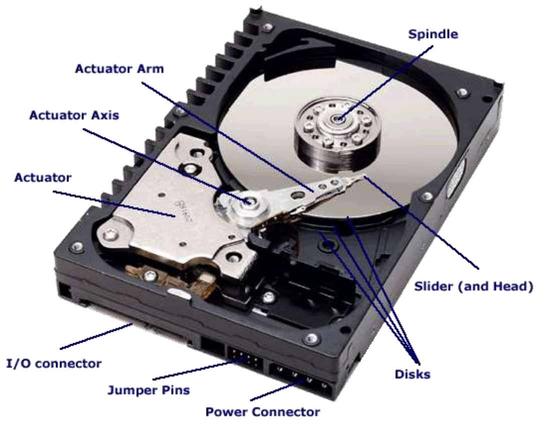
HARD DISK
(Hard Disk Drive HDD)



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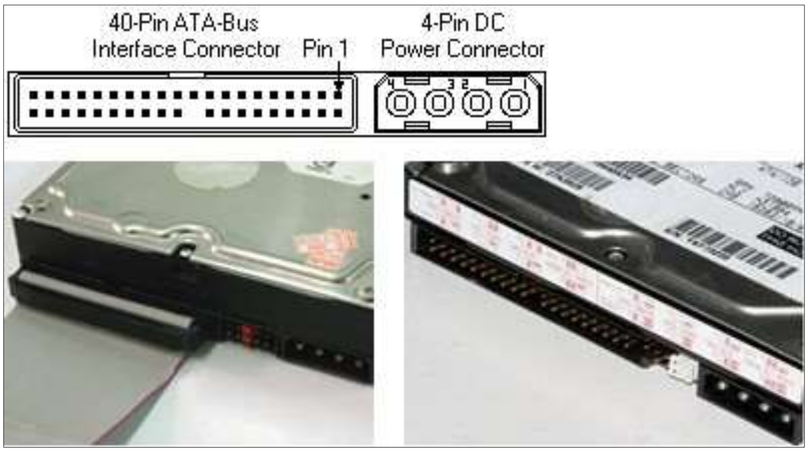
A) IDE/ATA Hard Drive

Integrated Device Electronics. It is the most widely-used hard drive interface on the market. The fancy name refers to how the IDE technology “integrates” the electronics controller into the drive itself. The IDE interface, which could only support drives up to 540 MB has been replaced by the superior EIDE (Enhanced-IDE) technology which supports over 50 GB and allows for over twice as fast data transfer rates. The other most common hard drive interface is SCSI, which is faster than EIDE, but usually costs more. Although it really refers to a general technology, most people use the term to refer the ATA specification, which uses this technology.
ATA
AT Attachment. The specification, formulated in the 1980s by a consortium of hardware and software manufacturers, that defines the IDE drive interface. AT refers to the IBM PC/AT personal computer and its bus architecture. IDE drives are sometimes referred to as ATA drives or AT bus drives. The newer ATA-2 specification defines the EIDE interface, which improves upon the IDE standard. (See also IDE and EIDE.)
There are several versions of ATA, all developed by the Small Form Factor (SFF) Committee:
ATA: Known also as IDE, supports one or two hard drives, a 16-bit interface and PIO modes 0, 1 and 2.
ATA-2: Supports faster PIO modes (3 and 4) and multiword DMA modes (1 and 2). Also, supports logical block addressing (LBA) and block transfers. ATA-2 is marketed as Fast ATA and Enhanced IDE (EIDE).
ATA-3: Minor revision to ATA-2.
Ultra-ATA: [b] Also called Ultra-DMA, ATA-33, and DMA-33, supports multiword DMA mode 3 running at 33 MBps.
[b]ATA/66: A version of ATA proposed by Quantum Corporation, and supported by Intel, that doubles ATA’s throughput to 66 MBps.
ATA/100: An updated version of ATA/66 that increases data transfer rates to 100 MBps.
ATA also is called Parallel ATA.



Hard drive with IDE interface

B) SATA Hard Drive

Definition

Serial Advanced Technology Attachment, often abbreviated SATA or S-ATA, is a serial link – a single cable with a minimum of four wires creates a point-to-point connection between devices. As an evolution of the older Parallel ATA physical storage interface, SATA host-adapters and devices communicate via a high-speed serial cable.

Hard drive with SATA interface

According to Wikipedia, SATA computer bus, a storage-interface for connecting host bus adapters (most commonly integrated into laptop computers and desktop motherboards) to mass storage devices (such as hard disk drives and optical drives), offers several compelling advantages over the older parallel ATA/" EIDE" interface: reduced cable-bulk and cost (7 pins vs 40 pins), faster and more efficient data transfer, and the ability to remove or add devices while operating (hot swapping).

