

Chapter 1: Computer Systems

**PRESENTED BY
SURAJIT NATH**

Computer Systems



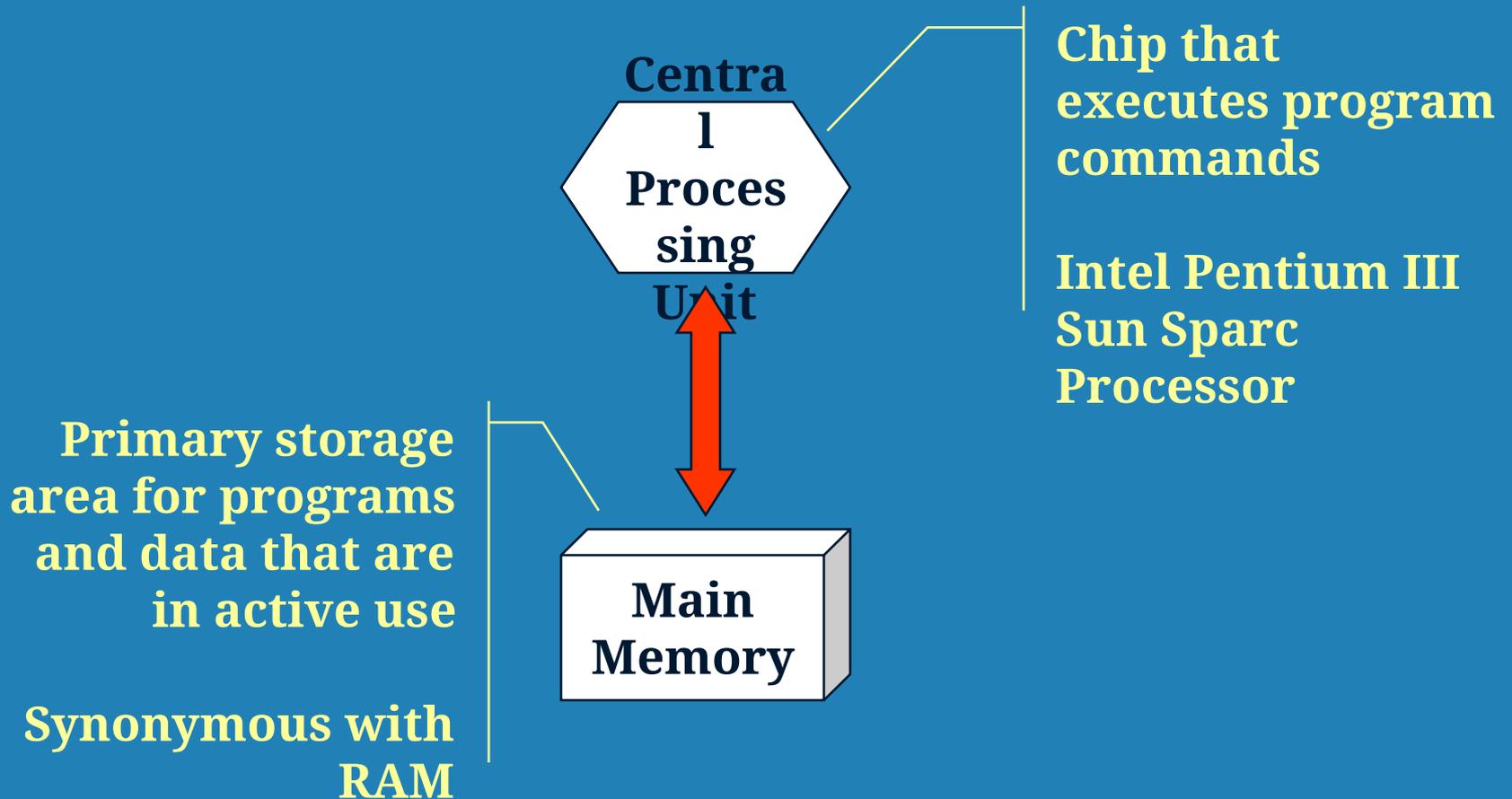
- **We first need to explore the fundamentals of computer processing**
- **Chapter 1 focuses on:**
 - **components of a computer**
 - **how those components interact**
 - **how computers store and manipulate information**
 - **computer networks**
 - **the Internet and the World-Wide Web**
 - **programming and programming languages**
 - **graphic systems**

Hardware and Software



- **Hardware**
 - the physical, tangible parts of a computer
 - keyboard, monitor, wires, chips, data
- **Software**
 - programs and data
 - a *program* is a series of instructions
- **A computer requires both hardware and software**
- **Each is essentially useless without the other**

