Information Technology Foundations

Chapter 3

Computer Hardware

Computer Hardware

- Define Computer hardware

Definition:

- ***Computer hardware*** is the collection of physical parts of a ***computer*** system. This includes the ***computer*** case, monitor, keyboard, and mouse. It also includes all the parts inside the ***computer*** case, such as the hard disk drive, motherboard, video card, and many others. ***Computer hardware*** is what you can physically touch.

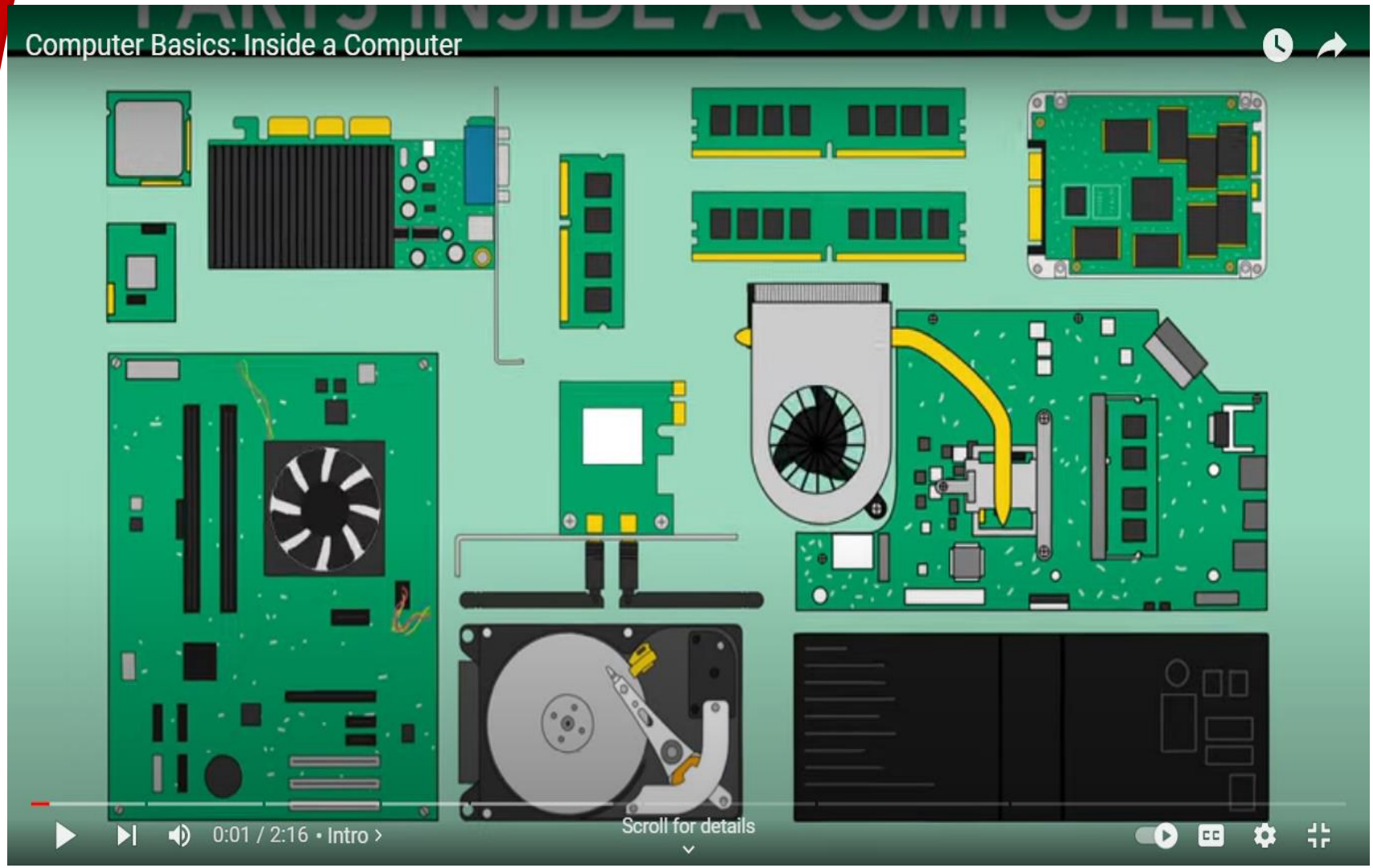
Computing History

- **1970**
  - **1970** IBM System/370 announced
  - **1975** MITS Altair 8800: micro kit
  - **1976** Cray I shipped supercomputer
  - **1978** TRS-80/I, Apple II introduced
- **1980**
  - **1982** IBM Personal Computer
  - **1984** Apple Macintosh
  - **1988** 32 bit microprocessors (I486 & M 68040)
  - **1989** RISC processors, LANs
- **1990**
  - **Rapidly declining cost of small computers**
  - **Software integration**
  - **The Internet expansion, Web browsers**
- **2000**
  - **Ubiquitous computing**
  - **Web 2.0 (interactive) and Social Networks**
  - **Cell phones and mobile computing**
- **2010**
  - **Cloud computing?**
  - **Touch and voice interfaces?**

