

Chapter 1: Computer Systems

**PRESENTED BY
SURAJIT NATH**

Computer Systems



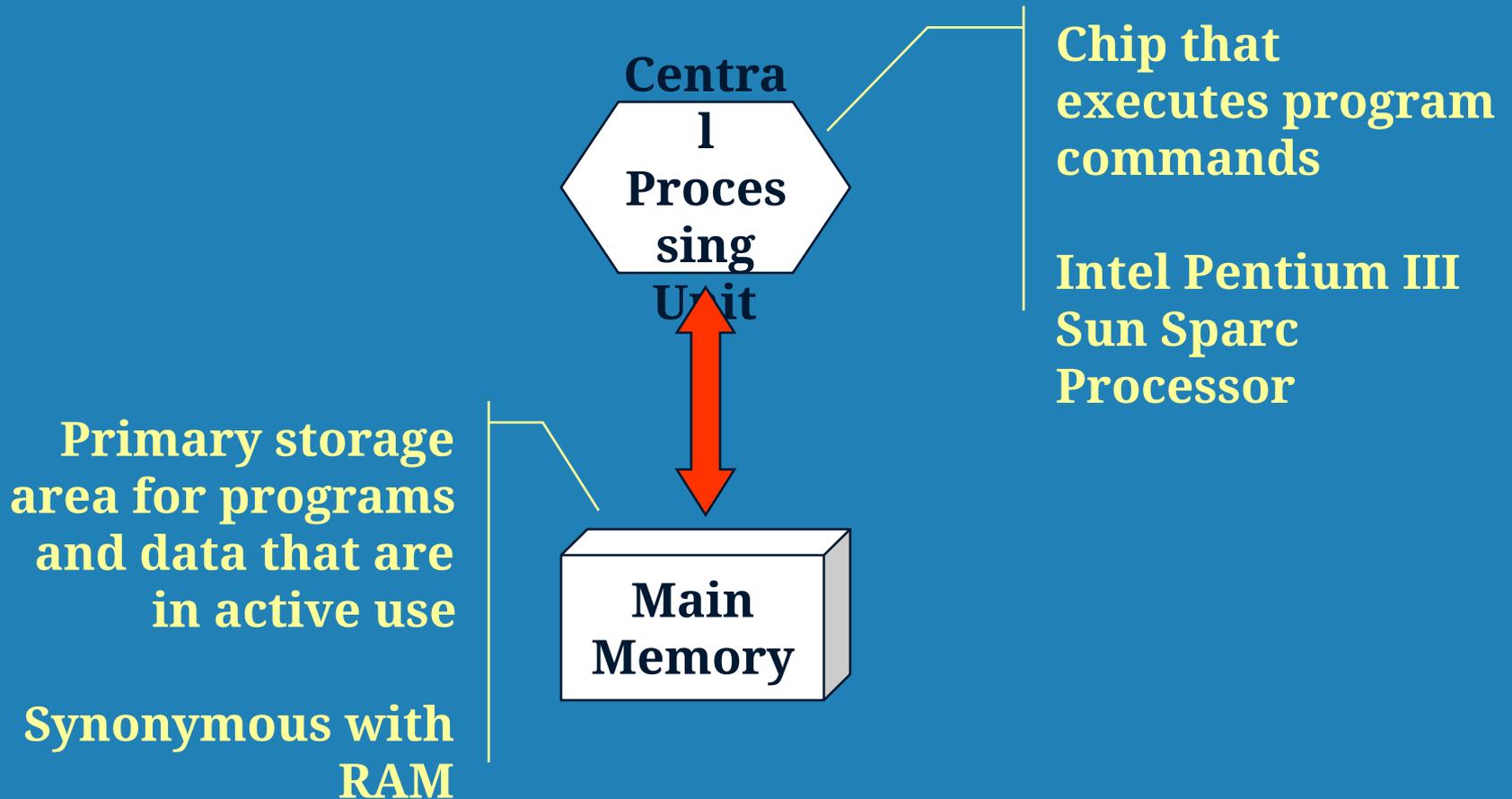
- **We first need to explore the fundamentals of computer processing**
- **Chapter 1 focuses on:**
 - **components of a computer**
 - **how those components interact**
 - **how computers store and manipulate information**
 - **computer networks**
 - **the Internet and the World-Wide Web**
 - **programming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

