Focus of the Course

- **Object-Oriented Software Development**
  - **problem solving**
  - **program design and implementation**
  - **object-oriented concepts**
    - **objects**
    - **classes**
    - **interfaces**
    - **inheritance**
    - **polymorphism**
  - **The Java programming language**
- **Aimed at students with LITTLE or NO background in programming**

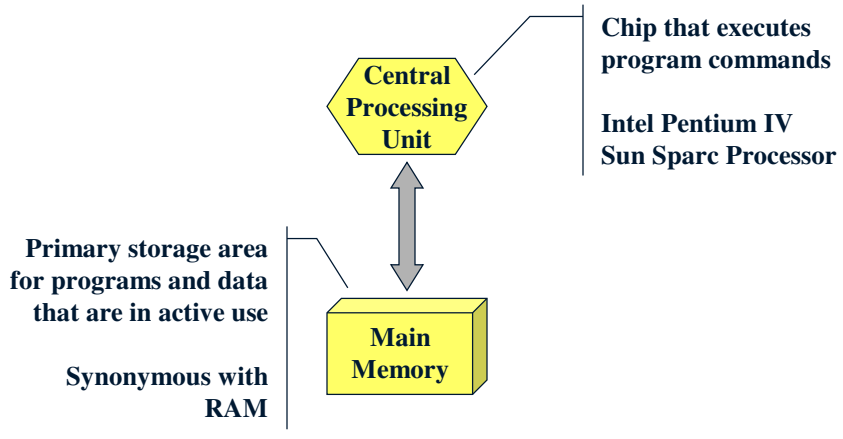
COMP 202 – Week 1

- **We first need to explore the fundamentals of computer processing.**
- **This week we focus on:**
  - **components of a computer**
  - **how those components interact**
  - **how computers store and manipulate information**
  - **computer networks (including the Internet and the WWW)**

Hardware and Software

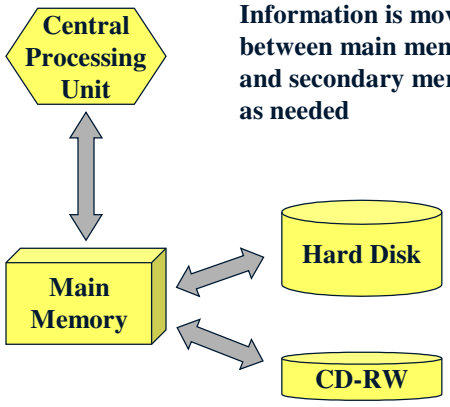
- Hardware
  - the physical, tangible parts of a computer
  - keyboard, monitor, wires, chips, mouse
- Software
  - programs and data
  - a *program* is a series of instructions
- A computer requires both hardware and software
- Each is essentially useless without the other

CPU and Main Memory



Secondary Memory Devices

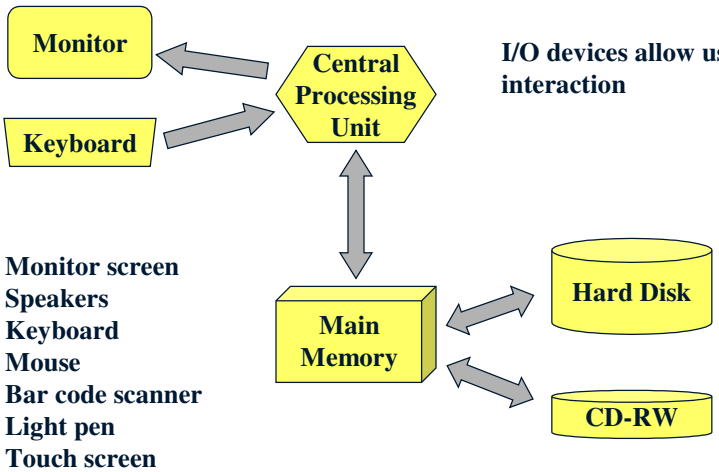
Secondary memory devices provide long-term storage



Information is moved between main memory and secondary memory as needed

Hard disks
USB keys
ZIP disks
DVDs/CDs

Input / Output Devices



I/O devices allow user interaction

Monitor screen
Speakers
Keyboard
Mouse
Bar code scanner
Light pen
Touch screen

Software Categories

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

Analog vs. Digital

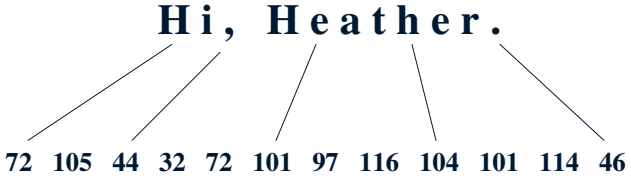
- **There are two basic ways to store and manage data:**
- ***Analog***
  - **continuous, in direct proportion to the data represented**
  - **music on a record album - a needle rides on ridges in the grooves that are directly proportional to the voltage sent to the speaker**
- ***Digital***
  - **the 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**