Trends

- Hardware
  - Size (capacity)
  - Speed (performance)
  - Reliability
  - Mobility and physical size
  - Price
  - Data types: Text, Images, Audio, Video
- Software and Operating System Trends
  - Original: User/Programmer
  - Early: Sequential Questions
  - Easier: Menus
  - Current: User/Event Driven

Inside a Computer



[Computer Basics: Inside a Computer - YouTube]

Changing Technology Selections

Desktop:

Workstation

Sun (extinct)

Laptop

Cell phone

Apple

Tablet

Motorola

Enterprise Server:

HP

Super computer:

Cray

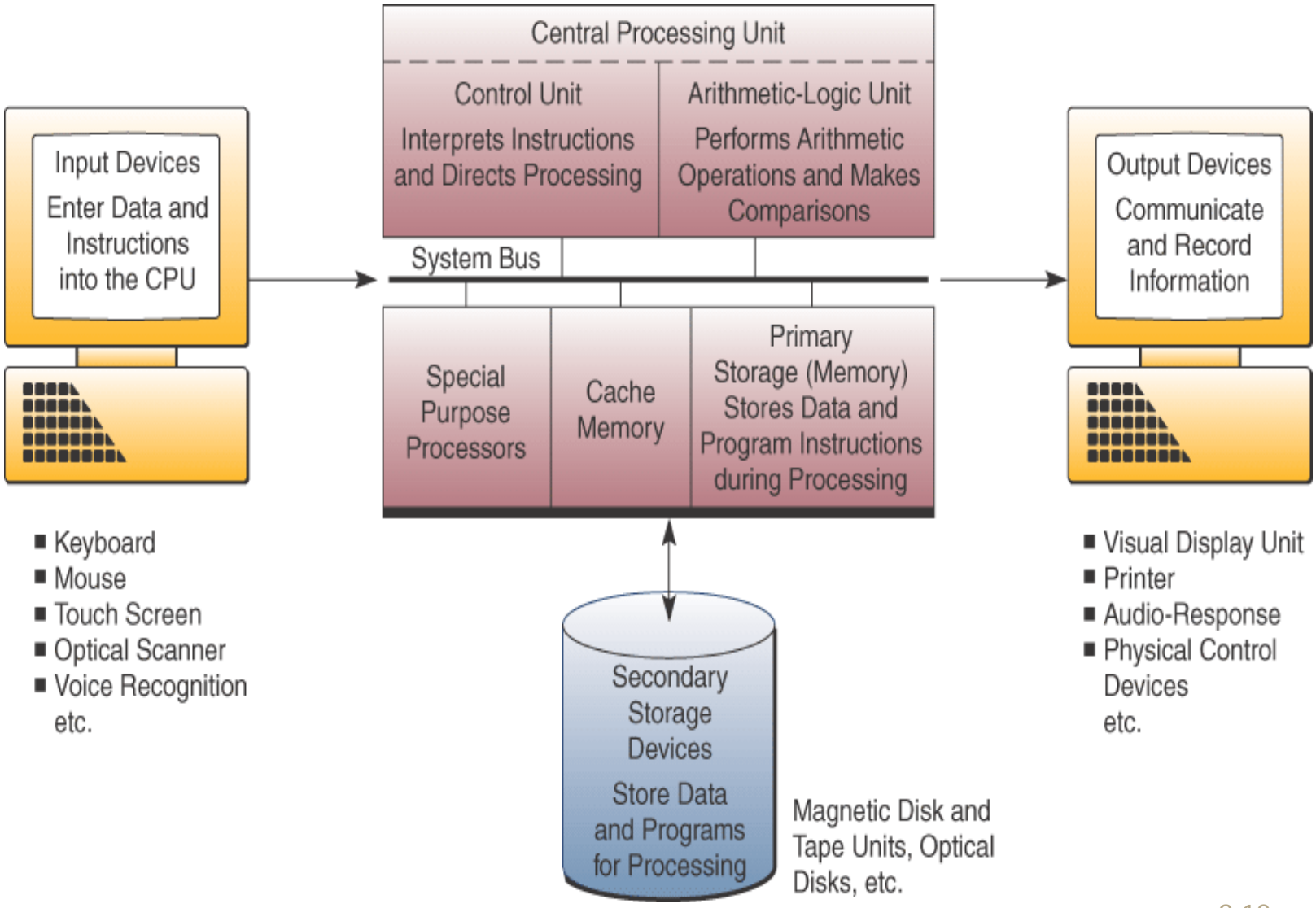
Computer System Concept

- A system of hardware devices organized by function
  - **Input**
    - Keyboards, touch screens, pens, electronic mice, optical scanners
    - Converts data into electronic form for entry into computer system
  - **Processing**
    - Central Processing Unit (CPU)
    - CPU subunits: arithmetic-logic and control unit