CPU and Main Memory



Secondary Memory Devices



Secondary memory devices provide long-term storage

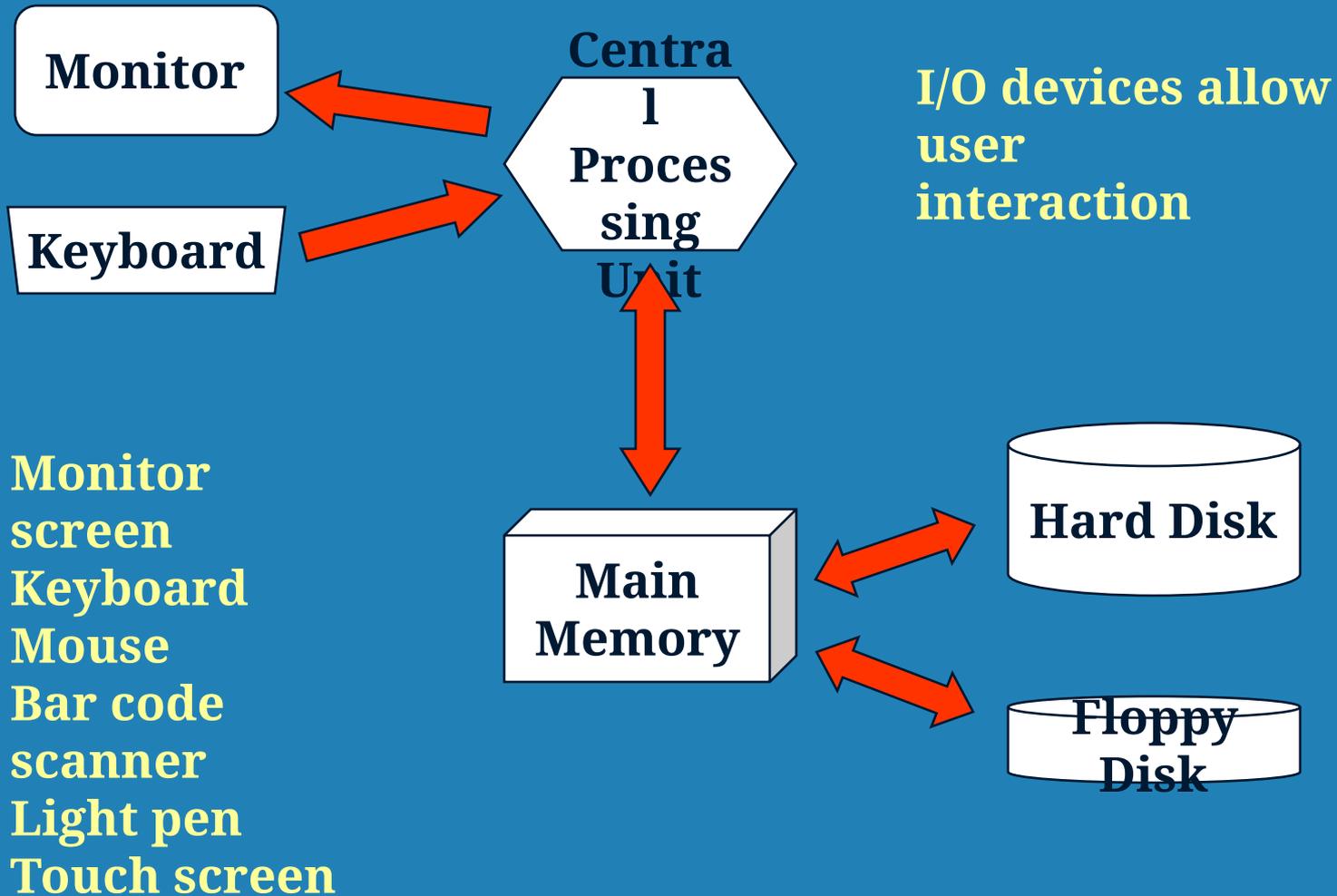
Hard disks
Floppy disks
ZIP disks
Writable CDs
Tapes



Information is moved between main memory and secondary memory as needed



Input / Output Devices



Software Categories



- **Operating System**
 - controls all machine activities
 - provides the user interface to the computer
 - manages resources such as the CPU and memory
 - Windows 98, Windows NT, Unix, **Linux**, Mac OS
- **Application program**
 - generic term for any other kind of software
 - word processors, missile control systems, games
- **Most operating systems and application programs have a graphical user interface (GUI)**

Analog vs. Digital



- There are two basic ways to store and manage data:
- *Analog*
 - continuous, in direct proportion to the data represented
 - music on a record album - a needle rides on ridges in the grooves that are directly proportional to the voltage sent to the speaker
- *Digital*
 - the information is broken down into pieces, and each piece is represented separately
 - music on a compact disc - the disc stores numbers representing specific voltage levels sampled at various points



- **Computers store all information digitally:**
 - numbers
 - text
 - graphics and images
 - audio
 - video
 - program instructions
- In some way, all information is *digitized* - broken down into pieces and represented as numbers

Representing Text Digitally



- For example, every character is stored as a number, including spaces, digits, and punctuation
- Corresponding upper and lower case letters are separate characters



Binary Numbers



- Once information is digitized, it is represented and stored in memory using the *binary number system*
- A single binary digit (0 or 1) is called a *bit*
- Devices that store and move information are cheaper and more reliable if they only have to represent two states
- A single bit can represent two possible states, like a light bulb that is either on (1) or off (0)
- Combinations of bits are used to store values

