USB flash drive

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USB Flash Drive

SanDisk Cruzer Micro is a brand of USB flash drives

A **USB flash drive** consists of a flash memory data storage device integrated with a USB (Universal Serial Bus) interface. USB flash drives are typically removable and rewritable, and physically much smaller than a floppy disk. Most weigh less than 30 g (1 oz).[1] Storage capacities in 2010 can be as large as 256 GB[2] with steady improvements in size and price per capacity expected. Some allow 1 million write or erase cycles[*citation needed*] and offer a 10-year[*citation needed*]shelf storage time.[3][4]

USB flash drives are often used for the same purposes for which floppy disks or CD-ROMs were used. They are smaller, faster, have thousands of times more capacity, and are more durable and reliable because of their lack of moving parts. Until approximately 2005, most desktop and laptop computers were supplied with floppy disk drives, but floppy disk drives have been abandoned in favor of USB ports.

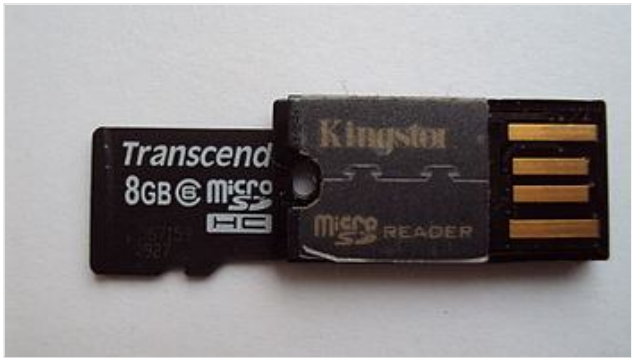
USB Flash drives use the USB mass storage standard, supported natively by modern operating systems such as Linux, Mac OS X, Windows, and other Unix-like systems. USB drives with USB 2.0 support can store more data and transfer faster than a much larger optical disc drives like CD-RW or DVD-RW drives and can be read by many other systems such as the Xbox 360, PlayStation 3, DVD players and in some upcoming mobile smartphones.

Nothing moves mechanically in a flash drive; the term *drive* persists because computers read and write flash-drive data using the same system commands as for a mechanical disk drive, with the storage appearing to the computer operating system and user interface as just another drive. Flash drives are very robust mechanically.

A flash drive consists of a small printed circuit board carrying the circuit elements and a USB connector, insulated electrically and protected inside a plastic, metal, or rubberized case which can be carried in a pocket or on a key chain, for example. The USB connector may be protected by a removable cap or by retracting into the body of the drive, although it is not likely to be damaged if unprotected. Most flash drives use a standard type-A USB connection allowing plugging into a port on a personal computer, but drives for other interfaces also exist.

USB flash drives draw power from the computer via external USB connection. Some devices combine the functionality of a digital audio player with USB flash storage; they require a battery only when used to play music.

Contents



Often USB flash drives can be assembled using memory cards and a card reader. Pictured here is a flash drive assembled with a Transcend 8GB Micro SD card and a Kingston card reader. The resulting flash drive is approximately 2cm in length, 1cm in width and 2mm in thickness.

Technology

Main articles: Flash memory and USB

Flash memory combines a number of older technologies, with lower cost, lower power consumption and small size made possible by advances in microprocessor technology. The memory storage was based on earlier EPROM and EEPROM technologies. These had very limited capacity, were very slow for both reading and writing, required complex high-voltage drive circuitry, and could only be re-written after erasing the entire contents of the chip.

Hardware designers later developed EEPROMs with the erasure region broken up into smaller "fields" that could be erased individually without affecting the others. Altering the contents of a particular memory location involved copying the entire field into an off-chip buffer memory, erasing the field, modifying the data as required in the buffer, and re-writing it into the same field. This required considerable computer support, and PC-based EEPROM flash memory systems often carried their own dedicated microprocessor system. Flash drives are more or less a miniaturized version of this.

Two Sandisk flash drives- an Extreme Contour 16GB and a Cruzer Slice

The development of high-speed serial data interfaces such as USB made semiconductor memory systems with serially accessed storage viable, and the simultaneous development of small, high-speed, low-power microprocessor systems allowed this to be incorporated into extremely compact systems. Serial access requires far fewer electrical connections for the memory chips than does parallel access, which has simplified the manufacture of multi-gigabyte drives.

