ACS-1803
Introduction to Information Systems

Instructor: Kerry Augustine

Introducing the Computer

Lecture Outline 9-1

Introducing the Computer

- Computer Components and Processing Functions

Introducing the Computer

- Information processor capable of performing electronically substantial computations including numerous arithmetic or logical operations without intervention by a human operator
- Basic architecture:

CENTRAL

INPUT → PROCESSING → OUTPUT

UNIT + MAIN

MEMORY (*internal*)

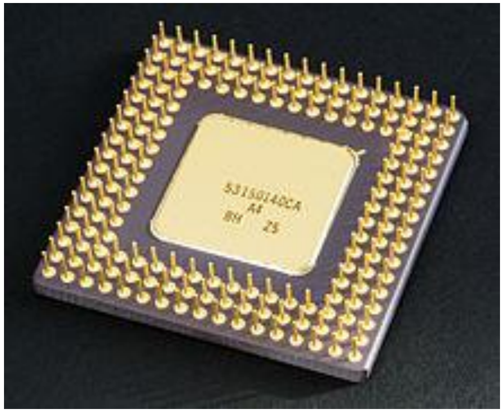
| | | | | | |

AUXILIARY

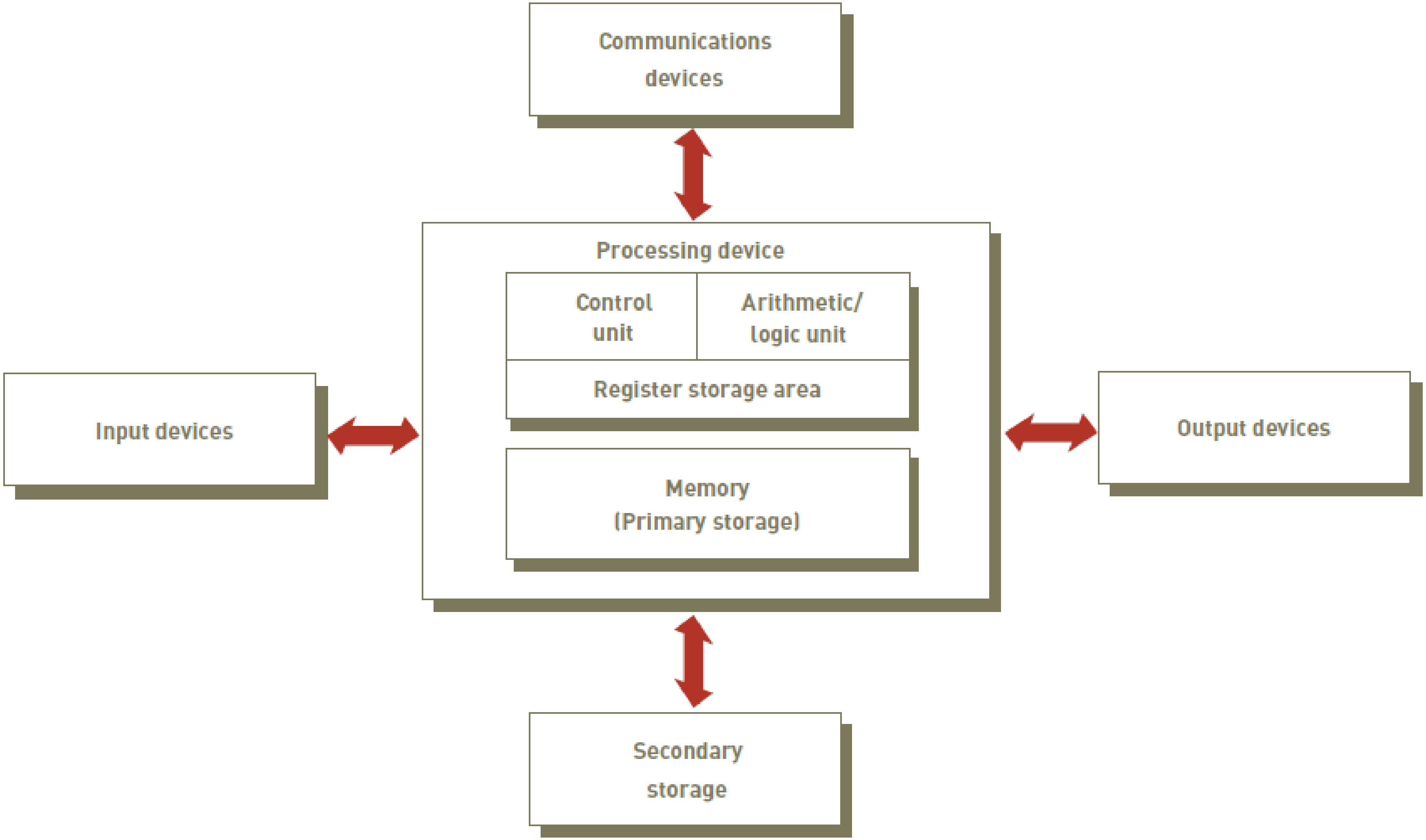
STORAGE (*external*)

Computer Components

- Central processing unit (CPU):
  - Arithmetic/logic unit (ALU): Performs mathematical calculations and makes logical comparisons
  - Control unit: Sequentially accesses program instructions, decodes them, and coordinates the flow of data in and out of the ALU, registers, primary storage, and even secondary storage and various output devices
  - Register: Small memory location where instructions to be processed are stored.



Computer Components (continued)



Processing Characteristics and Functions

- Clock speed:
  - Series of electronic pulses produced at a predetermined rate that affects machine cycle time
  - Often measured in:
    - Megahertz (MHz): millions of cycles per second
    - Gigahertz (GHz): billions of cycles per second
- Physical characteristics of the CPU
  - Most CPUs are collections of digital circuits imprinted on silicon wafers, or chips, each no bigger than the tip of a pencil eraser

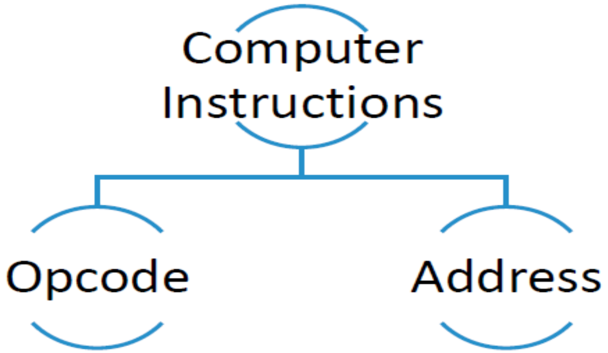
Memory Characteristics and Functions

- Memory:
  - Provides the CPU with a working storage area for programs and data
  - Rapidly provides data and instructions to the CPU
- Storage capacity:
  - Eight bits together form a *Byte*

Main Memory and Instructions

- Cells in main memory hold:
  - instructions and data for the instructions
  - both in electronic form
- Instructions for the CPU tell it to perform sequences of very basic operations
  - e.g., add, subtract, multiply, divide, move, store
  - these are the only kind of instructions that the computer can actually execute
- Every major problem that we want the computer to solve must be broken down into a series of instructions at this simple level

Sample Machine Level Program



Instruction for a computer: **opcode + address**

- Opcodes (engineers decide on these):
  - 008 - clear accumulator and add to it the contents of the main memory address that follows this opcode
  - 009 - add to the accumulator the contents of the main memory address that follows this opcode
  - 010 - store the result from the accumulator in the main memory address that follows this opcode

example of an instruction: **008 003**

Machine Level Program – First Generation

Instruction is : 008 003

008 - load into accumulator in ALU
003 - **whatever is in address** (cell) **3 <u>in memory</u>**

program:	memory cell	0:	008 003
		1:	009 004
		2:	010 005
data:	memory cell	3:	000 100
	memory cell	4:	000 050

Instructions are transferred, from memory into the CPU's control unit, one by one, where they are placed in a register and decoded by "wires"

Basic Workings of a CPU:

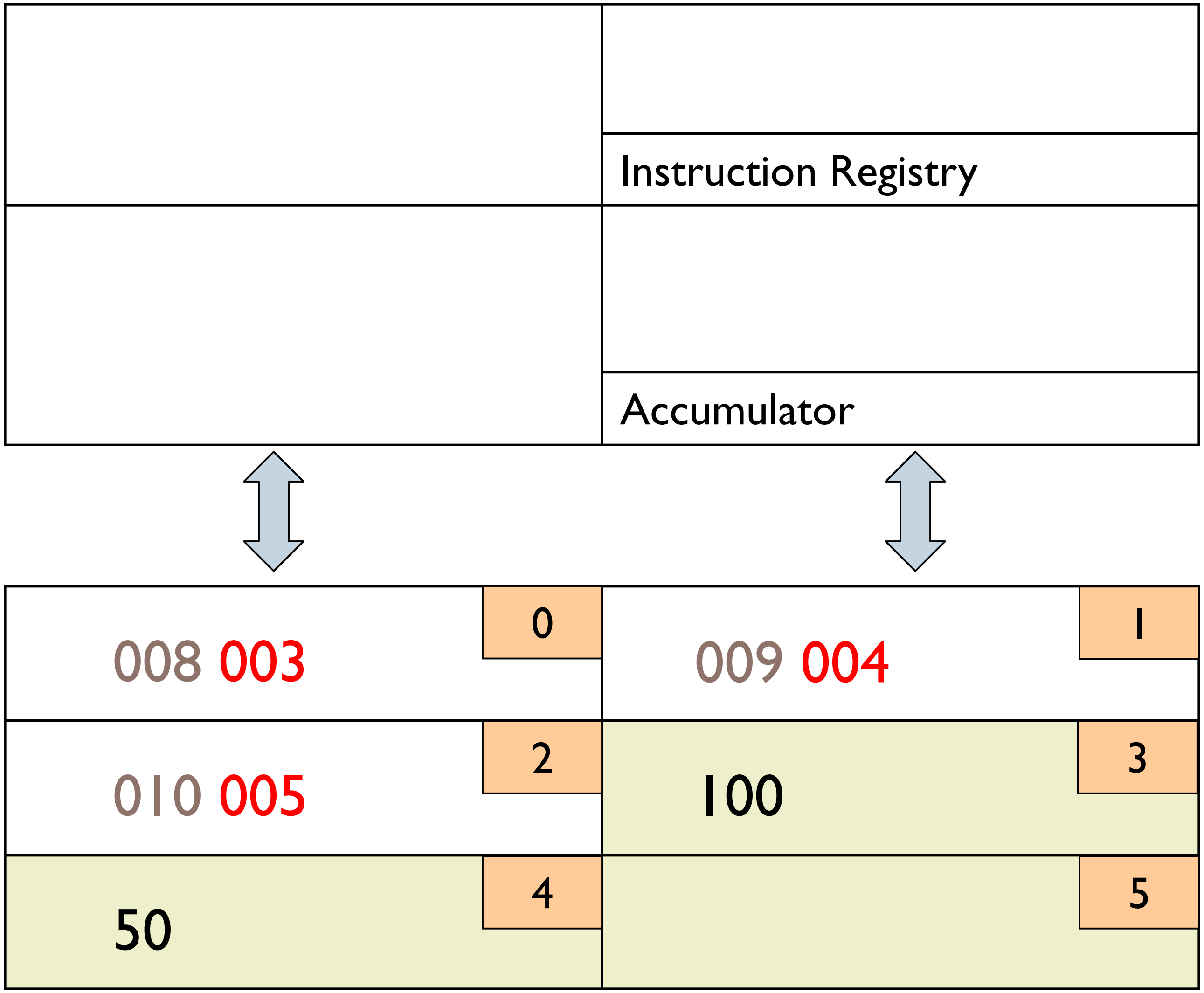
The CPU:

Control Unit:
(registers)

Arithmetic / Logic
Unit:
(ALU)

Main Memory:

(Primary Storage)



