IE 5521

Electronic Data Processing Systems

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Data Representation and Processing

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How computers represent data?

Bits and Bytes

- Binary digits—bits
- A byte comprises of 8 bits and represents one character.

Text codes

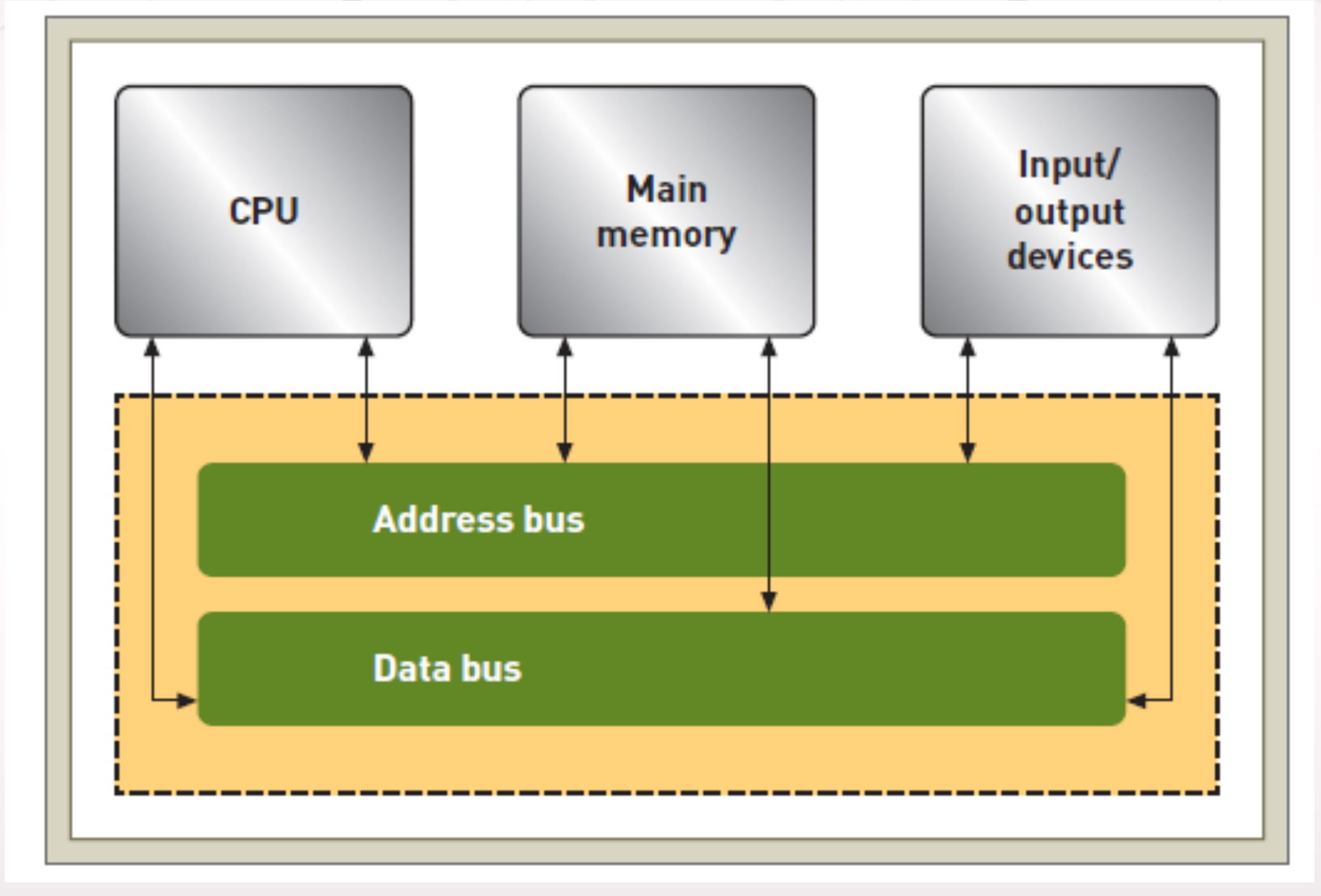
- Converts letters into binary format
- Is there a need of a standard code?
  - ASCII (American English symbols) —1 Byte
  - Unicode (All languages on the planet) — 2 Bytes