Computers access modern flash memory systems very much like hard disk drives, where the controller system has full control over where information is actually stored. The actual EEPROM writing and erasure processes are, however, still very similar to the earlier systems described above.

Many low-cost MP3 players simply add extra software and a battery to a standard flash memory control microprocessor so it can also serve as a music playback decoder. Most of these players can also be used as a conventional flash drive, for storing files of any type.

History

First commercial product

Trek Technology and IBM began selling the first USB flash drives commercially in 2000. The Singaporean Trek Technology sold a model under the brand name "ThumbDrive", and IBM marketed the first such drives in North America with its product named the "DiskOnKey" which was developed and manufactured by the Israeli company M-Systems.[5] IBM's USB flash drive became available on December 15, 2000,[6] and had a storage capacity of 8 MB, more than five times the capacity of the then-common floppy disks.

In 2000 Lexar introduced a Compact Flash (CF) card with a USB connection, and a companion card read/writer and USB cable that eliminated the need for a USB hub.

Both Trek Technology and Netac Technology have tried to protect their patent claims. Trek won a Singaporean suit,[7] but a court in the United Kingdom revoked one of Trek's UK patents.[8] While Netac Technology has brought lawsuits against PNY Technologies,[9] Lenovo,[10] aigo,[11] Sony,[12][13][14] and Taiwan's Acer and Tai Guen Enterprise Co,[14] most companies that manufacture USB flash drives do so without regard for Trek and Netac's patents.

Second generation

Modern flash drives have USB 2.0 connectivity. However, they do not currently use the full 480 Mbit/s (60MB/s) which the USB 2.0 Hi-Speed specification supports because of technical limitations inherent in NAND flash. The fastest drives currently available use a dual channel controller, although they still fall considerably short of

the transfer rate possible from a current generation hard disk, or the maximum high speed USB throughput.

File transfer speeds vary considerably and should be checked before purchase. Speeds may be given in Mbyte per second, Mbit per second or optical drive multipliers such as "180X" (180 times 150 KiB per second). Typical fast drives claim to read at up to 30 megabytes/s (MB/s) and write at about half that speed. This is about 20 times faster than USB 1.1 "full speed" devices which are limited to a maximum speed of 12 Mbit/s (1.5 MB/s).

Design and implementation

One end of the device is fitted with a single male type-A USB connector. Inside the plastic casing is a small printed circuit board. Mounted on this board is some power circuitry and a small number of surface-mounted integrated circuits (ICs). Typically, one of these ICs provides an interface to the USB port, another drives the onboard memory, and the other is the flash memory.

Drives typically use the USB mass storage device class to communicate with the host.

Essential components

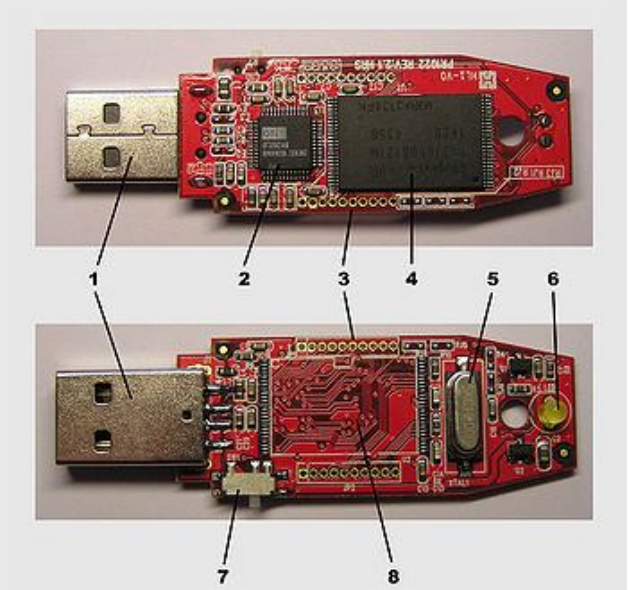
There are typically four parts to a flash drive:

- Male type-A USB connector – provides a physical interface to the host computer.
- USB mass storage controller – implements the USB host controller. The controller contains a small microcontroller with a small amount of on-chip ROM and RAM.
- NAND flash memory chip – stores data. NAND flash is typically also used in digital cameras.
- Crystal oscillator – produces the device's main 12 MHz clock signal and controls the device's data output through a phase-locked loop.