Instruction Registry

Accumulator

0 008 003

1 009 004

2 010 005

3 100

4 50

5

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Unit:
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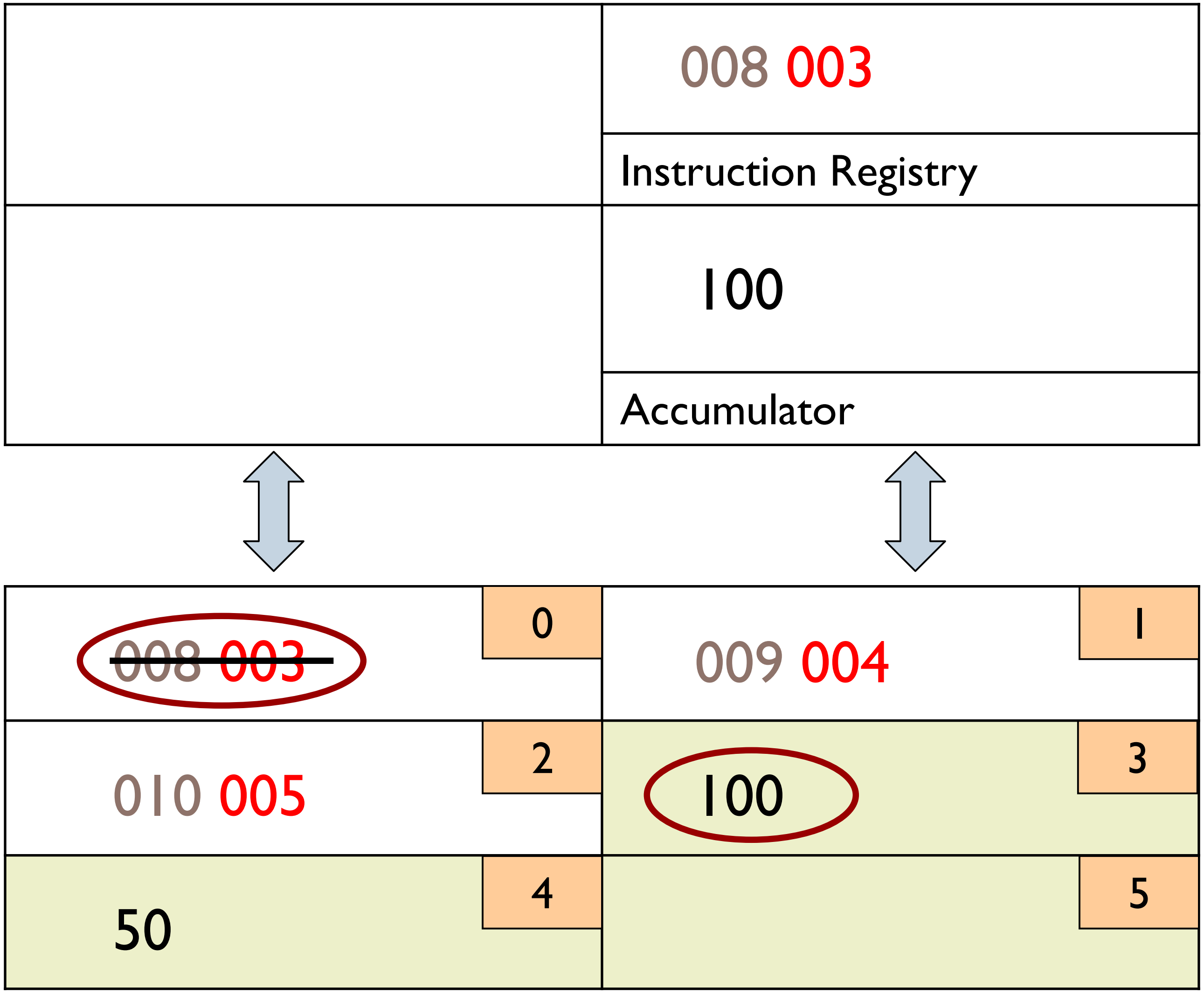
(Primary Storage)



008 003

Instruction Registry

100

Accumulator

0

~~008 003~~

1

009 004

2

010 005

3

100

4

50

5

Basic Workings of a CPU:

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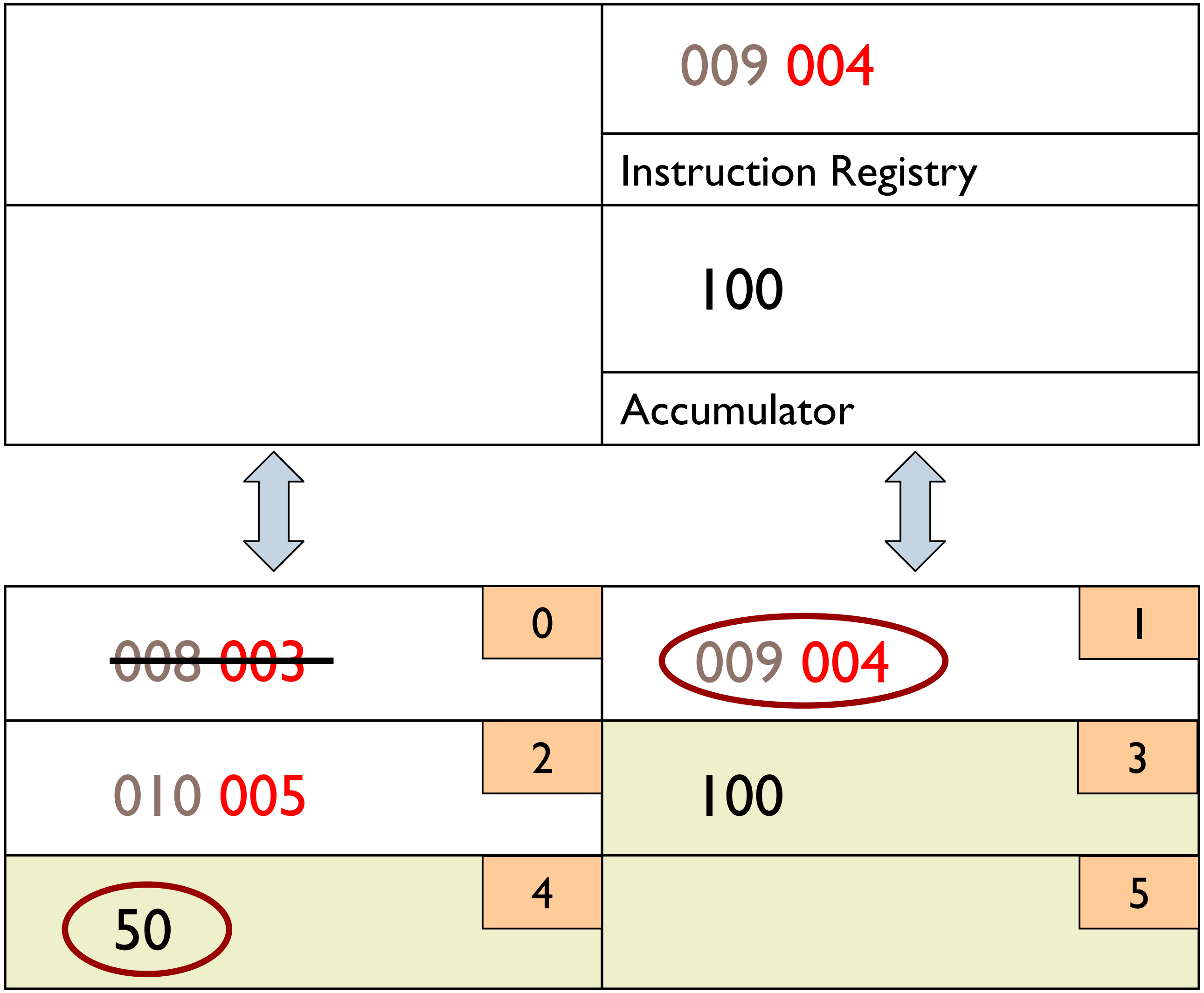

009 004

Instruction Registry

100

Accumulator

~~008 003~~ 0

009 004 1

010 005 2

100 3

50 4

5

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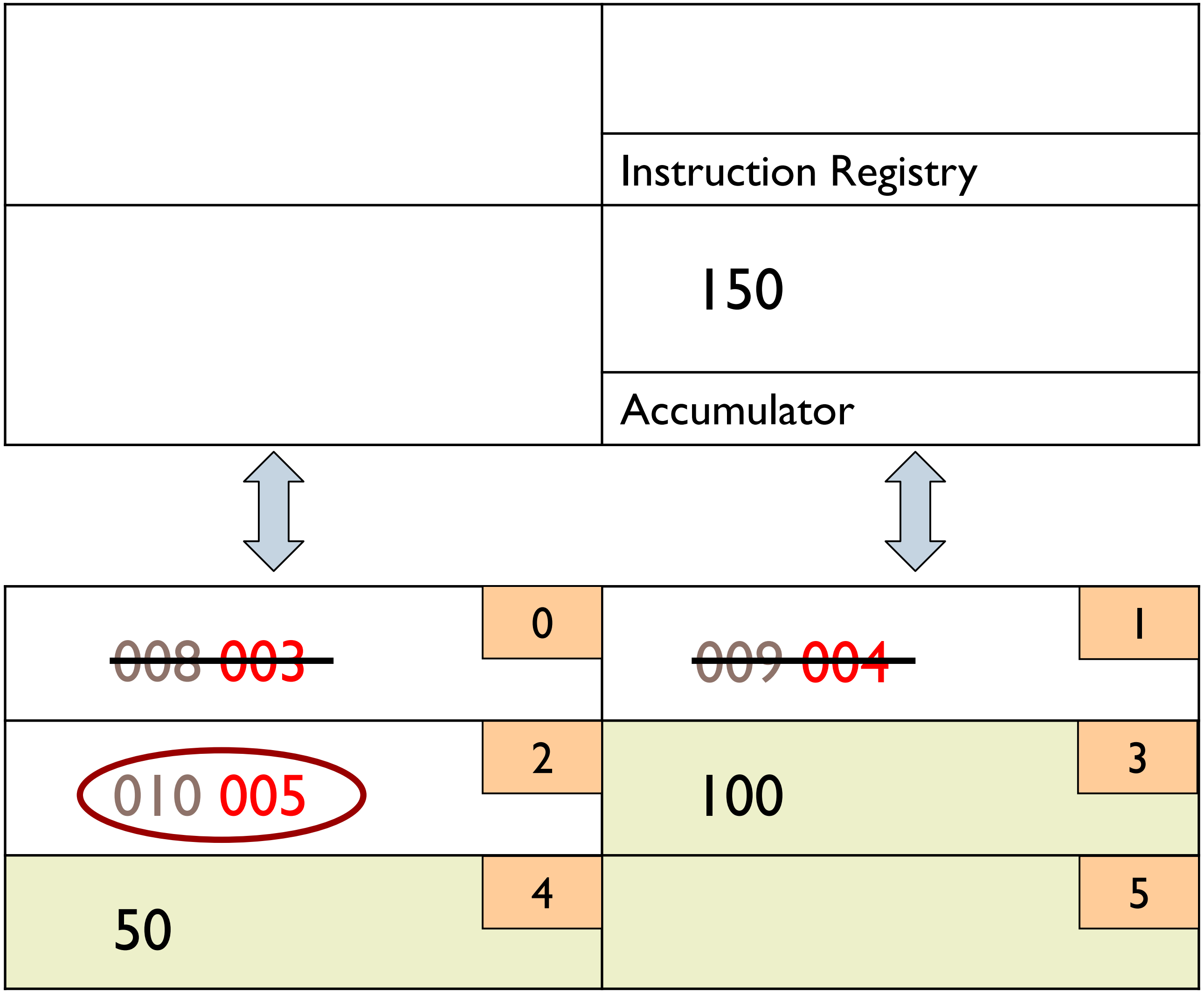

Instruction Registry

150

Accumulator

~~008 003~~ 0

~~009 004~~ 1

010 005 2

100 3

50 4

5

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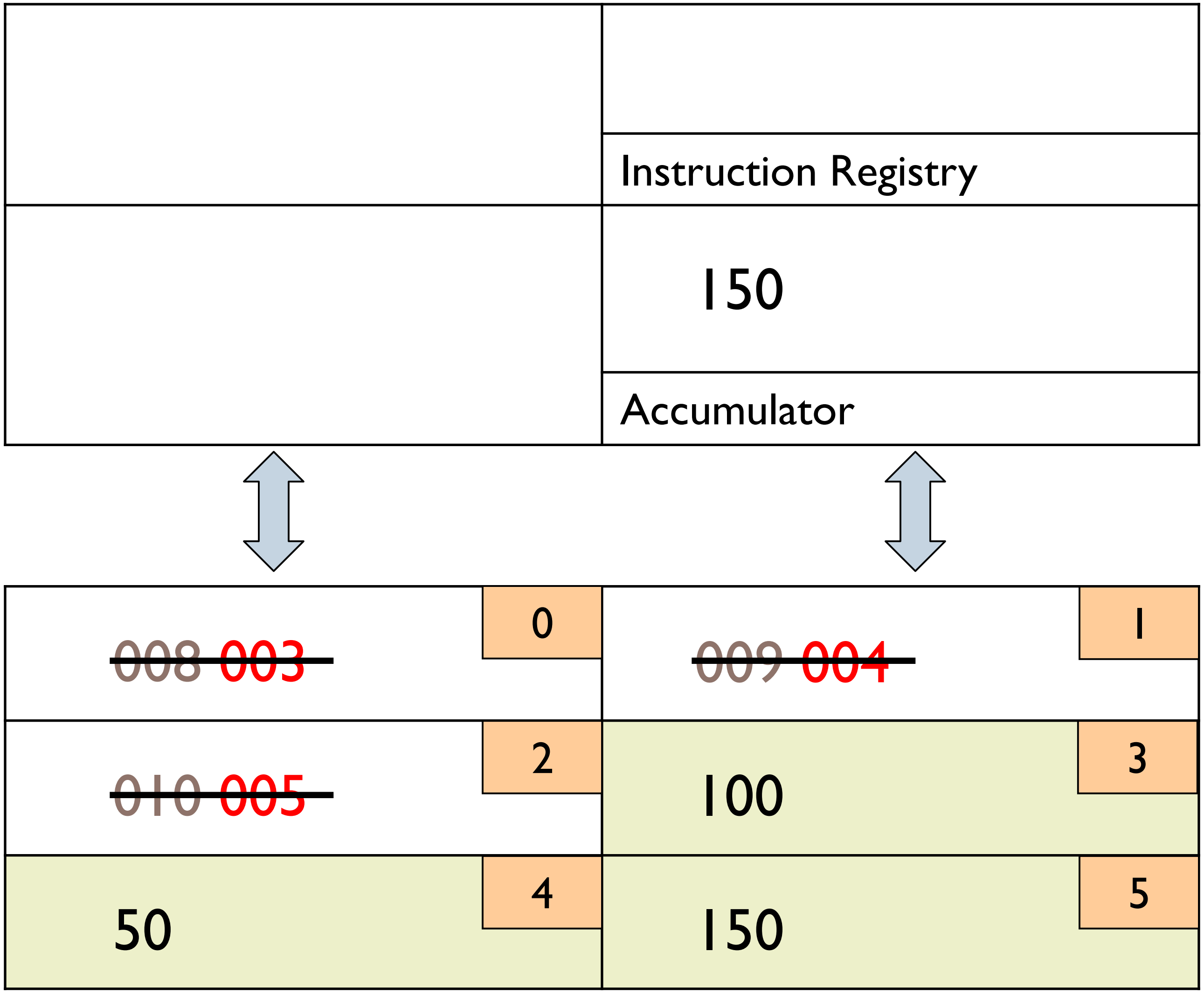


