

Storage

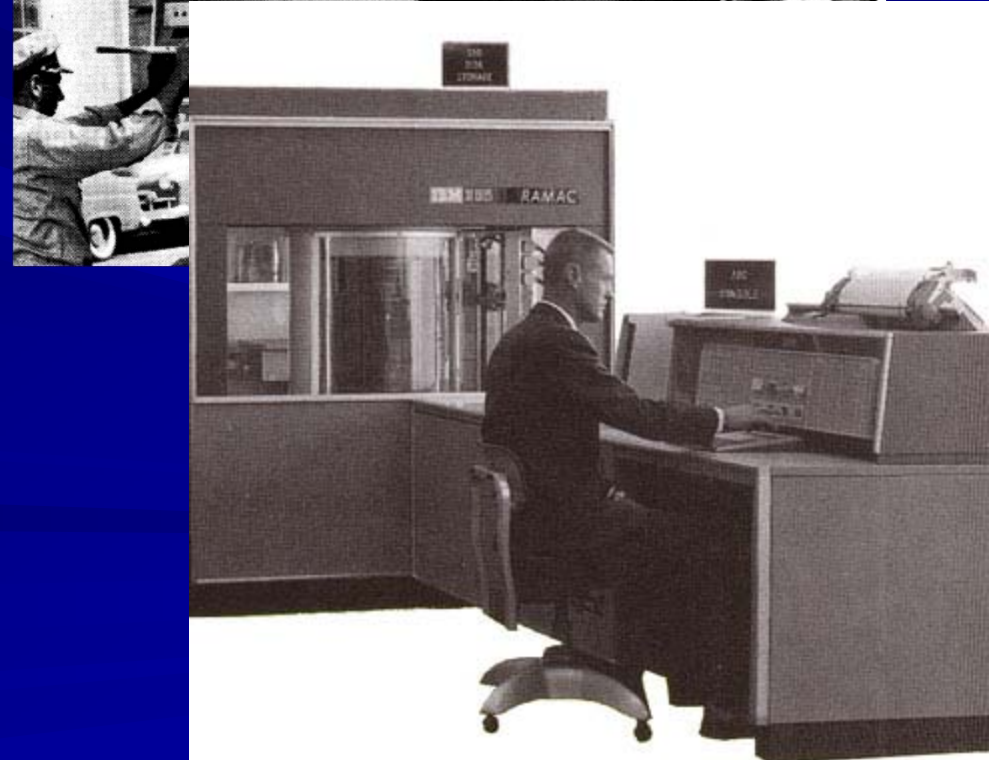
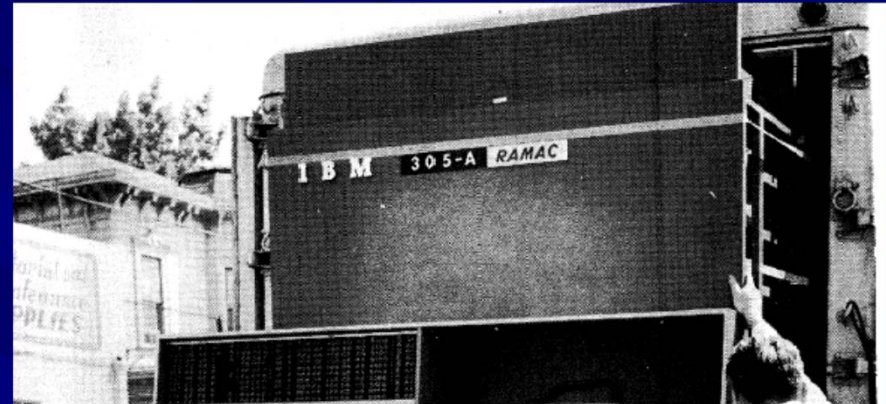
A+ Computer Tech

Tory Klementsens, A+ MCP

Sno Isle Skills Center

The first disk drive

- This is just part of the first "disk drive" being loaded onto a truck in 1956
- RAMAC was the first computer with a hard drive built in 1956
- Consisted of 50 24" disks and held about 4.4 MB of data.