Additional components

The typical device may also include:

- Jumpers and test pins – for testing during the flash drive's manufacturing or loading code into the microprocessor.
- LEDs – indicate data transfers or data reads and writes.
- Write-protect switches – Enable or disable writing of data into memory.
- Unpopulated space – provides space to include a second memory chip. Having this second space allows the manufacturer to use a single printed circuit board for more than one storage size device.
- USB connector cover or cap – reduces the risk of damage, prevents the ingress of fluff or other contaminants, and improves overall device appearance. Some flash drives use retractable USB connectors instead. Others have a swivel arrangement so that the connector can be protected without removing anything.
- Transport aid – the cap or the body often contains a hole suitable for connection to a key chain or lanyard. Connecting the cap, rather than the body, can allow the drive itself to be lost.
- Some drives offer expandable storage via an internal memory card slot, much like a memory card



Internals of a typical USB flash drive

1	USB connector
2	USB mass storage controller device
3	Test points
4	Flash memory chip
5	Crystal oscillator

reader.[15][16]

6	LED
7	Write-protect switch (Optional)
8	Space for second flash memory chip

Size and style of packaging

Some manufacturers differentiate their products by using elaborate housings, which are often bulky and make the drive difficult to connect to the USB port. Because the USB port connectors on a computer housing are often closely spaced, plugging a flash drive into a USB port may block an adjacent port. Such devices may only carry the USB logo if sold with a separate extension cable.

The internal mechanical and electronic parts of a Kingston 2GB flash drive

USB flash drives have been integrated into other commonly carried items such as watches, pens, and even the Swiss Army Knife; others have been fitted with novelty cases such as toy cars or LEGO bricks. The small size, robustness and cheapness of USB flash drives make them an increasingly popular peripheral for case modding.

Heavy or bulky flash drive packaging can make for unreliable operation when plugged directly into a USB port; this can be relieved by a USB extension cable. Such cables are USB-compatible but do not conform to the USB standard.[17][18]

Flash drives come in various, sometimes bulky or novelty, shapes and sizes, in this case ikura sushi

File system

Main article: Flash file system

Most flash drives ship preformatted with the FAT or FAT 32 file system. The ubiquity of this file system allows the drive to be accessed on virtually any host device with USB support. Also, standard FAT maintenance utilities (e.g. ScanDisk) can be used to repair or retrieve corrupted data. However, because a flash drive appears as a USB-connected hard drive to the host system, the drive can be reformatted to any file system supported by the host operating system.

Defragmenting: Flash drives can be defragmented, but this brings little advantage as there is no mechanical head that moves from fragment to fragment. Flash drives often have a large internal sector size, so defragmenting means accessing fewer sectors. Defragmenting shortens the life of the drive by making many unnecessary writes.[19]

Even Distribution: Some file systems are designed to distribute usage over an entire memory device without concentrating usage on any part (e.g. for a directory); this even distribution prolongs the life of simple flash memory devices. Some USB flash drives have this functionality built into the software controller to prolong device life, while others do not, therefore the end user should check the specifications of his device prior to changing the file system for this reason.[20]

Hard Drive: Sectors are 512 bytes long, for compatibility with hard drives, and the first sector can contain a Master Boot Record and a partition table. Therefore USB flash units can be partitioned as hard drives.

Longevity

Barring physical destruction of the drive, the memory or USB connector of a flash drive will eventually fail. SLC based memory is good for around 100,000 writes; more commonly used MLC for around 10,000. The USB connector can withstand approximately 1,500 connect/disconnect cycles.[21]

Fake products

Fake USB flash drives are sometimes sold, claiming to have higher capacities than they actually have. These are typically low capacity USB drives which are modified so that they emulate larger capacity drives (e.g. a 2 GB drive being marketed as an 8 GB drive). When plugged into a computer, they report themselves as being the larger capacity they were sold as, but when data is written to them, either the write fails, the drive freezes up, or it overwrites existing data. Software tools exist to check and detect fake USB drives.[22][23] In some cases it is possible to repair these devices to remove the false capacity information and use them normally.[24]

Uses

Personal data transport

The most common use of flash drives is to transport and store personal files such as documents, pictures and videos. Individuals also store medical alert information on MedicTag flash drives for use in emergencies and for disaster preparation.