Instruction Registry

150

Accumulator

~~008~~ ~~003~~ 0	~~009~~ ~~004~~ 1
~~010~~ ~~005~~ 2	100 3
50 4	150 5

How the Computer Understands Instructions

- The machine fetches instructions (from memory), decodes and executes (in CPU) and stores results of the execution (in memory)
  - example of an instruction for CPU: 008 003

- However, such an instruction must be represented electronically, ONLY in terms of + or -
  - 008 003 (base 10)
  - 1000 0011 (base 2) +--- --++ (electronic form)
    - This is how the instruction looks in the machine

How the Computer Understands Instructions

Base 10	Base 2	
Decimal pattern	Binary numbers	Electronic form
0	0	-
1	1	+
2	10	+ -
3	11	+ +
4	100	+ - -
5	101	+ - +
6	110	+ + -
7	111	+ + +
8	1000	+ - - -
9	1001	+ - - +

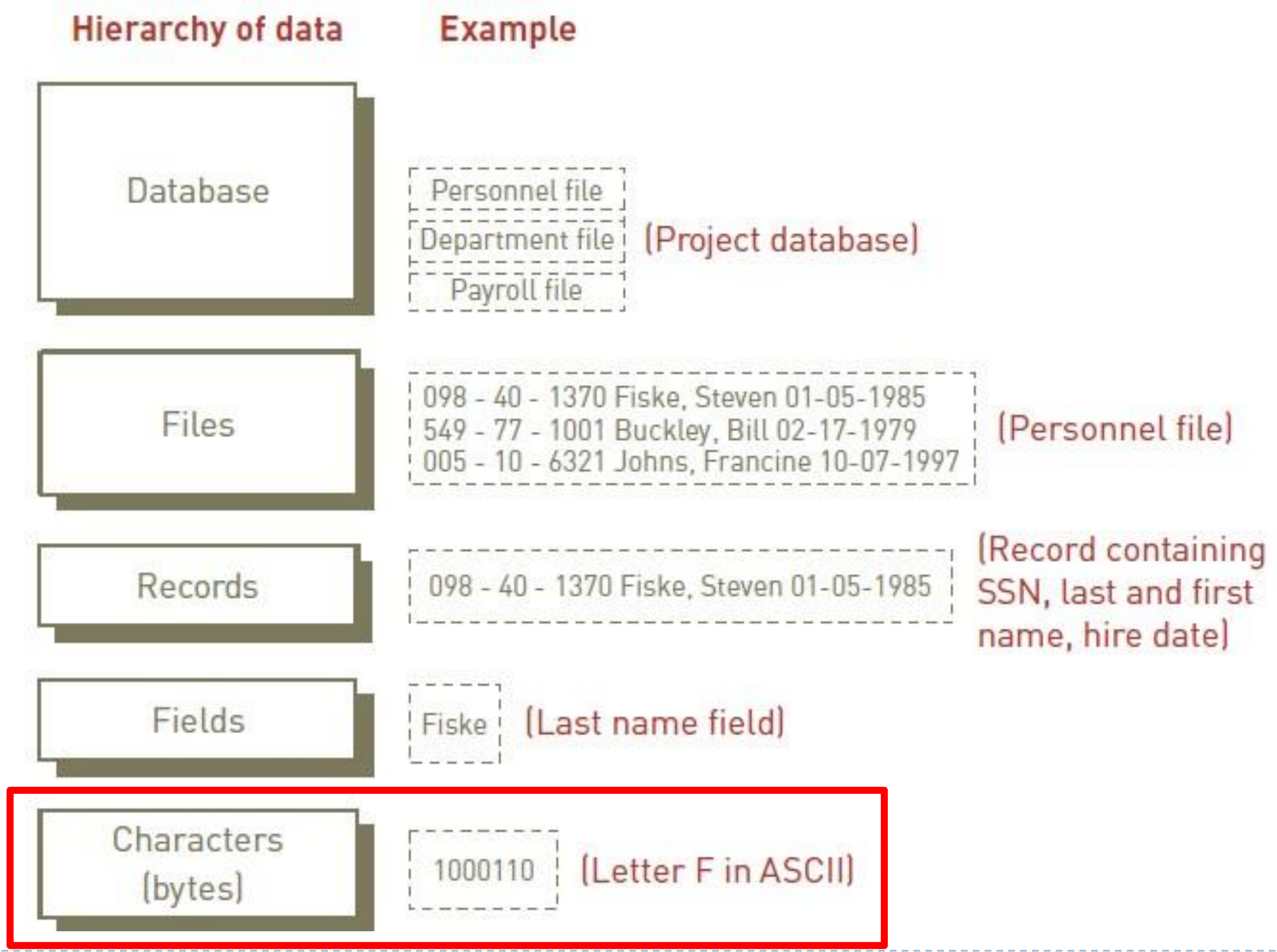
How the Computer Understands Instructions

- Base 10 → Use 10 different digits to represent numbers
- Base 2 → Use only two digits to represent numbers.

```
   1 1 1 1 1 (carried digits)
    0 1 1 0 1   (13)
  + 1 0 1 1 1   (23)
   -------------
= 1 0 0 1 0 0 = 36
```

- Binary is a base-2 system, each digit represents an increasing power of 2, with the rightmost digit representing 2^0, the next representing 2^1, then 2^2, and so on. T
- To determine the decimal representation of a binary number simply take the sum of the products of the binary digits and the powers of 2 which they represent.
- For example, the binary number 100100 is converted to decimal form as follows:
- $= [(1) \times 2^5] + [(0) \times 2^4] + [(0) \times 2^3] + [(1) \times 2^2] + [(0) \times 2^1] + [(0) \times 2^0]$
- $= [1 \times 32] + [0 \times 16] + [0 \times 8] + [1 \times 4] + [0 \times 2] + [0 \times 1]$
- 100100_2 **= 36_{10}**

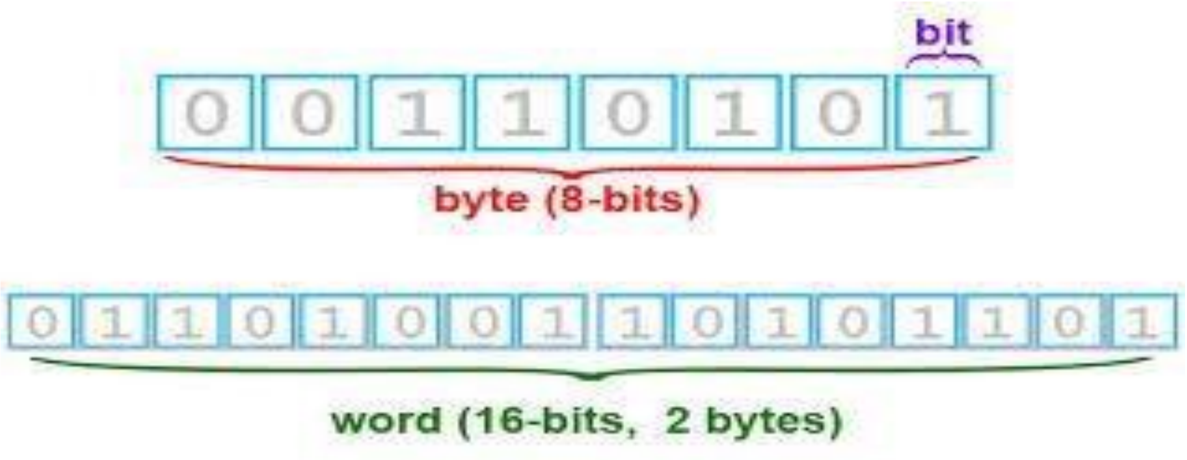
Hierarchy of Data



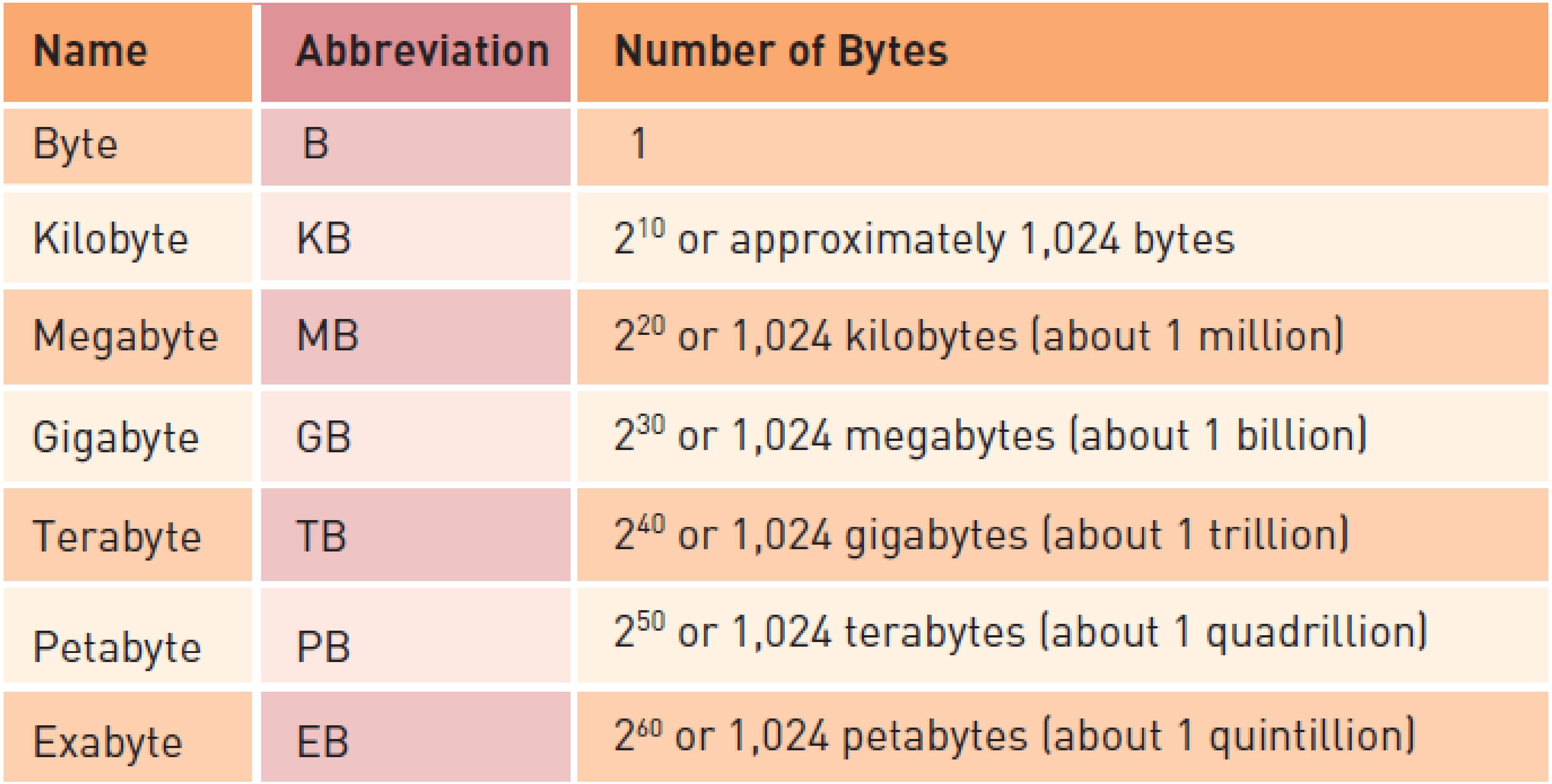
Hierarchy of data	Example	
Database	Personnel file Department file Payroll file	(Project database)
Files	098 - 40 - 1370 Fiske, Steven 01-05-1985 549 - 77 - 1001 Buckley, Bill 02-17-1979 005 - 10 - 6321 Johns, Francine 10-07-1997	(Personnel file)
Records	098 - 40 - 1370 Fiske, Steven 01-05-1985	(Record containing SSN, last and first name, hire date)
Fields	Fiske	(Last name field)
Characters (bytes)	1000110	(Letter F in ASCII)