More photos of the drive



Look at how
far we've
come in less
than 30 years

1998 DISK/TREND REPORT

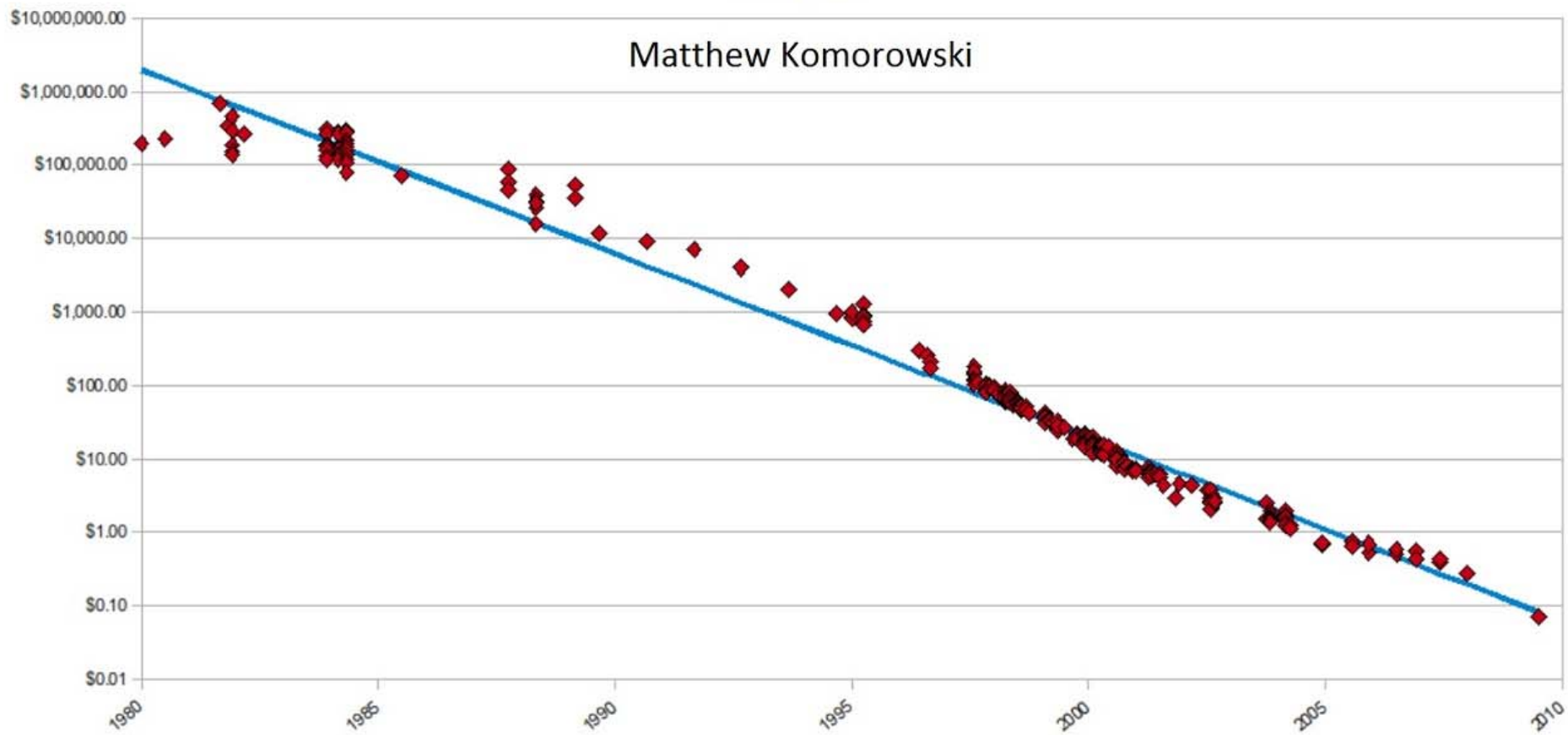
RIGID DISK DRIVES
DISK DRIVE CAPACITY AND PRICING HISTORY

Year	Worldwide disk drive sales revenues (\$ million)	÷	Total disk capacity shipped (Terabytes)	=	Overall average price per megabyte (\$)
1988	20,424.0		1,769.9		11.54
1989	22,660.3		2,435.9		9.30
1990	25,578.0		3,727.1		6.86
1991	24,632.0		4,710.8		5.23
1992	24,549.5		8,180.4		3.00
1993	21,729.8		14,855.5		1.46
1994	23,231.4		32,933.0		.705
1995	26,632.9		80,677.2		.330
1996	28,819.1		160,623.4		.179
1997	31,736.3		338,061.4		.094
<i>1998</i>	<i>34,229.3</i>		<i>772,275.4</i>		<i>.044</i>
<i>1999</i>	<i>37,094.2</i>		<i>1,534,068.4</i>		<i>.024</i>
<i>2000</i>	<i>38,621.2</i>		<i>3,279,513.8</i>		<i>.012</i>
<i>2001</i>	<i>38,672.4</i>		<i>6,141,889.4</i>		<i>.006</i>

Forecasts shown in italics above.