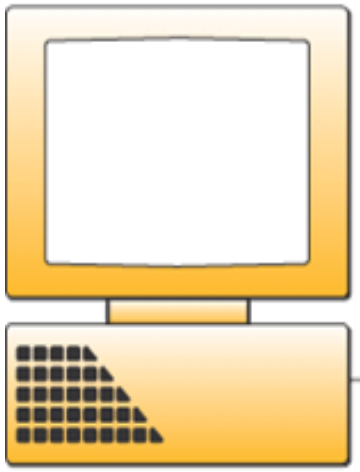
Computer System Concept

- **Output**
  - Video display units, printers, audio response units,
    and so on
  - Converts electronic information into human-intelligible form
- **Storage**
  - Primary storage (memory)
  - Secondary storage (disk drives)
- **Control**
  - CPU controls other components of the system

Computer System Concept



Categories of Computer Systems



- **Microcomputer Systems**
  Personal computers, network computers, technical workstations, personal digital assistants, information appliances, etc.

- **Midrange Systems**
  Network servers, minicomputers, Web servers, multiuser systems, etc.

- **Mainframe Systems**
  Enterprise systems, superservers, transaction processors, supercomputers, etc.

Microcomputer Systems

- Usually called a personal computer or PC
- Computing power now exceeds that of the mainframes of previous generations
- Relatively inexpensive
- Are the networked professional workstations used by business processions
- Versions include hand-held, notebook, laptop, tablet, portable, desktop, and floor-standing

Recommended PC Features

~2010	2010-2012	Newcomer ???????
2-3 GHz processor	Mac G4 or 2-3 GHz Intel processor	
512MB RAM	2 GB RAM	
80GB hard drive	500GB+ hard drive	
18-inch flat-panel display	18-inch or larger CRT, flat-panel LCD, or plasma display	
CD-RW/DVD drive or portable hard drives for backup	CD-RW/DVD+RW drive	
Network interface card (NIC)	High-end color printer	
Basic speaker system	Deluxe speaker system	

Information Appliances

- Hand-held microcomputer devices
- Known as personal digital assistants (PDAs)
  - Web-enabled PDAs use touch screens, handwriting recognition, or keypads
  - Mobile workers use to access email or the Web, exchange data with desktop PCs or servers
  - Latest entrant is the BlackBerry
- PDAs include
  - Video-game consoles
  - Cellular and PCS phones
  - Telephone-based home email appliances

Midrange Systems

- High-end network servers that handle large-scale processing of business applications
- Not as powerful as mainframes
  - Less expensive to buy, operate, and maintain
- Often used to manage
  - Large Internet websites
  - Corporate intranets and extranets
  - Integrated, enterprise-wide applications
- Used as front-end servers to assist mainframes with telecommunications and networks

Mainframe Computer Systems

- Large, fast, powerful computer systems
  - Large primary storage capacity
  - High transaction processing
  - Handles complex computations
- Widely used as superservers for…
  - Large client/server networks
  - High-volume Internet websites
- Becoming a popular computing platform for…
  - Data mining and warehousing
  - Electronic commerce applications