Advantage

Transfer rates for Serial ATA begin at 150MBps. One of the main design advantages of Serial ATA is that the thinner serial cables facilitate more efficient airflow inside a form factor and allow for smaller chassis designs. In contrast, IDE cables used in parallel ATA systems are bulkier than Serial ATA cables and can only extend to 40cm long, while Serial ATA cables can extend up to one meter.

C) SCSI

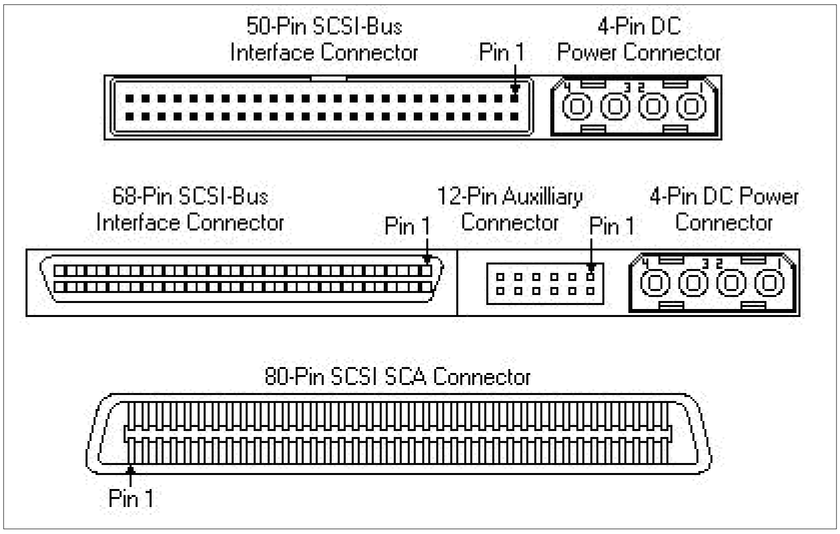
An acronym for Small Computer System Interface. This interface was introduced as a method of connecting multiple peripherals to computers. Based on a parallel bus structure, with each device having a unique ID (or address), the SCSI bus will support up to seven devices plus the host adapter. Newer 'wide' interfaces, used almost exclusively for hard drives, can support up to 15 devices plus the host controller, and can transfer data at burst speeds of up to 320 MB/sec. Because of the multiple device support and extended cable length (up to 6 meters for SCSI-2), the higher transfer rate, and the ability to install multiple host adapters on the motherboard or in available connectors, the SCSI interface is used most often to connect external devices such as scanners, CD-ROMs, CD duplicators, and multi-drive storage enclosures, while at the same time connecting to SCSI devices internally, usually on the same adapter.

Although SCSI is an ANSI standard, there are many variations of it, so two SCSI interfaces may be incompatible. For example, SCSI supports several types of connectors.

The following varieties of SCSI are currently implemented:

- SCSI-1: Uses an 8-bit bus, and supports data rates of 4 MBps.
- SCSI-2: Same as SCSI-1, but uses a 50-pin connector instead of a 25-pin connector, and supports multiple devices. This is what most people mean when they refer to plain SCSI.
- Wide SCSI: Uses a wider cable (168 cable lines to 68 pins) to support 16-bit transfers.
- Fast SCSI: Uses an 8-bit bus, but doubles the clock rate to support data rates of 10 MBps.
- Fast Wide SCSI: Uses a 16-bit bus and supports data rates of 20 MBps.
- Ultra SCSI: Uses an 8-bit bus, and supports data rates of 20 MBps.
- SCSI-3: Uses a 16-bit bus and supports data rates of 40 MBps. Also called Ultra-Wide SCSI.
- Ultra2 SCSI: Uses an 8-bit bus and supports data rates of 40 MBps.
- Wide Ultra2 SCSI: Uses a 16-bit bus and supports data rates of 80 Mbps.

Hard drive with SCSI interface



D) SAS Serial Attached SCSI Disk

Serial Attached SCSI (SAS) is both a storage interface to disk and tape drives, as well as a storage connectivity technology. As the natural evolution of the older parallel Small Computer System Interface (SCSI) technology to modern technology, SAS provides application and device driver investment protection. It also provides investment protection by providing system architects another alternative for midrange storage networks while supporting both SAS and SATA storage devices.