NOTES: 1 Byte = 8 bits
 1 Kilobyte = 1,000 bytes
 1 Megabyte = 1,000,000 bytes
 1 Gigabyte = 1,000,000,000 bytes
 1 Terabyte = 1,000,000,000,000 bytes
 1 Petabyte = 1,000,000,000,000,000 bytes
 1 Exabyte = 1,000,000,000,000,000,000 bytes
 1 Zettabyte = 1,000,000,000,000,000,000,000 bytes
 1 Yottabyte = 1,000,000,000,000,000,000,000,000 bytes

Hard Drive Cost per Gigabyte 1980 - 2009



Floppy Drives

- Connected to the controller card or motherboard by a ribbon cable with 34 pins and 2 connections.
- Powered by a small connector that connects to the power supply.
- Data is written via a read/write head that is housed on an actuator arm.
- The arm moves freely across the disk.*

Floppy Drives, cont.

- The arm has one read/write head above the disk and below.
- The heads move lightly across the disk as the disk spins either 300 or 360 rpm
- The heads do NOT touch the disk. If they do it causes a true crash and the disk is toast.*

Floppy Drives, cont.

- As data is written, eraser heads on either side of the r/w head clean up so there is no data bleed.
- This ensures each track is uniform in size.
- Disk turns on a spindle

Floppy Ribbon Cable



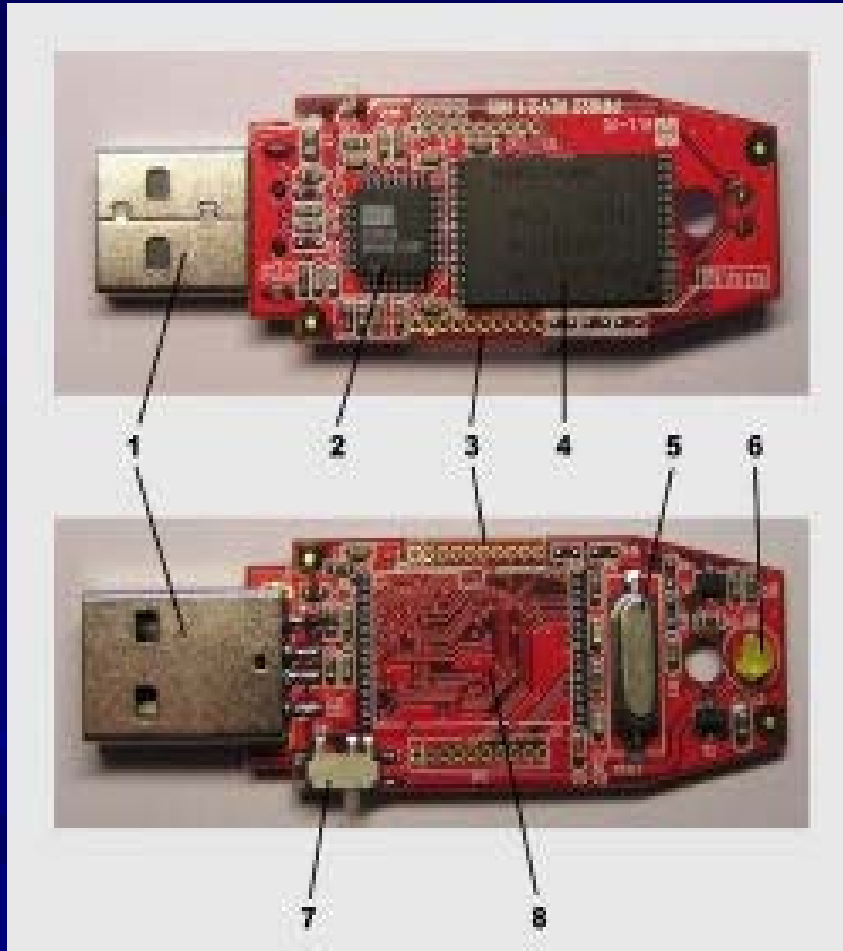
Flash Memory

- Flash memory is non-volatile memory that can be electrically erased and reprogrammed. It is a technology that is primarily used in memory cards.
- Unlike EEPROM, it is erased and programmed in blocks consisting of multiple locations (in early flash the entire chip had to be erased at once).
- Flash memory costs less than standard EEPROM and has become the dominant technology wherever a significant amount of non-volatile, solid-state storage is needed.