Bit Combinations



<u>1</u> <u>bit</u>	<u>2</u> <u>bits</u>	<u>3</u> <u>bits</u>	<u>4</u> <u>bits</u>
0	00	000	0000
1	01	001	0001
	10	010	0010
	11	011	0011
		100	0100
		101	0101
		110	0110
		111	0111
			1000
			1001
			1010
			1011
			1100
			1101
			1110
			1111

Each additional bit doubles the number of possible combinations

0	0
10	010
1	1
11	011
0	0



Bit Combinations



- Each combination can represent a particular item
- There are 2^N combinations of N bits
- Therefore, N bits are needed to represent 2^N unique items

How many
items can be
represented
by

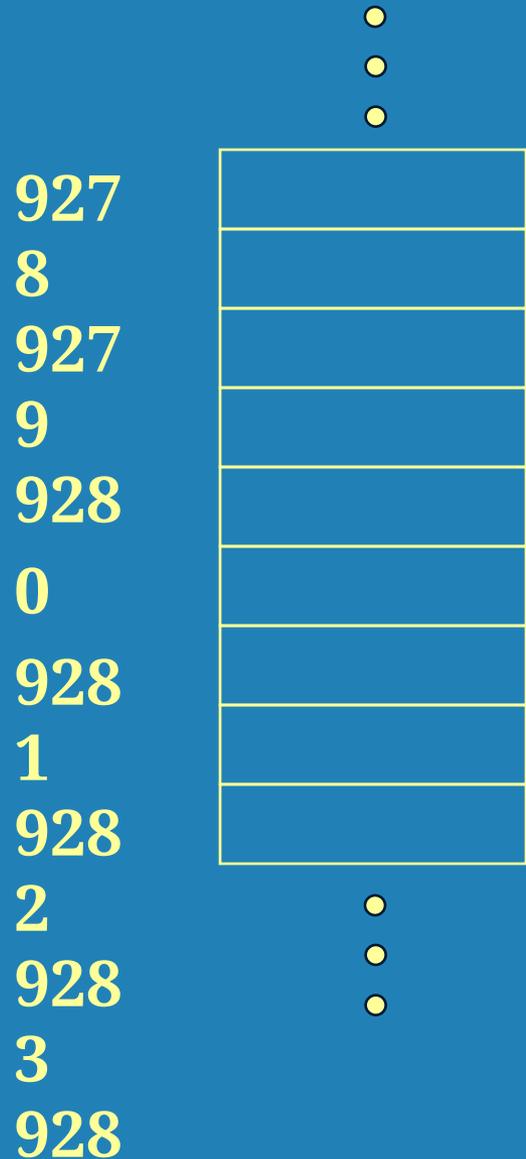
1 bit	$2^1 = 2$
?	items
2 bits	$2^2 = 4$
?	items
3 bits	$2^3 = 8$
?	items
4 bits	$2^4 = 16$
?	items
5 bits	$2^5 = 32$
?	items
6 bits	$2^6 = 64$
?	items
7 bits	$2^7 = 128$
?	items
8 bits	$2^8 = 256$
?	items
9 bits	$2^9 = 512$
?	items
10 bits	$2^{10} = 1024$
?	items
11 bits	$2^{11} = 2048$
?	items
12 bits	$2^{12} = 4096$
?	items
13 bits	$2^{13} = 8192$
?	items
14 bits	$2^{14} = 16384$
?	items
15 bits	$2^{15} = 32768$
?	items
16 bits	$2^{16} = 65536$
?	items
17 bits	$2^{17} = 131072$
?	items
18 bits	$2^{18} = 262144$
?	items
19 bits	$2^{19} = 524288$
?	items
20 bits	$2^{20} = 1048576$
?	items
21 bits	$2^{21} = 2097152$
?	items
22 bits	$2^{22} = 4194304$
?	items
23 bits	$2^{23} = 8388608$
?	items
24 bits	$2^{24} = 16777216$
?	items
25 bits	$2^{25} = 33554432$
?	items
26 bits	$2^{26} = 67108864$
?	items
27 bits	$2^{27} = 134217728$
?	items
28 bits	$2^{28} = 268435456$
?	items
29 bits	$2^{29} = 536870912$
?	items
30 bits	$2^{30} = 1073741824$
?	items
31 bits	$2^{31} = 2147483648$
?	items
32 bits	$2^{32} = 4294967296$
?	items
33 bits	$2^{33} = 8589934592$
?	items
34 bits	$2^{34} = 17179869184$
?	items
35 bits	$2^{35} = 34359738368$
?	items
36 bits	$2^{36} = 68719476736$
?	items
37 bits	$2^{37} = 137438953472$
?	items
38 bits	$2^{38} = 274877906944$
?	items
39 bits	$2^{39} = 549755813888$
?	items
40 bits	$2^{40} = 1099511627776$
?	items
41 bits	$2^{41} = 2199023255552$
?	items
42 bits	$2^{42} = 4398046511104$
?	items
43 bits	$2^{43} = 8796093022208$
?	items
44 bits	$2^{44} = 17592186044416$
?	items
45 bits	$2^{45} = 35184372088832$
?	items
46 bits	$2^{46} = 70368744177664$
?	items
47 bits	$2^{47} = 140737488355328$
?	items
48 bits	$2^{48} = 281474976710656$
?	items
49 bits	$2^{49} = 562949953421312$
?	items
50 bits	$2^{50} = 1125899906842624$
?	items
51 bits	$2^{51} = 2251799813685248$
?	items
52 bits	$2^{52} = 4503599627370496$
?	items
