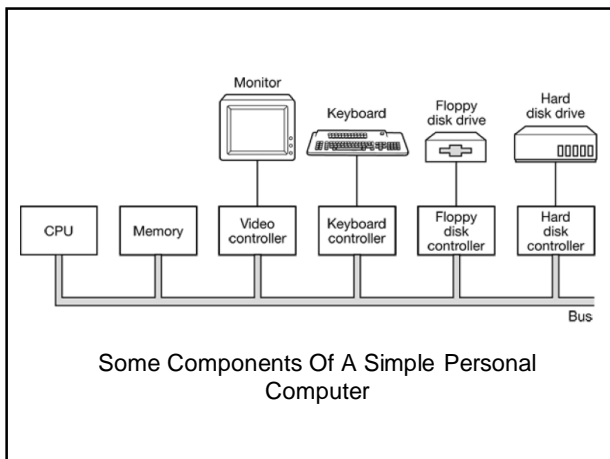


Computer Hardware Review

OS And Hardware

- An operating system is intimately tied to the hardware of the computer it runs on.
- It extends the computer's instruction set and manages its resources.
- To work it must know a great deal about the hardware, at least, about how the hardware appears to the programmer.



PROCESSORS

- “Brain” of the computer
- Components of a CPU :
 - Control unit (CU)
 - Arithmetic Logic Unit (ALU)
 - Registers
- Basic cycle of every CPU :
 - Fetch instructions from memory – decode – execute

CPU Registers

- all CPUs contain some registers inside to hold key variables and temporary results.
- Why? - Because accessing memory to get an instruction or data word takes much longer than executing an instruction
- the instruction set generally contains instructions to load a word from memory into a register, and store a word from a register into memory.
- Other instructions combine two operands from registers, memory, or both into a result, such as adding two words and storing the result in a register or in memory.

CPU Registers

- General registers - hold variables and temporary results
- Special registers
 - Program counter - contains the memory address of the next instruction to be fetched
 - Stack pointer - points to the top of the current stack in memory
 - Program status word (PSW) - contains the condition code bits

CPU Registers

- Speed – as fast as the CPU (no delay in accessing them)
- Capacity
 - 32 x 32 bits on a 32-bit CPU
 - 64 x 64 bits on a 64-bit CPU

Less than 1 KB

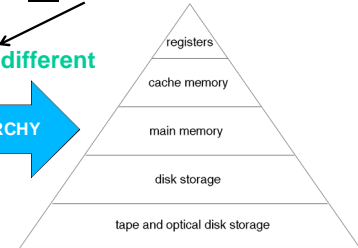
MEMORY

Ideally memory should be :

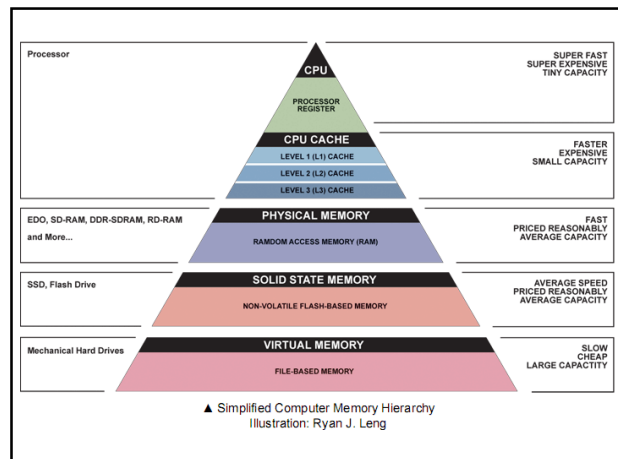
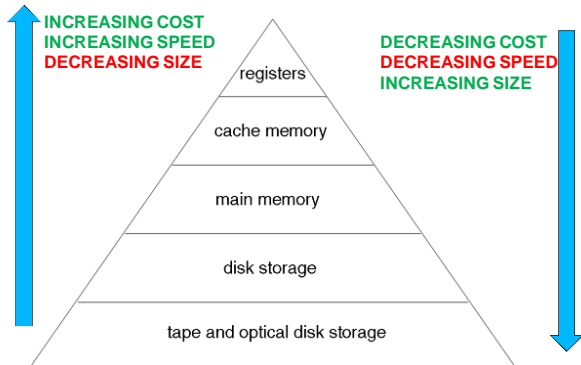
- Extremely fast
 - Large
 - Cheap
- No current technology satisfies all of these goals**