Flash Memory

- Examples of applications include digital audio players, digital cameras and mobile phones.
- Flash memory is also used in USB flash drives
- It has also gained some popularity in the gaming market, where it is often used instead of EEPROMs or battery-powered SRAM for game save data. *

Flash Drive Guts



1. USB Connector
2. USB Mass Storage Controller device
3. Test points
4. Flash memory chip
5. Crystal oscillator
6. LED
7. Write protect switch
8. Space for second memory chip

How Data is Stored to a Flash Drive

- Flash memory is made up of a grid
- At each intersection are two transistors
 - Control Gate
 - Floating Gate

How Data is Stored to a Flash Drive

- Connecting the two transistors is a thin layer of iron oxide that can pass power through (charge) the gates
- If the two transistors are "connected" through a charge the value of the cell is 1

How Data is Stored to a Flash Drive

- If not, the value is 0
- The floating gate gets charged
- Electrons travel down a "bitline" to the control gate

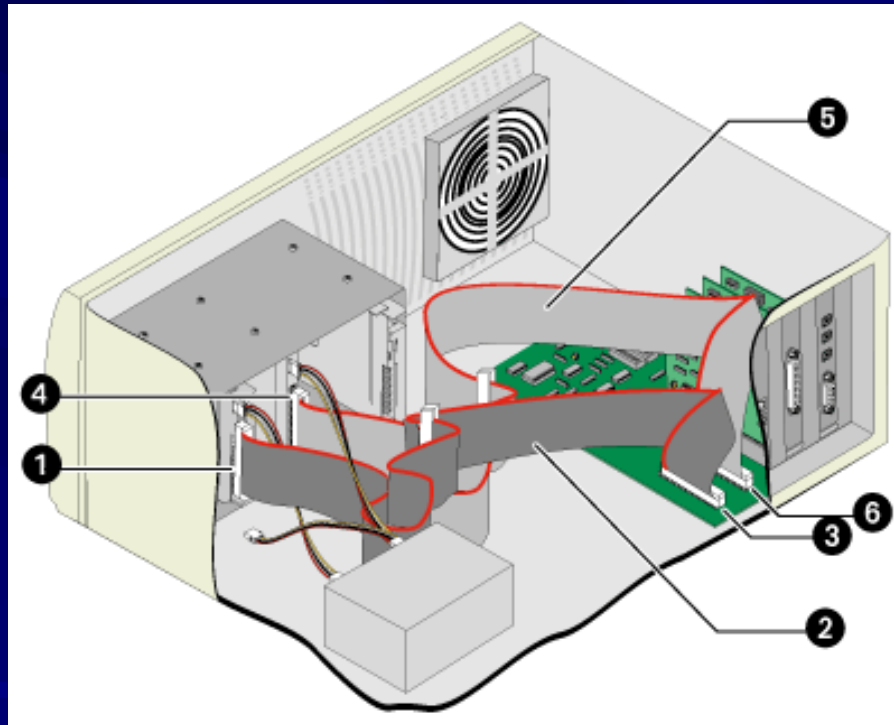
How Data is Stored to a Flash Drive

- The charge drains to the ground, like normal
- But as it forces its way through the control gate, the cell sensor reads the charge
 - Above 50% and it stays a 1
 - When it drops below, it goes to 0

Types of Hard Drive Interfaces

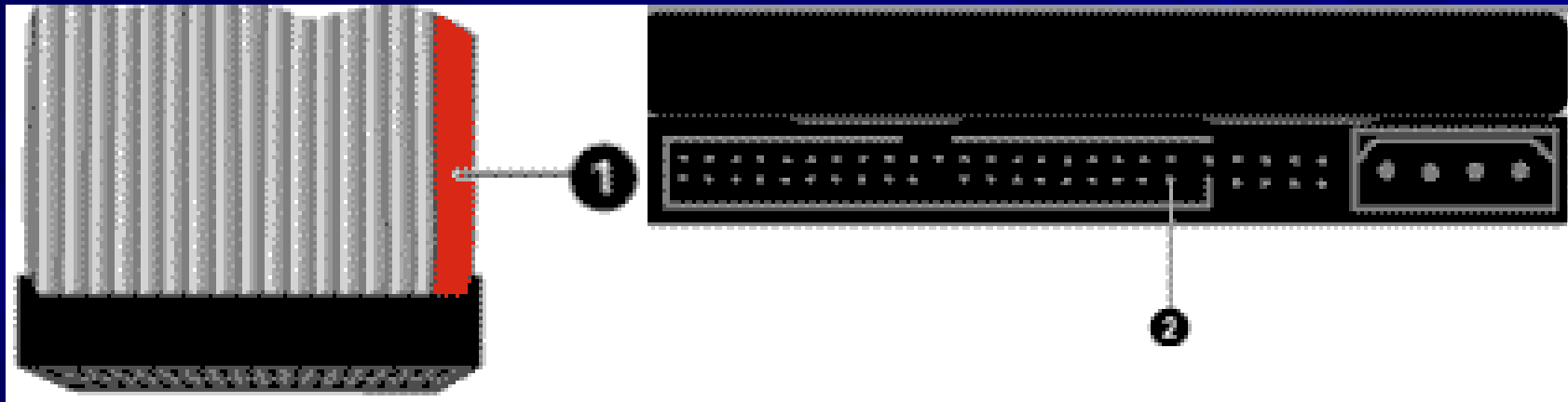
- IDE and EIDE standards (AKA PATA)
- Other interface standards
 - SCSI
 - IEEE 1394
 - USB
 - Fibre Channel
 - SATA*