In many ways, SAS uses the best of existing disk and connectivity technologies, leveraging Advanced Technology Attachment (ATA), SCSI and Fibre Channel (FC) technology. SAS is a continuation of the highly successful SCSI protocol, updated with current serial-attached connectivity technology. Additionally, SAS connectivity supports both high-performance SAS drives and high-capacity Serial ATA (SATA) drives simultaneously. SAS connectivity, along with SAS and SATA drive choices, provides users with the ability to mix and match drive types to best meet their business application requirements. These factors all serve to provide investment protection with past storage protocols while utilizing current technologies when choosing SAS technologies.

Prior to SAS, the connectivity choices for direct-connected external storage were limited to SCSI, or high-cost FC. SCSI was cumbersome, offered limited connectivity and expansion choices. The move to FC storage was often a large jump in terms of cost and complexity, which in many cases was not worth the investment for small enterprise deployments. The emergence of SAS provides another alternative, positioned as an expandable external connectivity technology, offering enterprise features for both direct and networked connected external storage deployments.

SAS combines the following benefits:

- Leverages the well-known and proven SCSI protocol
- Interoperability with SATA drives, offering low-cost high capacity for near-line applications
- Serial technology improves speed, expandability and error recovery versus bus technologies
- Provides full duplex and dual porting for enterprise environments
- Offers another alternative for storage networks with moderate scalability needs without high cost or complexity

Thus, SAS storage technologies are applicable across a broad range of SMB and enterprise environments.

E) SSD Solid State Drive

A solid-state drive uses a type of memory called "flash memory," which is like RAM. However, unlike RAM, which clears whenever the computer powers down, SSD memory remains even when it loses power.

If you were to take apart a typical hard disk, you'd see a stack of magnetic plates on an axis with a reading needle–kind of like a vinyl record player. Before the needle can read or write to the plate, it must spin around to the right location. SSDs, on the other hand, use a grid of electrical cells to quickly send and receive data. These grids are separated into sections called "pages," and these pages are where the data is stored. Pages are clumped together to form "blocks."

Why is this necessary to know? Because SSDs can only write to empty pages in a block. In a hard disk, data can be written to any location on the plate at any time, and that means that data can be overwritten easily. SSDs can't overwrite data directly. Instead, the SSD must first find an empty page in a block and then write to that empty page.

So then how does an SSD handle data deletion? When enough pages in a block are marked as unused, the SSD will take the entire content of that block, commit it to memory, and erase the whole block. Then it will take the committed image and reprint it on that block without the unused pages.

All this to say that SSDs necessarily become slower over time.
When you have a fresh SSD, it's loaded entirely with blocks full of blank pages. When you load new data into the SSD, it can immediately write into those blank pages with blazing speeds. However, as you use it, you'll end up running out of blank pages and you'll be left with random pages scattered through that are no longer being used.

Since an SSD can't overwrite data directly, every time you want to write new data from that point on, the drive will need to:

- Find a block with enough pages marked *unused*,
- Record which pages in that block are still necessary,
- Reset every page in that block to *blank*,
- Rewrite the necessary pages into the freshly reset block,
- Then fill the remaining pages with the new data.

So, once you've gone through all the blank pages from a new SSD purchase, your drive must go through this process whenever it wants to write new data. Hence, a slowdown in SSD speeds over time.

The Drawback of Solid-State Drives

One big problem of SSDs is inherent in flash memory itself: it can only sustain a finite number of writes before it dies. There is a lot of science that goes into explaining why this happens, but suffice it to say that as the SSD is used, the electrical charges within cells must be periodically reset.

Unfortunately, the electrical resistance increases slightly with every reset, which increases the voltage necessary to write into a cell. Eventually, the required voltage becomes so high that the cell becomes essentially useless. Thus, a finite number of writes.

But at the end of it all, the SSD does offer something that a traditional HDD could never bring: lightning-fast speeds. The SSD is an intricate creation that has many layers of complexity behind it, and while it does come with several its own disadvantages, it certainly does its job well.

Hopefully you now have a better understanding of how solid-state drives work. It's interesting to see how far technology has come and I can't wait to see where it takes us.