So we're using different approach

MEMORY HIERARCHY



Memory Hierarchy



registers

cache memory

main memory

disk storage

tape and optical disk storage

Primary storage - directly accessible to the CPU, small capacity, fast, volatile

Secondary storage - not directly accessible by the CPU. The computer usually uses its input/output channels to access secondary storage and transfers the desired data using intermediate area in primary storage, slow, large capacity, non-volatile

Non-volatile : Will retain the stored information even if it is not constantly supplied with electric power

Volatile : Requires constant power to maintain the stored information

Cache Memory

- Main memory is divided up into cache lines, typically 64 bytes, with addresses 0 to 63 in cache line 0, addresses 64 to 127 in cache line 1, and so on
- Some machines have more than 1 caches (ex. L2 cache, L1 cache), each one slower and bigger than the one before it
- When a program needs to read a memory word :
 1. Cache hardware checks to see if the line needed is in the cache
 2. If it is → **cache hit** (the request is satisfied from the cache, no memory request is sent to the main memory) → faster

Main Memory

- Often called Random Access Memory (RAM)
- All CPU requests that cannot be satisfied out of the cache go to main memory.
- Capacity – currently have a gigabyte-level capacity and a very fast speed

Secondary Storage

- Non-volatile
- Large capacity
- Much cheaper than primary storage
- Slower than primary storage
- Examples : hardisk

INPUT / OUTPUT DEVICES

- Consists of 2 parts :
 - The controller – chips that physically control the device, accepts commands from operating system and controls the device according to the commands.
 - The device
- the actual control of the device is very complicated and detailed, so it is the job of the controller to present a simpler interface to the operating system

Device Driver

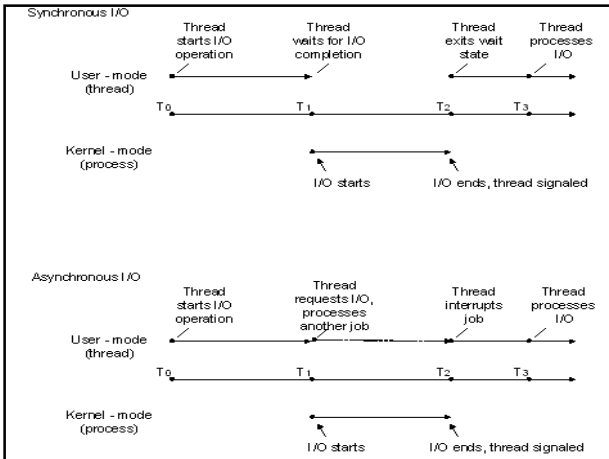
- Because each type of controller is different, different software is needed to control each one.
- The software that talks to a controller, giving it commands and accepting responses, is called a device driver.
- Each controller manufacturer has to supply a driver for each operating system it supports.

I/O Methods (1)

- Busy waiting / synchronous
 - a user program issues a system call
 - the kernel then translates into a procedure call to the appropriate driver.
 - The driver then starts the I/O and sits in a tight loop continuously polling the device to see if it is done.
 - When the I/O has completed, the driver puts the data where they are needed (if any), and returns.
 - disadvantage : tying up the CPU polling the device until it is finished.

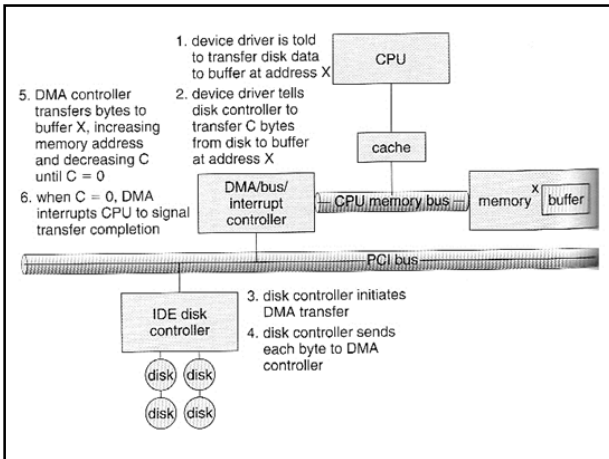
I/O Methods (2)

- Interrupt / asynchronous
 - The driver to start the device
 - The operating system looks for other work to do.
 - When the controller detects the end of the transfer, it generates an interrupt to signal completion