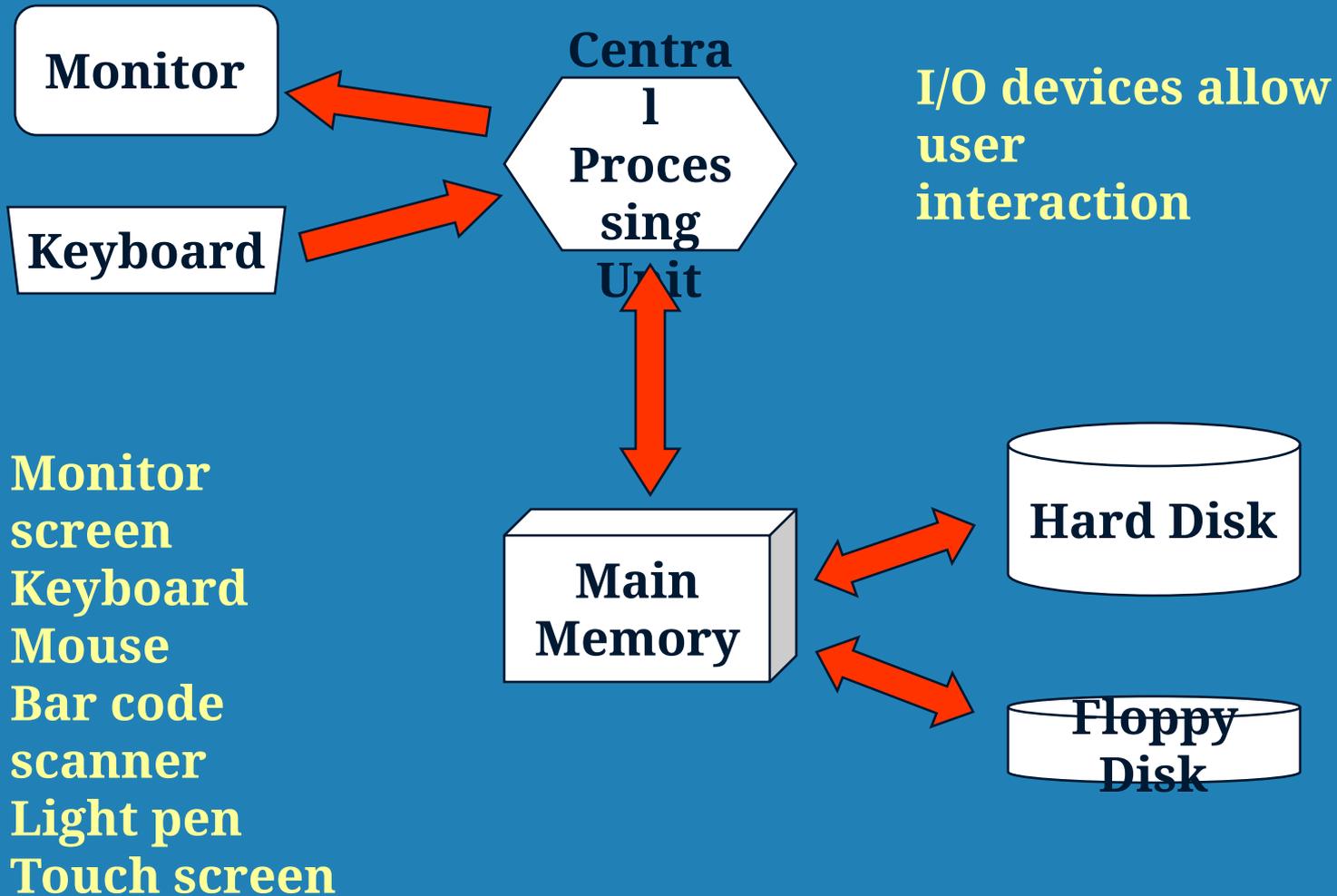
Hard disks
Floppy disks
ZIP disks
Writable CDs
Tapes