Unit of Digital Measure

- Bit (a binary digit):
  - Circuit that is either on (1) or off (0)
- Byte:
  - Made up of eight (8) bits
- Character:
  - Basic building block of information – two (2) or more bytes



Digital Measure



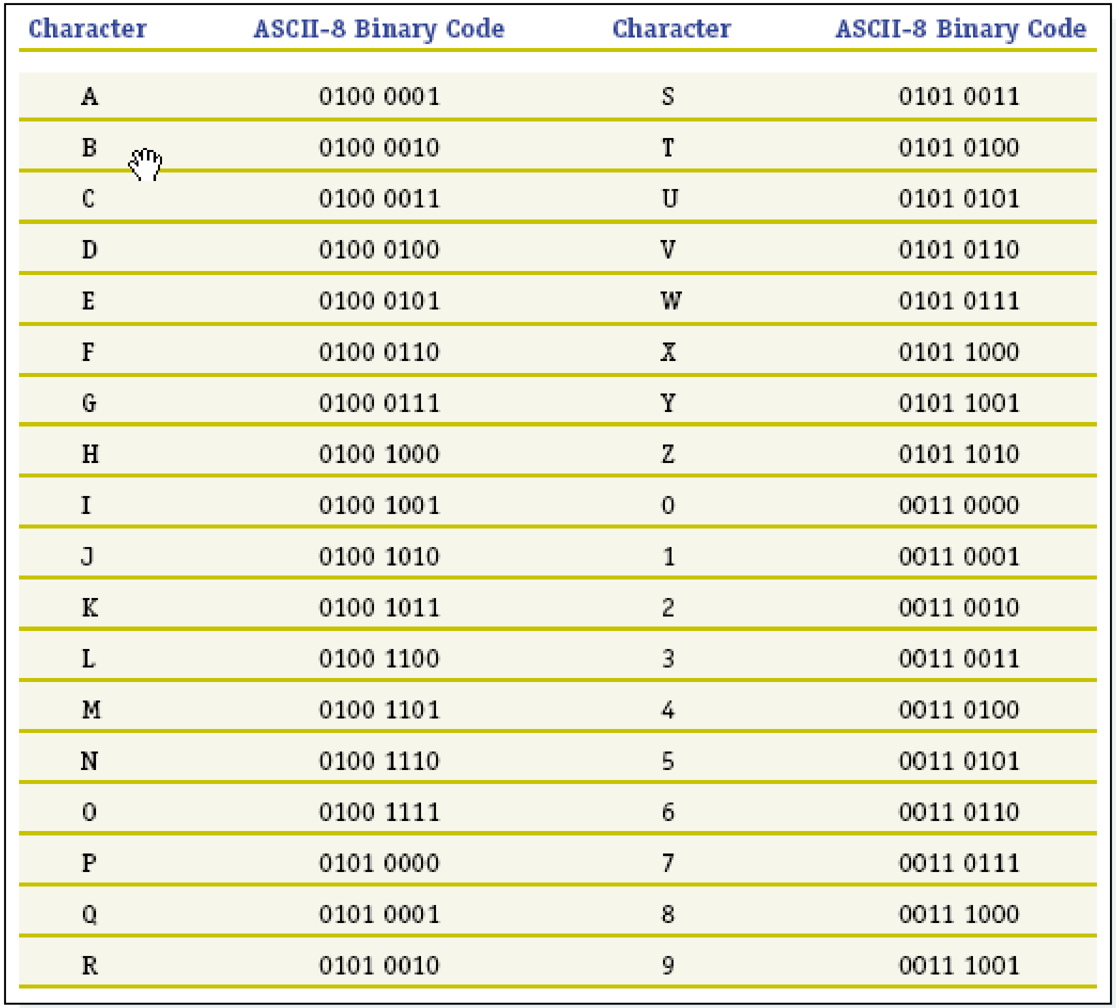
Name	Abbreviation	Number of Bytes
Byte	B	1
Kilobyte	KB	2^{10} or approximately 1,024 bytes
Megabyte	MB	2^{20} or 1,024 kilobytes (about 1 million)
Gigabyte	GB	2^{30} or 1,024 megabytes (about 1 billion)
Terabyte	TB	2^{40} or 1,024 gigabytes (about 1 trillion)
Petabyte	PB	2^{50} or 1,024 terabytes (about 1 quadrillion)
Exabyte	EB	2^{60} or 1,024 petabytes (about 1 quintillion)
Zettabyte	ZB	2^{70} or 1,024 exabytes (about 1 sextillion)
Yottabyte	YB	2^{80} or 1,024 zetabytes (about 1 septillion)

How the Computer Understands Instructions

- Instructions at this level (+ and -) are said to be in machine language
- Earliest programs were written in machine language (first generation language)
- Then, a coding system was developed
- each character on keyboard is represented by a specific sequence of 0s and 1s
- (ASCII or EBCDIC – agreed upon coding schemes)

Processing – Language Binary Example

American Standard Code for Information Interchange (ASCII)



Character	ASCII-8 Binary Code	Character	ASCII-8 Binary Code
A	0100 0001	S	0101 0011
B	0100 0010	T	0101 0100
C	0100 0011	U	0101 0101
D	0100 0100	V	0101 0110
E	0100 0101	W	0101 0111
F	0100 0110	X	0101 1000
G	0100 0111	Y	0101 1001
H	0100 1000	Z	0101 1010
I	0100 1001	0	0011 0000
J	0100 1010	1	0011 0001
K	0100 1011	2	0011 0010
L	0100 1100	3	0011 0011
M	0100 1101	4	0011 0100
N	0100 1110	5	0011 0101
O	0100 1111	6	0011 0110
P	0101 0000	7	0011 0111
Q	0101 0001	8	0011 1000
R	0101 0010	9	0011 1001

Types of Binary

Micro Computers

- ASCII - 8 bit
- Extended – 8 bit

Mainframe Computers

- EBCIDIC – 8 bit
- Extended Binary Coded Decimal Interchange Code

Other Types

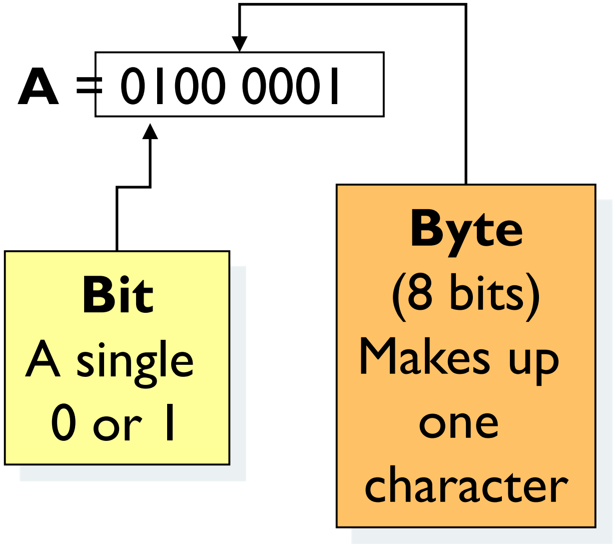
- Unicode – 16 bit
- Universal Character Set
- Used for international languages

Processing – Language

Binary or Machine Language (First General Language)

- The language that all computers use
- IT is expressed in 0s or 1s only (see below)
- Binary utilizes Base-2 math to convert from normal characters to binary code (e.g. A = 0100 0001 in binary)

Binary Example

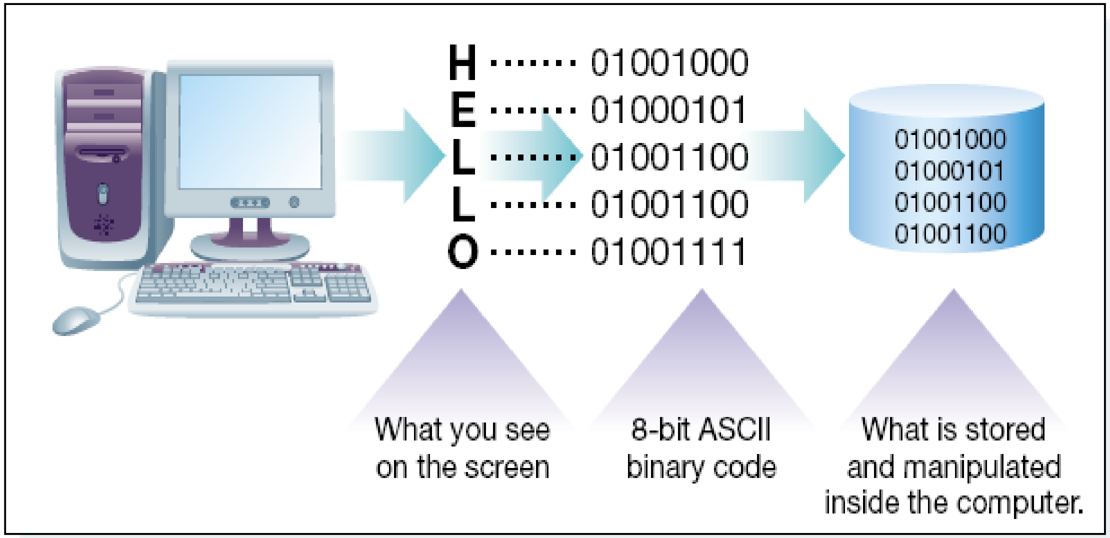


A = 0100 0001

Bit
A single
0 or 1

Byte
(8 bits)
Makes up
one
character

How a Computer Uses it



How did a coding system make programming easier?

- Now **programs could be written in <u>symbolic</u> machine language** (assembly language) **because *letters could be entered into a computer* in 0s and 1s**

- How would you write your first name in Binary?

Assembly Language – Second Generation

e.g.,

```
CLA X
ADD Y
STO Z
X
Y
Z
```

(second generation language)

ADDING TWO NUMERS IN ASSEMBLY LANGUAGE

A translation program [assembler], itself in machine language, would translate this code into actual machine language for the CPU

Translating Assembly Language

- Programmer writes CLA X
- Machine receives

0100 0011 0100 1100 0100 0001 0101 1001

C L A X

(if there was no ascii we couldn’t get this in)

- Assembler program translates this to:

1000 0011 (008 003) [equivalent machine language instruction]

Higher Level Languages

Assembly language [second generation] - low level:

- **one** statement in assembly language translates into
- **one** statement in machine language

A complicated, "real world" problem, still had to be broken down into small steps for the CPU

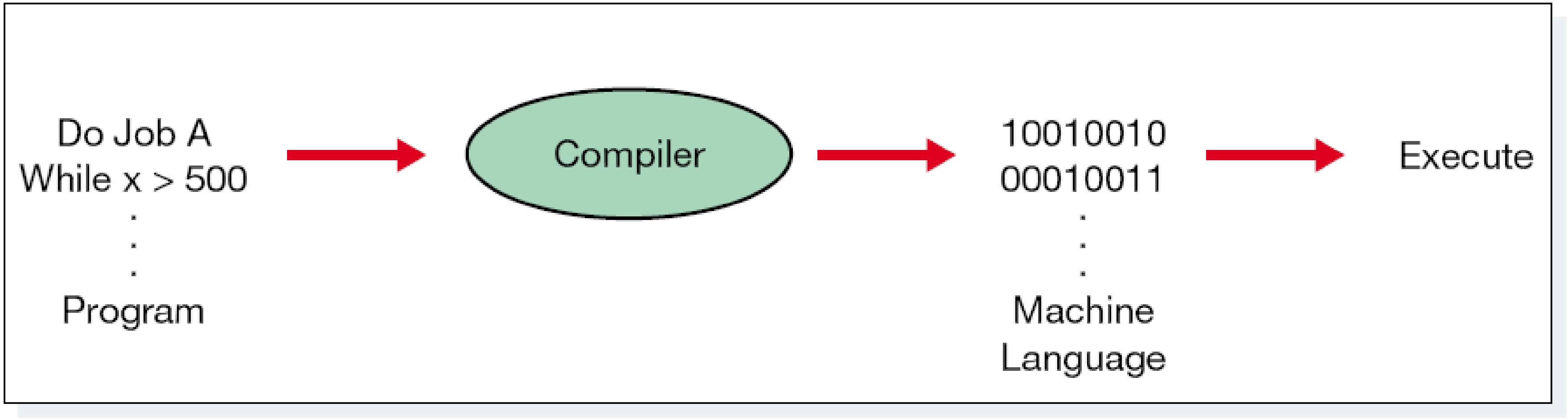
Then came third generation languages (high-level)

- **one** statement in 3GL translates into
- **many** statements in machine language

Compilers and Interpreters

Compilers
These highly-specialized software applications are used to convert program instructions (source code) into the machine code (object code) prior to being loaded into a computer's secondary storage

Compiler Example



Third Generation Languages

FORTRAN 3rd Generation Language:

Z = X + Y

(will be translated to mach. language by FORTRAN compiler)

COBOL 3rd Generation Language:

ADD Y TO X GIVING Z.