ASCII TABLE

Decimal	Hexadecimal	Binary	Octal	Char
0	0	0	0	*[NULL]*
1	1	1	1	*[START OF HEADING]*
2	2	10	2	*[START OF TEXT]*
3	3	11	3	*[END OF TEXT]*
4	4	100	4	*[END OF TRANSMISSION]*
5	5	101	5	*[ENQUIRY]*
6	6	110	6	*[ACKNOWLEDGE]*
7	7	111	7	*[BELL]*
8	8	1000	10	*[BACKSPACE]*
9	9	1001	11	*[HORIZONTAL TAB]*
10	A	1010	12	*[LINE FEED]*
11	B	1011	13	*[VERTICAL TAB]*
12	C	1100	14	*[FORM FEED]*
13	D	1101	15	*[CARRIAGE RETURN]*
14	E	1110	16	*[SHIFT OUT]*
15	F	1111	17	*[SHIFT IN]*
16	10	10000	20	*[DATA LINK ESCAPE]*
17	11	10001	21	*[DEVICE CONTROL 1]*
18	12	10010	22	*[DEVICE CONTROL 2]*
19	13	10011	23	*[DEVICE CONTROL 3]*
20	14	10100	24	*[DEVICE CONTROL 4]*
21	15	10101	25	*[NEGATIVE ACKNOWLEDGE]*
22	16	10110	26	*[SYNCHRONOUS IDLE]*
23	17	10111	27	*[ENG OF TRANS. BLOCK]*
24	18	11000	30	*[CANCEL]*
25	19	11001	31	*[END OF MEDIUM]*
26	1A	11010	32	*[SUBSTITUTE]*
27	1B	11011	33	*[ESCAPE]*
28	1C	11100	34	*[FILE SEPARATOR]*
29	1D	11101	35	*[GROUP SEPARATOR]*
30	1E	11110	36	*[RECORD SEPARATOR]*
31	1F	11111	37	*[UNIT SEPARATOR]*
32	20	100000	40	*[SPACE]*
33	21	100001	41	!
34	22	100010	42	"
35	23	100011	43	#
36	24	100100	44	$
37	25	100101	45	%
38	26	100110	46	&
39	27	100111	47	'
40	28	101000	50	(
41	29	101001	51	)
42	2A	101010	52	*
43	2B	101011	53	+
44	2C	101100	54	,
45	2D	101101	55	-
46	2E	101110	56	.
47	2F	101111	57	/
48	30	110000	60	**0**
49	31	110001	61	**1**
50	32	110010	62	**2**
51	33	110011	63	**3**
52	34	110100	64	**4**
53	35	110101	65	**5**
54	36	110110	66	**6**
55	37	110111	67	**7**
56	38	111000	70	**8**
57	39	111001	71	**9**
58	3A	111010	72	:
59	3B	111011	73	;
60	3C	111100	74	<
61	3D	111101	75	=
62	3E	111110	76	>
63	3F	111111	77	?
64	40	1000000	100	@
65	41	1000001	101	**A**
66	42	1000010	102	**B**
67	43	1000011	103	**C**
68	44	1000100	104	**D**
69	45	1000101	105	**E**
70	46	1000110	106	**F**
71	47	1000111	107	**G**
72	48	1001000	110	**H**
73	49	1001001	111	**I**
74	4A	1001010	112	**J**
75	4B	1001011	113	**K**
76	4C	1001100	114	**L**
77	4D	1001101	115	**M**
78	4E	1001110	116	**N**
79	4F	1001111	117	**O**
80	50	1010000	120	**P**
81	51	1010001	121	**Q**
82	52	1010010	122	**R**
83	53	1010011	123	**S**
84	54	1010100	124	**T**
85	55	1010101	125	**U**
86	56	1010110	126	**V**
87	57	1010111	127	**W**
88	58	1011000	130	**X**
89	59	1011001	131	**Y**
90	5A	1011010	132	**Z**
91	5B	1011011	133	[
92	5C	1011100	134	\
93	5D	1011101	135	]
94	5E	1011110	136	^
95	5F	1011111	137	_
96	60	1100000	140	`
97	61	1100001	141	**a**
98	62	1100010	142	**b**
99	63	1100011	143	**c**
100	64	1100100	144	**d**
101	65	1100101	145	**e**
102	66	1100110	146	**f**
103	67	1100111	147	**g**
104	68	1101000	150	**h**
105	69	1101001	151	**i**
106	6A	1101010	152	**j**
107	6B	1101011	153	**k**
108	6C	1101100	154	**l**
109	6D	1101101	155	**m**
110	6E	1101110	156	**n**
111	6F	1101111	157	**o**
112	70	1110000	160	**p**
113	71	1110001	161	**q**
114	72	1110010	162	**r**
115	73	1110011	163	**s**
116	74	1110100	164	**t**
117	75	1110101	165	**u**
118	76	1110110	166	**v**
119	77	1110111	167	**w**
120	78	1111000	170	**x**
121	79	1111001	171	**y**
122	7A	1111010	172	**z**
123	7B	1111011	173	{
124	7C	1111100	174	|
125	7D	1111101	175	}
126	7E	1111110	176	~
127	7F	1111111	177	*[DEL]*

How computers process data?