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
	00	100	0100
	01	101	0101
	10	110	0110
	11	111	0111

Each additional bit doubles the number of possible combinations

0	0000
10	0001
1	0010
11	0011
0	0100
1	0101
10	0110
11	0111
0	1000
1	1001
10	1010
11	1011
0	1100
1	1101
10	1110
11	1111



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

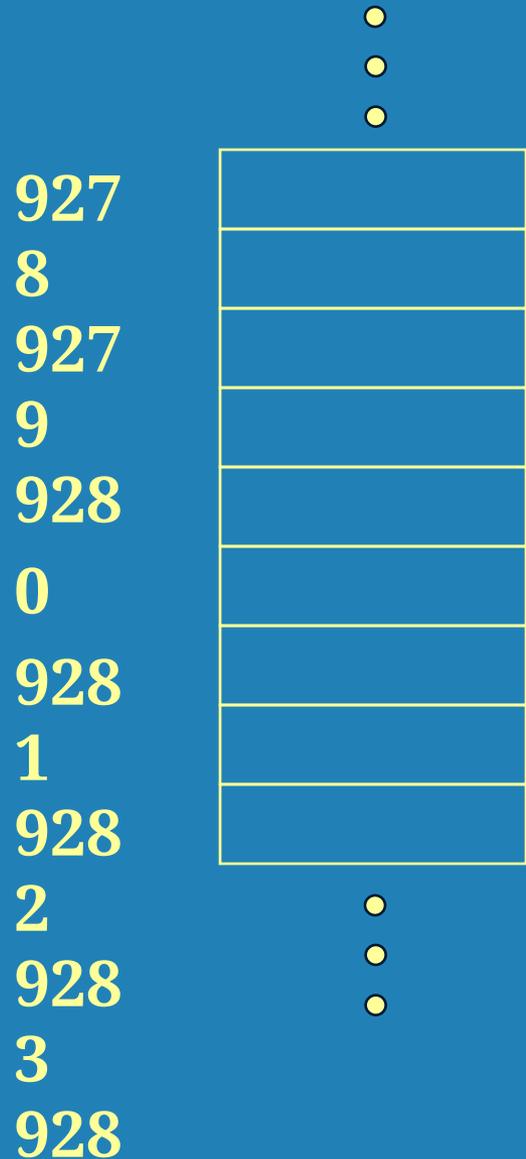


A Computer Specification



- **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?**

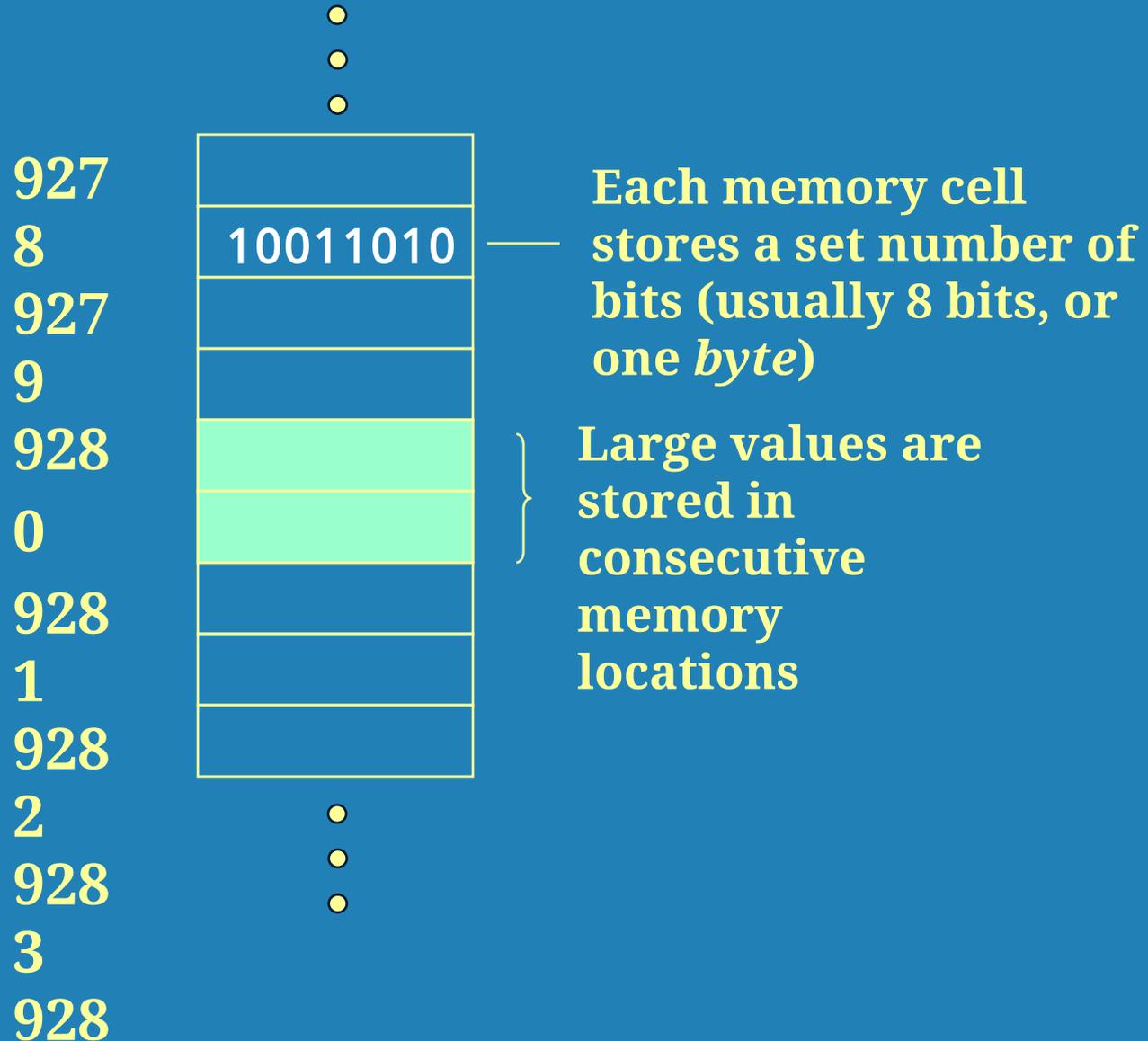
Memory



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)