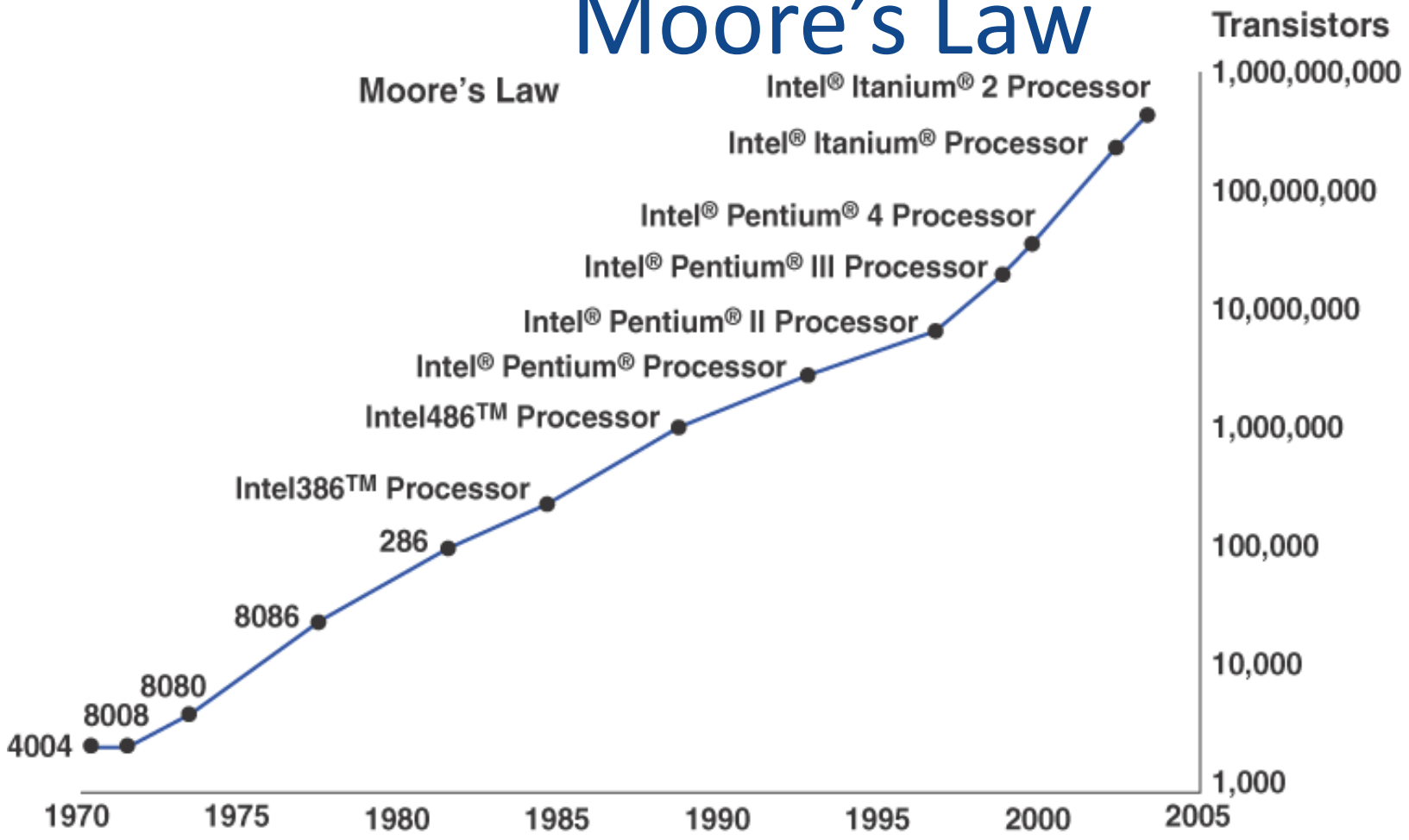
What is a Server?

- Reliability
- Easy backup
- Easy maintenance
- Multi-user
- Scalability
  - Product family consistency (IBM)
  - Server Farm (Microsoft)

Moore's Law

- A doubling in the number of transistors per integrated circuit every 18 to 24 months
  - Originally observed in 1965, it holds true today
- Common consequence of Moore's Law…
  - Computing prices will be cut in half every 18 to 24 months
  - This has been consistently accurate
  - Applies to cost of storage as well

Moore's Law



➔ 2005 Intel Itanium: 100 Million

➔ 2014 Intel I7: 4.3 Billion

IT related LAW

- Kryder's law ~disk storage
- Butter's law ~ Network Capacity
- Wirth's law ~ Software Performance

Binary Data: bits and Bytes

Single bit: one or zero (on or off)
8 bits = 1 Byte: 10101010
1 byte holds values from 0 – 255

$2^{20} = 1{,}048{,}576$
$2^{10} = 1024$
$2^{8} = 256$
$2^{7} = 128$
$2^{6} = 64$
$2^{5} = 32$
$2^{4} = 16$
$2^{3} = 8$
$2^{2} = 4$
$2^{1} = 2$
$2^{0} = 1$

Bytes	bits	Power of 2
1	8	256
2	16	65,536
3	24	16,777,216
4	32	4,294,967,296
8	64	18,446,744,073,709,551,616

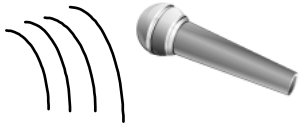
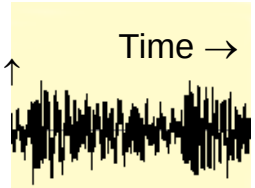
Note that 32-bit hardware/software cannot address more than 4 GB of memory. Windows 7/32 max is 3 GB.

Big Numbers (Terminology)

Term	Approximate	Power of 10	Power of 2	IEC term	Binary value
Kilo	Thousand	3	10	Kibi	1024
Mega	Million	6	20	Mebi	1,048,576
Giga	Billion	9	30	Gibi	1,073,741,824
Tera	Trillion	12	40	Tebi	1,099,511,627,776
Peta	Quadrillion	15	50	Pebi	1,125,899,906,842,624
Exa	Quintillion	18	60	Exbi	1,152,921,504,606,846,976
Zetta	Sextillion	21	70	Zebi	1,180,591,620,717,411,303,424
Yotta	Septillion	24	80	Yobi	…

Some people use different names for powers of ten versus two.
Powers of ten use a base of 1000.
Powers of two use a base of 1024.
The IEC (electrical) standard in 1999 defines different terms for decimal versus binary numbers.