(will be translated to mach. language by COBOL compiler)

Third Generation Languages

- Not necessary to think at the level of a machine
- Translation program [*compiler or interpreter*] translates 3GL to machine language

- However, in a 3GL, we still have to tell the computer both **WHAT** to do and **HOW** to do it.
- We call this **PROCEDURAL** Language

- Different 3GLs:

COBOL (business)	**FORTRAN** (scientific)
BASIC	PASCAL
C, C++, C#	JAVA

- each 3GL has different grammar; suited to different problems

Fourth Generation Languages

- Much more user-friendly

- Tell the computer **WHAT** to do but not **HOW** to do it.
- We call this **NON-PROCEDURAL** Language

- Eg: average <list of numbers>
  - exist only for specific problems / uses

Different 4GLs: DOS
dBASE
SQL
PowerBuilder

Fourth Generation Computing

- We can also call common application software
  - Word processing
  - Spreadsheets
  - Web browsers
  - Multimedia programs

Fourth generation (non-procedural) software [WHAT to do; not HOW] *but they are* ***not, properly, languages***

- Sometimes called <u>productivity tools</u>

-They use a **GRAPHICAL USER INTERFACE**

Procedural and Non-procedural Computing

PROCEDURAL **(3rd Generation Language)**

- Need to tell the computer **WHAT** you want **and HOW** to do it (how to *proceed*)

- Need to **have an *algorithm*** for the problem

(sequence of logical steps necessary to solve the problem)

-Need to **code the algorithm** in a procedural (3rd Gen) language

NON-PROCEDURAL **(4th Generation Language)**

- Tell the computer what to do, **but not** how to do it.

Finding the Average of Numbers

- **AVERAGE: 232, 452, 554, 667, 932, 122;**

- **The Algorithm:**

```
NNum = 0; SumNum=0
While there are numbers to read
    Read a number
    Add 1 to NNum
    Add the number to SumNum
End While
Average = SumNum / NNum
Print "Average is:", Average
```

Coding the Algorithm

- The algorithm (set of steps) will now be coded in a non-procedural language: Microsoft Excel
- This program tells the computer HOW to find the average
- The program compiles to machine language using an algorthm

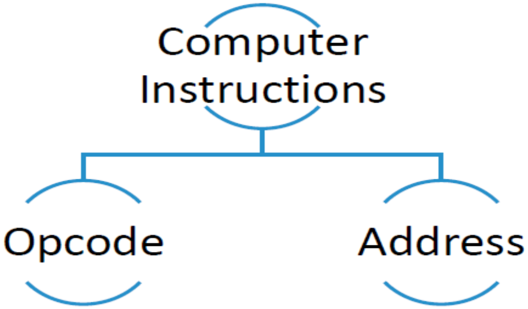
- Type in the numbers into a box
- **Click a button for "Average"** (using GUI)

First to Second Generation Languages

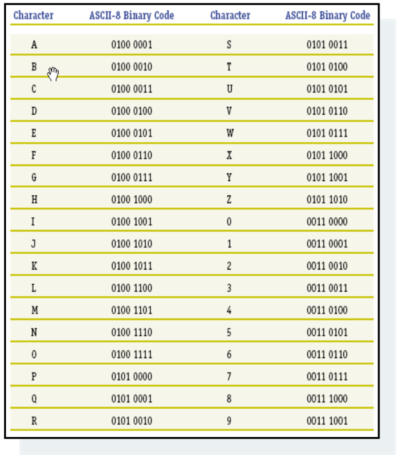
1st GL

Machine Language:

```
1000  0011
1001  0100
1010  0101
```



Binary Code Table



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G	0100 0111	Y	0101 1001
H	0100 1000	Z	0101 1010
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J	0100 1010	1	0011 0001
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O	0100 1111	6	0011 0110
P	0101 0000	7	0011 0111
Q	0101 0001	8	0011 1000
R	0101 0010	9	0011 1001

2nd GL

Assembly Language:

```
CLA  X
ADD Y
STO Z
X
Y
Z
```

Second to Third Generation Languages

2nd GL

Assembly Language:

CLA X

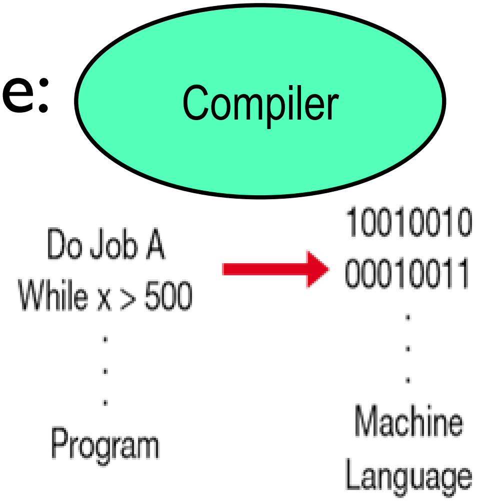
ADD Y

STO Z

X

Y

Z



3rd GL

High Level Language:

PROCEDURAL Language

Third to Fourth Generation Languages

3rd GL

High Level Language:

PROCEDURAL Language

- **The Algorithm:**

```
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While there are numbers to read
    Read a number
    Add 1 to NNum
    Add the number to SumNum
End While
Average = SumNum / NNum
Print "Average is:", Average
```

4th GL

High Level Language:

Non-PROCEDURAL Language

- Type in the numbers into a box
- **Click a button for "Average"** (using GUI)

Generations of Programming Languages

Programming Languages
Used to generate program instructions and have evolved over time making them more powerful, easier to read and write, and more natural language-focused

Generations of Programming Languages

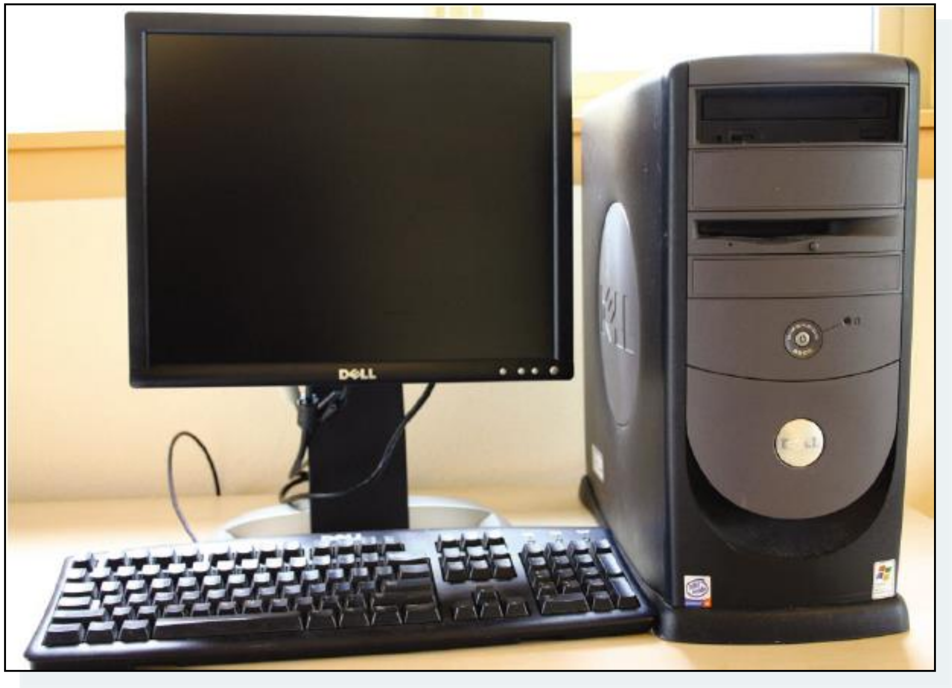
1940s	1950s	mid 1950-60s	1970s	1990s
1st	2nd	3rd	4th	5th
Machine Binary	Symbolic Use of symbols	High-Level Use English like words for procedures	Outcome Oriented Use outcome focused words	Artificial Intelligence Natural language (spoken English)

Computer Hardware

- Microcomputer System

Microcomputer System

Output Device
Monitor



Input Device
Keyboard

Processing Device
The System Unit

The Microcomputer

E.g., PC or Apple

- microprocessor (chip) is the CPU
- much elaborate, user-friendly software
- consists of: **system unit (box), monitor (screen), keyboard, mouse, printer**

In the system unit:

- **motherboard**, disk drives, CD-ROM drive, cards, cables, power supply

Motherboard

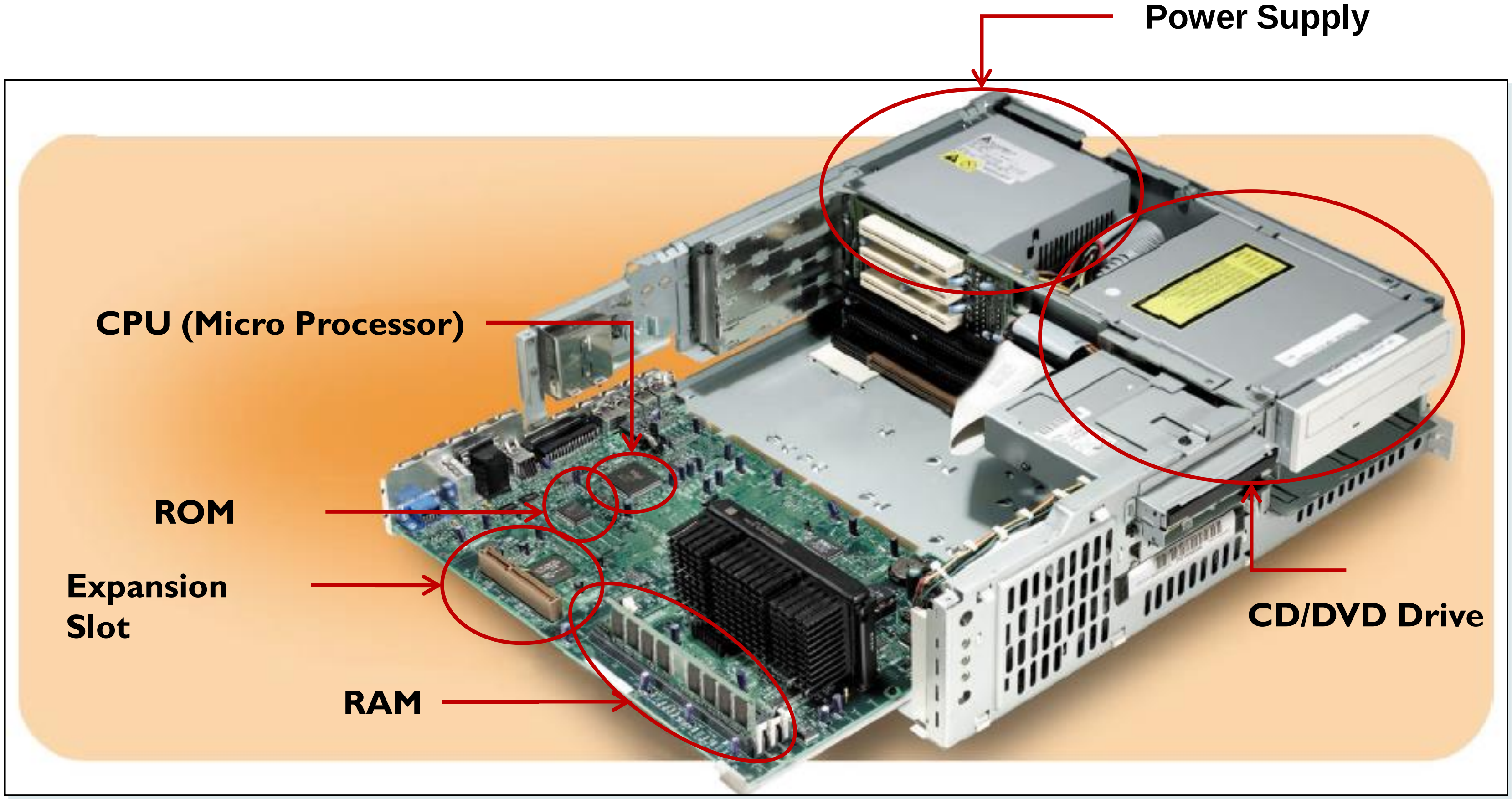
- Main circuit board: **microprocessor (CPU chip), RAM (Random Access memory - main memory),** buses, cards

- Intel microprocessor chips (past and present):

  8088, 8086, 80286, 80386, 80486, Pentium+++

  -speed in MegaHertz (Million of vibrations per second) or GigaHertz (1024 MHz)
  -all processing (calculations) done in the microprocessor