Anatomy of a Computer



Central Processing Unit (CPU)

- Arithmetic/logic unit, the control unit, and the register areas
- Part of the computer that sequences and executes instructions

System Clock

- A series of electronic pulses produced at a predetermined rate that affects machine cycle time
- Often measured in gigahertz (GHz): billions of cycles per second
- Many of today's computers operate in the 1 to 4 GHz range

System Clock

- Synchronizes all computer operations
- Faster clock speed means the CPU can execute more instructions each second

CPU Registers

- Temporary storage location used by the CPU
- High speed memory in CPU that stores:
  - Instruction while being decoded
  - Location from where instruction was fetched
  - Data while the ALU processes it
  - Results of a calculation

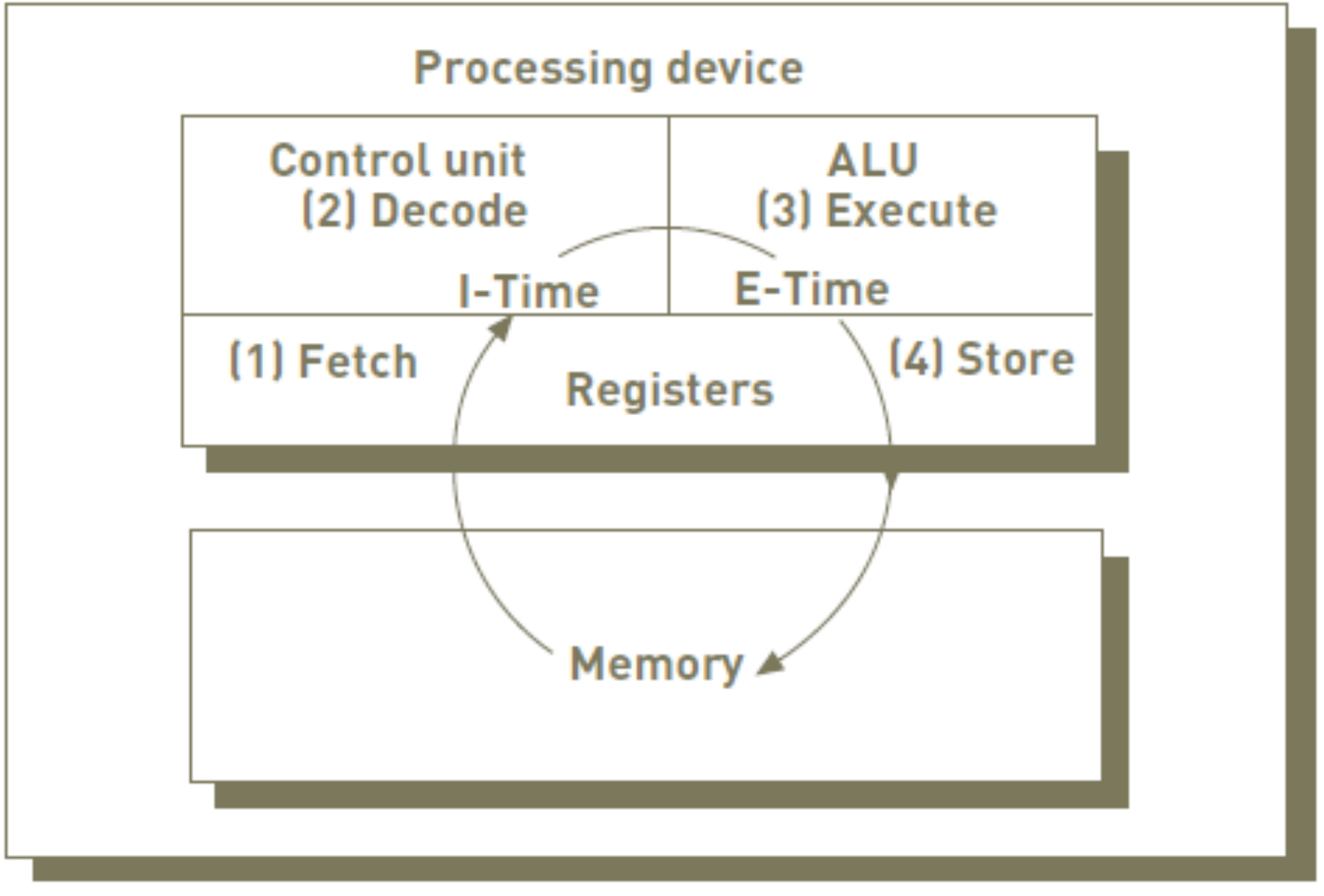
Control Unit

- **Directs and coordinates most of the computer operations**
- 4 basic operations of Machine Cycle:
  - **Fetch** – obtain a program instruction or data item from memory
  - **Decode** - translate the instruction into commands
  - **Execute** - carry out the command
  - **Store** - write the result to memory