Digital Information

- 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



Ctrl	Dec	Hex	Char	Code
^@	0	00		NUL
^A	1	01		SOH
^B	2	02		STX
^C	3	03		ETX
^D	4	04		EOT
^E	5	05		ENQ
^F	6	06		ACK
^G	7	07		BEL
^H	8	08		BS
^I	9	09		HT
^J	10	0A		LF
^K	11	0B		VT
^L	12	0C		FF
^M	13	0D		CR
^N	14	0E		SO
^O	15	0F		SI
^P	16	10		DLE
^Q	17	11		DC1
^R	18	12		DC2
^S	19	13		DC3
^T	20	14		DC4
^U	21	15		NAK
^V	22	16		SYN
^W	23	17		ETB
^X	24	18		CAN
^Y	25	19		EM
^Z	26	1A		SUB
^[	27	1B		ESC
^\	28	1C		FS
^]	29	1D		GS
^^	30	1E	▲	RS
^-	31	1F	▼	US

Dec	Hex	Char
32	20	
33	21	!
34	22	"
35	23	#
36	24	$
37	25	%
38	26	&
39	27	'
40	28	(
41	29	)
42	2A	*
43	2B	+
44	2C	,
45	2D	-
46	2E	.
47	2F	/
48	30	0
49	31	1
50	32	2
51	33	3
52	34	4
53	35	5
54	36	6
55	37	7
56	38	8
57	39	9
58	3A	:
59	3B	;
60	3C	<
61	3D	=
62	3E	>
63	3F	?

Dec	Hex	Char
64	40	@
65	41	A
66	42	B
67	43	C
68	44	D
69	45	E
70	46	F
71	47	G
72	48	H
73	49	I
74	4A	J
75	4B	K
76	4C	L
77	4D	M
78	4E	N
79	4F	O
80	50	P
81	51	Q
82	52	R
83	53	S
84	54	T
85	55	U
86	56	V
87	57	W
88	58	X
89	59	Y
90	5A	Z
91	5B	[
92	5C	\
93	5D	]
94	5E	^
95	5F	_

Dec	Hex	Char
96	60	`
97	61	a
98	62	b
99	63	c
100	64	d
101	65	e
102	66	f
103	67	g
104	68	h
105	69	i
106	6A	j
107	6B	k
108	6C	l
109	6D	m
110	6E	n
111	6F	o
112	70	p
113	71	q
114	72	r
115	73	s
116	74	t
117	75	u
118	76	v
119	77	w
120	78	x
121	79	y
122	7A	z
123	7B	{
124	7C	|
125	7D	}
126	7E	~
127	7F	Δ*

* ASCII code 127 has the code DEL. Under MS-DOS, this code has the same effect as ASCII 8 (BS). The DEL code can be generated by the CTRL + BKSP key.

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

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

Each additional bit doubles the number of possible combinations

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**

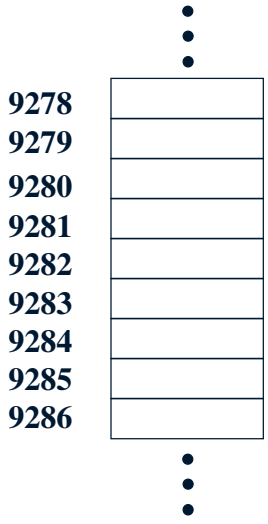
How many items can be represented by

- **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

A Computer Specification

- **Computer architecture describes how the hardware components are put together.**
- **Consider the specifications when buying a personal computer…**
- **What does it all mean?**

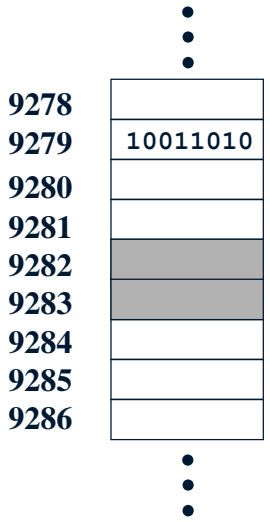
Memory



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

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

Storing Information



Each memory cell stores a set number of bits (usually 8 bits, or one *byte*)

Large values are stored in consecutive memory locations

Storage Capacity

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

Unit	Symbol	Number of Bytes
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