Processing – Mother Board Example



- A computer's Motherboard holds or connects to all of the computer's electronic components

Ram/Rom /Expansion Cards

- **RAM**: main memory chips: 2-8 GB +.
  - RAM holds the **Operating System, Application Software, Data**

- **ROM** (Read Only Memory) – burned-in programs to start up the computer

- **Buses** (multi-lane highways) carry instructions from memory to microprocessor and back

- **Expansion Cards**: circuit boards that plug into expansion slots on the motherboard;
  - Links peripheral equipment (printers, disks) with motherboard at the back of the cards are **ports**

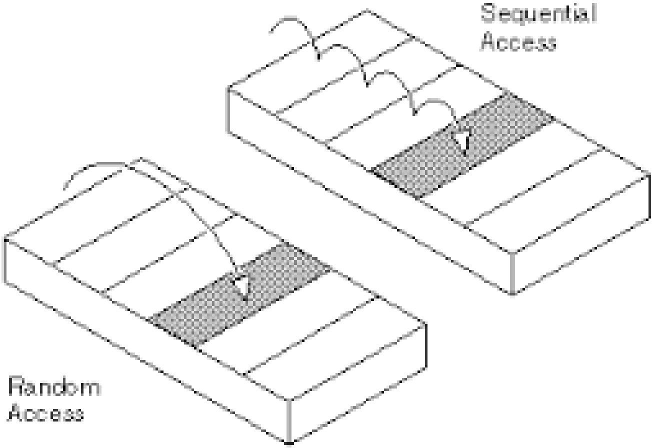
Computer Storage – Primary/Secondary

- Primary (Internal) Storage:
  - Main memory
  - Stores **instructions** and **data** that are being worked on by the CPU
  - Contents erased when power off

- Secondary (External) Storage:
  - Devices that store large amounts of data, instructions, and information more permanently than allowed with memory
    - Nonvolatility
    - Greater capacity
    - Greater economy
  - Most common forms
    - Magnetic disk, tape
    - Optical storage
    - Solid state

Secondary Storage Devices

- Sequential access
  - Data must be retrieved in the order in which it is stored
  - Devices used are called sequential access storage devices (SASDs)
- Direct access
  - Records can be retrieved in any order
  - Devices used are called direct access storage devices (DASDs)

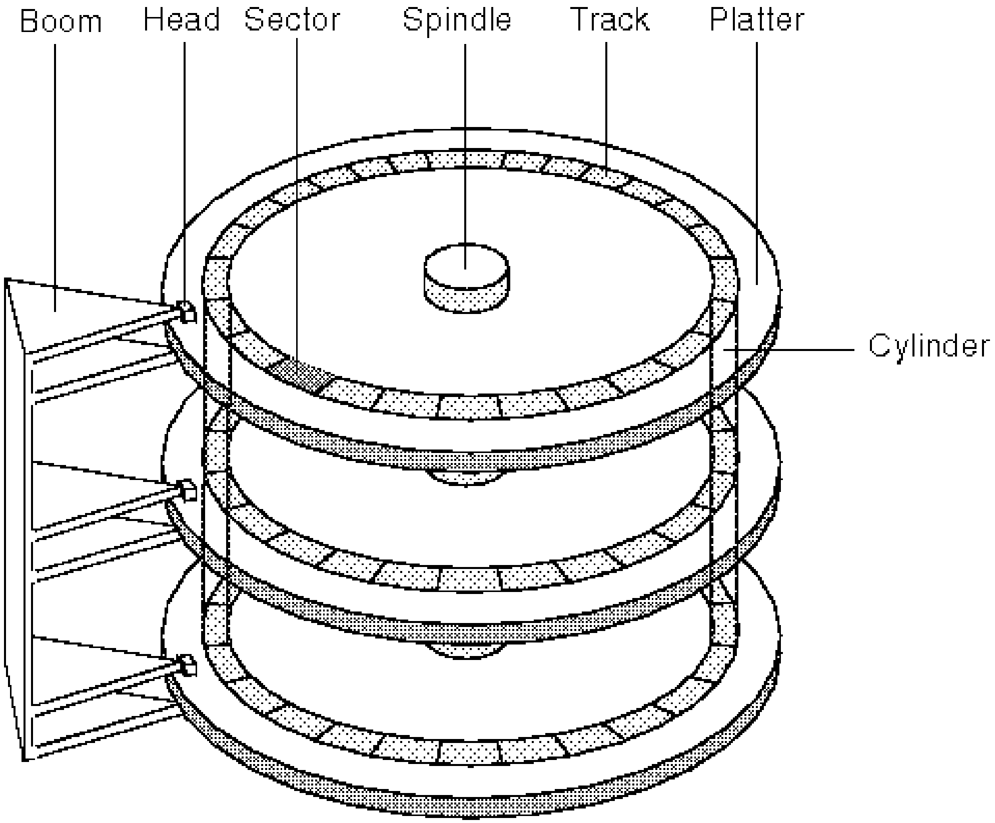


Magnetic Disk

- hard disk
- platters one below other
- each platter has tracks
- data stored along tracks
- info. picked up by read / write heads

- software and data taken from disk to main memory

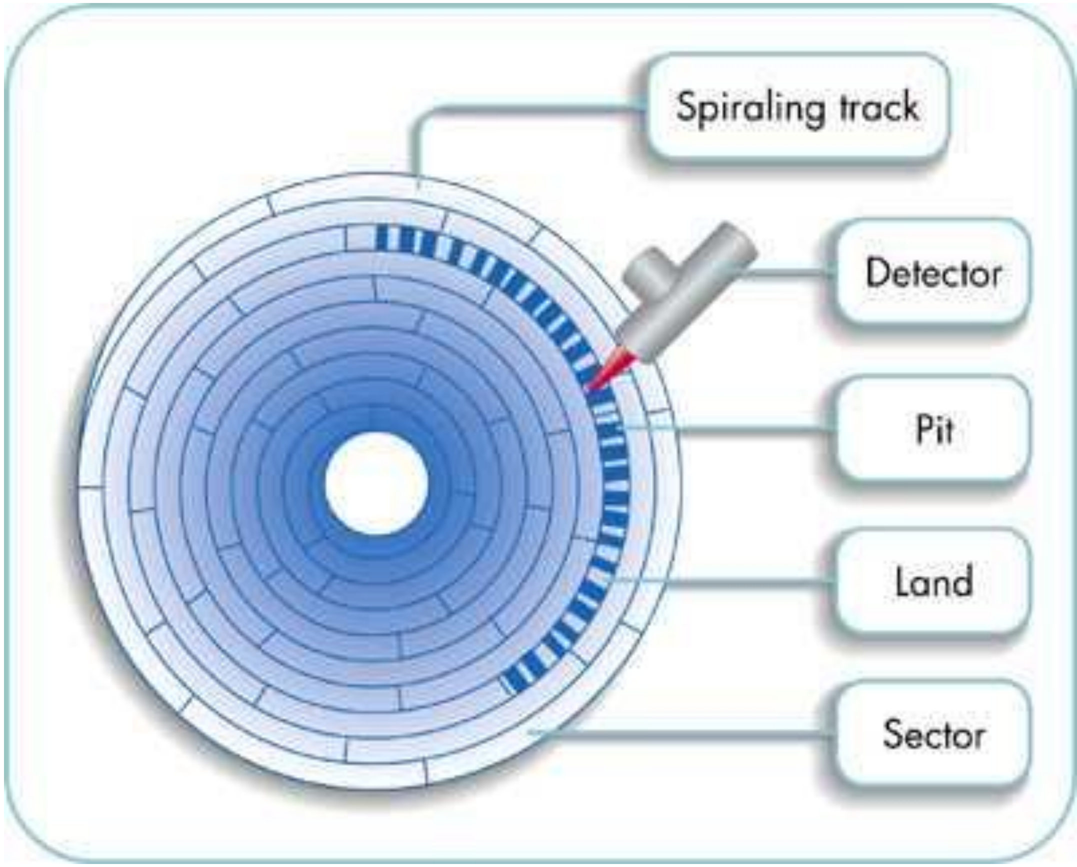
- disk allows direct access as opposed to tape which is sequential



Optical Storage

CD ROM

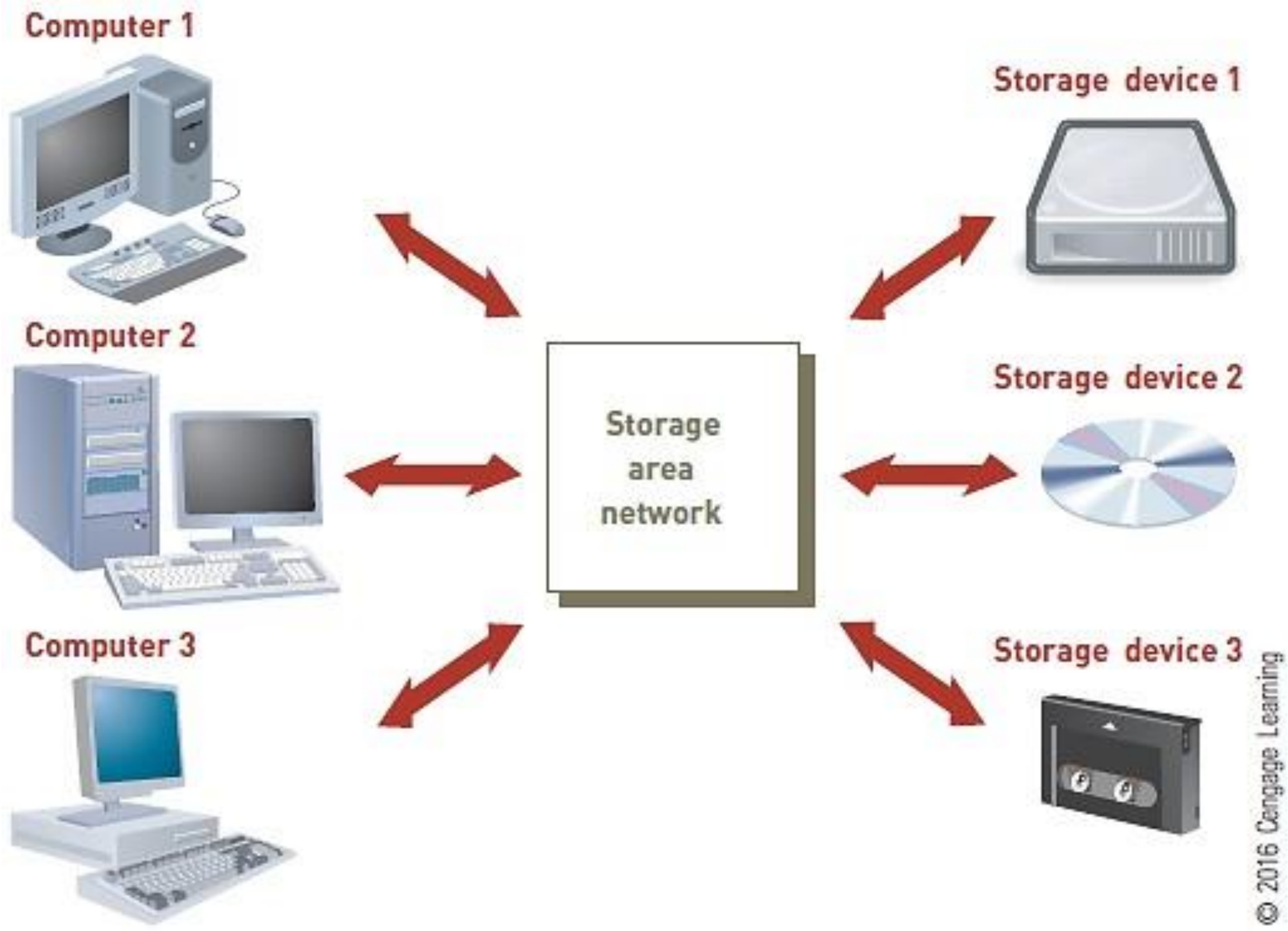
- laser light instead of magnetic form
- can store much more data in same amount of space
- A CD can hold up to 740 MB Data



Secondary Storage Devices

- Digital video disc (DVD):
  - Storage medium used to store software, video games, and movies
- Solid state secondary storage devices:
  - Store data in memory chips rather than magnetic or optical media
  - Have few moving parts, so they are less fragile than hard disk drives
  - High cost per GB of data storage
  - Lower capacity compared to current hard drives

Storage Area Network (SAN)