53 bits	$2^{53} = 9007199254740992$
?	items
54 bits	$2^{54} = 18014398509481984$
?	items
55 bits	$2^{55} = 36028797018963968$
?	items
56 bits	$2^{56} = 72057594037927936$
?	items
57 bits	$2^{57} = 144115188075855872$
?	items
58 bits	$2^{58} = 288230376151711744$
?	items
59 bits	$2^{59} = 576460752303423488$
?	items
60 bits	$2^{60} = 1152921504606846976$
?	items
61 bits	$2^{61} = 2305843009213693952$
?	items
62 bits	$2^{62} = 4611686018427387904$
?	items
63 bits	$2^{63} = 9223372036854775808$
?	items
64 bits	$2^{64} = 18446744073709551616$
?	items
65 bits	$2^{65} = 36893488147419103232$
?	items
66 bits	$2^{66} = 73786976294838206464$
?	items
67 bits	$2^{67} = 147573952589676412928$
?	items
68 bits	$2^{68} = 295147905179352825856$
?	items
69 bits	$2^{69} = 590295810358705651712$
?	items
70 bits	$2^{70} = 1180591620717411303424$
?	items
71 bits	$2^{71} = 2361183241434822606848$
?	items
72 bits	$2^{72} = 4722366482869645213696$
?	items
73 bits	$2^{73} = 9444732965739290427392$
?	items
74 bits	$2^{74} = 18889465931478580854784$
?	items
75 bits	$2^{75} = 37778931862957161709568$
?	items
76 bits	$2^{76} = 75557863725914323419136$
?	items
77 bits	$2^{77} = 151115727451828646838272$
?	items
78 bits	$2^{78} = 302231454903657293676544$
?	items
79 bits	$2^{79} = 604462909807314587353088$
?	items
80 bits	$2^{80} = 1208925819614629174706176$
?	items
81 bits	$2^{81} = 2417851639229258349412352$
?	items
82 bits	$2^{82} = 4835703278458516698824704$
?	items
83 bits	$2^{83} = 9671406556917033397649408$
?	items
84 bits	$2^{84} = 19342813113834066795298816$
?	items
85 bits	$2^{85} = 38685626227668133590597632$
?	items
86 bits	$2^{86} = 77371252455336267181195264$
?	items
87 bits	$2^{87} = 154742504910672534362390528$
?	items
88 bits	$2^{88} = 309485009821345068724781056$
?	items
89 bits	$2^{89} = 618970019642690137449562112$
?	items
90 bits	$2^{90} = 1237940039285380274899124224$
?	items
91 bits	$2^{91} = 2475880078570760549798248448$
?	items
92 bits	$2^{92} = 4951760157141521099596496896$
?	items
93 bits	$2^{93} = 9903520314283042199192993792$
?	items
94 bits	$2^{94} = 19807040628566084398385987584$
?	items
95 bits	$2^{95} = 39614081257132168796771975168$
?	items
96 bits	$2^{96} = 79228162514264337593543950336$
?	items
97 bits	$2^{97} = 158456325028528675187087900672$
?	items
98 bits	$2^{98} = 316912650057057350374175801344$
?	items
99 bits	$2^{99} = 633825300114114700748351602688$
?	items
100 bits	$2^{100} = 1267650600228229401496703205376$
?	items