- 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

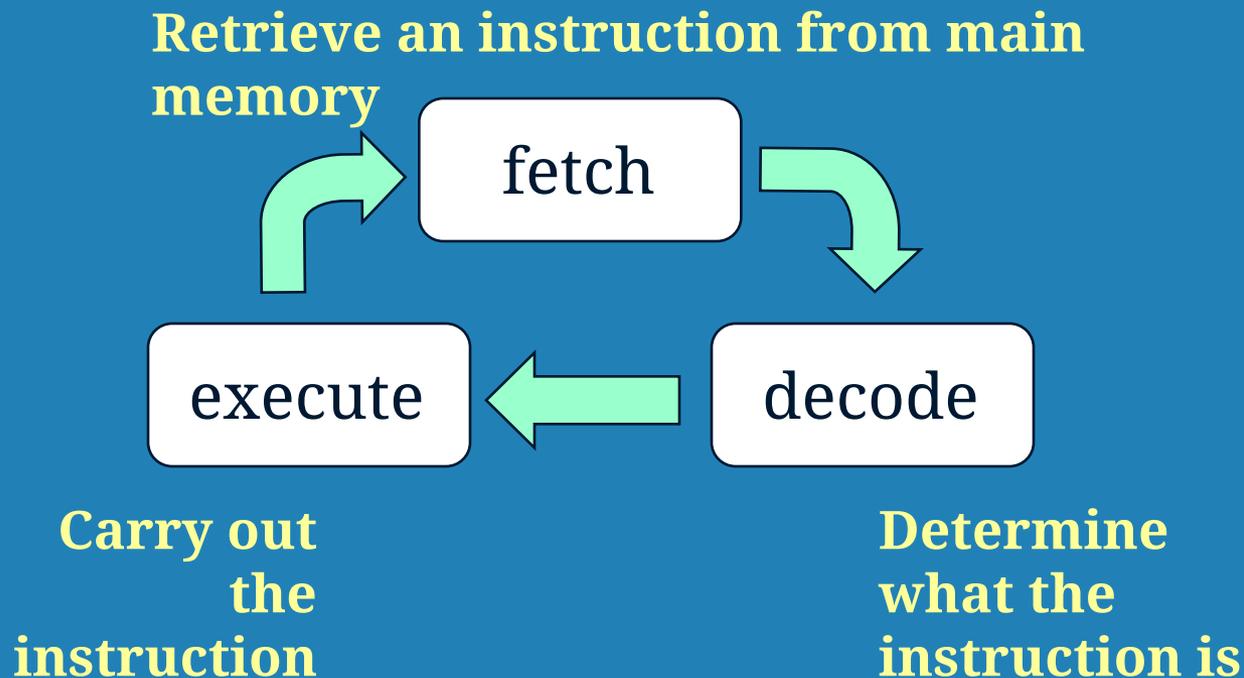


- **RAM** - Random Access Memory (direct access)
- **ROM** - Read-Only Memory
- The terms RAM and main memory are basically interchangeable
- ROM could be a set of memory chips, or a separate device, such as a CD ROM
