

CPU

*Central Processing Unit*

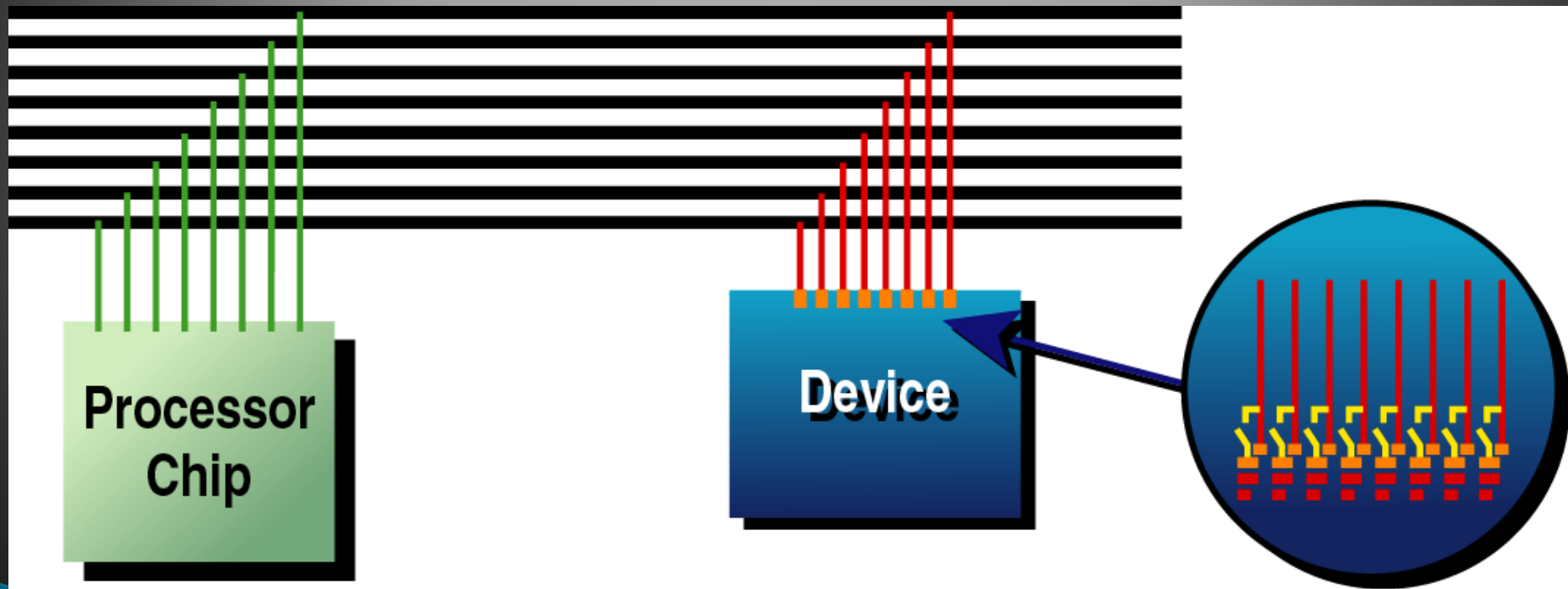
# Chapter Overview

- ▶ Microprocessors
- ▶ Replacing and Upgrading a CPU

# Microprocessor Basics

- ▶ Components
- ▶ How microprocessors work
- ▶ PC microprocessor developments and features