A Computer Specification



- **Consider the following specification for a personal computer:**
 - **600 MHz Pentium III Processor**
 - **256 MB RAM**
 - **16 GB Hard Disk**
 - **24x speed CD ROM Drive**
 - **17" Multimedia Video Display with 1280 x 1024 resolution**
 - **56 KB Modem**
- **What does it all mean?**

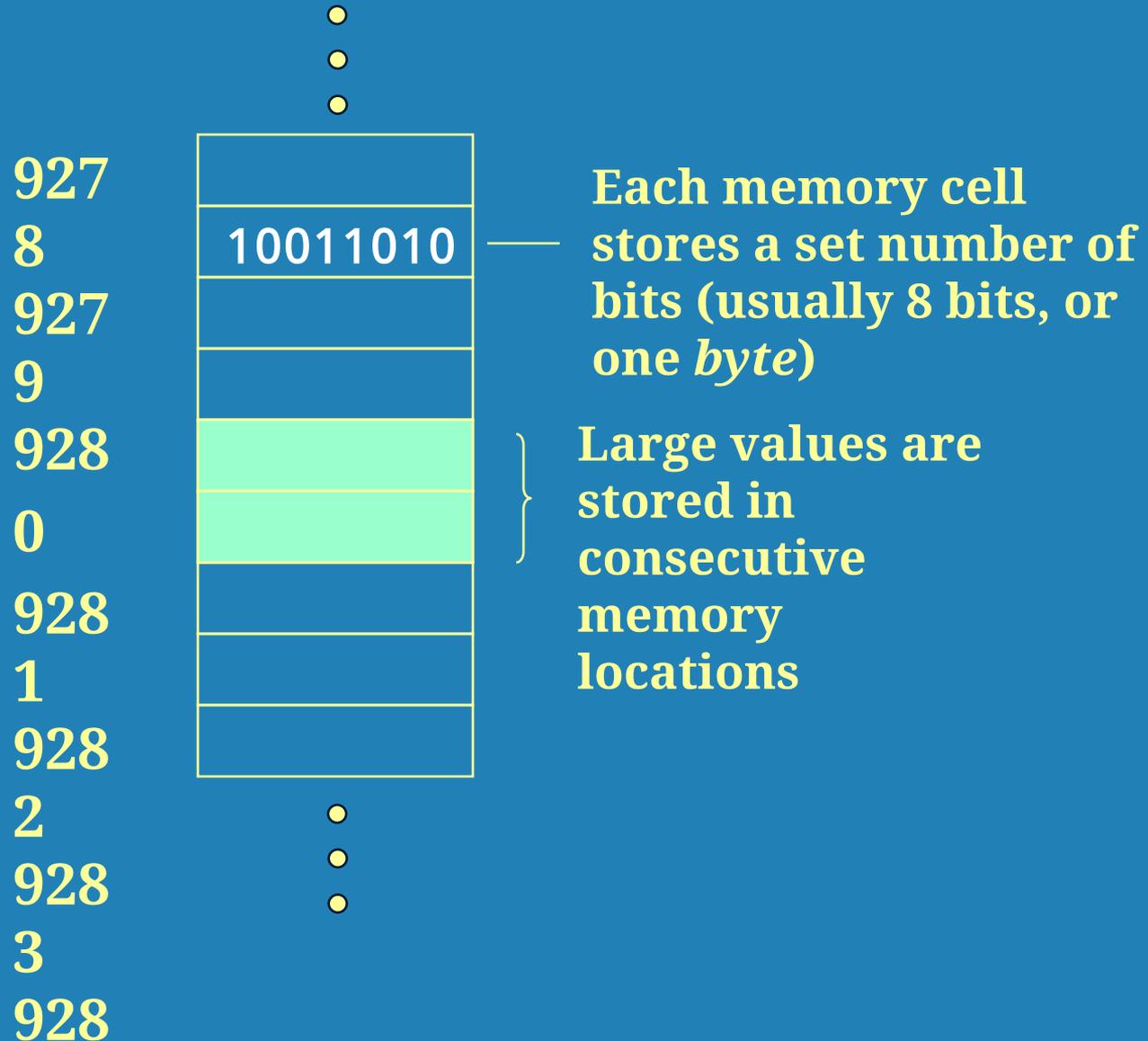
Memory



Main memory is divided into many memory locations (or *cells*)

Each memory cell has a numeric *address*, which uniquely identifies it

Storing Information



Storage Capacity



- Every memory device has a *storage capacity*, indicating the number of bytes it can hold
- Capacities are expressed in various units:

<u>Unit</u>	<u>Symbol</u>	<u>Number of Bytes</u>
kilobyte	KB	$2^{10} = 1024$
megabyte	MB	2^{20} (over 1 million)
gigabyte	GB	2^{30} (over 1 billion)
terabyte	TB	2^{40} (over 1 trillion)

Memory



- Main memory is *volatile* - stored information is lost if the electric power is removed
- Secondary memory devices are *nonvolatile*
- Main memory and disks are *direct access* devices - information can be reached directly
- The terms *direct access* and *random access* are often used interchangeably
- A magnetic tape is a *sequential access* device since its data is arranged in a linear order - you must get by the intervening data in order to access other information

