Module 3

CPUs and Cooling

Objectives

PC Hardware

1. 1.4 Differentiate among various CPU types and features
2. 1.4 Select the appropriate cooling method

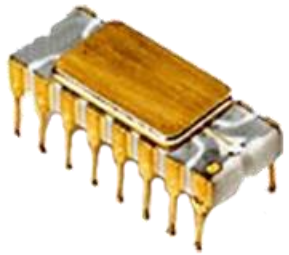
THE CENTRAL PROCESSING UNIT (CPU)

Microprocessor History

1. 1945, John von Neumann was the first to suggest storing a sequence of instructions (a program) in the same memory as the data
2. "First Draft of a Report on the EDVAC“ organized the computer system into four main parts:
   A. Central Arithmetic unit
   B. Central Control unit
   C. Memory
   D. Input/Output devices
3. Today, more than half a century later, nearly all processors have a "von Neumann" architecture

Microprocessor History

1. Also known as a **CPU** or central processing unit
2. Complete computation engine fabricated on a single chip
3. **Intel 4004**
   A. Introduced in 1971
   B. First microprocessor
   C. Was not very powerful – could only add and subtract 4 bits at a time
   D. Powered one of the first portable electronic calculators



Microprocessor History

Intel 8080

1. Introduced in 1974
2. First microprocessor to make it into a home computer
3. Complete 8-bit computer on one chip

Microprocessor History

Intel 8088

1. Introduced in 1979
2. Incorporated into the IBM PC (which first appeared around 1981)
3. The PC market moved from the 8088 to:
   A. 80286
   B. 80386
   C. 80486
   D. Pentium
   E. Pentium II
   F. Pentium III
   G. Pentium 4
   H. Dual/Quad/Six/Eight Cores
4. All of these microprocessors are improvements on the basic design of the 8088

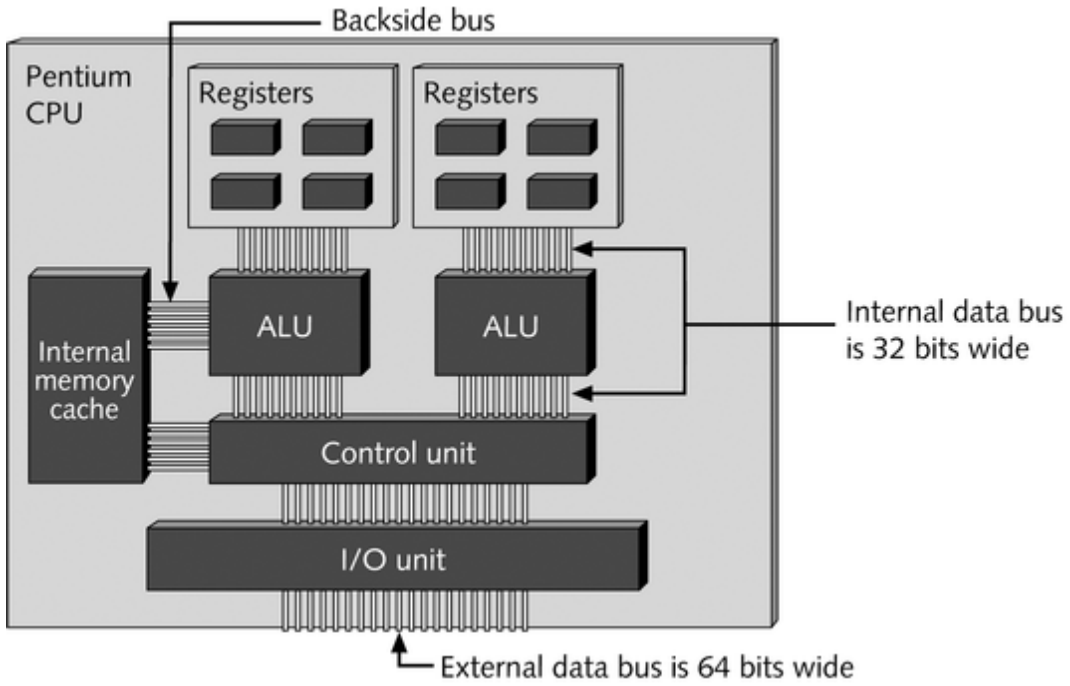
Attributes Used to Rate CPU

1. CPU speed measured in Hertz, Megahertz or Gigahertz
2. Efficiency of programming code
3. Number of transistors
4. Number of registers
5. Data path
6. Maximum number of memory addresses
7. Amount of memory included with the CPU
8. Multiprocessing ability
9. Special functionality

