

Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

1

Technology in Action

Technology in Focus:
Under the Hood

Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

2

Electrical Switches

- The system unit contains the CPU
- The CPU uses a large number of switches
 - Two states: 1 or 0 (on or off)
 - Binary language consists of two numbers: 1 or 0
- These switches are used to process data



Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

3

Early Computer Switches

- Vacuum tubes
 - Allow or block the flow of electrical current
 - Take up a large amount of space
 - Generate heat and burn out frequently
 - Impractical due to size and reliability issues

Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

4

Transistors

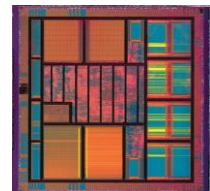
- Transistors
 - Electrical switches built of layers of silicon
 - Early transistors were built in separate units as small metal rods
 - Each rod was a small on/off switch
 - Smaller and faster than vacuum tubes
 - Produced less heat

Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

5

Integrated Circuits

- Made of semiconductor material, silicon
- Contain huge number of transistors, resistors, capacitors, and diodes
- Small size, only ¼ inch in diameter



Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

6

Microprocessors

- Chip that contains CPU
- Intel 4004
 - First complete microprocessor on a single integrated circuit
 - Built in 1971
 - Contained 2,300 transistors
- Current CPUs contain more than 500 million transistors

Base 10 Number System

- Organized plan for representing a number
 - Base 10 or decimal notation
 - Uses 10 digits (0–9)
 - System used to represent all of the numeric values we use each day

10^3	10^2	10^1	10^0	$(6,000 + 900 + 50 + 4) = 6,954$
1,000s place	100s place	10s place	1s place	
$6 * 1,000 + 9 * 100 + 5 * 10 + 4 * 1$				

Base 2 Number System

- Base 2 or binary
- Uses two digits (1,0)
- Computers use binary because each switch can be in one of two positions: on or off.

2^3	2^2	2^1	2^0	$(8 + 0 + 2 + 1) = 11$
8s place	4s place	2s place	1s place	
1	0	1	1	

Hexadecimal Notation: Base 16

- Base 16 (0–9, A–F)

Character representation

Base 10	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Base 16	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

16^3	16^2	16^1	16^0
4,096s place	256s place	16s place	1s place
1	A	4	3
$1 * 4,096 + 10 * 256 + 4 * 16 + 3 * 1$			
$4,096 + 2,560 + 64 + 3$			
6,723			

Hex 1A43 =
6,723 in Base 10

ASCII

- American Standard Code for Information Interchange
- Pronounced “As-key”
- Represents each letter or character as an 8-bit (or 1-byte) binary code.

ASCII Code	Represents This Symbol	ASCII Code	Represents This Symbol
01000001	A	01100001	a
01000010	B	01100010	b
01000011	C	01100011	c
01011010	Z	00100011	#
00100001	!	00100100	\$
00100010	“	00100101	%

EBCDIC and Unicode

- EBCDIC
 - Used by older mainframe computers
- Unicode
 - Uses 16 bits (2 bytes)
 - Multilanguage support
 - Currently assigns more than 96,000 unique character symbols

Decimal Numbers

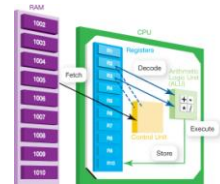
- Floating-point standard established by IEEE
- 32-bit (4-byte) system
 - First bit (sign bit) indicates positive or negative
 - Next 8 bits indicate magnitude (hundreds, millions, etc.)
 - Remaining 23 bits store number

Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

13

CPU Machine Cycle

- All CPUs must perform a series of similar steps:
 - Fetch
 - Decode
 - Execute
 - Store



Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

14

System Clock

- Moves CPU from one stage of the machine cycle to the next
- Acts as a metronome, keeping a steady beat or tick
 - Ticks, known as the clock cycle, set the pace
 - Pace, known as clock speed, is measured in hertz (Hz)

Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

15

Control Unit

- Manages switches inside the CPU
- Remembers
 - Sequence of processing stages
 - How switches are set for each stage
- Uses beat of system clock to move switch to correct on or off setting for each stage

Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

16

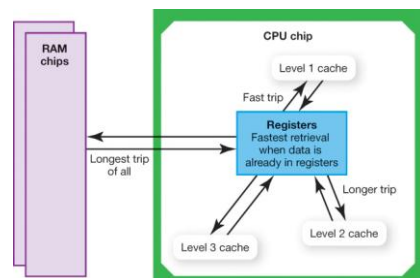
Stage 1: The Fetch Stage

- Data and program instructions stored in various areas of the computer
- Data moved from storage to RAM
- CPU accesses RAM and moves data into registers
- Cache memory
 - Stores recent or frequently used instructions
 - Faster to access than RAM

Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

17

Cache Memory



Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

18

Stage 2: The Decode Stage

- The CPU's control unit decodes a program's instructions into commands
- Instruction set
 - The collection of commands a CPU can interpret
 - Written in assembly language for programmers.
 - Assembly language is translated into machine language for the CPU

Copyright© 2011 Pearson Education, Inc. Publishing as Prentice Hall

19

Stage 3: The Execute Stage

- Arithmetic logic unit (ALU) performs
 - Mathematical operations
 - Addition
 - Subtraction
 - Multiplication
 - Division
 - Test comparisons (<, >, =)
 - Logical OR, AND, and NOT operations

Copyright© 2011 Pearson Education, Inc. Publishing as Prentice Hall

20

Stage 4: The Store Stage

- Results produced by the ALU in Stage 3 are stored in the registers

Copyright© 2011 Pearson Education, Inc. Publishing as Prentice Hall

21

Moore's Law

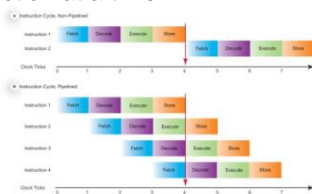
- The number of transistors on a processor doubles every 18 months
 - The first 8086 chip had 29,000 transistors and ran at 5 MHz
 - Today's Penryn chip for notebook computers has 820 million transistors and runs at 2.6 GHz

Copyright© 2011 Pearson Education, Inc. Publishing as Prentice Hall

22

Pipelining

- Boosts CPU performance
- CPU works on more than one stage or instruction at a time



Copyright© 2011 Pearson Education, Inc. Publishing as Prentice Hall

23

Multiple Processing

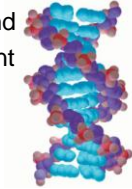
- Multiple processors or computers work on a problem simultaneously
 - Dual- or multicore: Multiple processors in one computer
 - Parallel processing: Multiple computers working on one problem
 - Problem must be able to be divided into a set of independent tasks

Copyright© 2011 Pearson Education, Inc. Publishing as Prentice Hall

24

DNA Computers

- Use DNA molecules and special enzymes instead of silicon chips
- 330 trillion operations per second
- 100,000 times faster than current silicon-based computers
- No practical applications yet



Copyright © 2011 Pearson Education, Inc. Publishing as Prentice Hall

25



This work is protected by United States copyright laws and is provided solely for the use of instructors in teaching their courses and assessing student learning. Dissemination or sale of any part of this work (including on the World Wide Web) will destroy the integrity of the work and is not permitted. The work and materials from it should never be made available to students except by instructors using the accompanying text in their classes. All recipients of this work are expected to abide by these restrictions and to honor the intended pedagogical purposes and the needs of other instructors who rely on these materials.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the publisher. Printed in the United States of America.

Copyright © 2011 Pearson Education, Inc.
Publishing as Prentice Hall

Technology in Focus

26