RAM vs. ROM

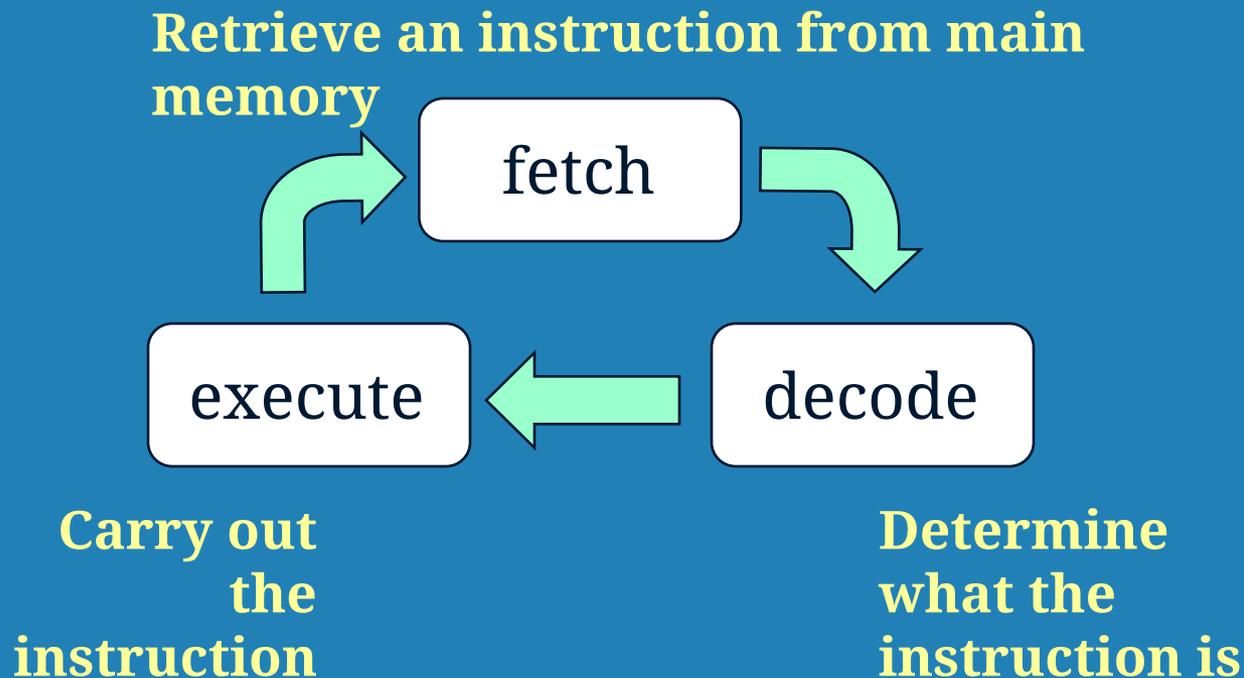


- **RAM** - Random Access Memory (direct access)
- **ROM** - Read-Only Memory
- The terms RAM and main memory are basically interchangeable
- ROM could be a set of memory chips, or a separate device, such as a CD ROM
- Both RAM and ROM are random (direct) access devices!
- RAM should probably be called Read-Write Memory

The Central Processing Unit



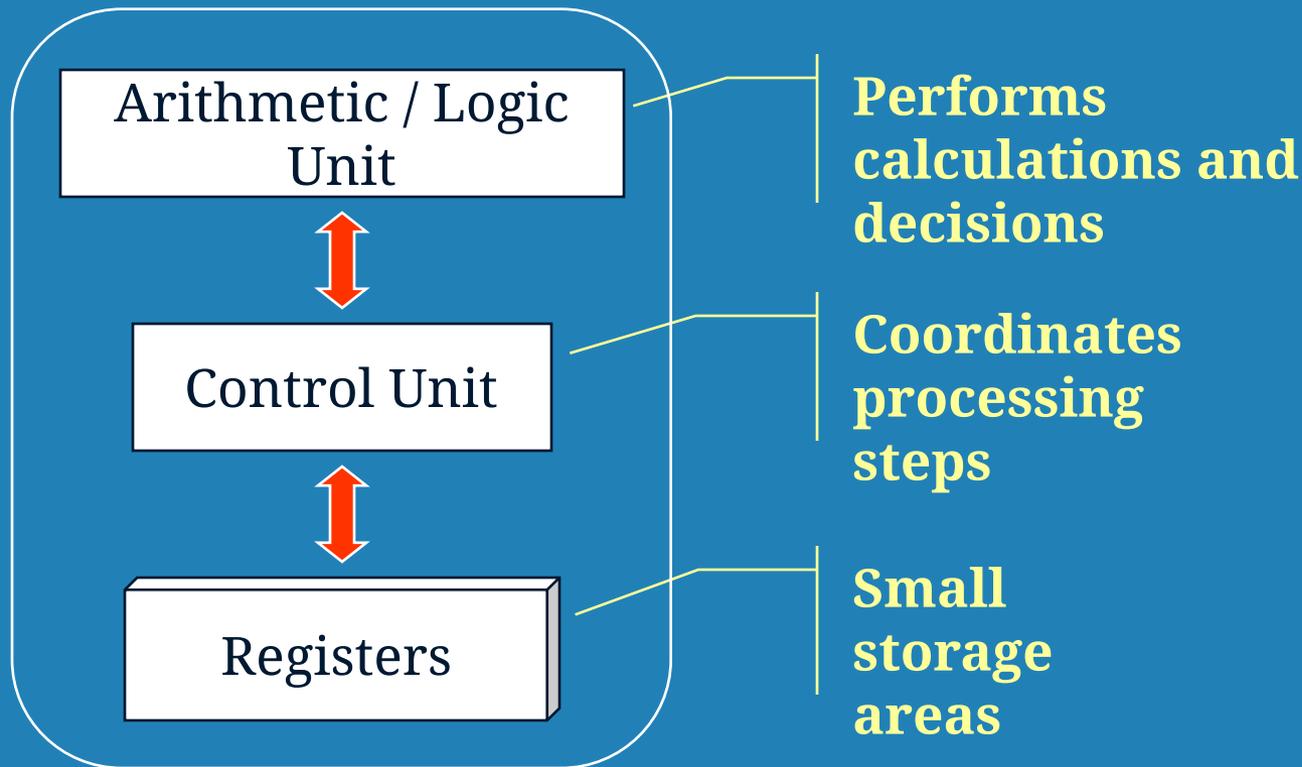
- A CPU is also called a *microprocessor*
- It continuously follows the *fetch-decode-execute cycle*:



The Central Processing Unit (CPU)



- **The CPU contains:**



The Central Processing Unit



- The speed of a CPU is controlled by the *system clock*
- The system clock generates an electronic pulse at regular intervals
- The pulses coordinate the activities of the CPU
- The speed is measured in *megahertz* (MHz)





- The size of a monitor (17") is measured diagonally, like a television screen
- Most monitors these days have *multimedia* capabilities: text, graphics, video, etc.
- A monitor has a certain maximum *resolution* , indicating the number of picture elements, called *pixels*, that it can display (such as 1280 by 1024)
- High resolution (more pixels) produces sharper pictures



Modem



- *Data transfer devices* allow information to be sent and received between computers
- Many computers include a *modem*, which allows information to be moved across a telephone line
- A data transfer device has a maximum *data transfer rate*
- A modem, for instance, may have a data transfer rate of 56,000 *bits per second* (bps)



Networks



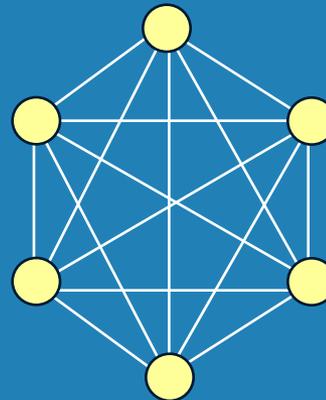
- **A *network* is two or more computers that are connected so that data and resources can be shared**
- **Most computers are connected to some kind of network**
- **Each computer has its own *network address*, which uniquely identifies it among the others**
- **A *file server* is a network computer dedicated to storing programs and data that are shared among network users**

Network Connections



- Each computer in a network could be directly connected to each other computer in the network
- These are called *point-to-point* connections

Adding a computer requires a new communication line for each computer already in the network

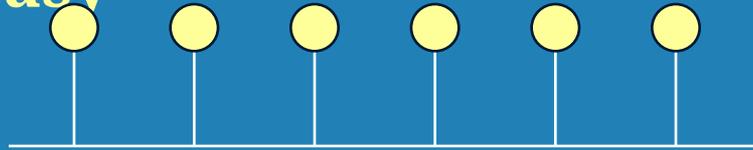


This technique is not feasible for more than a few close machines

Network Connections



- Most modern networks share a single communication line
- Adding a new computer to the network is relatively easy



Network traffic must take turns using the line, which introduces delays

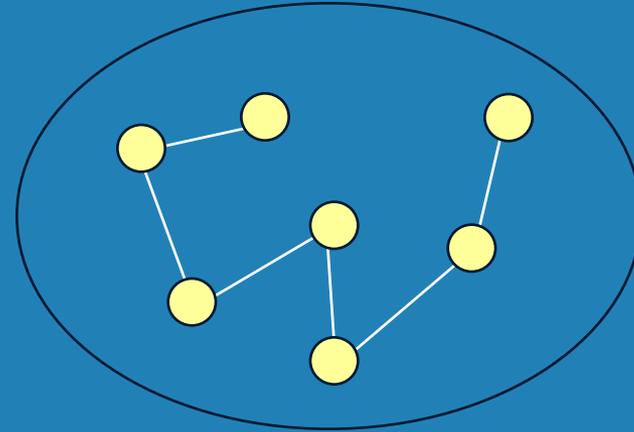
Often information is broken down in parts, called *packets*, which are sent to the receiving machine then reassembled



Local-Area Networks



A Local-Area Network (LAN) covers a small distance and a small number of computers