IDE Channels on a Motherboard



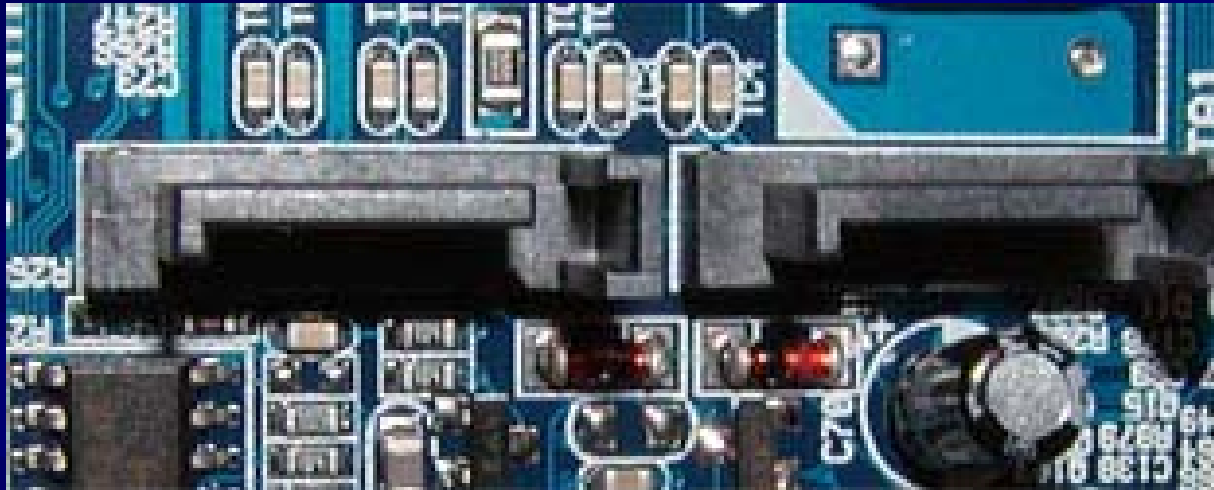
1. Hard Drive
2. Primary IDE Cable to
3. Primary IDE Channel
4. CD-ROM
5. Secondary IDE Cable to
6. Secondary IDE Channel

I DE Cable



- Ensure that the pin 1, indicated by a red line on the cable, is connected to pin one on the hard drive.

SATA Channels on a Motherboard



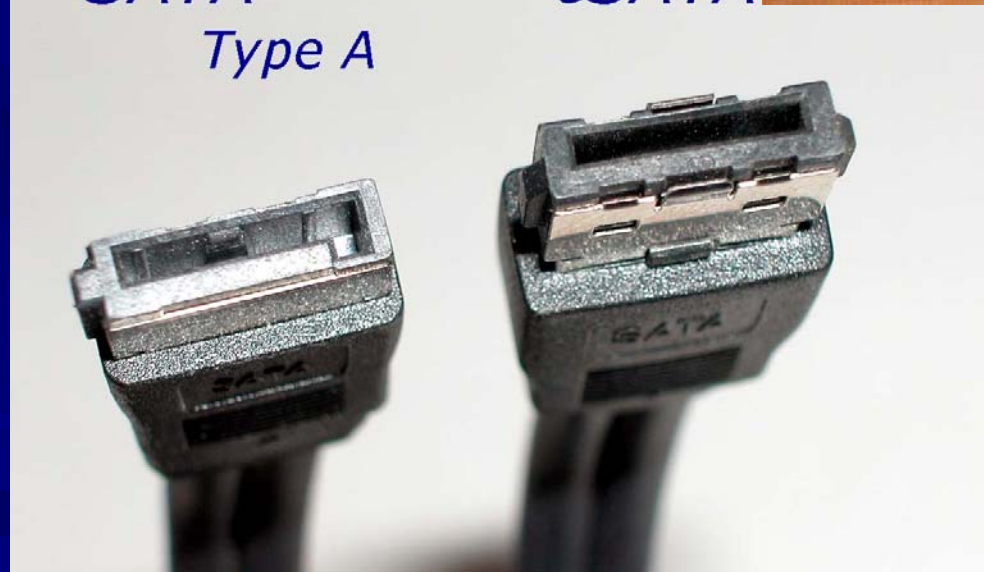
- SATA Channels provide for better airflow (among other things).
- One device can be attached per channel
- Most mobos come with 4 or more SATA connections
- Some come with 1 or 2 eSATA connections