USB flash drive with an Ubuntu-branded lanyard.

Secure storage of data, application and software files

With wide deployment(s) of flash drives being used in various environments (secured or otherwise), the issue of data and information security remains of the utmost importance. The use of biometrics and encryption is becoming the norm with the need for increased security for data; OTFE systems are particularly useful in this regard, as they can transparently encrypt large amounts of data. In some cases a Secure USB Drive may use a hardware-based encryption mechanism that uses a hardware module instead of software for strongly encrypting data. IEEE 1667 is an attempt to create a generic authentication platform for USB drives and enjoys the support of Microsoft with support in Windows 7 and in Windows Vista Service Pack 2 with a hotfix.[25]

System administration

Flash drives are particularly popular among system and network administrators, who load them with configuration information and software used for system maintenance, troubleshooting, and recovery. They are also used as a means to transfer recovery and antivirus software to infected PCs, allowing a portion of the host machine's data to be archived. As the drives have increased in storage space, they have also replaced the need to carry a number of CD ROMs and installers which were needed when reinstalling or updating a system.

Application carriers

Flash drives are used to carry applications that run on the host computer without requiring installation. While any standalone application can in principle be used this way, many programs store data, configuration information, etc. on the hard drive and registry of the host computer

The U3 company works with drive makers (parent company SanDisk as well as others) to deliver custom versions of applications designed for Microsoft Windows from a special flash drive; U3-compatible devices are designed to autoload a menu when plugged into a computer running Windows. Applications must be modified for the U3 platform not to leave any data on the host machine. U3 also provides a software framework for independent software vendors

interested in their platform.

Ceedo is an alternative product with the key difference that it does not require Windows applications to be modified in order for them to be carried and run on the drive.

Similarly, other application virtualization solutions and portable application creators, such as VMware ThinApp (for Windows) or RUNZ (for Linux) can be used to run software from a flash drive without installation.

In October 2010, Apple Inc. released their newest iteration of the MacBook Air, which had the system's restore files contained on a USB card drive rather than the traditional install CDs due to the Air not coming with an optical drive.[26]

A wide range of portable applications which are all free of charge, and able to run off a computer running Windows without storing anything on the host computer's drives or registry, can be found in the list of portable software.

Computer forensics and law enforcement

A recent development for the use of a USB Flash Drive as an application carrier is to carry the Computer Online Forensic Evidence Extractor (COFEE) application developed by Microsoft. COFEE is a set of applications designed to search for and extract digital evidence on computers confiscated from suspects.[27] Forensic software should not alter the information stored on the computer being examined in any way; other forensic suites run from CD-ROM or DVD-ROM, but cannot store data on the media they are run from (although they can write to other attached devices such as external drives or memory sticks).

Booting operating systems

Most current PC firmware permits booting from a USB drive, allowing the launch of an operating system from a bootable flash drive. Such a configuration is known as a Live USB.

Original flash memory designs had very limited estimated lifetimes. The failure mechanism for flash memory cells is analogous to a metal fatigue mode; the device fails by refusing to write new data to specific cells that have been subject to many read-write cycles over the device's lifetime. Originally, this potential failure mode limited the use of "live USB" system to special purpose applications or temporary tasks, such as:

- Loading a minimal, hardened kernel for embedded applications (e.g. network router, firewall).
- Bootstrapping an operating system install or disk cloning operation, often across a network.
- Maintenance tasks, such as virus scanning or low-level data repair, without the primary host operating system loaded.

As of 2011, newer flash memory designs have much higher estimated lifetimes. Several manufacturers are now offering warranties of 5 years, or more. That should make the device more attractive for more applications. By reducing the probability of the device's premature failure, flash memory devices can now be considered for use where a magnetic disk would normally have been required. Flash drives have also experienced an exponential growth in their storage capacity over time (following the Moore's Law growth curve). As of 2011, single packaged devices with capacities of 64GB are readily available, and devices with 8GB capacity are very economical. Storage capacities in this range have traditionally been considered to offer adequate space, because they allow enough space for both the operating system software and some free space for the user's data.

Windows Vista and Windows 7 ReadyBoost

In Windows Vista and Windows 7, the ReadyBoost feature allows use of flash drives (up to 4 GB in the case of Windows Vista) to augment operating system memory[28]

Audio players

Many companies make small solid-state digital audio players, essentially producing flash drives with sound output and a simple user interface. Examples include the Creative MuVo, Philips GoGear and the first generation iPod shuffle. Some of these players are true USB flash drives as well as music players; others do not support general-purpose data storage.