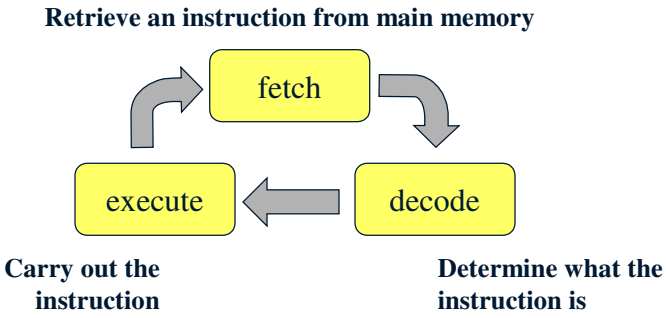
- **Main memory is *volatile* - stored information is lost if the electric power is removed**
- **Secondary memory devices are *nonvolatile***
- **Main memory and disks are *direct access* devices - information can be reached directly**
- **The terms direct access and *random access* are often used interchangeably**

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**

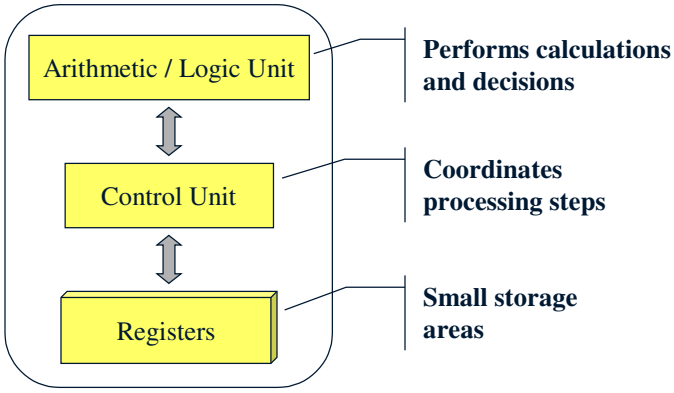
The Central Processing Unit

- 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) or *gigahertz* (GHz)**

Monitor

- **The size of a monitor (17") is measured diagonally, like a television screen**
- **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)**

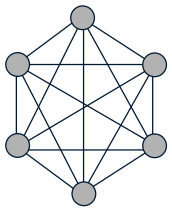
Networks

- **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**

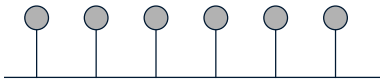
Adding a computer requires a new communication line for each computer already in the network



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**

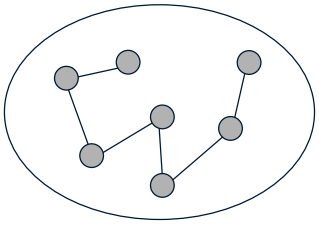


Network traffic must take turns using the line, which introduces delays

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

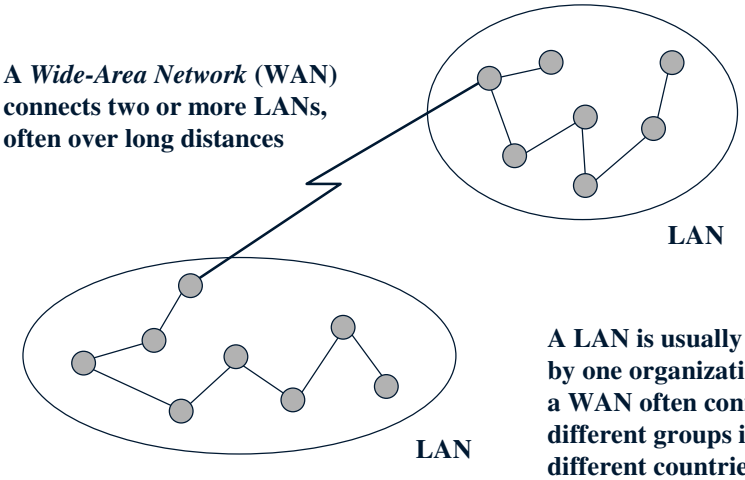


LAN

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



LAN

LAN

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**
- **Less than 600 computers were connected to the Internet in 1983; now there are over 600 million**

TCP/IP

- **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:**

  `132.206.51.10`

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

  `mimi.cs.mcgill.ca`

- **The first part indicates a particular computer (`mimi`)**
- **The rest is the *domain name*, indicating the organization (`cs.mcgill.ca`)**

Domain Names

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

  `edu` - **educational institution**
  `com` - **commercial business**
  `org` - **non-profit organization**
  `net` - **network-based organization**

Sometimes the suffix indicates the country:

`uk` - **United Kingdom**
`au` - **Australia**
`ca` - **Canada**
`bo` - **Bolivia**

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.google.com
http://java.sun.com/j2se/1.5.0/docs/api/index.html
ftp://sunsite.unc.edu/pub/docs/humor/murphy
```

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