- Both RAM and ROM are random (direct) access devices!
- RAM should probably be called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

The Central Processing Unit



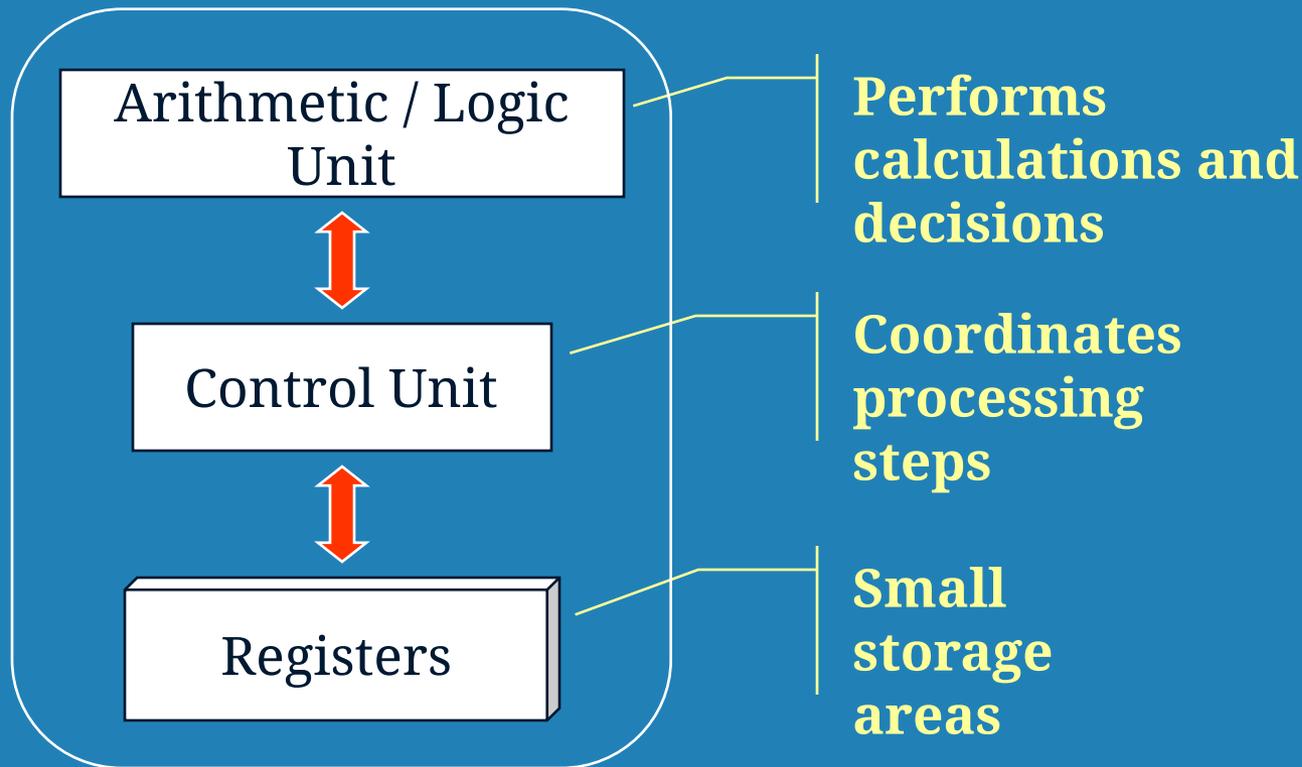
- A CPU is also called a *microprocessor*
- It continuously follows the *fetch-decode-execute cycle*:



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



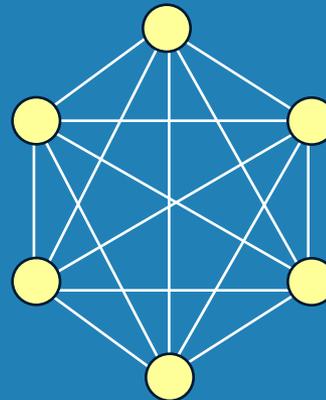
- **A *network* is two or more computers that are connected so that data and resources can be shared**
- **Most computers are connected to some kind of network**
- **Each computer has its own *network address*, which uniquely identifies it among the others**
- **A *file server* is a network computer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

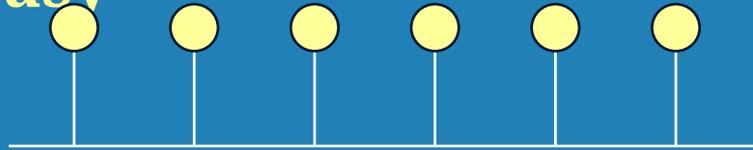


This technique is not feasible for more than a few close machines

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

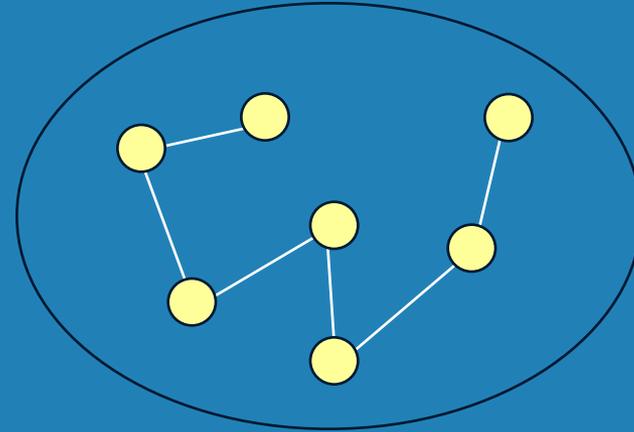
Often information is broken down in parts, called *packets*, which are sent to the receiving machine then reassembled