Data Types

		Input	Process	Output
Numbers	12 + 8 = 20		000001100 000001000 --- 000010100	20
Text	This is a test		84 104 73 115 …	This is a test
Images			0010000000000000000 0100000000000001001 0110000011000011011 0111111111111001111 1111111111111011111 1111111111100011111	
Sound	 	pitch or volume ↑ Time →  8 9 0 5 … 000001000 000001001 000010100 …		
Video			00101010111 00101010111 00101010111 11010101010 11010101010 11010101010 01010101010 01010101010 01010101010 11110100011 11110100011 11110100011 00101011011 00101011011 00101011011 00101010111 00101010111 11010101010 11010101010 01010101010 01010101010 11110100011 11110100011 00101011011 00101011011	

Computer Components

Input

seconds - milliseconds

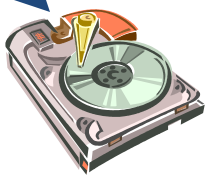
- Keyboard
- Mouse
- Optical scanner
- Voice input
- Bar code
- Touch screen
- Light pen
- MICR
- Magnetic strips
- Card reader
- Other computers

Process

nanoseconds

- Processor
- RAM
- Device controllers

Secondary storage



milliseconds

- Magnetic Disk
- Floppy Disk
- Optical Disk
- Tape Drive
- USB Drive

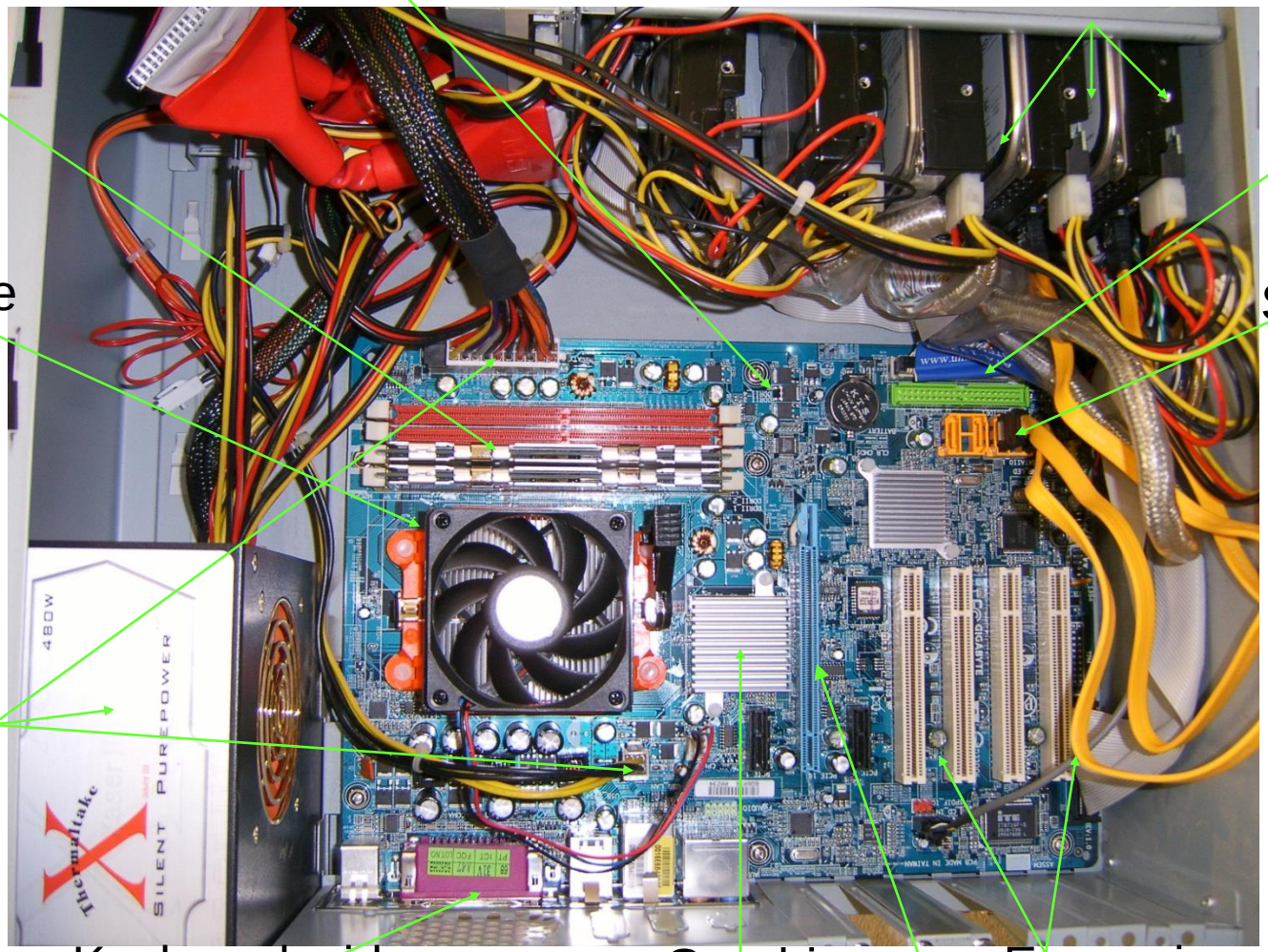
Output

seconds - milliseconds

- Video monitor
- Printer
- Plotter
- Process control
- Voice output
- Music synthesizers
- Other computers