LA
N

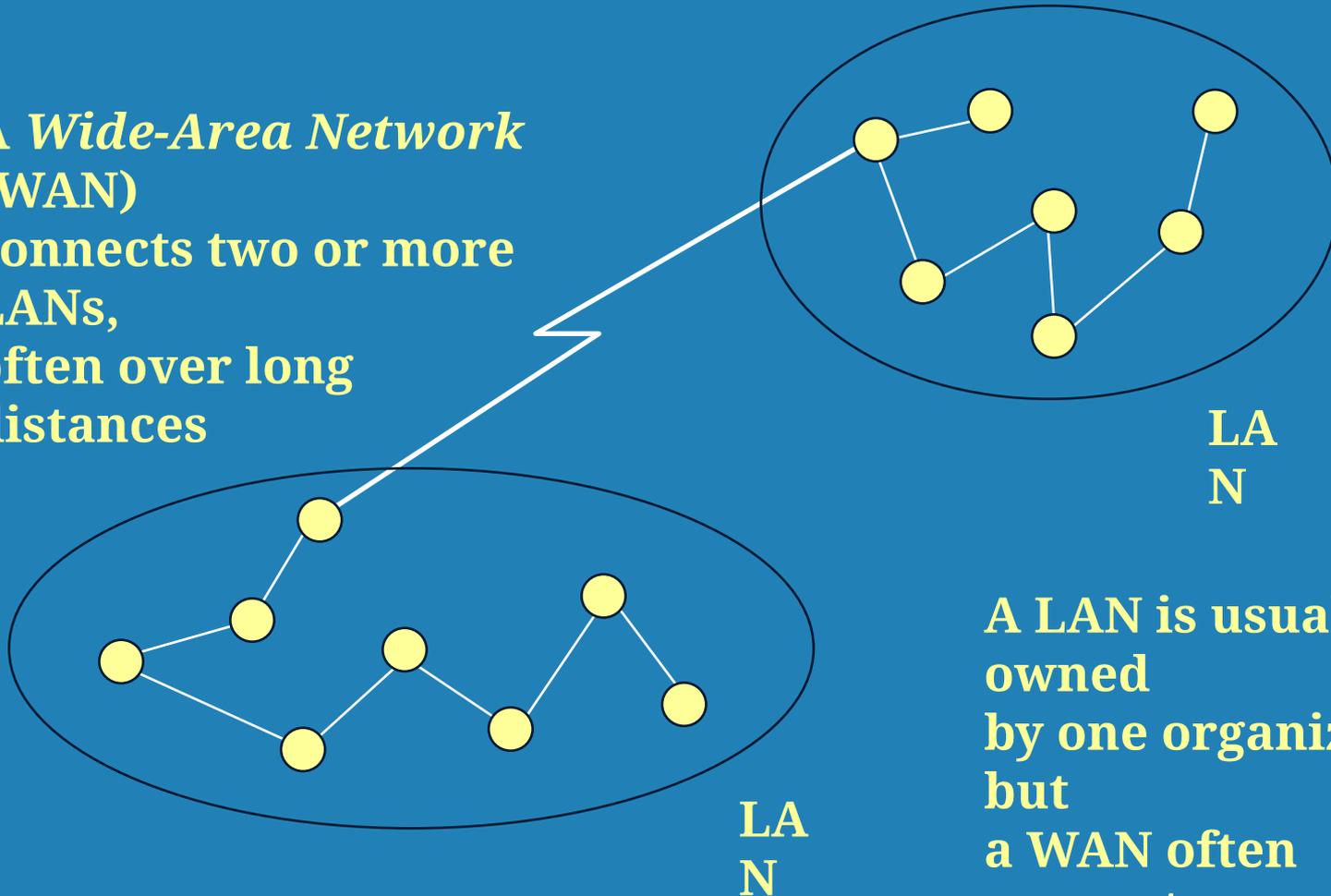
A LAN often connects the machines in a single room or building



Wide-Area Networks



A Wide-Area Network (WAN) connects two or more LANs, often over long distances



A LAN is usually owned by one organization, but a WAN often connects different groups in different countries



The Internet



- The *Internet* is a WAN which spans the entire planet
- The word Internet comes from the term *internetworking*, which implies communication among networks
- It started as a United States government project, sponsored by the Advanced Research Projects Agency (ARPA), and was originally called the ARPANET
- The Internet grew quickly throughout the 1980s and 90s



- A protocol is a set of rules that determine how things communicate with each other
- The software which manages Internet communication follows a suite of protocols called *TCP/IP*
- The *Internet Protocol* (IP) determines the format of the information as it is transferred
- The *Transmission Control Protocol* (TCP) dictates how messages are reassembled and handles lost information

IP and Internet Addresses



- Each computer on the Internet has a unique *IP address*, such as:

204.192.116.2

- Most computers also have a unique Internet name, which is also referred to as an *Internet address*:

renoir.villanova.edu

kant.breakaway.com

- The first part indicates a particular computer (renoir)
- The rest is the *domain name*, indicating the organization (villanova.edu)

Domain Names



- The last section (the suffix) of each domain name usually indicates the type of organization:

edu	- educational
com	commercial
org	business
net	network-based organization

Sometimes the suffix

indicates the country:

uk	- United Kingdom
au	Australia
ca	Canada
se	Sweden

New suffix categories are being considered

Domain Names



- A domain name can have several parts
- Unique domain names mean that multiple sites can have individual computers with the same local name
- When used, an Internet address is translated to an IP address by software called the *Domain Name System* (DNS)
- There is no one-to-one correspondence between the sections of an IP address and the sections of an Internet address

The World-Wide Web



- The *World-Wide Web* allows many different types of information to be accessed using a common interface
- A *browser* is a program which accesses and presents information
 - text, graphics, sound, audio, video, executable programs
- A Web document usually contains *links* to other Web documents, creating a *hypermedia* environment
- The term Web comes from the fact that information is not organized in a linear fashion

The World-Wide Web



- Web documents are often defined using the *HyperText Markup Language* (HTML)
- Information on the Web is found using a *Uniform Resource Locator* (URL):

`http://www.lycos.com`

`http://www.villanova.edu/webinfo/domains.html`

`ftp://java.sun.com/applets/animation.zip`

- A URL indicates a protocol (http), a domain, and possibly specific documents