CPU Architecture

1. Input/output (I/O) unit
    A. Manages data and instructions entering and leaving the CPU
2. Arithmetic logic units (ALUs)
    A. Does all comparisons and calculations
3. Control unit
    A. Manages all activities inside the CPU itself
4. Memory unit
    A. Everything the CPU access must first be stored in memory

How the CPU Works

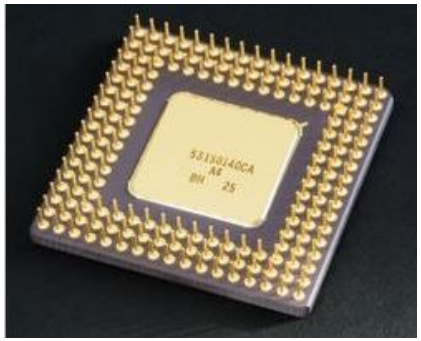


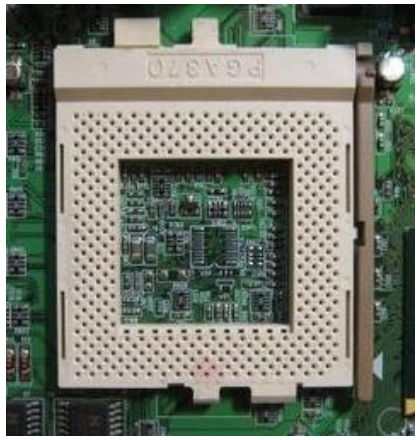
Beginning with the Pentium, CPUs had two arithmetic logic units and could process two instructions at once

CPU Packages

1. SECC (Single Edge Contact Cartridge)
2. SEP (Single Edge Processor)
3. PPGA (Plastic Pin Grid Array)
4. PGA (Pin Grid Array)
5. LGA (Land Grid Array)
6. SPGA (Staggered Pin Grid Array)
7. mPGA (Micro Pin Grid Array)

Pin Grid Array and Land Grid Array





Land Grid Array

1. Most common type of CPU
2. Inserted into a **Zero Insertion Force** (ZIF) socket mounted on the motherboard
3. Processor referred to as a ZIF Chip

Comparison Chart

CPU Slots and Sockets

1. Physical connection used to connect the CPU to the motherboard
2. Socket *X* (*X* being numerical) is a descriptive term for the way certain processors plug into a motherboard
   A. Terminology like Socket 7, Socket 370, LGA 775, or LGA1155
3. Slot-type processors had a very brief lifespan
   A. Slots 1 was proprietary to the Intel Pentium II
   B. Slot A was proprietary to the AMD Athlon

CPU Slots and Sockets

Current sockets types:

1. LGA 1156 (Celeron, Pentium, Core i3, i5, or i7)
2. LGA 1155 (replaces the LGA 1156)
3. LGA 2011 (replaces LGA 1366 and LGA 1567)
4. LGA 1150 (replaces the LGA 1155)
5. Socket FM1
6. Socket AM3+
7. Socket FM2

Cache

1. Memory is relocated into a special section of high-speed **SRAM** inside the processor
   A. Uses a small amount of expensive memory to speed up processing instead of a large amount of slower, less-expensive memory
2. Increases the memory-access speed of a computer
3. Microprocessor could access these locations without requiring any wait time

Cache

1. **L1 cache**
   A. Fastest memory
   B. Smallest size (4 kilobytes to 16 kilobytes in size) built into the CPU
   C. Stores frequently used information that the CPU needs
2. **L2 cache**
   A. Next fastest memory
   B. A little larger
   C. Stores frequently used information that cannot be held in L1 cache
3. **L3 cache**
   A. Stores frequently used information that cannot be held in L1 or L2 cache
   B. Largest type of cache
4. Can be built directly on peripherals

Pipelining

1. Instruction execution overlaps
   A. Even though it might take eight clock cycles to execute each instruction, there can be eight simultaneous instructions in various stages of execution
   B. Looks like one instruction completes every clock cycle
2. Many modern processors have multiple instruction decoders, each with its own pipeline
   A. Allows for multiple instruction streams, which means that more than one instruction can complete during each clock cycle
   B. Technique can be quite complex to implement
   C. Takes lots of transistors

Multiprocessing

1. Running a system with more than one processor
2. In theory you can double performance by using two processors
3. Operating system must support it
4. Operating system divides tasks between the processors in:
   A. **Asymmetric**
   B. **Symmetric**