Local-Area Networks



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



LAN

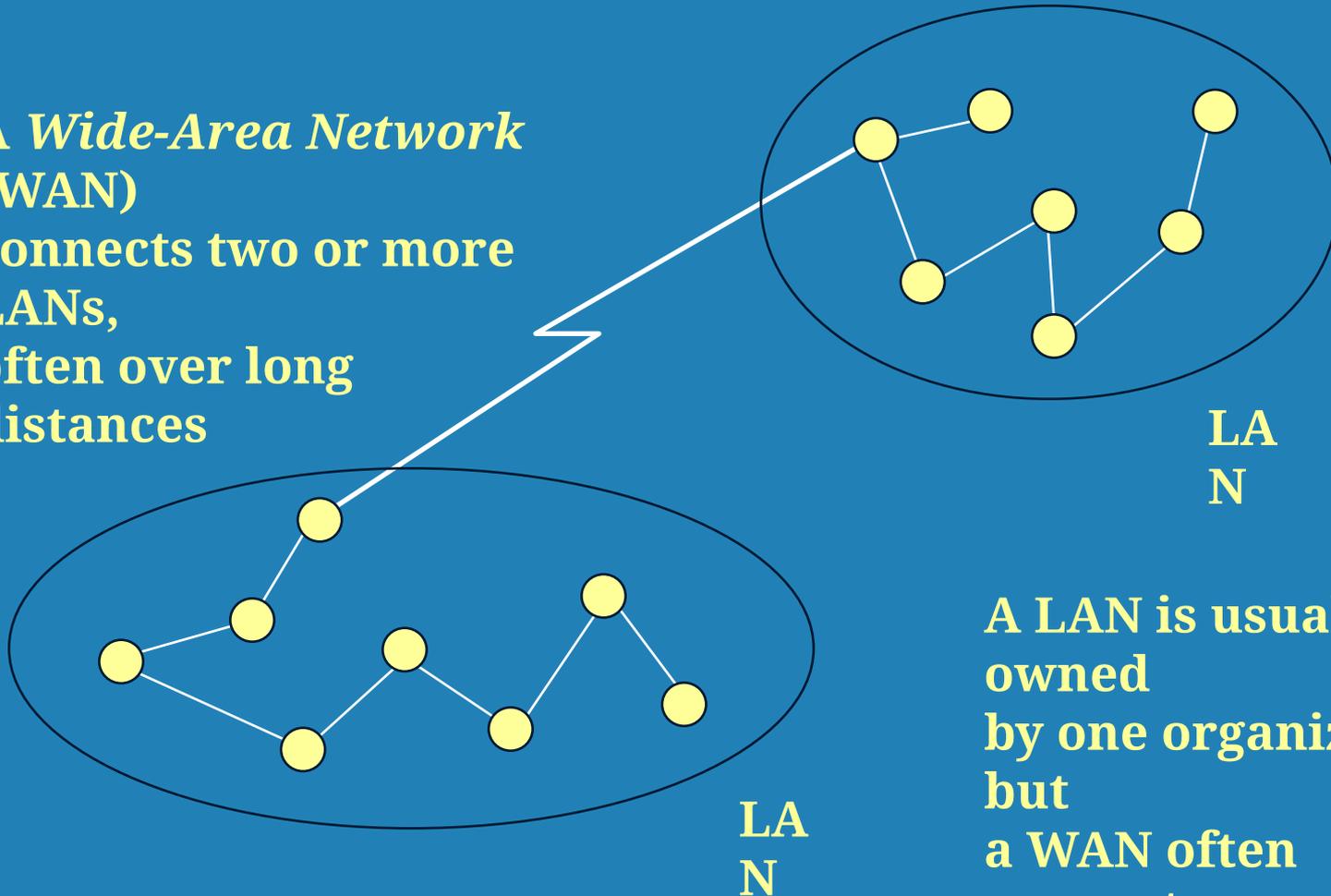
A LAN often connects the machines in a single room or building



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 or not-for-profit
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

