I/O Devices

How to Integrate I/O into Systems?

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I/O Devices

Computer are not much use without Input and Output

I/O is tremendously slower that the CPU and our goal is to keep the CPU busy

We have seen multiprogramming as an example of how to achieve this

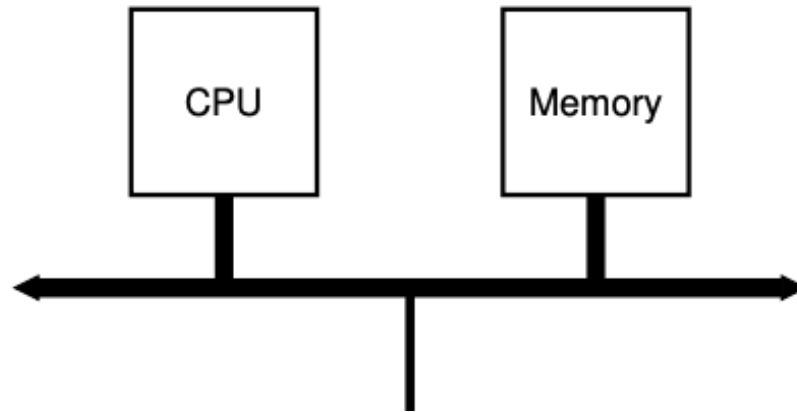How should computers and OSes be organized to perform I/O efficiently?
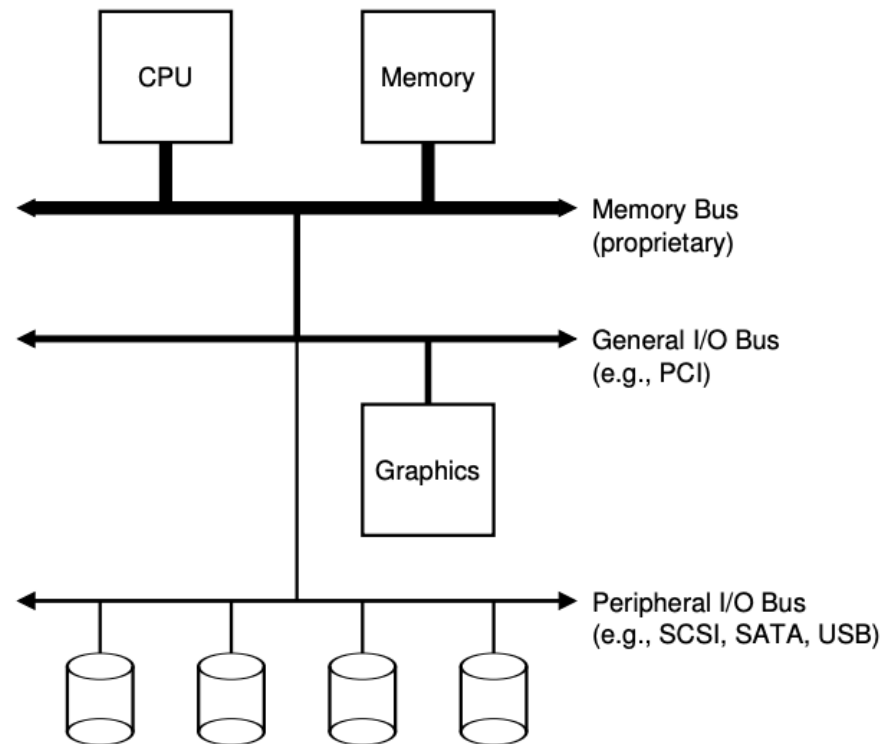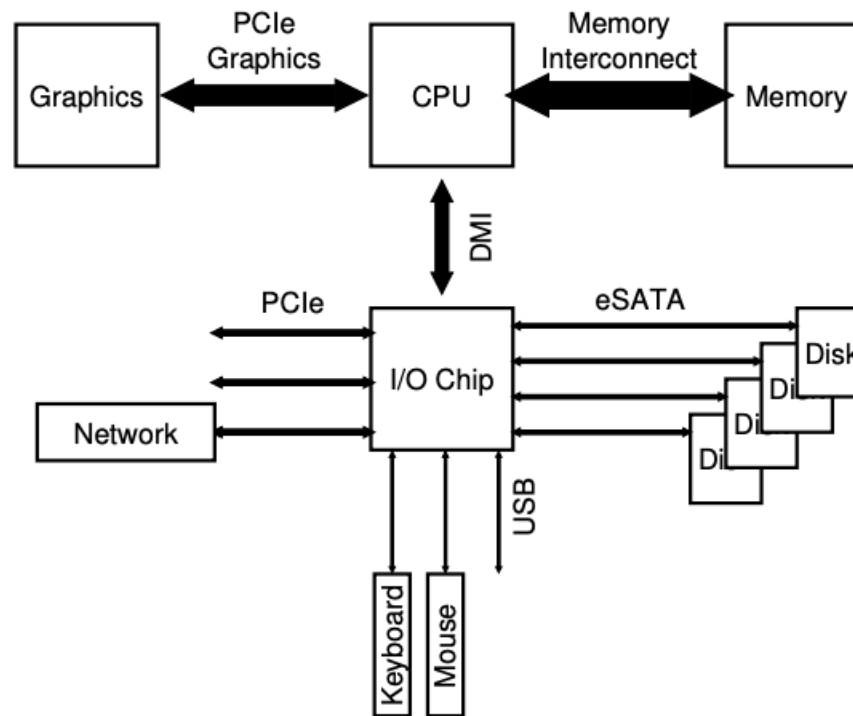

