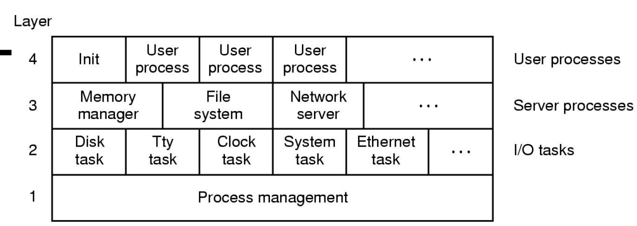
CSCE 351
Operating System Kernels

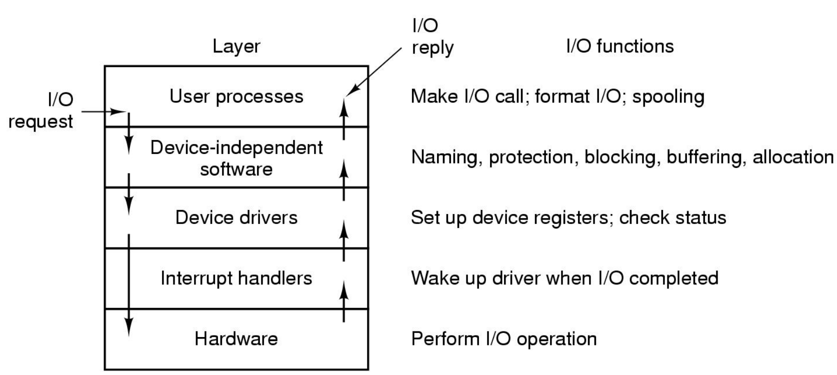
Overview of MINIX I/O Software

Steve Goddard
goddard@cse.unl.edu

http://www.cse.unl.edu/~goddard/Courses/CSCE351

MINIX I/O and Layered Structure





MINIX Interrupt Handlers

- Most interrupt handlers generate and send *wake-up* messages for blocked device tasks, as described in Ch 2
- For Disk devices, the handler may be as simple as:

```
w_status = in_byte(w_wn->base+REG_STATUS);
interrupt(WINCHESTER);
return 1;
```

- However, not all work this way due to the message passing overhead of this methodology.

Clock Handlers

- Clock Handler does intermediate work to reduce message passing overhead
  - » Accumulates ticks in **`pending_ticks`**
  - » Sends message to clock task when
    - An alarm expires, or
    - Scheduling change required (quantum expires)
- If the handler doesn't not notify the clock task of every clock tick, does that mean the clock is not accurate?

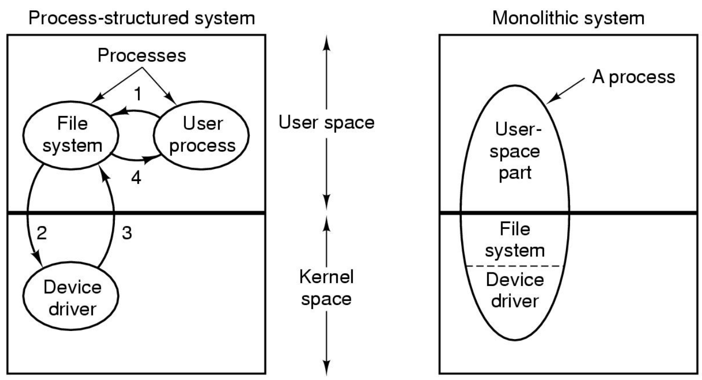
Keyboard Handler and other Terminal Device Interrupt Handlers

- Sends no messages!
- Reads data from keyboard and filters events
  - » How?
  - » What is an event?
- Adds significant events/codes to a buffer and updates **`tty_timeout`** (i.e., clears it)
- Clock handler sends message to the terminal task when **`tty_timeout`** expires
- TTY task processes the queue of keyboard events and all other terminal device queues as well (e.g., RS-232)

Device Drivers in MINIX

- Separate I/O task (device driver) for each class of I/O devices
- Communicate via the file system
- Simple drivers are in their own file
- More complex drivers are subdivided into device dependent (e.g., RAM Disk, hard disk, floppy disk, and terminal) code and device independent/common code (driver.c or tty.c)
- Still separate task for each type of device
  - » Why?
- Device drivers are linked into the kernel
  - » Why?