Motherboard

Basic Computer Board



Disk drives

RAM

IDE

Processor —under the fan and heat sink

SATA

Power supply

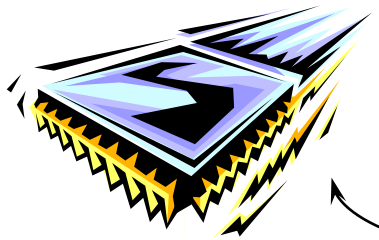
Keyboard, video, and other connectors

Graphics Onboard and external

Expansion slots

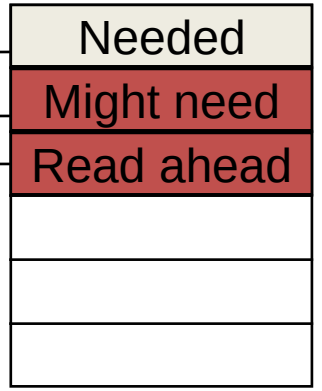
Cache Memory

Processor



Cache on Processor

File

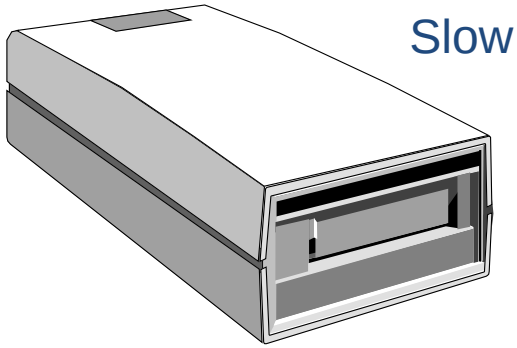


Fast

Cache Memory

Disk Drive

Slow



Processor is faster than disk drive.

Reads ahead and stores several pieces of the file into cache memory.

Pulls data from cache as needed.

Cache is used as a buffer between two devices of different speeds. Disk->RAM, RAM->Processor