Douglas Engelbert. [source]

Mother of All Demos

https://www.youtube.com/watch?v=yJDv-zdhzMY

Main System Bus

Bus Hierarchy

Modern System Architecture

Hardware Device

Peripheral Bus

Device controller registers are mapped to memory addresses

Device Controller Interface

Registers	Status	Command	Data

Micro-controller (CPU)
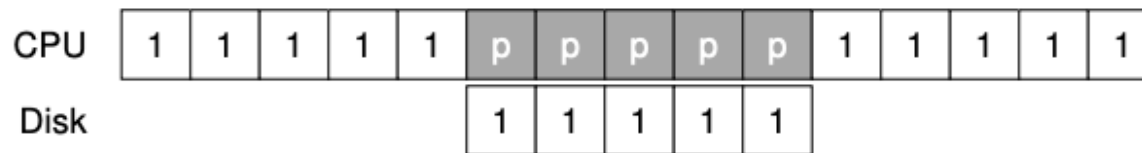Memory (DRAM or SRAM or both)
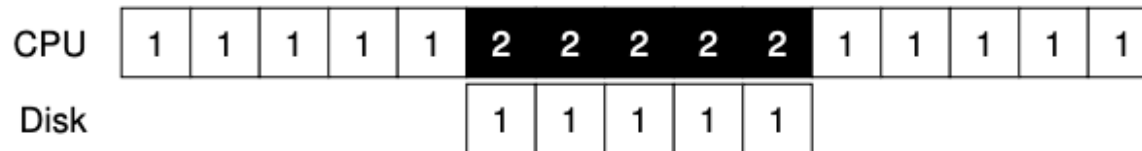Other Hardware-specific Chips