# The External Data Bus



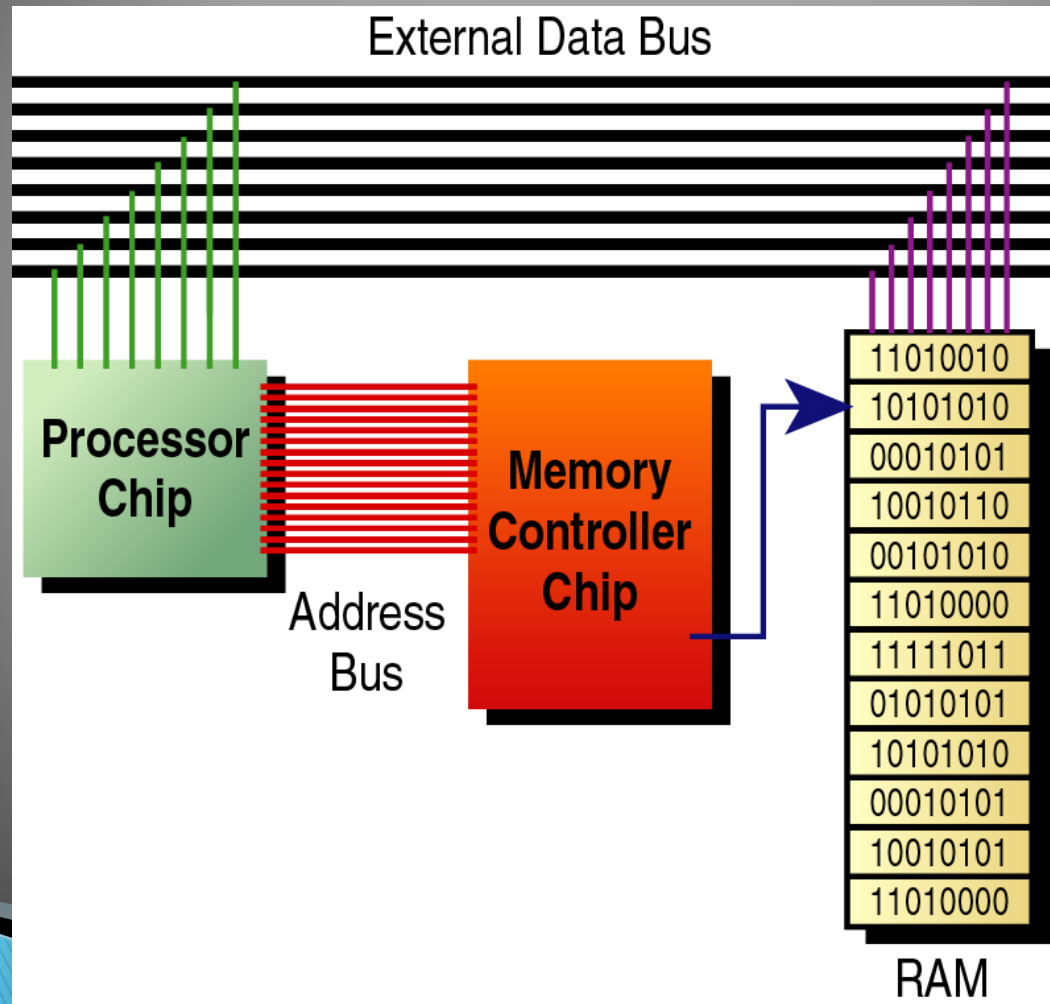
# The CPU

- ▶ Performs operations and decodes and executes instructions
- ▶ Controls computer operation
- ▶ Includes transistors, integrated circuits, and microprocessors

# Microprocessor Design

- ▶ Three subsystems
  - Control unit (CU)
  - Arithmetic logic unit (ALU)
  - Input/output (I/O) unit
- ▶ Registers
- ▶ Codes
- ▶ Clock
- ▶ Clock speed

# Memory



# How Microprocessors Work

1. Instruction Fetch

```
graph TD; A[1. Instruction Fetch] --> B[2. Instruction Decode (in RAM)]; B --> C[3. Instruction Execution];
```

2. Instruction Decode (in RAM)

3. Instruction Execution



# PC Microprocessor Developments and Features

- ▶ Use the following elements to gauge CPU performance:
  - Speed
  - Transistors
  - Registers
  - External data bus
  - Address bus
  - Internal cache

# The Birth of the PC

- ▶ 8086 and 8088
- ▶ 80286
- ▶ 80386
- ▶ 80486

# The First Pentiums

- ▶ The Pentium (Series I)
  - Runs at 60 MHz to 200 MHz
  - Offers superscalar technology and on-board cache

# The First Pentiums (Cont.)

- ▶ Pentium Pro
- ▶ Pentium MMX
- ▶ Pentium II
- ▶ Celeron
- ▶ Xeon
- ▶ Pentium III

# Possible Upgrade Scenarios

- ▶ 8086/8088
- ▶ 80286-80486
- ▶ 80386SX
- ▶ Pentium I
- ▶ Pentium II
- ▶ Pentium III