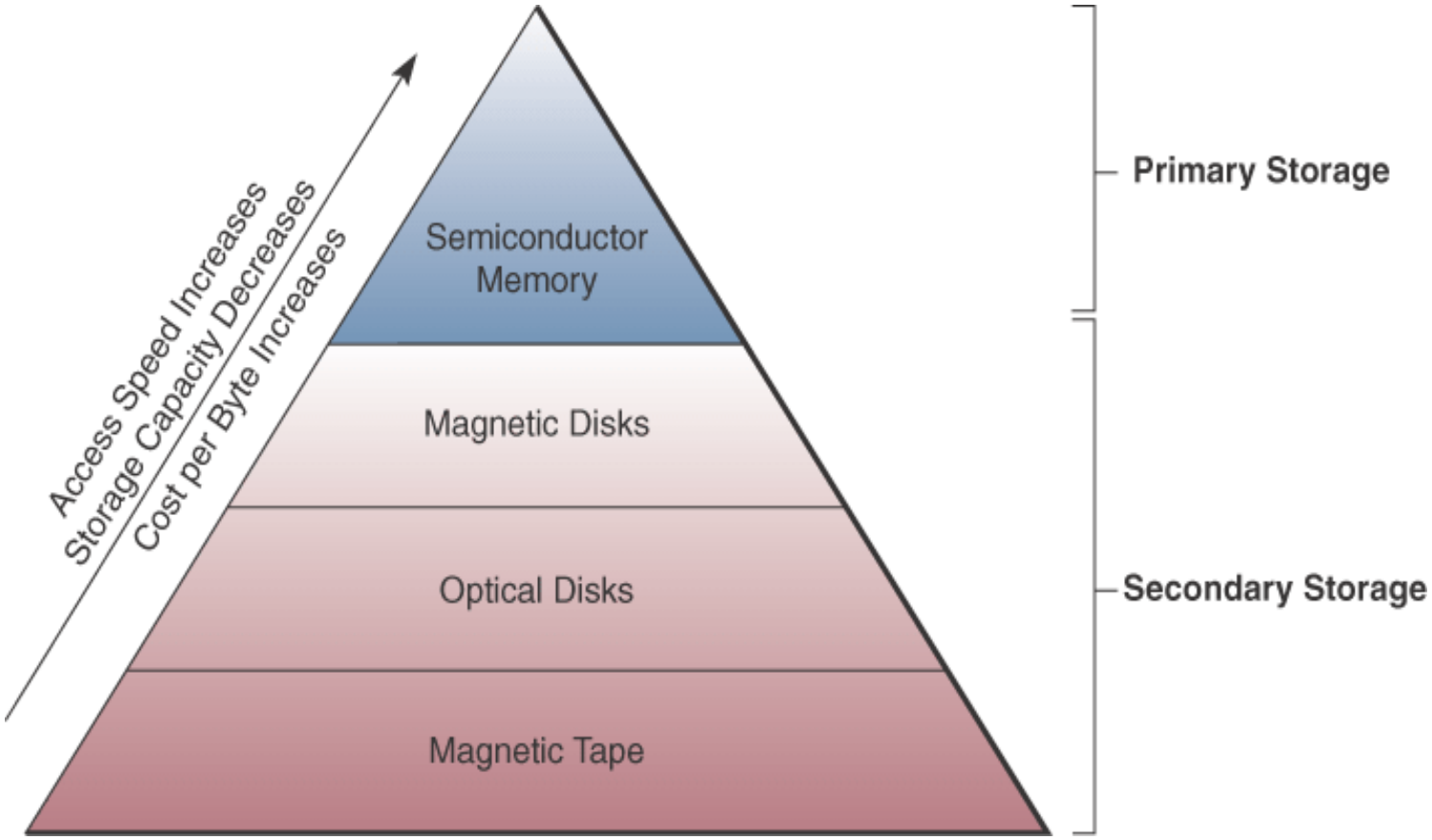
Peripherals

- **Peripheral** is a generic name for all input, output, and secondary storage devices
  - Parts of the computer system, but not the CPU
  - Are all online devices
- Online devices
  - Separate from the CPU, but electronically connected to and controlled by it
- Offline devices
  - Separate from and not under the control of the CPU

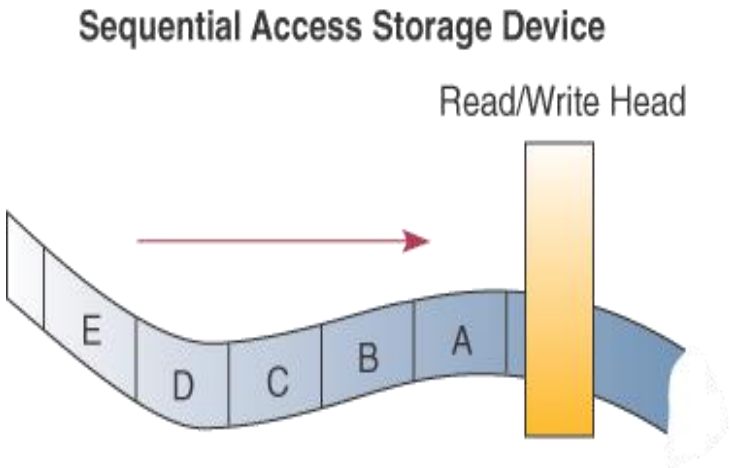
Peripherals Device

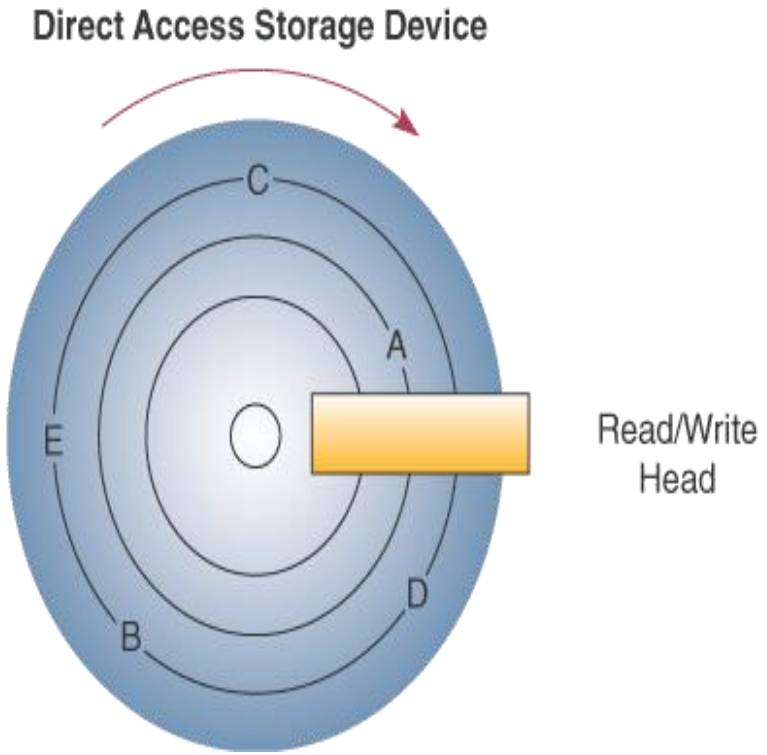
Peripherals Checklist
• **Monitors.** Bigger is better for computer screens. Consider a high-definition 19-inch or 21-inch flat screen CRT monitor, or LCD flat panel display. That gives you much more room to display spreadsheets, Web pages, lines of text, open windows, etc. An increasingly popular setup uses two monitors that allow multiple applications to be used simultaneously.
• **Printers.** Your choice is between laser printers or color inkjet printers. Lasers are better suited for high-volume business use. Moderately priced color inkjets provide high-quality images and are well suited for reproducing photographs. Per-page costs are higher than for laser printers.
• **Scanners.** You'll have to decide between a compact, sheet-fed scanner and a flatbed model. Sheet-fed scanners will save desktop space, while bulkier flatbed models provide higher speed and resolution.
• **Hard Disk Drives.** Bigger is better; as with closet space, you can always use the extra capacity. So go for 40 gigabytes at the minimum to 80 gigabytes and more.
• **CD and DVD Drives.** CD and DVD drives are a necessity for software installation and multimedia applications. Common today is a built-in CD-RW/DVD drive that both reads and writes CDs and plays DVDs.
• **Backup Systems.** Essential. Don't compute without them. Removable mag disk drives and even CD-RW and DVD-RW drives are convenient and versatile for backing up your hard drive's contents.