SATA Cables



*SATA
Type A*

eSATA



Parallel vs Serial Communications

- PATA (Parallel Advanced Technology Attachment aka IDE) communicates using parallel communications.
 - Parallel devices communicate by sending data in bytes vs bits. A parallel device can send one or two bytes of data down a bus at a time.
 - Both the sending and receiving devices must synchronize the transfer
 - Originally parallel communications were more reliable
 - Parallel devices must take turns communicating*

Parallel vs Serial Communications

- SATA (Serial Advanced Technology Attachment)
 - Serial devices communicate one bit at a time, however communications are faster and more reliable
 - Can go up to 6 Gbps (whew)
 - SATA 1–1.5 Gbps
 - SATA 2–3 Gbps
 - SATA 3–6 Gbps
 - Sata 4–12 Gbps (out in 2017)

Parallel vs Serial Communications

- SATA does advanced error checking, resulting in more reliable communications
- Serial devices can communicate in tandem with other serial devices
- Serial devices operate at a lower voltage
- eSATA—used for external devices
- eSATAp—Power over eSATA*

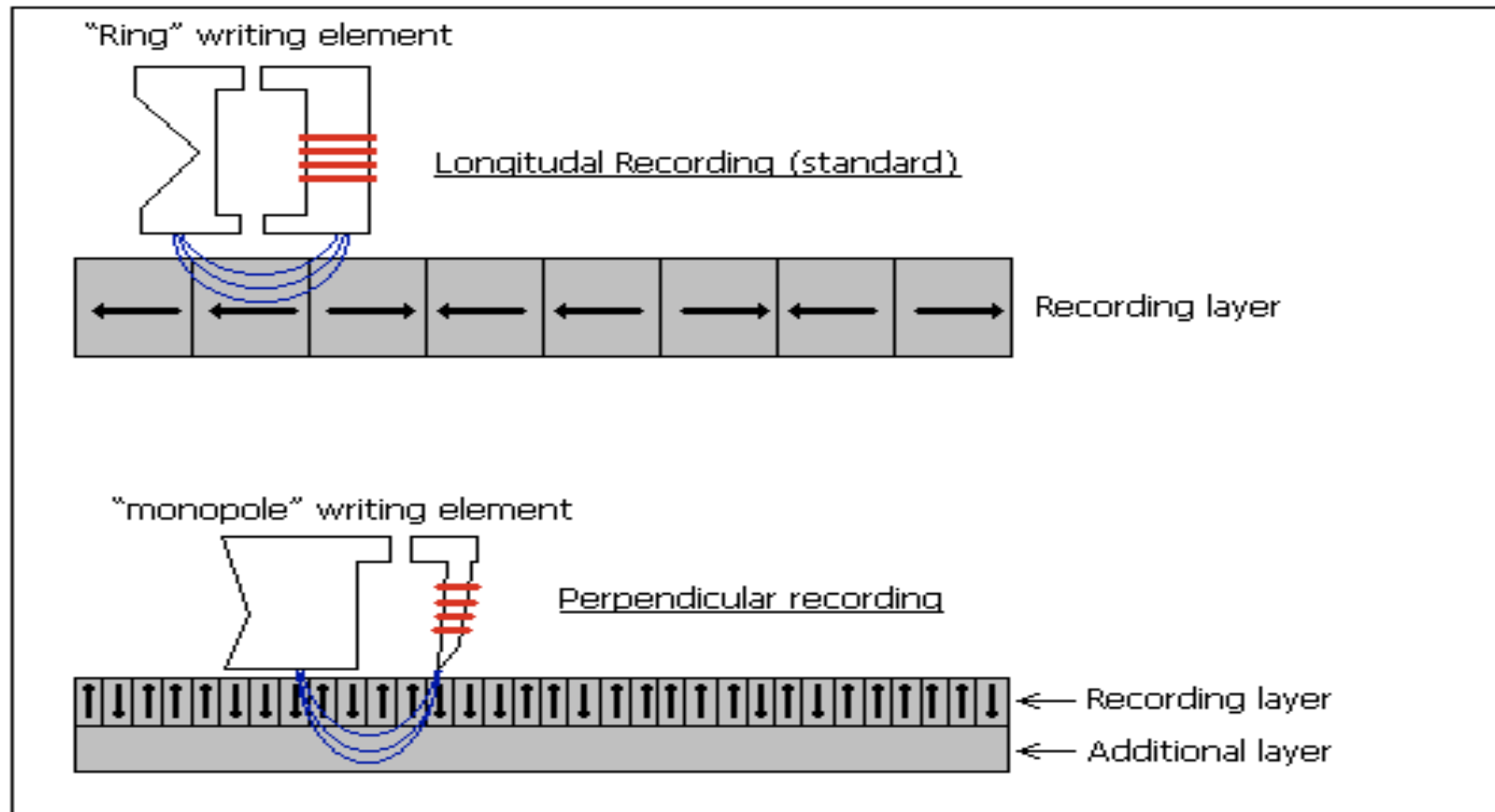
PATA vs SATA

	Parallel ATA	Serial ATA
Maximum Speed	100 MB/s with bursts up to 133 MB/s	6000 MB/s (12 Gbps burst)
Cable Length	18 Inches	1 Meter (about 40 inches)
Cable Pins	40	7
Power Connector Pins	15	4
Data transfer wires used	26	2
Power Consumption	5V	250 mV
Hot Swappable?	No	Yes

Vertical Drives

- Traditionally, bits are arranged in a flat, horizontal manner
- To increase size of the disk, the size of the bits have been decreased, however we're reaching the limits at about 500GB
- Laying the bits vertically frees up a lot of real estate, allowing the bits to be closer together and increasing the size of drives.
- Also known as perpendicular recording

Perpendicular Recording



http://www.hitachigst.com/hdd/research/recording_head/pr/PerpendicularAnimation.html

Solid State Drives

- A solid state drive is a flash device with a storage capacity similar to a small hard drive. Solid state drives are used as replacements for hard disk drives for storing operating system, application, and data files. Some advantages of solid state drives:

Solid State Drives

- They are faster than hard drives
- They have no moving parts so they last longer

Solid State Drives

- Faster than ATA drives
- No moving parts
- Lower power consumption than hard drives (good for laptops)
- They are less susceptible to physical damage (from dropping) and immune from magnetic fields