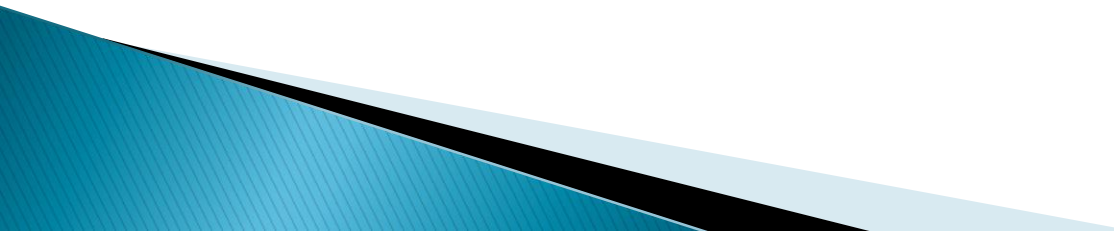
# Inserting a CPU

- ▶ Low-insertion-force (LIF)
- ▶ Zero-insertion-force (ZIF)
- ▶ Single-edge connector (SEC/slot 1)

# Chapter Summary

- ▶ Understanding processor development and progress is essential.
- ▶ The three key elements for measuring a CPU's performance are its speed, address bus, and external data bus.
- ▶ Several key CPU developments have occurred since the 80286 processor.
- ▶ Today's standard processor is the Pentium III chip.
- ▶ Replacing a CPU is usually simple.
- ▶ You must watch for electrostatic discharge (ESD) and pin damage when handling a CPU.

# Chapter 5 Objectives

- ▶ Understand how a CPU holds and processes data
  - ▶ Identify ways by which a CPU is categorized and evaluated
  - ▶ Distinguish between PGA and SECC packaging
  - ▶ Understand how modern CPUs have evolved from earlier versions
- 