Multiprocessing

1. **Symmetric**
   A. Designates some processors to perform system tasks only, and others to run applications only
   B. A rigid design that may result in lost performance
2. **Asymmetric**
   A. Allows either system or user tasks to run on any processor
   B. Leads to better performance
   C. Used by most multiprocessing motherboards

Hyper-threading

1. Enhances CPU performance
2. Schedules multiple processes simultaneously among multiple logical processors
3. Makes every logical processor cores appear as physical cores

CISC (Complex Instruction Set Computer)

1. The traditional architecture of a computer
2. Allows multiple instructions to be written in one line of code
3. Higher efficiency programming
4. Varies in length
5. Requires complex circuitry to decode them

RISC (Reduced Instruction Set Computer)

1. Execute instructions very fast (one cycle or less)
2. Require fewer transistors
3. Cheaper to design and produce
4. Keeps instruction size constant
5. Ban the indirect addressing mode
6. Retains only those instructions that can be overlapped
7. Used by Apple computers

64-bit Processors

1. Introduced in 1992
2. Now becoming mainstream
3. Produced by Intel and AMD
4. 64-bit ALUs
5. 64-bit registers
6. 64-bit buses

Microsoft's first 64-bit processors were known as Itanium processors

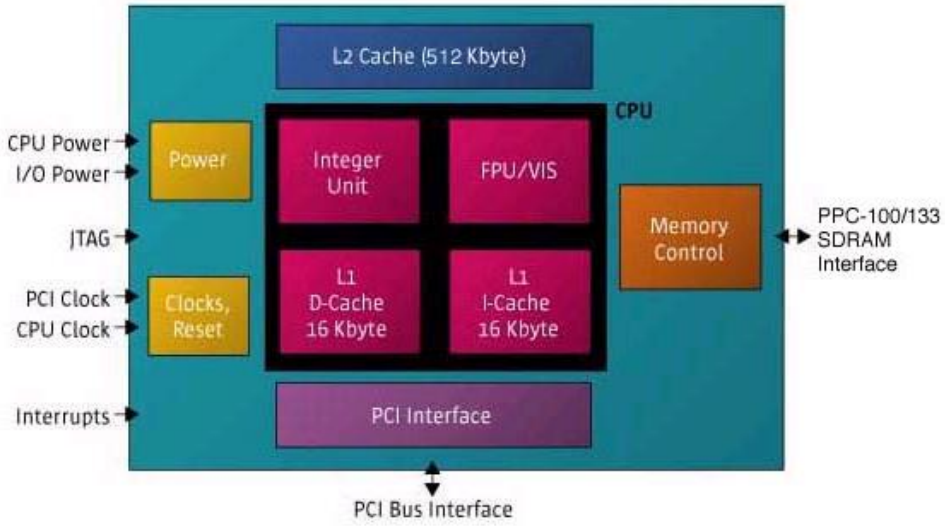
64-bit Processors and Memory

1. 32-bit chips have maximum of 4 GB of RAM
   A. Limits size of programs and data
2. 64-bit RAM access is essentially infinite
   A. 2^{64} equals about a quadrillion gigabytes or 1,024 terabytes or 1 petabyte
3. Increase system performance
   A. Creates high-speed data buses on the motherboard
   B. Faster I/O (input/output) speeds

Xeon

1. Intel’s Server CPU
2. x86 and 64x versions
3. Have more cache than their desktop counterparts
4. Multiprocessing capabilities
5. Found in the top ten of the fastest supercomputers in the world

Sun SPARC Processor

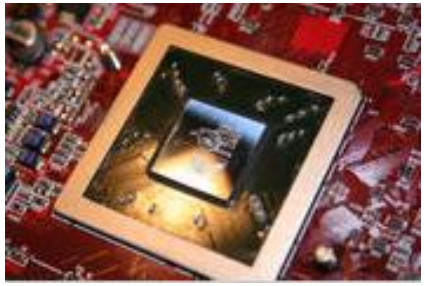


1. 64-bit processor built to run Sun Unix servers
2. Eliminated the Northbridge by incorporating the memory and PCI controllers into the CPU