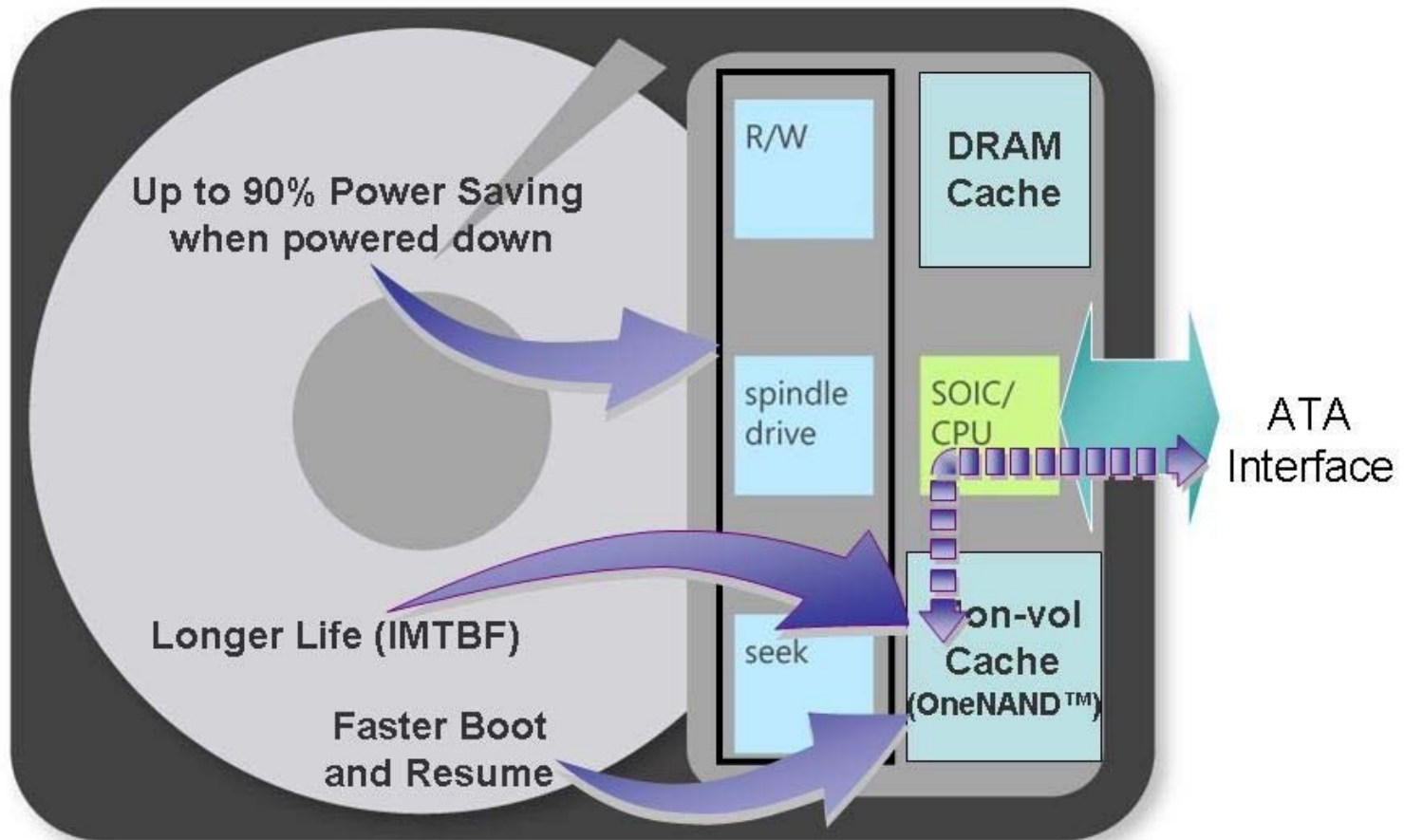
Solid State Drives

- They are smaller and lighter than hard drives
- main disadvantage is cost--they are several times more expensive than comparable hard drives.

Hybrid Hard Drives

- a hard drive that contains a flash memory chip that stores data and applications.
- processor can retrieve data from flash, the drive--which spins constantly in an ordinary computer--can stay asleep most of the time.
- Speeds up applications and takes out issue of hard drive being the bottleneck of the system, depending on the amount of flash memory.
- Improves speed, power consumption, and reliability of hard drives (less wear and tear on platters).

Hybrid Drive Benefits



New types of Storage

■ HAMR Drives

- Heat assisted magnetic recording
- Small laser is used to heat up part of the disk that is being written to.
- This changes the coercivity of the disk for a short time, which reduces the paramagnetic effect.
- Writes on a much smaller scale allowing more data to be written to the same size platter.
- Theoretically this could get up to 50 TB per square inch with the costs expected to be about the same as what we use now

New types of Storage

■ 3D Xpoint

- Developed by Intel and Micron
- Can be used for both Solid State storage and RAM
- Initially will work in PCI Express slots
- 1000 times faster than current NAND storage used in SSDs and 10 times the density
- Energy efficient
- Memory will be stackable
 - Currently is 128 Gb per die across two layers. Future generations will increase layers
- Selectors instead of transistors