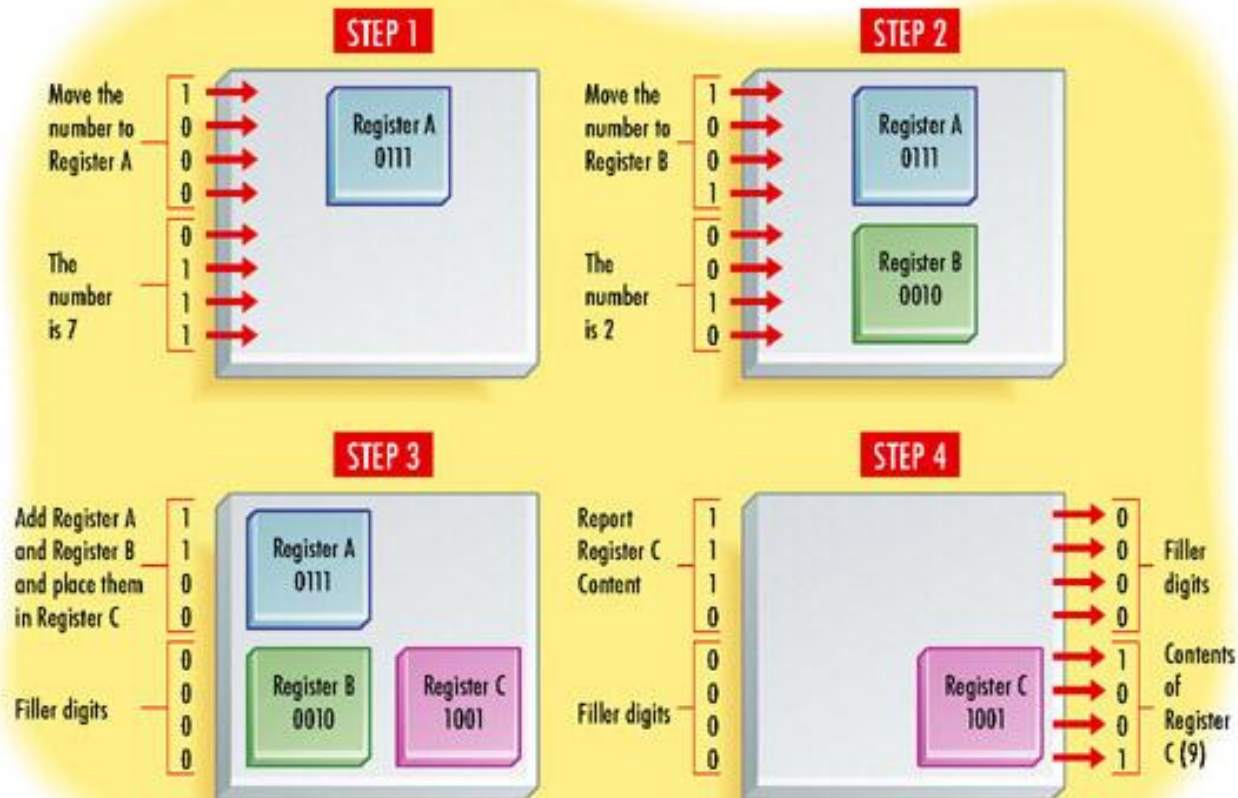
# Inside the CPU

- ▶ **Low-order bits:** data that represents numbers to be calculated
- ▶ **High-order bits:** data that represents instructions to the CPU

# Inside the CPU

- ▶ **Instruction set:** high-order bit codes that the CPU understands
- ▶ **Registers:** holding areas for data inside the CPU

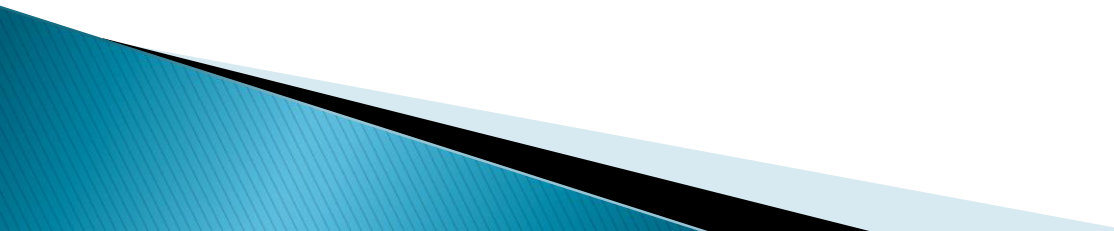
# Example Process



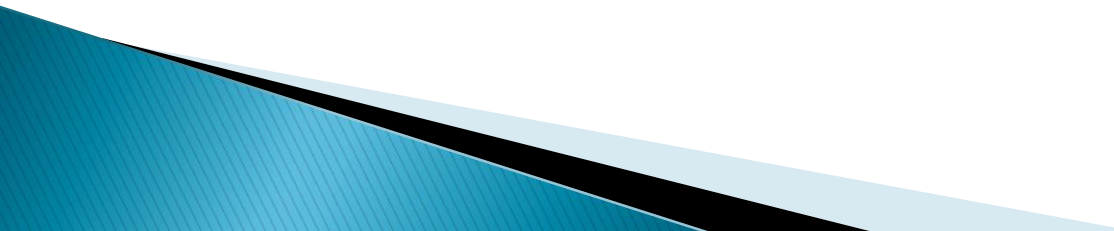
# Data Processing Speed

- ▶ External speed
  - Speed at which motherboard and CPU communicate
  - Controlled by system crystal
- ▶ Internal speed
  - Speed at which CPU performs internal operations
  - Usually a multiple of the external speed

# Overclocking and Underclocking

- ▶ **Overclocking:** operating a CPU at a higher internal speed than it is rated for
  - ▶ **Underclocking:** operating a CPU at a lower internal speed than it is rated for
- 

# Core Voltage

- ▶ Voltage that the CPU requires to operate
  - ▶ Ranges from approximately +1.5v to +5v
  - ▶ Newer CPUs = lower voltages
  - ▶ Motherboard must provide correct voltage
- 

# CPU Cache Usage

## ▶ L1 cache

- Front-side cache
- Holds data waiting to enter the CPU
- Built into the CPU on modern systems

## ▶ L2 cache

- Back-side cache
- Holds data exiting the CPU
- Built into the CPU packaging, but on a separate chip