Multi-Core Processors

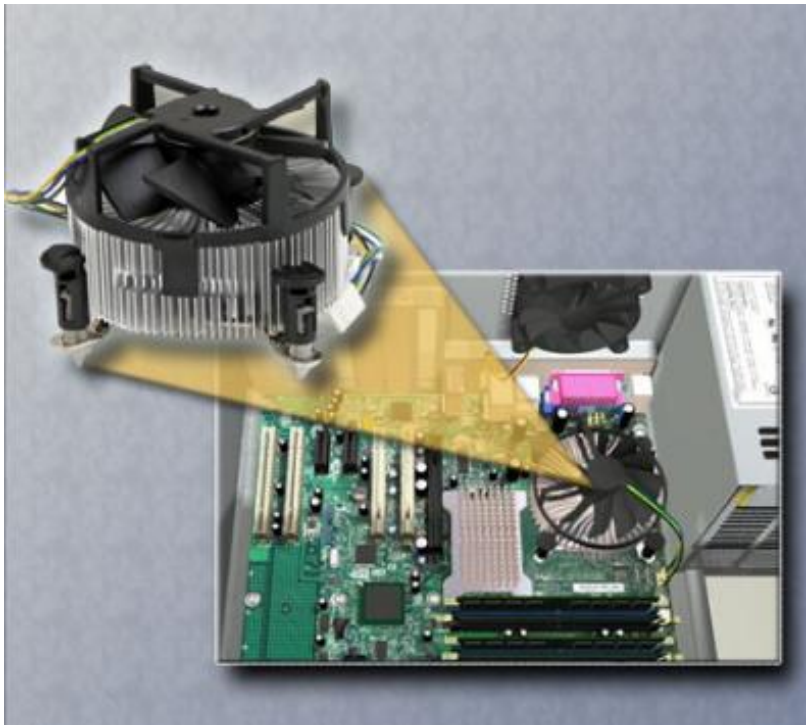
1. Incorporate more than one CPU core onto a single chip
2. Capable of processing multiple instructions concurrently
3. Available processors:
   A. Single Core CPU
   B. Dual Core CPU
   C. Quad Core CPU
   D. Six Core CPU
   E. Eight Core CPU
4. A motherboard may have multiple sockets

Thermal Compound



1. Keep your CPU from overheating
2. Better CPU performance and stability
3. Creates a reliable transfer of heat from processor to heat sink
4. Made of micron sized silver and ceramic particles

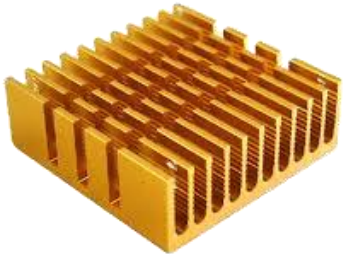
CPU Cooling



1. All electronic components generate heat causing:
   A. Slower performance
   B. Component damaged
2. Computer components perform better when kept cool

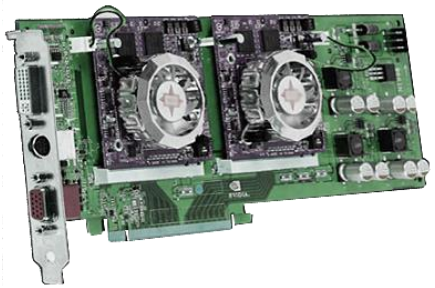
Microprocessor Cooling Systems

1. Heat sinks (Passive Cooling)
   A. Used by older CPUs to pull heat away from the CPU
   B. Mounts on top of the CPU
2. Cooling fans (Active Cooling)
   A. Keep temperatures lower by drawing air across the heat sink
   B. powered by an electrical connection



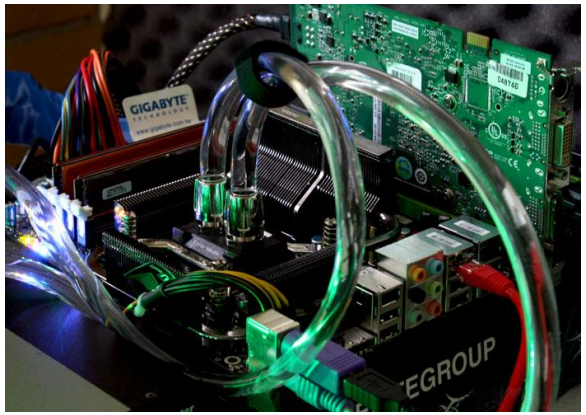
Passive Cooling

Active Cooling



Video Card with active cooling

Water Cooling



1. Used with extremely fast CPUs and GPUs
2. A metal plate is placed over the processor and water is pumped over the top to collect the heat that the CPU creates
3. Water is pumped to a radiator to be cooled by the air and then re-circulated
4. Provides a very quiet option when noise is a factor

Summary

In this module we discussed:

1. Processor history, attributes, and makeup
2. Processor packages and motherboard slots and sockets
3. Cache
4. Pipelining, Multi-Processing, and Hyper-Threading
5. Types of processors
6. Types of cooling