FIGURE 3.2

Execution of an instruction

(1) In the instruction phase, a program's instructions and any necessary data are read into the processor. (2) The instruction is then decoded by the control unit of the CPU so that the central processor can understand what to do. (3) In the execution phase, the arithmetic and logic unit (ALU) component of the CPU does what it is instructed to do, making either an arithmetic computation or a logical comparison. (4) The results are then stored in the registers or in memory. The instruction and execution phases together make up one machine cycle.



Arithmetic and Logic Unit (ALU)

Performs the execution part of the machine cycle

- Arithmetic
  (addition, subtraction, multiplication, and division)
- Comparison
  (greater than, equal to, or less than)
- Logical
  (AND, OR, NOT)

Memory

Provides the CPU with a working storage area for programs and data and rapidly provides data and instructions to the CPU

- Storage capacity

  Byte (B): eight bits that together represent a single character of data

Memory

TABLE 3.2 Computer storage units

Name	Abbreviation	Number of Bytes
Byte	B	1
Kilobyte	KB	1,000
Megabyte	MB	$1,000^2$
Gigabyte	GB	$1,000^3$
Terabyte	TB	$1,000^4$
Petabyte	PB	$1,000^5$
Exabyte	EB	$1,000^6$
Zettabyte	ZB	$1,000^7$
Yottabyte	YB	$1,000^8$

Types of Memory

Random access memory (RAM) is temporary and volatile

- Types of RAM
  - Static random access memory (SRAM) used for high-speed registers and caches
  - Dynamic random access memory (DRAM) used for main memory
  - Double data rate synchronous dynamic random access memory (DDR SDRAM)