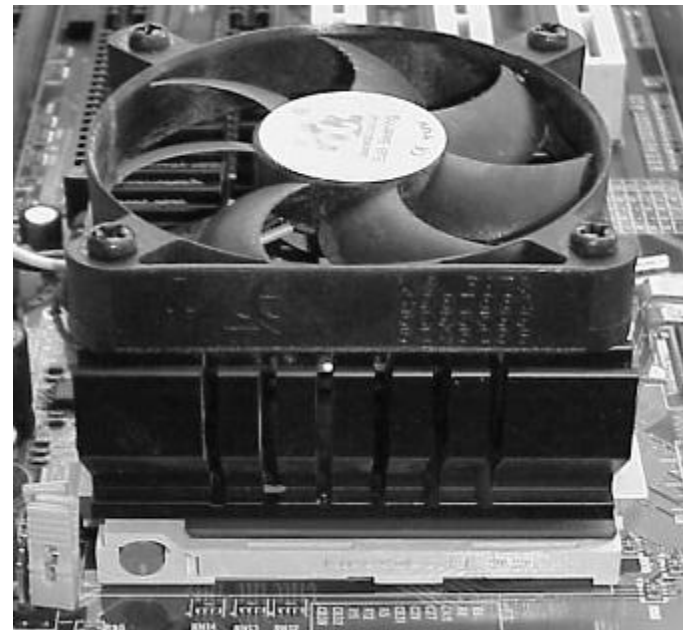
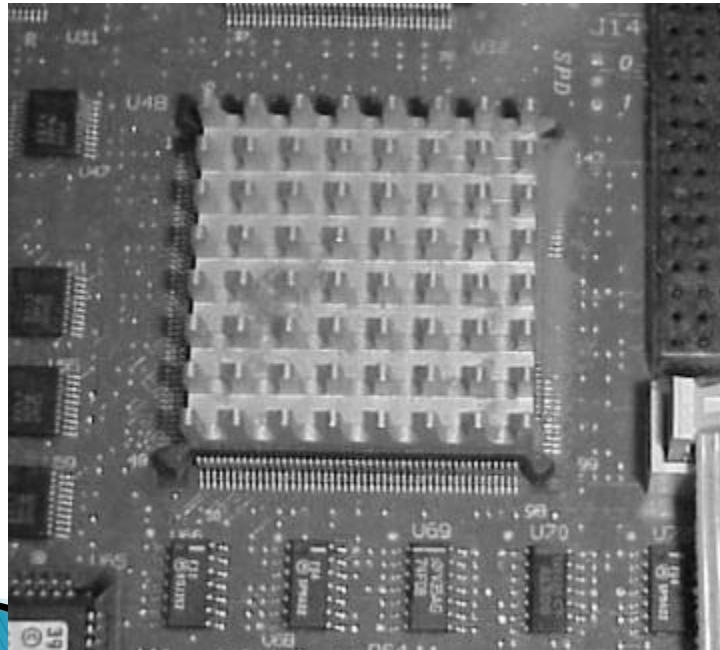
# CPU Cooling

- ▶ Fan
  - Pulls heat away from CPU
- ▶ Heat sink
  - Spikes channel heat away from CPU



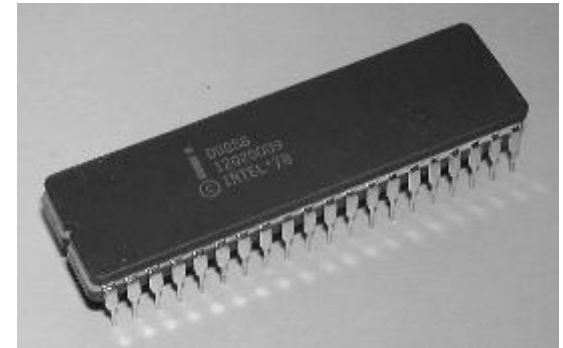
# Passive/Active Heat Sink

- Passive: without fan
- Active: with fan



# Pre-Pentium CPUs

- ▶ 8088
  - 16-bit internal registers
  - 20-bit address bus
  - 8-bit external data bus
  - 4.77MHz to 10MHz
  - Optional 8087 math coprocessor



# Pre-Pentium CPUs

## ▶ 80286

- Could run in Protected Mode
  - More RAM could be addressed
  - Multitasking
- Could run in Real Mode
  - Backward compatible with applications for 8088
- Could use expanded memory on an ISA expansion board
- Up to 20MHz in speed