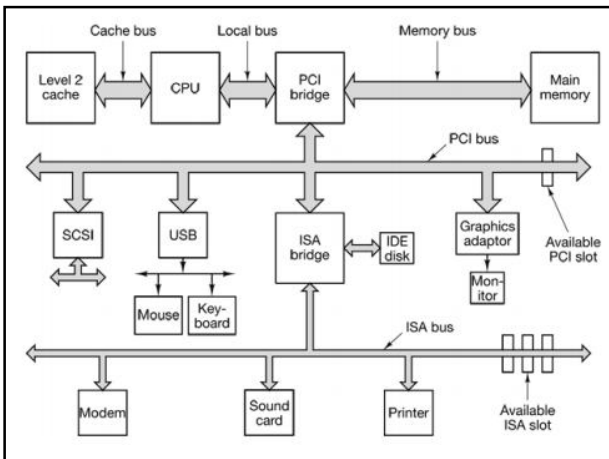
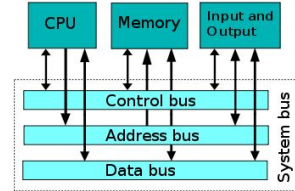
I/O Methods (3)

- DMA (Direct Memory Access)
 - I/O operation without constant CPU intervention
 - The CPU sets up the DMA chip telling it how many bytes to transfer, the device and memory addresses involved, and the direction, and lets it go.
 - When the DMA chip is done, it causes an interrupt.



BUS

- Handles the traffic between CPU, I/O devices and Memory
- Generally, there are 3 types of bus :
 - Address bus
 - Data bus
 - Control bus



- ISA (Industry Standard Architecture) bus - for backward compatibility with old and slow I/O cards
- PCI (Peripheral Component Interconnect) bus - Most high-speed I/O devices use this bus
- USB (Universal Serial Bus) - attach all the slow I/O devices, such as the keyboard and mouse, to the computer
- SCSI (Small Computer System Interface) bus - high-performance bus intended for fast disks, scanners, and other devices needing considerable bandwidth
- IDE (Integrated Drive Electronics) bus - for attaching peripheral devices such as disks and CD-ROMs to the system

HARDWARE PROTECTION

WHY ?

- OS will protect the hardware due to heavy use of computer resources
- So if there is one program that does not work then it will not disturb the performance of OS and other programs that are running

- Dual Mode Operation
- I/O Protection
- Memory Protection
- CPU Protection

Dual-mode operation

Sharing system resources requires operating system to ensure that an incorrect program cannot cause other programs to execute incorrectly.

Provide hardware support to differentiate between at least two modes of operation:

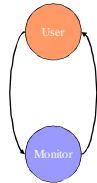
1. User mode -- execution done on behalf of a user.
2. Monitor mode (supervisor/kernel/system mode) -- execution done on behalf of operating system.

Dual-mode operation(cont.)

Mode bit added to computer hardware to indicate the current mode: monitor(0) or user(1).

When an interrupt or fault occurs, hardware switches to monitor mode.

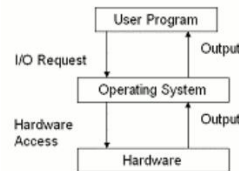
Privileged instructions only in monitor mode.



I/O Protection

All I/O instructions are privileged instructions.

Must ensure that a user program could never gain control of the computer in monitor mode



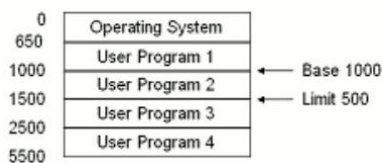
Memory Protection

•Must provide memory protection at least for the interrupt vector and the interrupt service routines.

•To provide memory protection, add two registers that determine the range of legal addresses a program may address.

- Base Register - holds smallest legal physical memory address.
- Limit register - contains the size of the range.

•Memory outside the defined range is protected.



CPU Protection

Timer - interrupts computer after specified period to ensure that OS maintains control.

Timer is decremented every clock tick.

When timer reaches a value of 0, an interrupt occurs.

Timer is commonly used to implement time sharing.

Timer is also used to compute the current time.

Load timer is a privileged instruction.

Tugas / Homeworks

1. Tulis tentang sejarah sistem operasi / Write about history of operating system
2. Beri contoh dan jelaskan tentang bus yang ada sekarang (cont. PCI Express, SATA, dll)/ Give examples and explain about the current buses (ex. PCI Express, SATA, etc)
3. Jelaskan istilah berikut / Explain these terms :
 - Interrupt
 - System call
 - Dynamic RAM
 - Static RAM
 - BIOS
 - CMOS
 - ROM

Tugas / Homeworks

- Dikumpulkan minggu depan
- Ditulis tangan
- Berikan identitas : Nama, NIM, Kelas (A12.6508)

- Will be collected next week
- Handwritten
- Write your ID : Name, Student ID, Class (A12.6508)