Device Internals
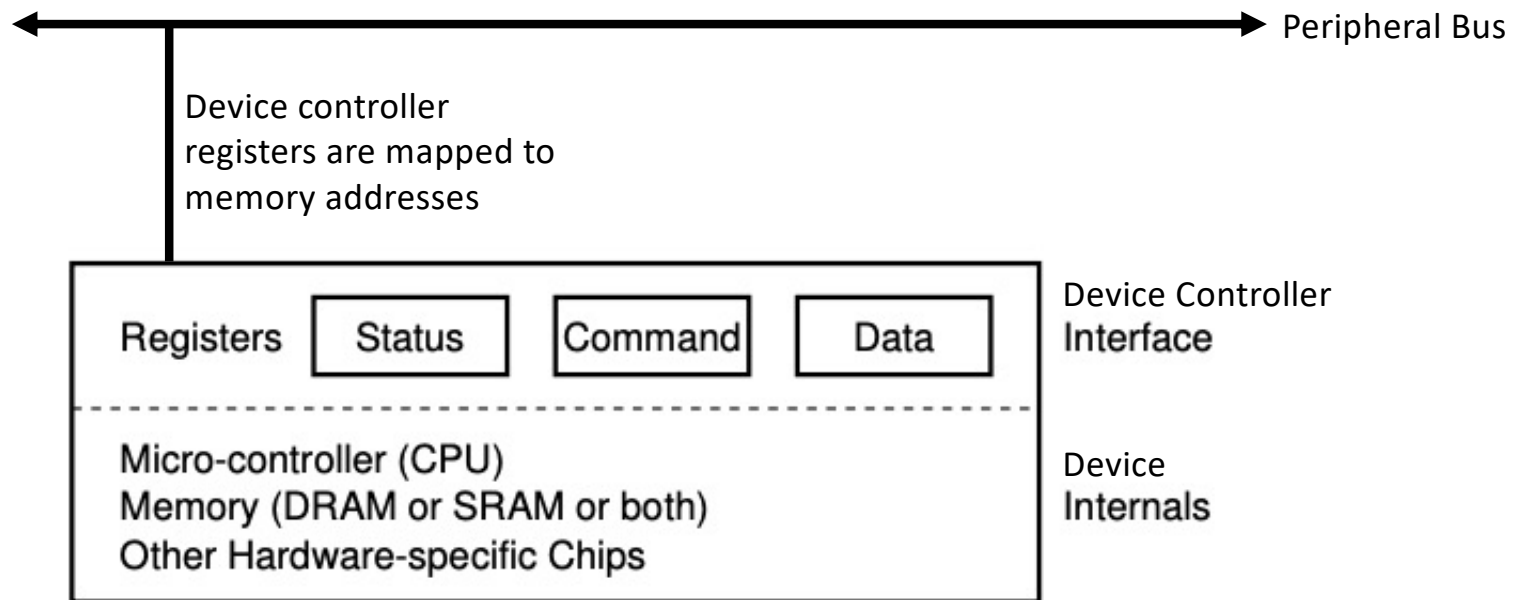
Interrupts

Without Interrupts – P means CPU is in polling (spinning) loop
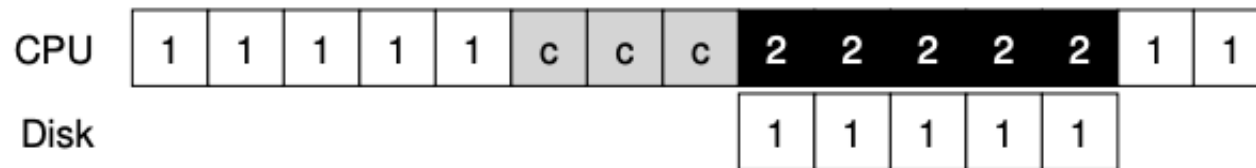

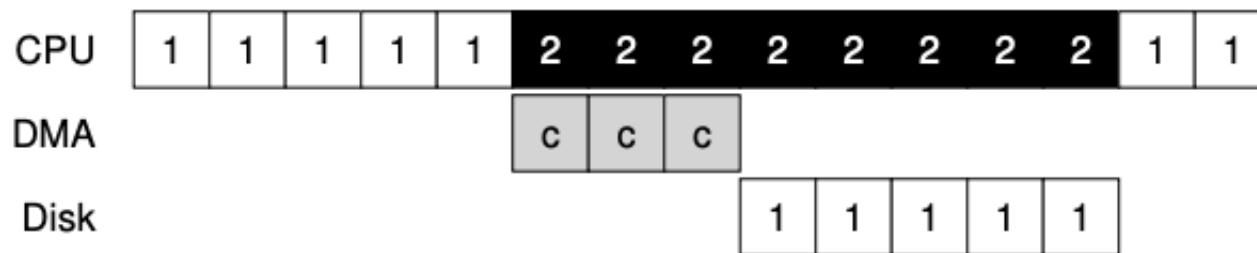With Interrupts – CPU can be switched to running process 2 during I/O
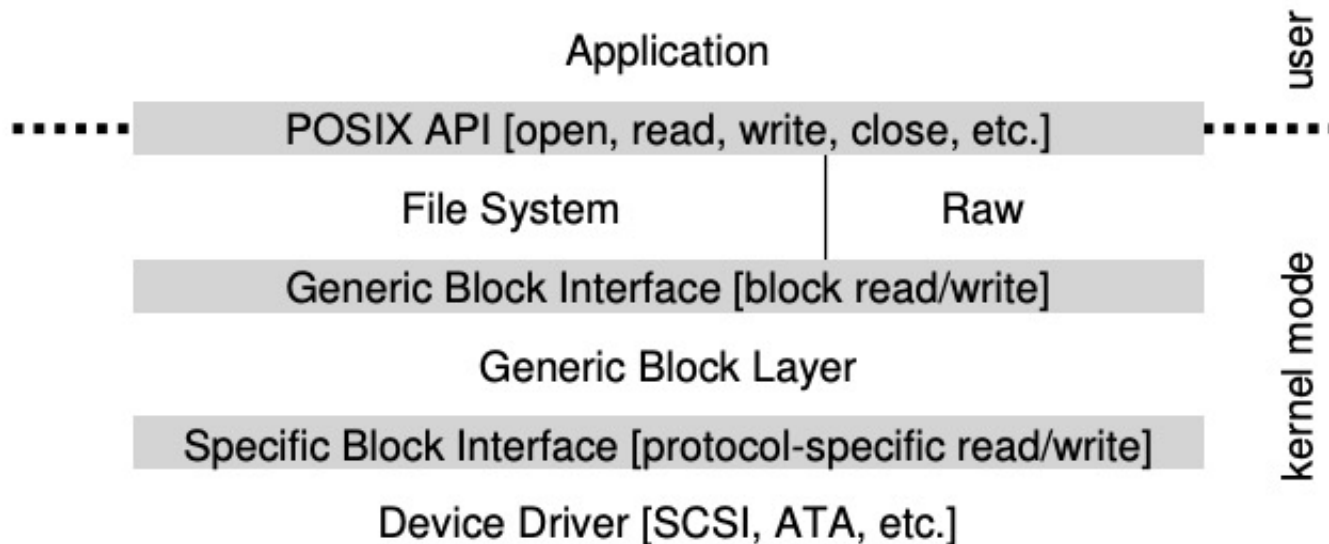
Direct Memory Access (DMA)

Without DMA – C means CPU is copying

With DMA

Device Drivers (Levels of Abstraction)

Putting it Together

Application

Device Drivers – software connected to interrupt handlers in the OS

Bus(es) – set of wires that transfer addresses and data between any two connected hardware

DMA (Direct Memory Access) – hardware that takes over the job of moving data between device controllers and memory

Device Controller – Hardware/Firmware Interface

Device – Hardware/Firmware Internals

CPU

Memory

DMA

Registers | Status | Command | Data

Micro-controller (CPU)
Memory (DRAM or SRAM or both)
Other Hardware-specific Chips