Storage Tradeoffs



Direct and Sequential Access





Semiconductor Memory

- Microelectronic semiconductor memory chips are used for primary storage
  - **Advantages**: small size, fast, shock and temperature resistance
  - **Disadvantages**: volatility; must have uninterrupted electric power or loses memory

Types of Semiconductor Memory

- Random Access Memory (RAM)
  - Most widely used primary storage medium
  - Volatile memory
  - Read/write memory
- Read-Only Memory (ROM)
  - Permanent storage
  - Can be read, but not overwritten
  - Frequently used programs burnt into chips during manufacturing process
  - Called firmware

Flash Drives

- Sometimes referred to as a **jump drive, USB Drive**
  - Uses a small chips containing thousands of transistors
  - Can store data for virtually unlimited periods without pov
  - Easily transported and highly durable Plugs into any USB por
  - Storage capacity as of 2014 is available up to **1TB**

Magnetic Disks

- Used for secondary storage
  - Fast access and high capacity
  - Reasonable cost

(**Extinct**)

Types of Magnetic Disks

- Floppy Disks (diskettes)
  - Magnetic disk inside a plastic jacket
- Hard Disk Drives (hard drives)
  - Magnetic disk, access arms, and read/write heads in sealed module for stable environment
  - Fixed or removable
  - Capacity from several hundred MBs to hundreds of GBs

RAID Storage

- Redundant Arrays of Independent Disks
  - Disk arrays of hard disk drives
  - Provides virtually unlimited online storage
  - Combines from 6 to more than 100 small hard disk drives into a single unit
  - Data are accessed in parallel over multiple paths from many disks
  - Redundant storage of data on several disks provides fault-tolerant capacity
  - Storage area networks can interconnect many RAID units

Magnetic Tape

- Secondary storage
  - Tape reels, cassettes, and cartridges
  - Used in robotic, automated drive assemblies
  - Archival and backup storage
  - Lower-cost storage solution

Optical Disks

Optical Disk Drive Capabilities
• **CD-ROM** A CD-ROM drive provides a low-cost way to read data files and load software onto your computer, as well as play music CDs.
• **CD-RW** A CD-RW drive allows you to easily create your own custom data CDs for data backup or data transfer purposes. It will also allow you to store and share video files, large data files, digital photos, and other large files with other people that have access to a CD-ROM drive. This drive will also do anything your CD-ROM drive will do. It reads all your existing CD-ROMs, Audio CDs, and CDs that you have created with your CD burner.
• **CD-RW/DVD** A CD-RW/DVD combination drive brings all the advantages of CD-RW, CD-ROM, and DVD-ROM to a single drive. With a CD-RW/DVD combo drive, you can read DVD-ROM disks, read CD-ROM disks, and create your own custom CDs.
• **DVD-ROM** A DVD-ROM drive allows you to enjoy the crystal clear color, picture, and sound clarity of DVD video on your PC. It will also prepare you for future software and large data files that will be released on DVD-ROM. A DVD-ROM drive can also read CD-ROM disks, effectively providing users with full optical read capability in one device.
• **DVD+RW/+R with CD-RW** A DVD-RW/R with CD-RW drive is a great all-in-one drive, allowing you to burn DVD-RW or DVD-R disks, burn CDs, and read DVDs and CDs. It enables you to create DVDs to back up and archive up to 4.7GB of data files (that's up to 7 times the capacity of a standard 650MB CD) and store up to to 2 hours of MPEG2 digital video.

Source: Adapted from "Learn More–Optical Drives," www.dell.com.