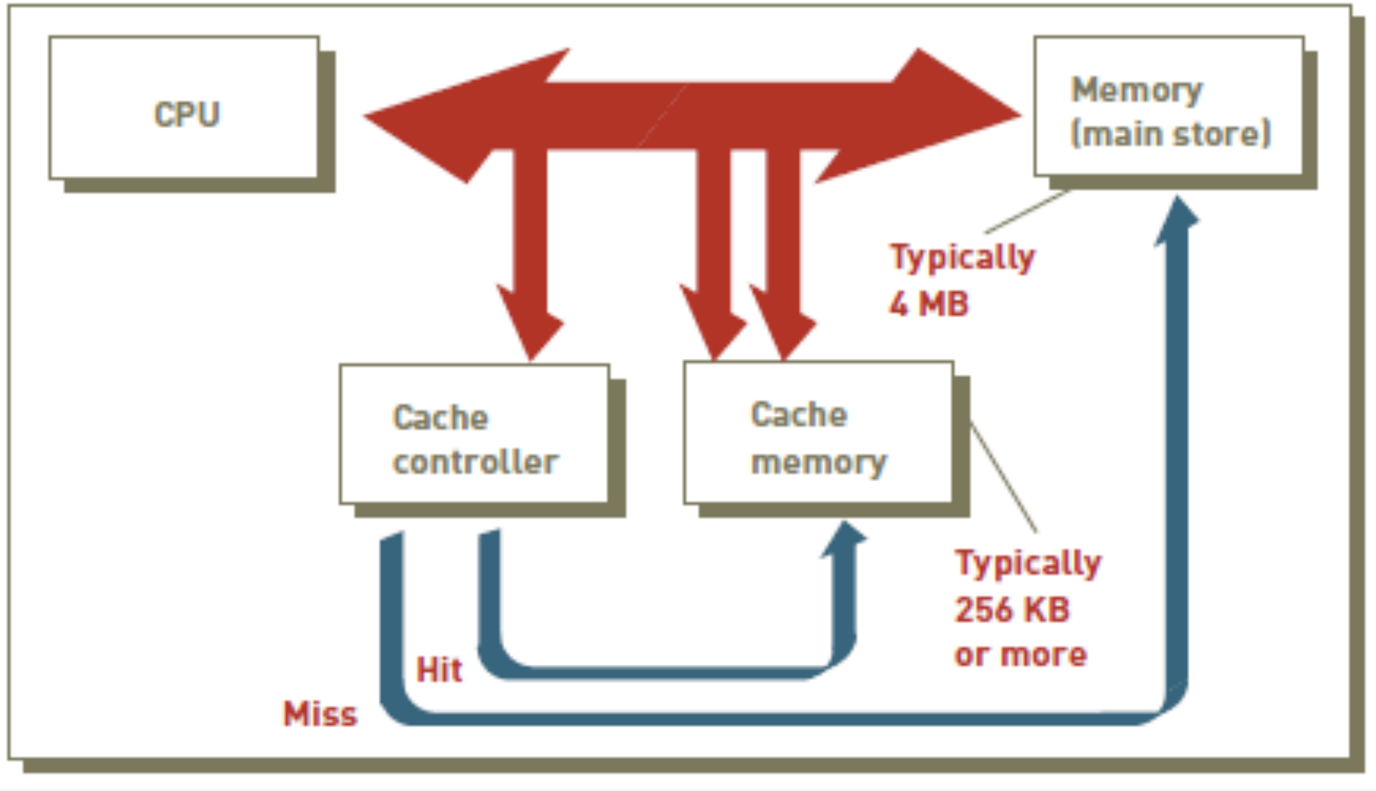
Types of Memory

Cache memory: a type of high-speed memory that a processor can access more rapidly than main memory

FIGURE 3.3

Cache memory

Processors can access this type of high-speed memory faster than main memory. Located on or near the CPU chip, cache memory works with main memory. A cache controller determines how often the data is used, transfers frequently used data to cache memory, and then deletes the data when it goes out of use.



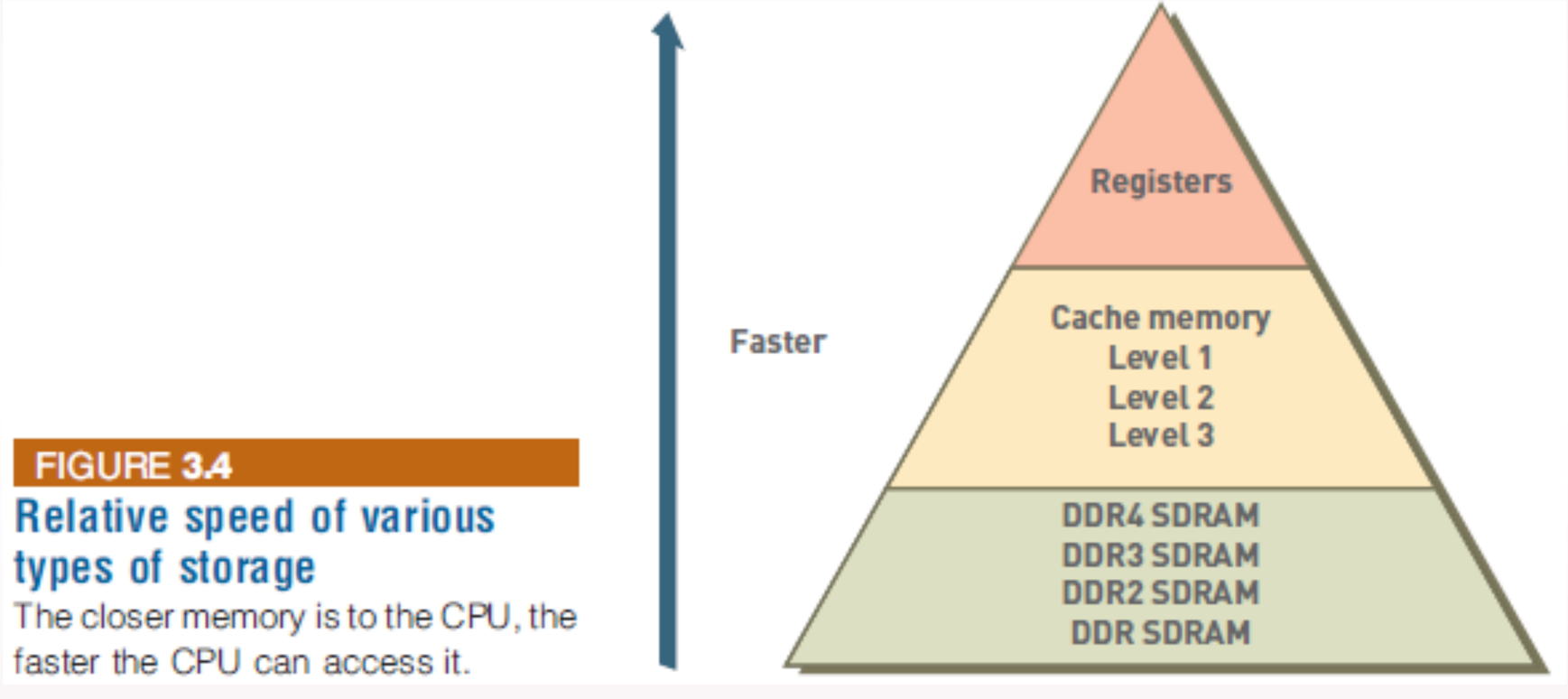


FIGURE 3.4

Relative speed of various types of storage

The closer memory is to the CPU, the faster the CPU can access it.