 - Uses varying amounts of voltage sent to each selector, eliminating the need for transistors
- Fast switching cell selectors make it way faster
- Should come out in 2016

New types of Storage

■ Holographic Drives

- Pack data into a gel using a pair of laser beams that cross through the gel medium.
- One pulse can etch one million bits (four times the write speed of Blu-Ray)
- Can last for 50-years
- One disk can hold 300 GB of Memory
- More for archival than read/write

FAT32 vs NTFS

- When you partition your drive, you choose a file system.
- NTFS—most security options
- FAT32—more accessible by other Oses
- Always use NTFS in a network

File systems

Fat32

- Partition size: 32 TB (but Windows can only handle 32 GB)
- 255 long file names
- File size: 4 GB
- 268,435,437 max files
- 2 TB largest volume size
- Limited permissions
- Can be read by older OSes

NTFS

- 256 TB
- 255 long file names
- 16 TB file size
- 4,294,967,295 max files
- 256 TB largest volume size (woot)
- Smaller cluster sizes
- Ability to encrypt files
- Compression
- Use disk quotas
- Use volume mount points
- Permissions are WAY advanced

Managing and Troubleshooting Hard Drives

- Error messages
- Tools for troubleshooting and maintaining hard drive
- Solving common hard drive problems
- General troubleshooting guidelines

An Ounce of Prevention

- Make backups and keep them current
- Run antivirus software regularly
- Defragment files; scan hard drive occasionally
- Don't smoke around the hard drive
- Don't leave PC turned off for weeks/months at a time
- High humidity can be dangerous for hard drives
- Be gentle with a hard drive