F) Conclusion

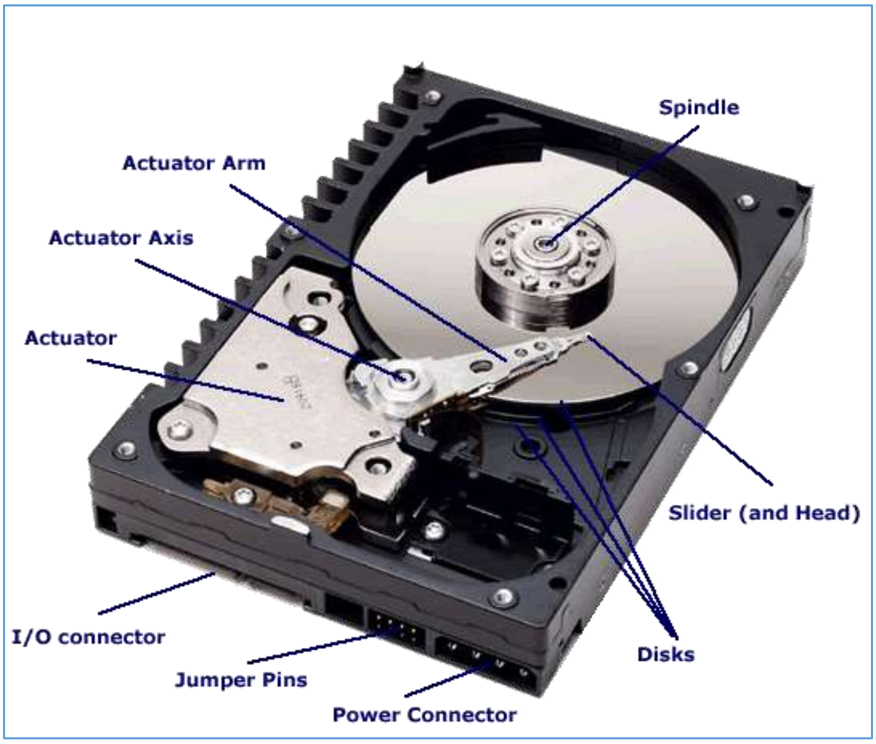
Just as parallel lines never intersect, so too were the parallel storage interfaces of the last two decades destined to remain independent.
When parallel SCSI and parallel ATA were conceived over 20 years ago, their roles in IT infrastructure were fundamentally distinct: servers needed the speed and reliability of SCSI storage, while economical ATA storage was adequate for desktop use.

Given their disparate duties, compatibility between the two seemed unnecessary. However, over time it became increasingly clear that server storage embraced a broad variety of data, some of which didn't necessitate the superior performance and dependability of SCSI storage
(and the higher cost per GB that such storage entailed). Deploying a separate, redundant parallel ATA infrastructure for such data was an inefficient and unwieldy workaround.

Furthermore, the fundamental physical and electrical constraints of **parallel storage buses** had become increasingly problematic as faster throughput was sought, discouraging further development.

By contrast, **serial interfaces** were growing by leaps and bounds thanks to recent breakthroughs in very large scale integration (VLSI) technology and high-speed serial transceivers. Simpler, faster and more robust, serial architecture was clearly the wave of the future. Change for the Better Thus when Serial ATA (SATA) arrived to supplant its parallel predecessor, the substantial gains it delivered in speed, scalability, data integrity and reliability were more than enough to ensure swift and enthusiastic adoption throughout the storage industry.
Serial Attached SCSI (SAS) soon followed, and had it merely emulated SATA's transition from parallel to serial architecture,
it would nevertheless have represented a significant advance in SCSI storage.

Disk Interfaces	ATA	SATA	SCSI	SAS	FC
Year Introduced	1986	2003	1986	2004	1995
Deployment	Desktop	Desktop	Enterprise	Enterprise	Enterprise
Current Interface Speed	0.8 Gb/s	3 Gb/s	2.56 Gb/s	3 Gb/s	4 Gb/s
Max Capacity	500 GB - 1 TB	500 GB - 1 TB	36 GB - 73 GB	36 GB - 300 GB	36 GB - 300 GB
Average Latency (Seek + Rotational Delay)	9 - 16 ms	9 - 16 ms	4 - 6 ms	3 - 6 ms	3 - 6 ms
Typical I/O per second	70 - 100	80 - 120	150 - 180	150 - 180	150 - 180
Number of I/O ports	1	1	2	2	2
MTBF Rating	0.6 - 0.8 Million hours	0.6 - 0.8 Million hours	1.2 - 1.4 Million hours	1.2 - 1.4 Million hours	1.2 - 1.4 Million hours
Duty Cycle	20%	20%	80%+	80%+	80%+
Duplex	Half	Half	Half	Full	Full
Hot Plug	No	Yes	No*	Yes	Yes


Spindle
Actuator Arm
Actuator Axis
Actuator
Slider (and Head)
I/O connector
Jumper Pins
Disks
Power Connector