT, now a part of LPC IO
  - PS2 signals: clock, data 5V, and GND.
    - CLOCK and DATA are of "open collector" type
  - bidirectional serial protocol (start, data, parity, stop)
    - PC has always a priority and can stop the transmission any time by setting CLOCK low



(http://wiki.osdev.org/images/5/55/Ps2-kbc.png)



(http://codelake9.files.wordpress.com/2012/09/3.jpg)

What is done in i8042.c

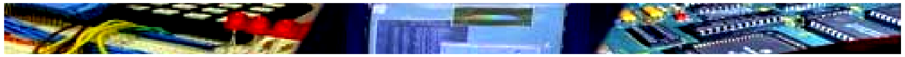
- The driver for the adapter (controller)
- When installed –
  - create a platform_device
  - initialize kbd and aux controllers
  - create serio ports with ids (*serio->id.type = SERIO_8042*;)
  - request_IRQ and add interrupt handler, and register ports

```
error = request_irq(I8042_KBD_IRQ, i8042_interrupt, IRQF_SHARED,
                    "i8042", i8042_platform_device);
```

```
if (likely(port->exists))
                    serio_interrupt(port->serio, data, dfl);
```

- Important fields in ***struct serio***

```
struct serio_device_id id;
struct serio_driver *drv;
struct device dev;
```



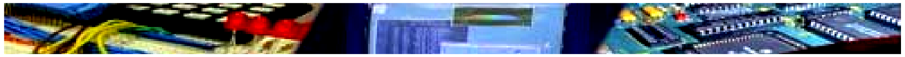
Request_threaded_irq

Threaded interrupt handlers

- isr acknowledges the interrupt to the hardware
- wake the kernel interrupt handler thread

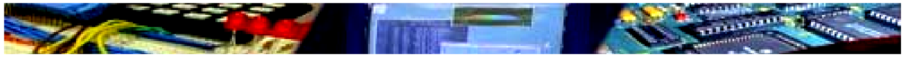
```
int request_threaded_irq(unsigned int irq, irq_handler_t handler,
                irq_handler_t thread_fn,
                unsigned long flags, const char *name, void *dev)
```

- *handler* is called in hard interrupt context and checks if the interrupt was from the device
  - if *thread_fn* is *NULL*, use the normal handler, no irq thread
- *handle_IRQ_event – calls handler (check or normal)*



What is done in psmouse-base.c

- **The driver to handle ps2 mouse protocol**
- **When installed,**
  - probe serio bus, connect to serio device via the matching serio_id and *create a “psmouse” device*
- **psmouse registers itself as an input device to input core**
  - report events: EV_KEY and EV_REL
  - eventually, *input_pass_event* to handlers
- **When psmouse_interrupt is called**
  - received mouse data and process the protocol
  - *psmouse_process_byte()* analyzes the PS/2 data stream and reports relevant events to the input module once full packet has arrived.
- **What else –**
  - mouse type and protocol – command and response with adapter, mouse state, and data decoding.



Event Handlers

- ❑ **evdev:**
  - ❖ a generic input event interface to pass the events generated in the kernel straight to the program, with timestamps.
  - ❖ a char device to user space
    - ➢ when open, an evdev client is created with a buffer for events and is attached to file struct.
    - ➢ when read, fetch the events in the buffer and return to the user call.
  - ❖ register as a handler of an input device
    - ➢ when connected, evdev is created
    - ➢ handle is added to the input device
  - ❖ input device passes events to handler's clients via
    - ➢ input core's *input_pass_event*
    - ➢ handler's *evdev_pass_event*

```
struct input_event {
        struct timeval time;
        __u16 type;
        __u16 code;
        __s32 value;
 };
```