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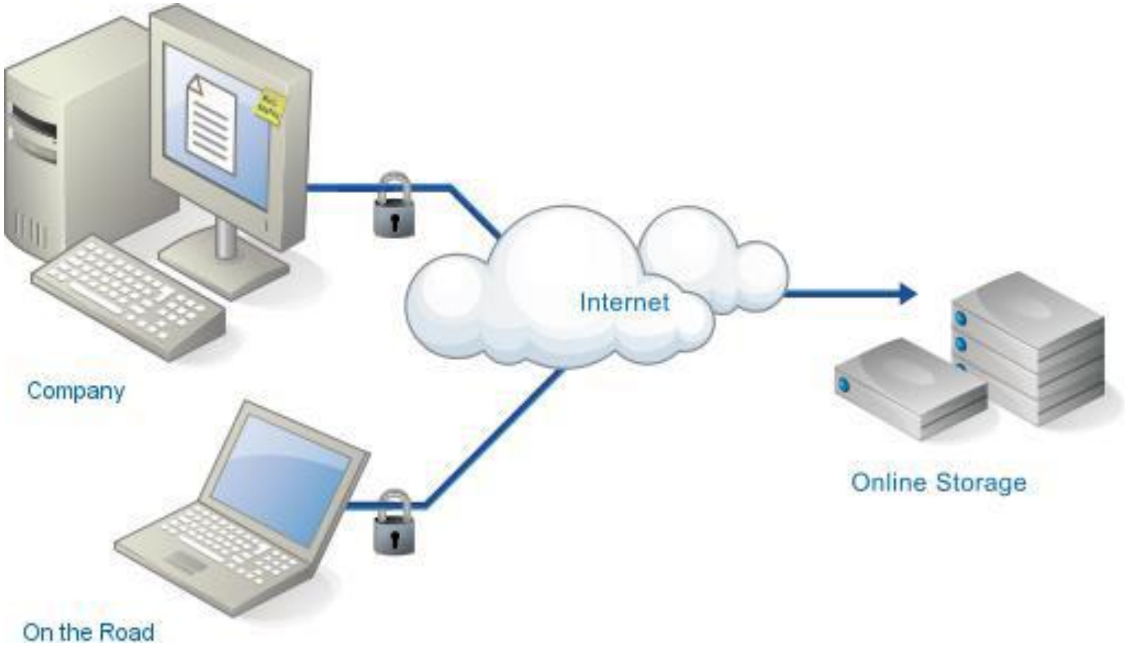
Secondary Storage Devices

- Storage as a Service:
  - Data storage service provider rents space to people and organizations
  - Users access their rented storage space via the Internet



Input Devices

- Devices used to input general types of data:
  - Personal computer input devices
  - Speech recognition technology
  - Digital cameras
  - Touch-sensitive screens
  - Barcode Readers
  - Pen input devices
  - Magnetic stripe card
  - Radio Frequency Identification

Input Devices (Continued)

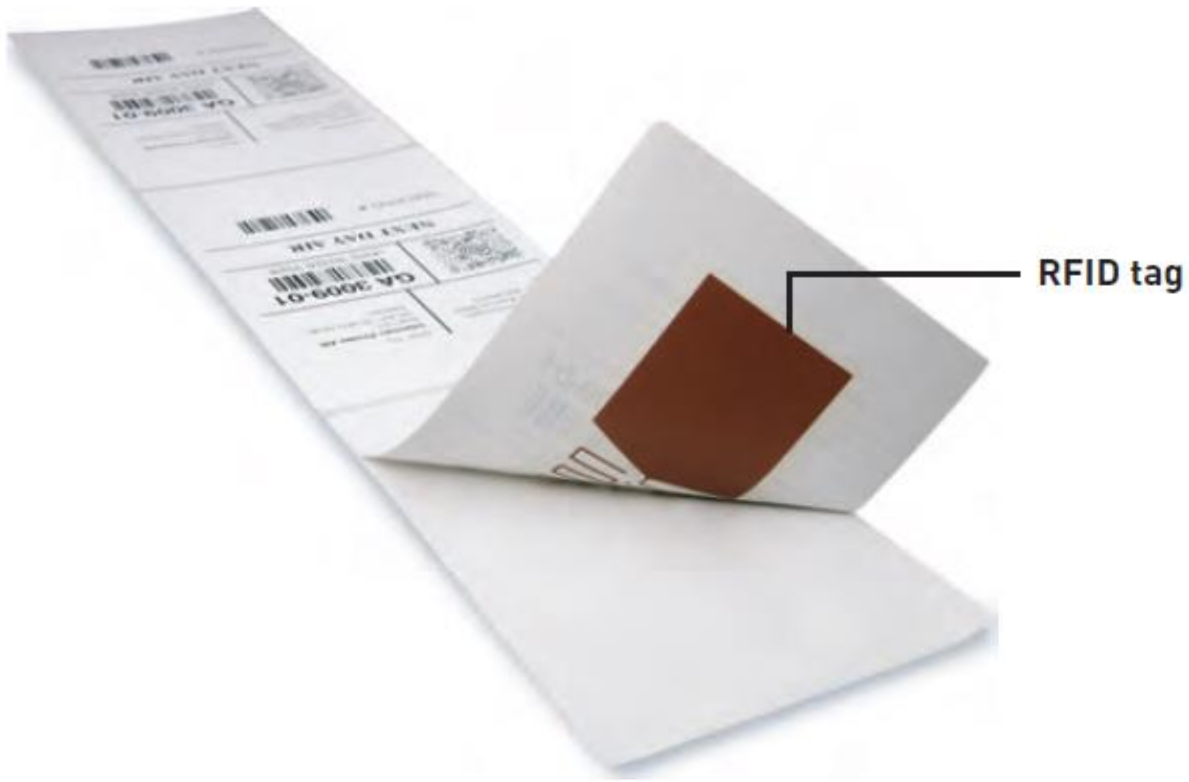


Figure 2.6

RFID Tag

An RFID tag is small compared to current bar-coded labels used to identify items.

(Source: Courtesy of Intermec Technologies Corporation.)

Output Devices

- Display monitors:
  - Used to display the output from the computer
  - Plasma display:
    - Uses thousands of smart cells (pixels) consisting of electrodes and neon and xenon gases that are electrically turned into plasma to emit light

  - Liquid Crystal Display (LCD):
    - Flat displays that use liquid crystals
  - Light-Emitting Diodes (LEDs):
    - Use a layer of organic material sandwiched between two conductors

Output Devices

- Printers and plotters:
  - Printers and plotters produce hard copy
  - Laser printers and inkjet printers
  - Multi-function printers
  - 3D printers
  - Plotters are used for general design work
- Digital audio player:
  - Can store, organize, and play digital music files
- E-books:
  - Digital media equivalent of a conventional printed book

Computer System Types

- Computer systems can range from desktop or portable computers to massive supercomputers
- Two major groups of general-purpose computers
    - Single-user computers with portable and nonportable option
    - Multiple-user computers

Portable Single-User Computers

- **Handheld computer**: a compact computing device
  - Typically includes a display screen with stylus or touch screen input along with a compact keyboard or numeric keypad
  - Applicable as POS devices
  - Rugged versions are available for military applications
- **Laptop computers** are designed for use by mobile users
  - Notebook and ultrabook computers are smaller than laptop computers
  - Tablet computers are portable, lightweight computers with or without a keyboard

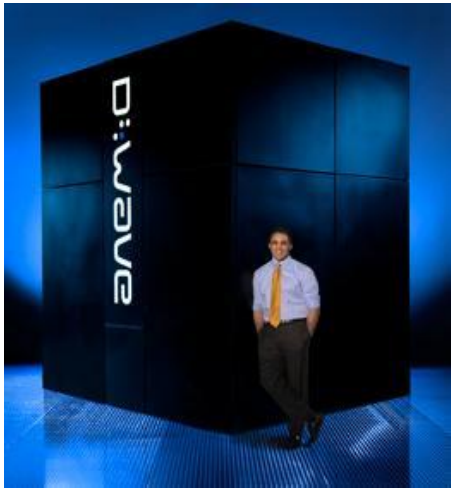
Multi-User Computer Systems

- A server is employed by many users to perform a specific task, such as running network or Internet applications
- Server systems consist of multiuser computers, including supercomputers, mainframes, and other servers
- Blade server: a server that houses many individual computer motherboards

Multi-User Computer Systems

- Supercomputers: largest, most powerful, $$$; perform parallel processing
- Mainframes: central, many dumb terminals
- Minicomputers: smaller mainframes
- Microcomputers: can be networked; others: {e.g., portable computers, laptops, tablets, etc.

- Next: Quantum Computing

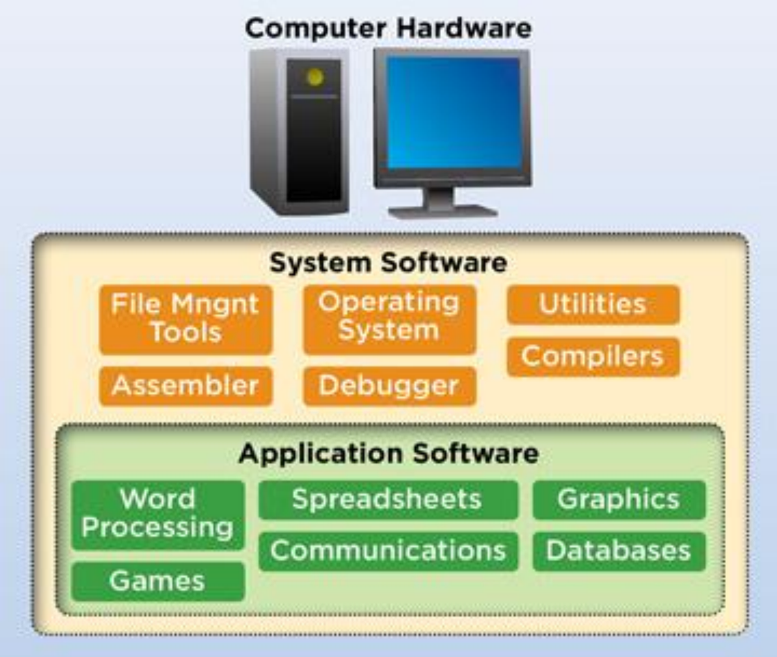


Computer Software

- Operating System and Application Software

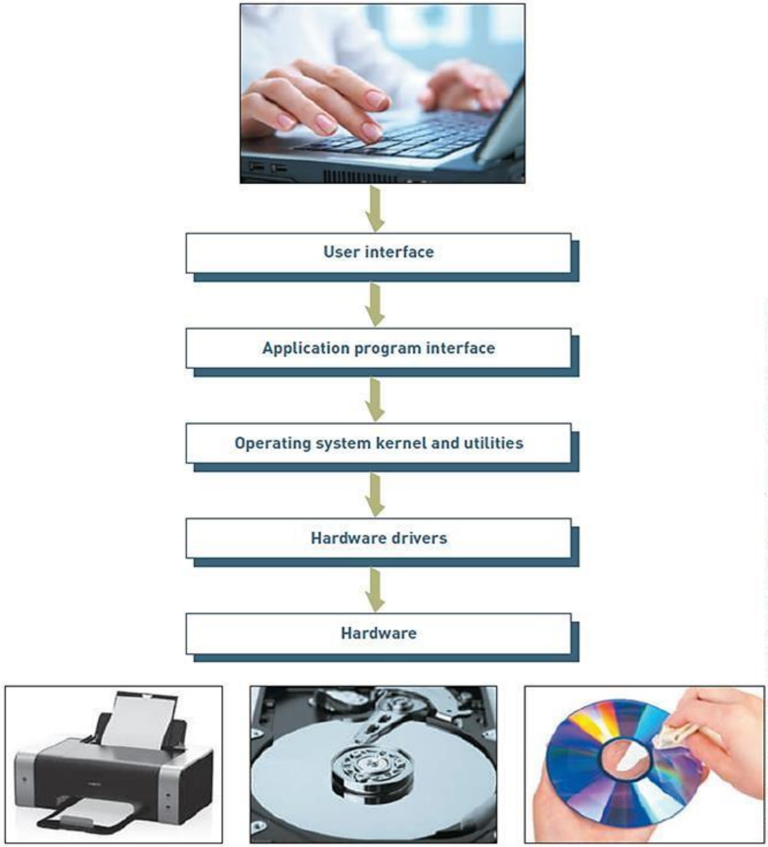
System vs Application Software

- **Systems Software**
  - The set of programs that coordinates the activities and functions of hardware and other programs
  - Each type of systems software is designed for a specific CPU and class of hardware
- **Application Software**
  - Helps users solve particular problems
  - In most cases, resides on the computer's hard disk
  - Can be stored on CDs, DVDs, or USB flash drives



Operating Systems

- A set of programs that controls computer hardware and acts as an interface with application programs


User interface
Application program interface
Operating system kernel and utilities
Hardware drivers
Hardware