# Pre-Pentium CPUs

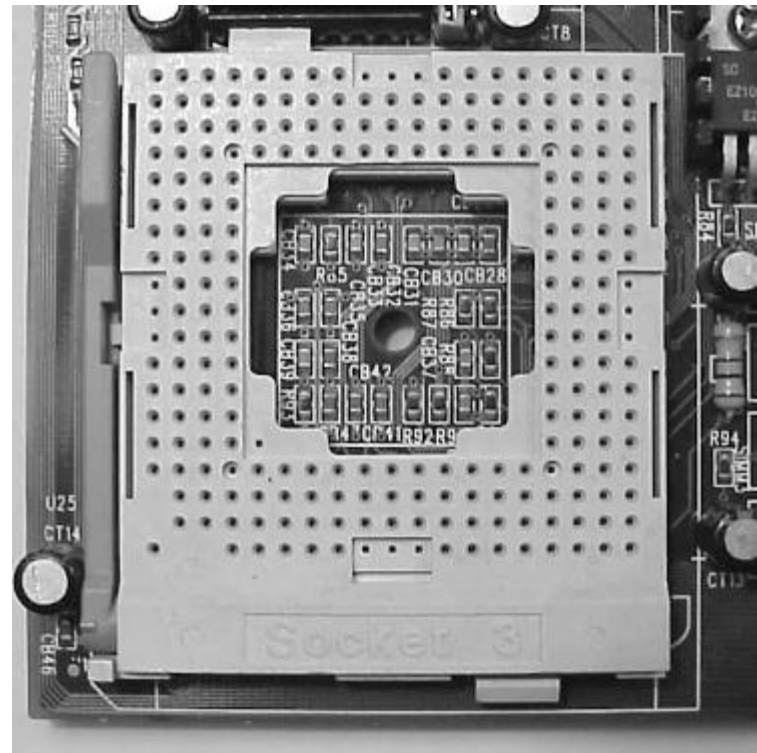
- ▶ 80386 (i386)
  - 386 protected mode, 286 protected mode, and real mode
  - Virtual memory
  - Virtual 8086 mode
- ▶ 386DX versus 386SX
  - 32-bit versus 16-bit external data bus
  - 32-bit versus 24-bit address bus

# Pre-Pentium CPUs

- ▶ 80486 (i486)
  - Built-in coprocessor (on DX models)
  - Clock multipliers
  - Up to 120MHz (clock-tripled)
  - First CPU to use ZIF packaging
- ▶ 486DX versus 486SX
  - Disabled math coprocessor on 486SX