Process Structured vs. Monolithic Structured



1–4 are request and reply messages between three independent processes.

(a)

The user-space part calls the kernel-space part by trapping. The file system calls the device driver as a procedure. The entire operating system is part of each process

(b)

Generic Message Formats

Requests		
Field	**Type**	**Meaning**
m.m_type	int	Operation requested
m.DEVICE	int	Minor device to use
m.PROC_NR	int	Process requesting the I/O
m. COUNT	int	Byte count or ioctl code
m. POSITION	long	Position on device
m.DEVICE	int	Minor device to use

Replies		
Field	**Type**	**Meaning**
m.m_type	int	Always TASK_REPLY
m.REP_PROC_NR	int	Same as PROC_NR in request
m.REP_STATUS	int	Bytes transferred or error number

Generic Device Driver Structure

```
message mess;        /* message buffer */
void io_task() {
  initialize();      /* only done once */
  while(TRUE){
      receive(ANY, &mess); /* wait for a request for work */
      caller = mess.source;      /* process sending msg */
      switch(mess.type){
             case READ:   rcode = dev_read(&mess);break;
             case WRITE:  rcode = dev_write(&mess);break;
  /* Other cases go here, e.g., OPEN, CLOSE, IOTCTL */
             default:     rcode = ERROR;
      }
      mess.type = TASK_REPLY;
      mess.status = rcode;       /* result code */
      send(caller, &mess);       /* send reply to caller */
  }
}
```


Block Devices in MINIX

- MINIX always has at least three block device tasks compiled into the kernel:
  - » RAM disk driver
  - » Floppy disk driver
  - » Hard disk driver(s)
- Each block device driver does device specific initialization and then calls a shared I/O function that implements the main loop
  - » A data structure that points to the device specific routines to handle reads, writes, etc. is passed as an input parameter

MINIX Main I/O Loop
Block Device Shared Function

```
message mess;       /* message buffer */
void shared_io_task(struct driver_table *entry_points) {
   /* initialization is done before calling this routine */
   while(TRUE){
     receive(ANY, &mess); /* wait for a request for work */
     caller = mess.source; /* process sending msg */
     switch(mess.type){
       case READ:  rcode =(*entry_points->dev_read)(&mess);break;
       case WRITE: rcode=(*entry_points->dev_write)(&mess);break;
   /* Other cases go here, e.g., OPEN, CLOSE, IOTCTL */
       default:    rcode = ERROR;
     }
     mess.type = TASK_REPLY;
     mess.status = rcode;         /* result code */
     send(caller, &mess);         /* send reply to caller */
  }
}
```


Six Operations Supported by MINIX Block Device Drivers

1. OPEN
2. CLOSE
3. READ
4. WRITE
5. IOCTL
6. SCATTERED_IO

Common Block Device SW

- The driver structure that contains the pointers to device specific routines is defined in **`driver.h`**
- The main loop (shared I/O function) is defined in **`driver.c`**
  - » It does not return to the caller
- Device specific code is in separate files
  - » **`at_wini.c`**
  - » **`floppy.c`**
  - » **`memory.c`**

Driver Library

- "Files **`drvlib.h`** and **`drvlib.c`** contain system-dependent code that supports disk partions on IBM PC compatible computers."
- Reasons to partition a disk:
  - » Large disks are cheaper/byte than small disks
    - ❖ Use one disk for multiple OS rather than use two disks
  - » Put different file system types (for different OS) on one disk
  - » OS disk size limits, e.g., 1-GB file system limit
  - » Convenient to put a portion of a file system in its own partition