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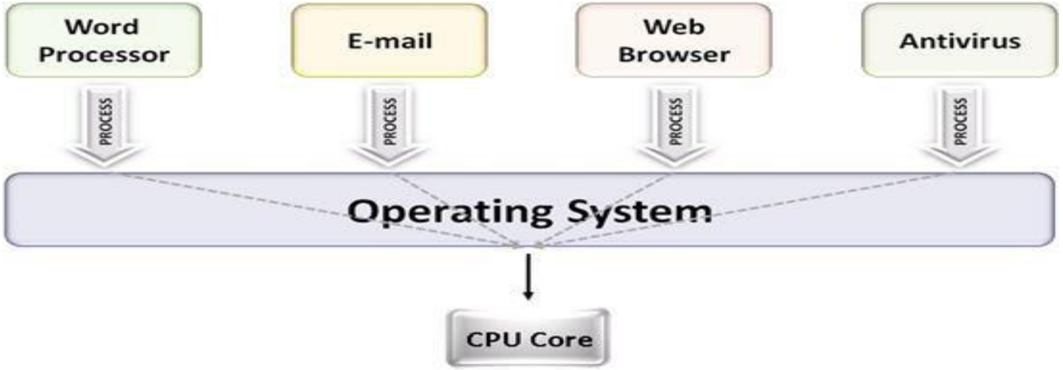
Operating Systems Activities

- Controlling common computer hardware functions
- Providing a user interface and input/output management
- Providing a degree of hardware independence
- Managing system memory
- Managing processing tasks
- Providing networking capability
- Controlling access to system resources
- Managing files

Operating Systems: Processing Tasks

- Five basic task management techniques
  - Multiuser: allows two or more users to run programs at the same time on one computer
  - Multiprocessing: supports running a program on more than one CPU
  - Multitasking: allows more than one program to run concurrently
- Multithreading: allows different threads of a single Program to run concurrently
  - A thread is a set of instructions within an application that s independent of other threads
  - Real time: responds to input instantly



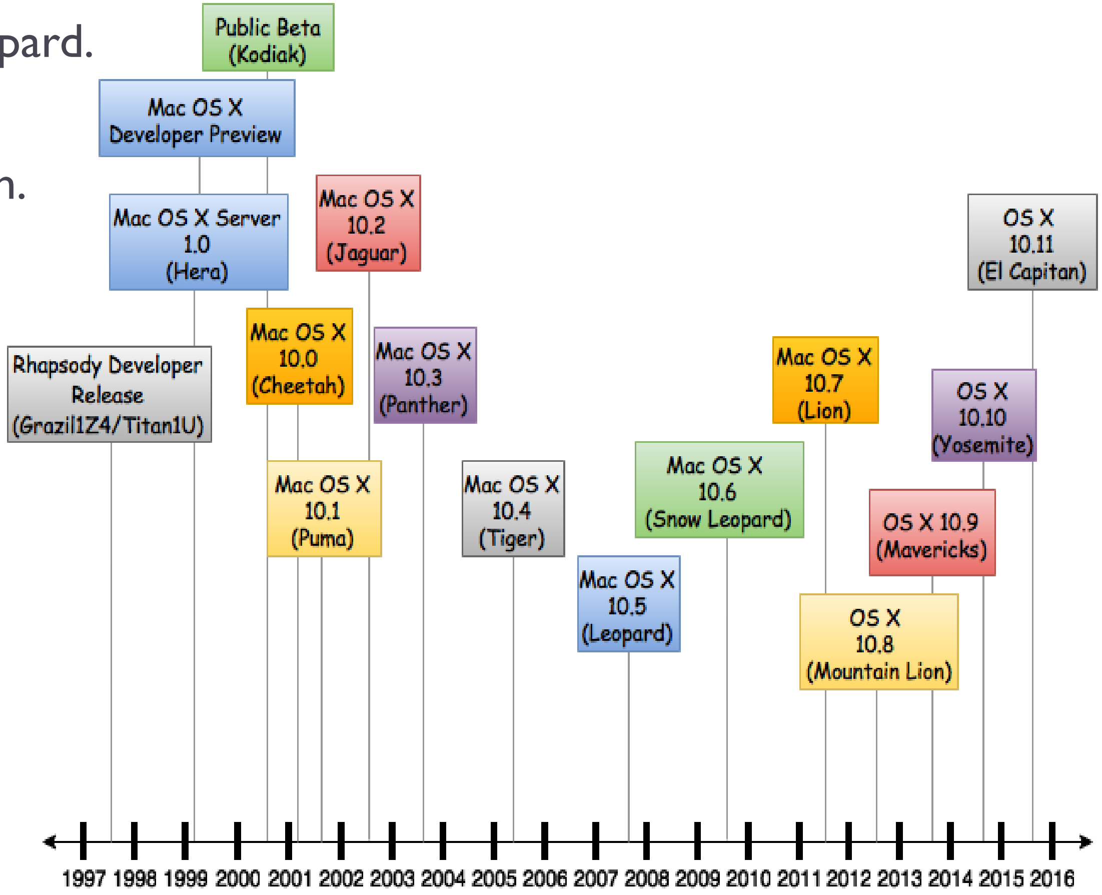
Current Operating Systems

- Microsoft PC operating systems
  - Windows
  - Windows 95
  - Windows XP
  - WindowsVista
  - Windows 7
  - Windows 8
  - Windows 10

Windows1 1985
Windows 3.1 1992
Windows 95 1995
Windows XP 2001
Windows Vista 2006
Windows 7 2009
Windows 8 2012
Windows 10 2015

Current Operating Systems

- Apple computer operating systems
  - 4.7 Mac OS X 10.5 Leopard.
  - 4.8 Mac OS X 10.6 Snow Leopard.
  - 4.9 Mac OS X 10.7 Lion.
  - 4.10 OS X 10.8 Mountain Lion.
  - 4.11 OS X 10.9 Mavericks.
  - 4.12 OS X 10.10 Yosemite.
  - 4.13 OS X 10.11 El Capitan.
  - 4.14 macOS 10.12 Sierra.



Current Operating Systems

- Linux
  - Open-source operating system
  - Red Hat (most common)
- Chrome OS
  - Linux-based operating system designed for netbooks and nettops
  - Designed to run on inexpensive low-power computers
  - Chromium OS: an open-source version of Chrome OS
  - Android-based apps are made available on Chromebooks which makes the platform more general-purpose than a typical thin client.
- Android: an operating system for mobile devices

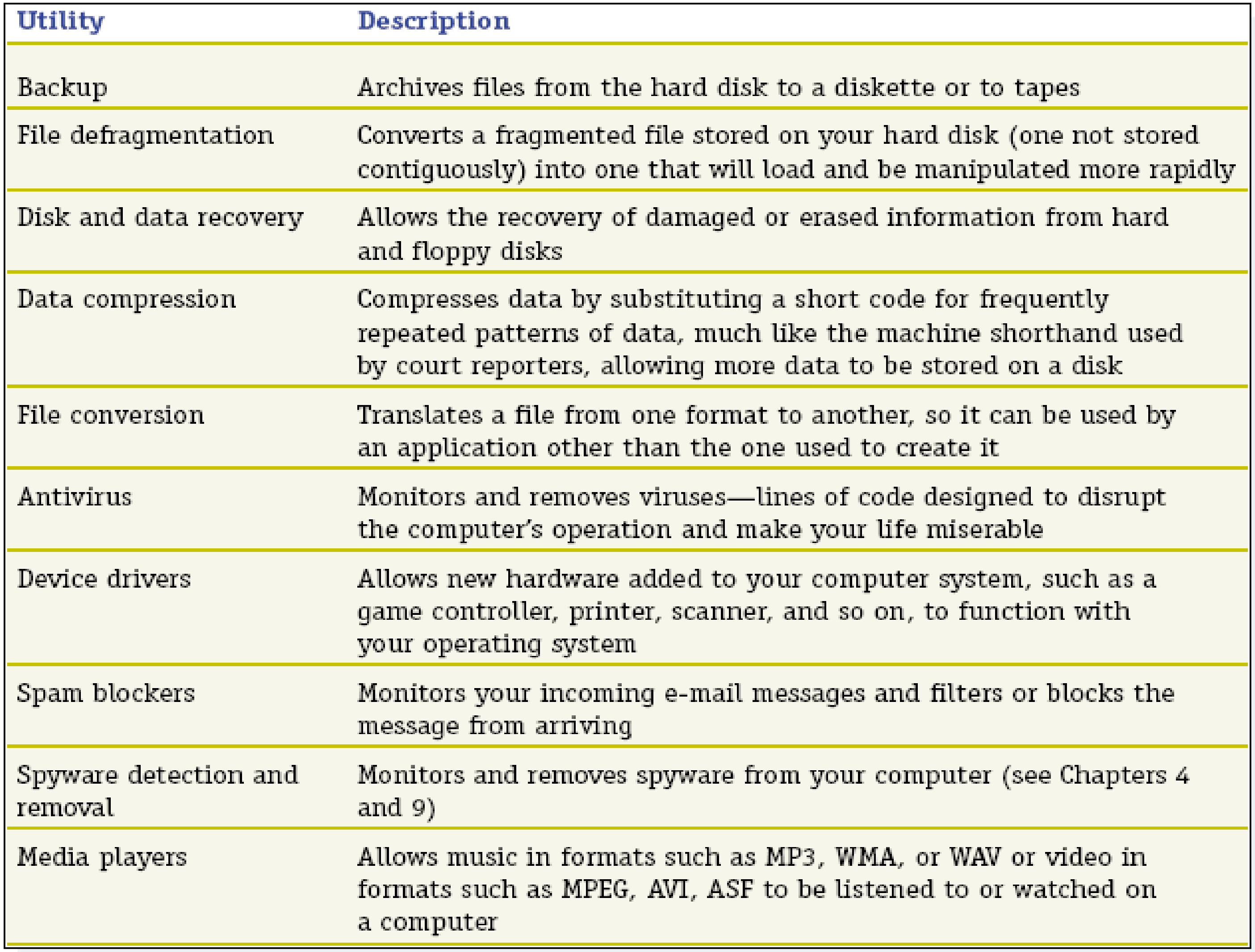
Mobile Operating Systems

Smartphone Operating System	Worldwide Market Share of Sales during 2Q 2013	Estimated Total Number of Applications Mid-2013	Estimated Rate of Increase in Number of New Applications
Google Android	56.5%	>1,000,000	800/day
Apple iPhone OS	39.6%	900,000	600/day
Microsoft Windows Mobile	3.3%	145,000	130/day
Blackberry Limited, Blackberry	2.9%	120,000	NA

Operating Systems - Utilities

Utilities:

Programs that manage **computer resources** and **files** and may be included in the **operating system** or purchased **separately** as needed



Utility	Description
Backup	Archives files from the hard disk to a diskette or to tapes
File defragmentation	Converts a fragmented file stored on your hard disk (one not stored contiguously) into one that will load and be manipulated more rapidly
Disk and data recovery	Allows the recovery of damaged or erased information from hard and floppy disks
Data compression	Compresses data by substituting a short code for frequently repeated patterns of data, much like the machine shorthand used by court reporters, allowing more data to be stored on a disk
File conversion	Translates a file from one format to another, so it can be used by an application other than the one used to create it
Antivirus	Monitors and removes viruses—lines of code designed to disrupt the computer's operation and make your life miserable
Device drivers	Allows new hardware added to your computer system, such as a game controller, printer, scanner, and so on, to function with your operating system
Spam blockers	Monitors your incoming e-mail messages and filters or blocks the message from arriving
Spyware detection and removal	Monitors and removes spyware from your computer (see Chapters 4 and 9)
Media players	Allows music in formats such as MP3, WMA, or WAV or video in formats such as MPEG, AVI, ASF to be listened to or watched on a computer

Application Software

- Application programs:
- Interact with systems software and the systems software directs computer hardware to perform necessary tasks
- Help you perform common tasks, such as:
  - Creating and formatting text documents
  - Performing calculations
  - Managing information
  - Some applications are more specialized

Application Software

- Proprietary software:
    - One-of-a-kind program for a specific application, usually developed and owned by a single company
- Off-the-shelf software:
    - Existing software program that is purchased
    - Application service provider (ASP):
        - Company that can provide software, support, and computer hardware on which to run the software from the user's facilities over a network

Proprietary Software Advantages and Disadvantages

Advantages	Disadvantages
You can get exactly what you need in terms of features, reports, and so on.	It can take a long time and significant resources to develop required features.
Being involved in the development offers control over the results.	In-house system development staff may be hard pressed to provide the required level of ongoing support and maintenance because of pressure to move on to other new projects.
You can modify features that you might need to counteract an initiative by competitors or to meet new supplier or customer demands.	The features and performance of software that has yet to be developed presents more potential risk.

Off-the-Shelf Software Advantages and Disadvantages

Advantages	Disadvantages
The initial cost is lower because the software firm can spread the development costs over many customers.	An organization might have to pay for features that are not required and never used.
The software is likely to meet the basic business needs—you can analyze existing features and the performance of the package before purchasing.	The software might lack important features, thus requiring future modification or customization. This lack can be very expensive because users must adopt future releases of the soft- ware as well.
The package is likely to be of high quality because many customer firms have tested the software and helped identify its bugs.	The software might not match current work processes and data standards.

Application Software: Software as a Service (SaaS) and Cloud Computing

- Software as a service (SaaS):
  - Allows businesses to subscribe to Web-delivered business application software by paying a monthly service charge or a per-use fee
  - Can reduce expenses by sharing its running applications among many businesses

- Cloud computing:
  - Use of computing resources, including software and data storage, on the Internet (the cloud) rather than on local computers