Types of Memory

- Read-only memory (ROM) is nonvolatile
  - It provides permanent storage for data and instructions that do not change
- Types of ROM
  - Programmable read-only memory (PROM)
  - Electrically erasable programmable read-only memory (EEPROM)

Secondary Data Storage Devices

- Secondary storage
  - Devices that store large amounts of data, instructions, and information more permanently than allowed with memory
- Advantages over memory
  - Nonvolatility
  - Greater capacity
  - Greater economy

Secondary Data Storage Devices

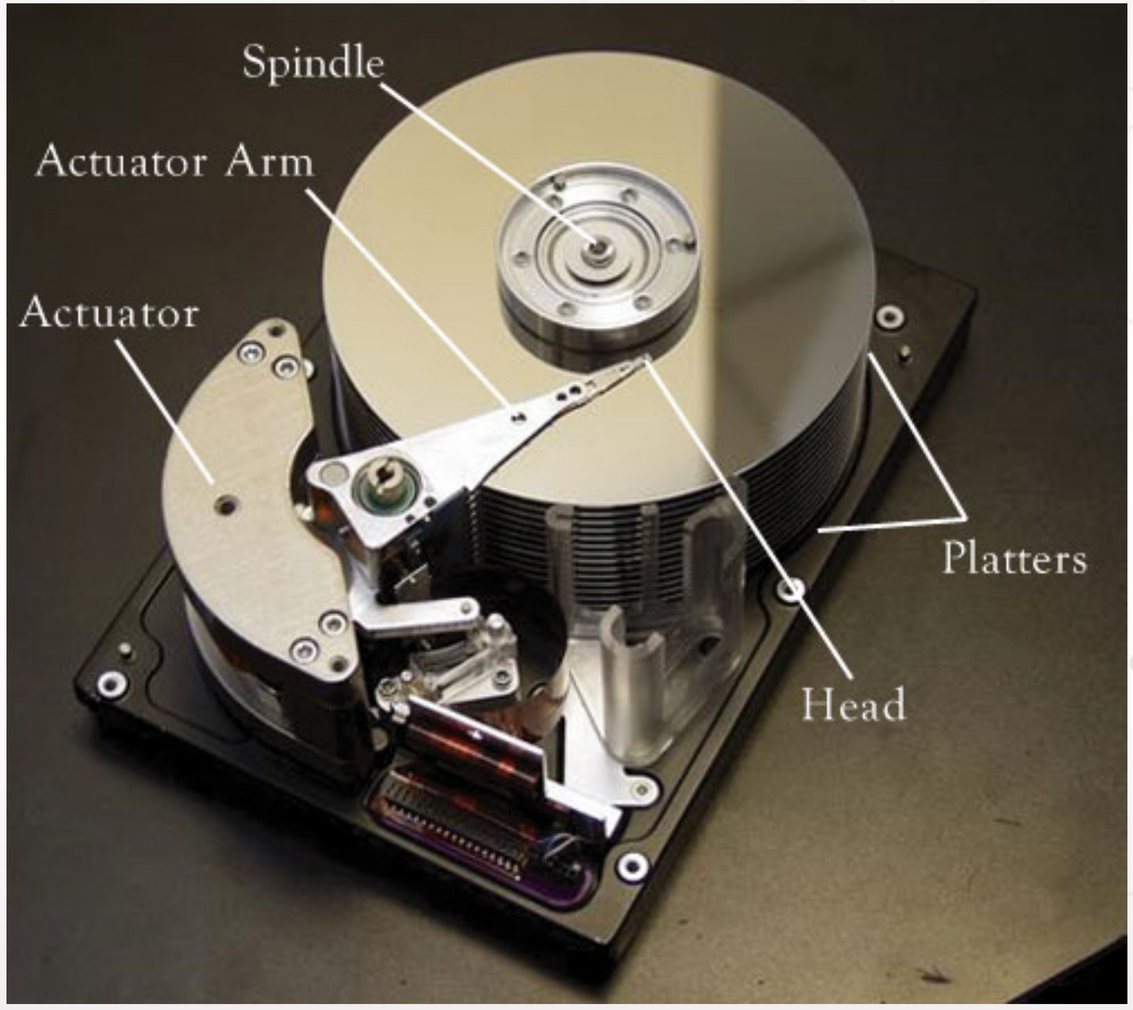
- Secondary storage is not directly accessible by the CPU
  - Computers usually use input/output channels to access secondary storage and then transfer the desired data to intermediate areas in primary storage
- Most common forms
  - Magnetic
  - Optical
  - Solid state

