Lecture 9

I/O Device Management

- How are I/O devices connected to a computer ?
- How does the system accommodate devices of different characteristics, namely speed ?
- What techniques are used for the management of I/O devices ?

I/O subsystem

- A device stores data or is the one with which we communicate.
- It is controlled by a device controller that can be very simple, allowing to control basic operations, or complex that allows to program sequences of operations; sometimes, a controller is called channel (IBM), or IO Processors (IOP).
- The trend is to develop standardized controller/device interfaces, such as Universal Serial Bus (USB), or the Small Computer System Interface (SCSI).
- The device driver is the software that runs the controller. A part of it is the interrupt handler that manages events generated by the controller.

I/O device hardware features

- Heterogeneous in terms of performance, especially speed.
- Different in terms of reliability, and the level of detail of the control.
- Functionally:
  - Interrupt/poll in terms of service they receive;
  - DMA to free CPU;
  - Controller registers memory-mapped or addressed within the I/O space;
  - Operations can be blocking or non-blocking.

The device driver work

Example:

- Process A starts a disk read operation;
- The device driver translates the params into controller params and writes them in regs
- The driver initiates the read.
- Process A is replaced by process B;
- B requests a disk write on the same disk;
- The driver queues B's request
- The controller finished the read and issues an interrupt;

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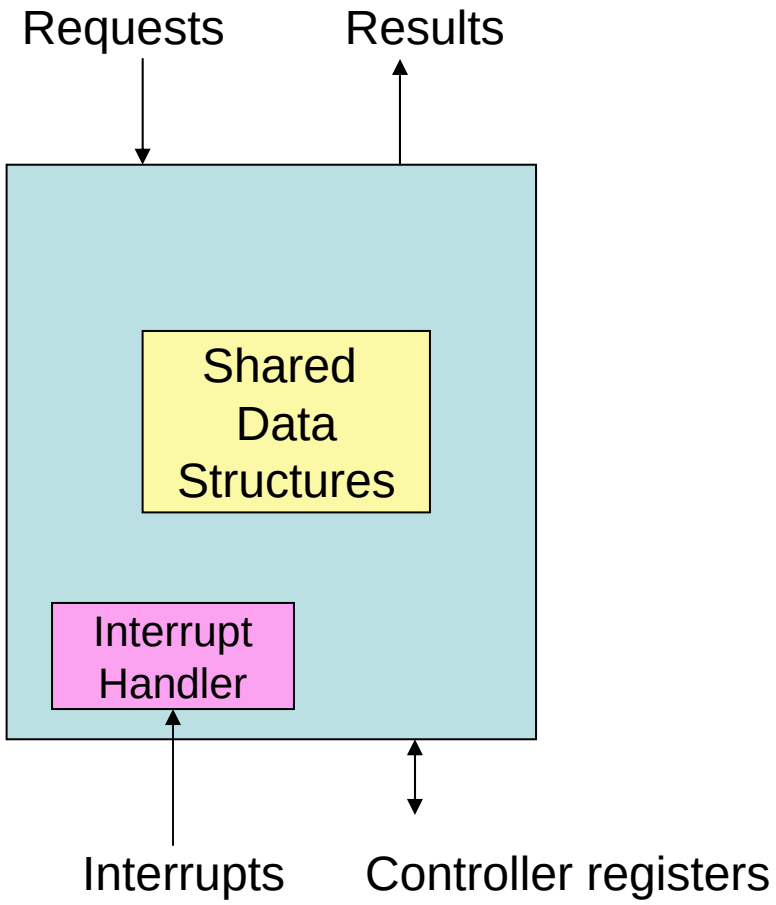

Device driver structure

- There are two cooperating control flows that share a data structure:
  - one flow of control that is executed on behalf of a user process requesting an I/O service;
  - a second flow of control executed as a response to interrupts.
  - Because the first flow can be interrupted, the two flows must coordinate their access to the request queue that they share.
  - Similarly, they should not try to command the controller in the same time.
- The driver can be divided in two halves:
  - The upper deals with user requests;
  - The lower deals with the controller.
  - The two threads of control use mutual exclusion techniques in order to prevent corruption of the shared queue.

Device management techniques

- Buffers as interfaces between the producers and consumers of data when their rates are different.
- In the case of device drivers, buffers store requests and data.
- Interleaving the sectors on a track in order to give the interrupt handler time to process the next request before the data is under the head.
- RAID (redundant array of inexpensive disks) is a technique for using multiple disks as if they were a single disk. To the OS, the whole RAID array looks like a single disk – the concept is implemented by the controller.
- Water marks are used with buffers:
  - the mark close to the full end (**high water mark**) signals when the buffer is about to become full (a message is sent to the producer);
  - The mark close to the empty end (**low water mark**) signals when the buffer is about to become empty.

The exact values of the two marks are not critical. However, if the high water mark is too high, the producer might send enough items before processing the stop message.