# ZIF Packaging

- ▶ Pin Grid Array (PGA)
- ▶ Removable without force
- ▶ Raise/lower lever

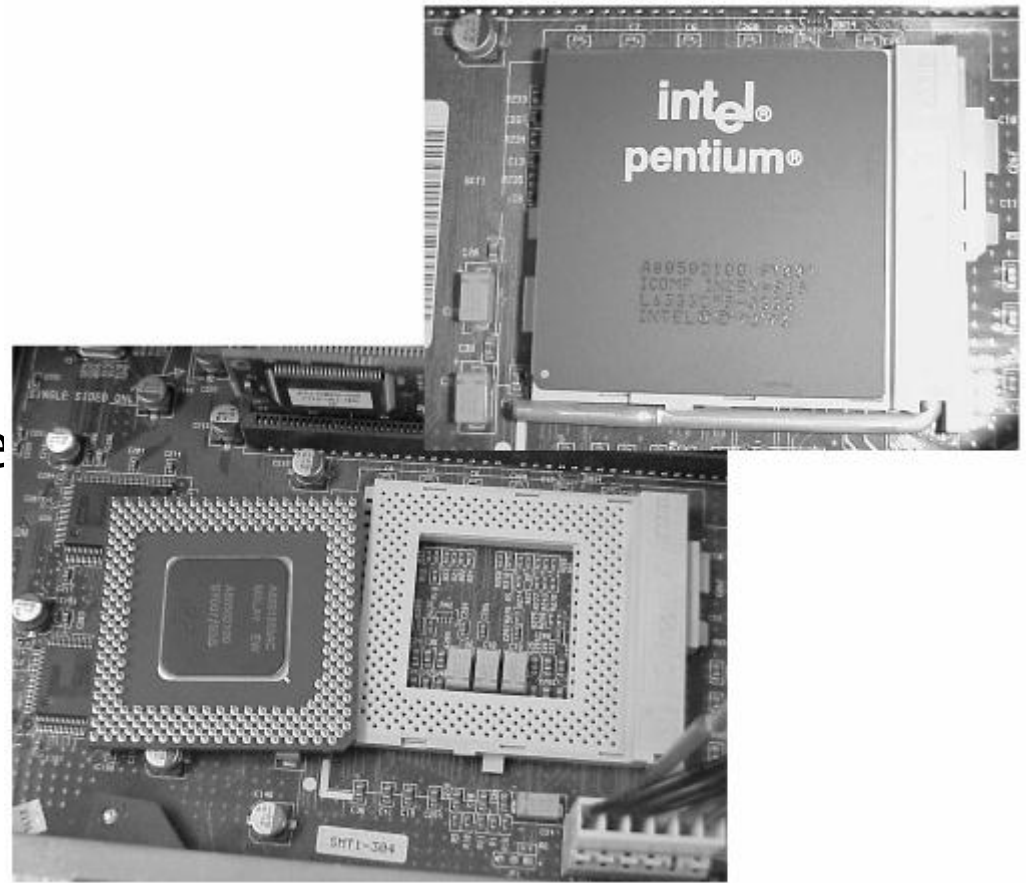


# Pentium Packaging

- ▶ Socket 4
  - +5v socket
  - Used for 1<sup>st</sup> Generation Pentium (60, 66MHz)
  - 273-pin
- ▶ Socket 3
  - Variable-voltage socket, +3.3v or +5v
  - Introduced *after* Socket 4
  - Works with either 486 or 1<sup>st</sup> Generation Pentium

# Pentium Packaging

- ▶ Socket 5
  - +3.3v socket
  - 2<sup>nd</sup> Generation Pentiums (77 to 100MHz)
  - First to use staggered PGA (SPGA)
  - 320-pin





# Pentium Packaging

## ▶ Socket 6

- +3.3v socket
- Used for Pentium OverDrive and 486DX4

## ▶ Socket 7

- Variable voltage socket, +3.3v or +5v
- 321 pins (rather than 320 on Socket 5)
- Otherwise the same as Socket 5

# Pentium Packaging

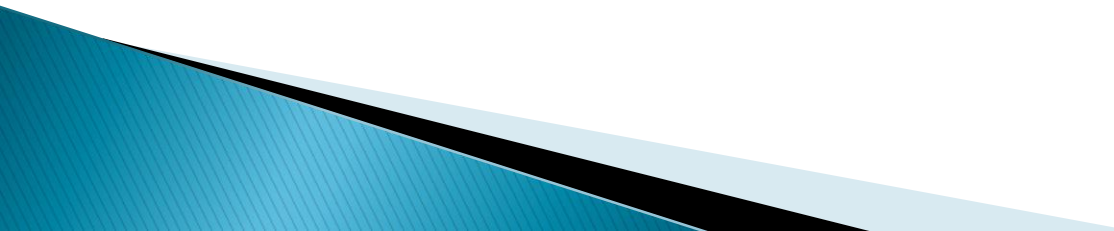
## ▶ **Super Socket 7 (Super7)**

- Enhanced Socket 7
- Used with 2<sup>nd</sup> Generation Pentium and non-Intel competitor chips
- Provides split voltage capability that allows higher external than internal voltage

# Pentium CPUs

- ▶ First-Generation
  - 60 or 66MHz
  - Used Socket 3 or Socket 4
- ▶ Second-Generation
  - 75 to 100MHz
  - Used Socket 5 or Socket 7
- ▶ Third-Generation
  - 166 to 233MHz
  - Adds MMX capability

# Pentium Pro

- ▶ Improvement on Second-Generation Pentium
  - ▶ Introduced quad pipelining
  - ▶ Introduced on-chip L2 cache
  - ▶ Lacked MMX
  - ▶ Optimized for 32-bit operating systems
  - ▶ Socket 8: +3v rectangular socket, 387 pins
- 