Magnetic Secondary Storage Devices

- Magnetic tape
  - A type of sequential secondary storage medium
  - Primarily for storing backups of critical organizational data

Magnetic Secondary Storage Devices

- Hard disk drive (HDD)
  - A direct access storage device; consists of rapidly rotating disks coated with magnetic material



Magnetic Secondary Storage Devices

- Redundant array of independent/ inexpensive disks (RAID)
  - A method of storing data that generates extra bits of data from existing data

Optical Secondary Storage Devices

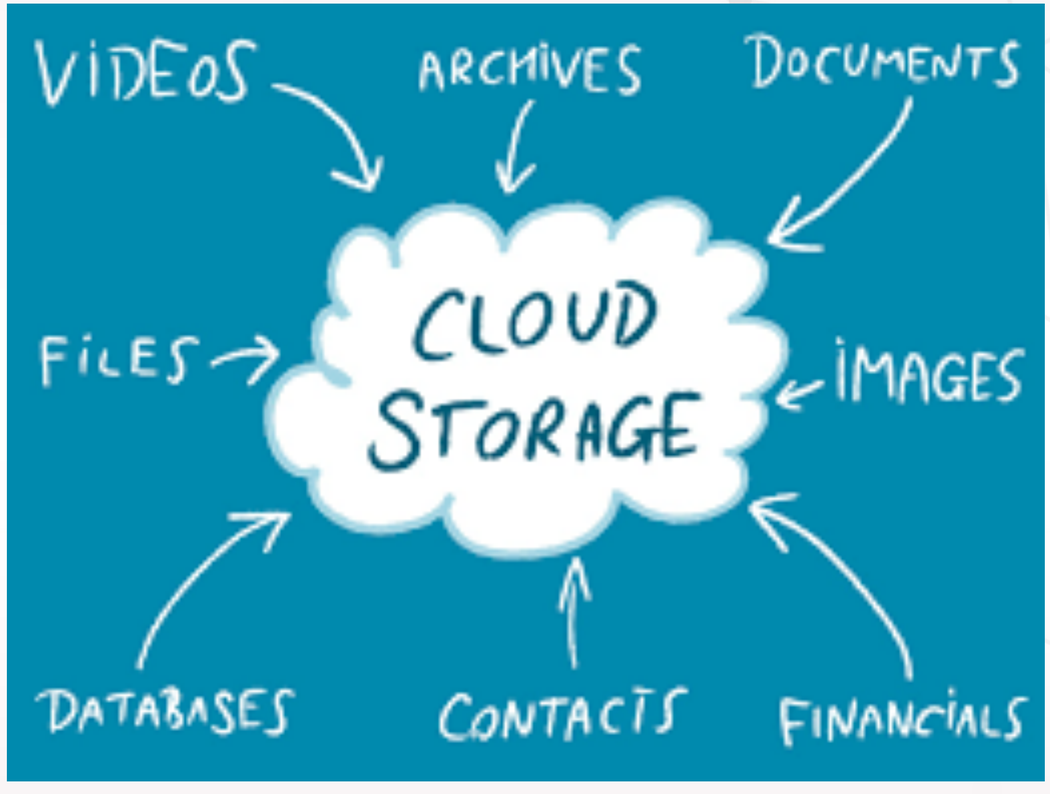
- A form of data storage that uses lasers to read and write data
- Common types of optical storage devices
  - Compact disc read-only memory (CD-ROM)
  - Digital video disc (DVD)
  - Blu-ray high-definition video disk
  - DNA data storage: experimental at this time

Solid State Secondary Storage Devices

- Solid state storage device (SSD)
  - Stores data in memory chips rather than magnetic or optical media
- Advantages
  - Require less power and provide faster access than magnetic data storage devices
  - Have no moving parts, so they are less fragile than hard disk drives

Enterprise Storage Options

- Large secondary storage
- Forms of enterprise storage
  - Network-attached storage (NAS)
  - Storage area networks (SANs)
  - Cloud computing storage



Network-Attached Storage

- Network-attached storage (NAS)
  - A hard disk drive storage device that is set up with its own network address and provides file-based storage services to other devices on the network
- Common applications for NAS
  - Internet and e-commerce applications
  - Digital media

Storage Area Networks

- Storage Area Networks (SAN)
  - A high-speed, special-purpose network that integrates different types of data storage devices into a single storage system and connects that to computing resources across an entire organization
- SANs can provide capabilities such as
  - Disk mirroring, data backup and restore, data archiving, data migration from one storage device to another, and sharing data among other devices

Storage Area Networks

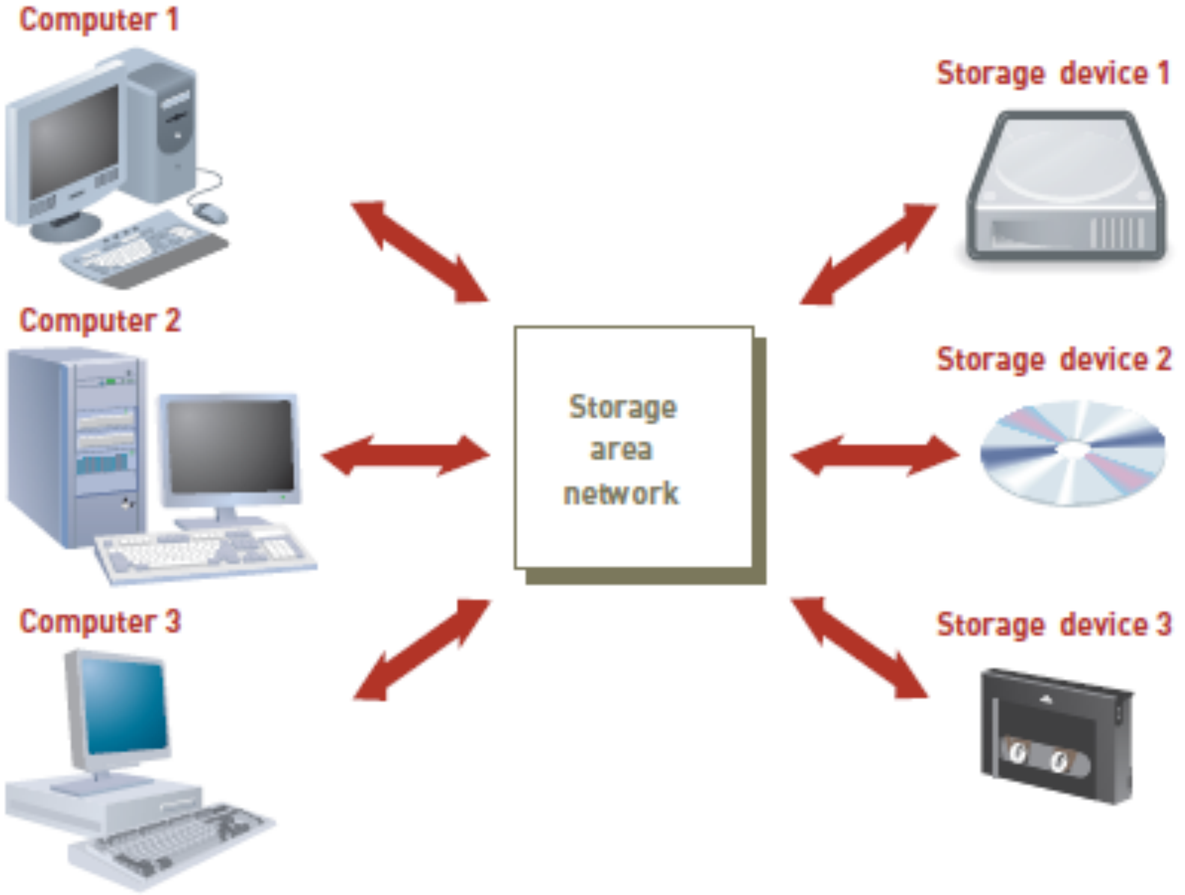


FIGURE 3.7

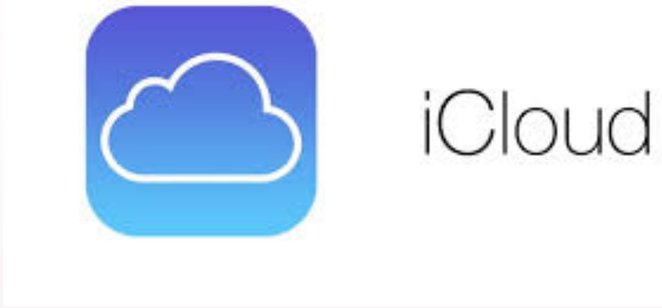
Storage area network

A SAN provides high-speed connections among data storage devices and computers over a network.

Storage as a Service

- Storage as a Service
  - A data storage model where a data storage service provider rents space to individuals and organizations
  - Rented data storage is accessed via the Internet
- Cloud-based storage services
  - Amazon's Elastic Compute Cloud, Apple iCloud, Dropbox, Google Drive, Microsoft AZURE, and Mozy
  - Amazon's Simple Storage Service (Amazon S3) allows subscribers to upload, store, and download data

Storage as a Service



Storage as a Service


thank you