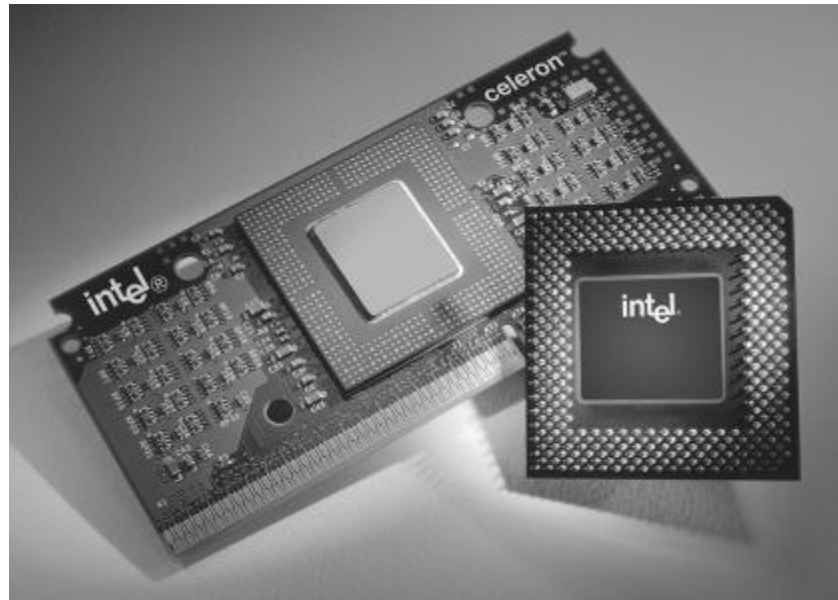
# Pentium II

- ▶ A fast Pentium Pro with MMX added
- ▶ Internal speeds from 233 to 450MHz
- ▶ External buses of 66 or 100MHz
- ▶ Single Edge Contact Cartridge (SECC)

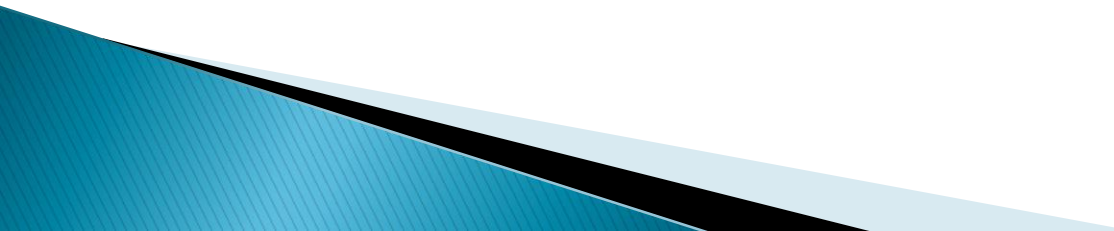


# Celeron

- ▶ Low-budget Pentium II (or Pentium III)
- ▶ Packaging:
  - Single Edge Processor (SEP)
  - Socket 370



# AMD K6

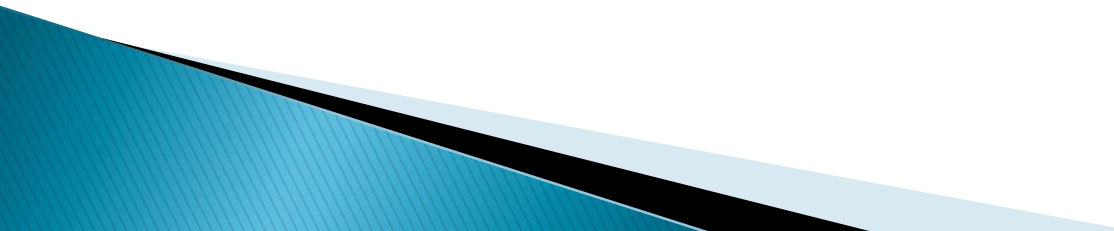
- ▶ Competitor to Pentium II
  - ▶ Socket 7 PGA chip
  - ▶ Versions:
    - K6: 166 to 300MHz
    - K6-2: 266 to 475MHz, 3DNow! Technology
    - K6-3: 400 to 450MHz, full-speed L2 cache
- 

# Pentium III

- ▶ 450MHz to 1GHz
- ▶ Packaging:
  - SECC2
  - Socket 370
  - Flip–Chip (FC) design



# Pentium 4

- ▶ 1.3GHz to more than 2.8GHz
  - ▶ Socket 423 or Socket 478
  - ▶ NetBurst architecture
  - ▶ 64-bit, 100MHz quad pipelining
  - ▶ 20Kb L1 cache, 256KB full-speed L2 cache
- 

**TERIMA KASIH**