Many of the smallest players are powered by a permanently fitted rechargeable battery, charged from the USB interface.

Music storage and marketing

Digital audio files can be transported from one computer to another like any other file, and played on a compatible media player (with caveats for DRM-locked files). In addition, many home Hi-Fi and car stereo head units are now equipped with a USB port. This allows a USB flash drive containing media files in a variety of formats to be played directly on devices which support the format.

Artists have sold or given away USB flash drives, with the first instance believed to be in 2004 when the German band WIZO released the "Stick EP", only as a USB drive. In addition to five high-bitrate MP3s, it also included a video, pictures, lyrics, and guitar tablature. Subsequently artists including Kanye West,[29] Nine Inch Nails, Kylie Minogue[30] and Ayumi Hamasaki [31] have released music and promotional material on USB flash drives. In 2009 a USB drive holding fourteen remastered Beatles albums in both FLAC and MP3 was released.

In arcades

In the arcade game *In the Groove* and more commonly *In The Groove 2*, flash drives are used to transfer high scores, screenshots, dance edits, and combos throughout sessions. As of software revision 21 (R21), players can also store custom songs and play them on any machine on which this feature is enabled. While use of flash drives is common, the drive must be Linux compatible.

In the arcade games *Pump it Up NX2* and *Pump it Up NXA*, a special produced flash drive is used as a "save file" for unlocked songs, as well as progressing in the WorldMax and Brain Shower sections of the game.

In the arcade game *Dance Dance Revolution X*, an exclusive USB flash drive was made by Konami for the purpose of the link feature from its Sony PlayStation 2 counterpart. However, any USB flash drives can be used in this arcade game.

Brand and product promotion

The availability of inexpensive flash drives has enabled them to be used for promotional and marketing purposes, particularly within technical and computer-industry circles (e.g. technology trade shows). They may be given away for free, sold at less than wholesale price, or included as a bonus with another purchased product.

Usually, such drives will be custom-stamped with a company's logo, as a form of advertising to increase mind share and brand awareness. The drive may be a blank drive, or preloaded with graphics, documentation, web links, Flash animation or other multimedia, and free or demonstration software. Some preloaded drives are

read-only while others are configured with both read-only and user-writable segments, such dual-partition drives are more expensive.[32]

Flash drives can be set up to automatically launch stored presentations, websites, articles, and any other software immediately on insertion of the drive using the Microsoft Windows AutoRun feature.[33] Autorunning software this way does not work on all computers, and is normally disabled by security-conscious users.

Backup

Some value-added resellers are now using a flash drive as part of small-business turnkey solutions (e.g. point-of-sale systems). The drive is used as a backup medium: at the close of business each night, the drive is inserted, and a database backup is saved to the drive. Alternatively, the drive can be left inserted through the business day, and data regularly updated. In either case, the drive is removed at night and taken offsite.

- This is simple for the end-user, and more likely to be done;
- The drive is small and convenient, and more likely to be carried off-site for safety;
- The drives are less fragile mechanically and magnetically than tapes;
- The capacity is often large enough for several backup images of critical data;
- And flash drives are cheaper than many other backup systems.

It is also easy to lose these small devices, and easy for people without a right to data to take illicit backups.

Advantages and disadvantages

Advantages

Data stored on flash drives is impervious to scratches and dust, and flash drives are mechanically very robust making them suitable for transporting data from place to place and keeping it readily at hand. Most personal computers support USB as of 2010.

Flash drives also store data densely compared to many removable media. In mid-2009, 256 GB drives became available, with the ability to hold many times more data than a DVD or even a Blu-ray disc.

Compared to hard drives, flash drives use little power, have no fragile moving parts, and for most capacities are small and light.

Flash drives implement the USB mass storage device class so that most modern operating systems can read and write to them without installing device drivers. The flash drives present a simple block-structured logical unit to the host operating system, hiding the individual complex implementation details of the various underlying flash memory devices. The operating system can use any file system or block addressing scheme. Some computers can boot up from flash drives.

Specially manufactured flash drives are available that have a tough rubber or metal casing designed to be waterproof and virtually "unbreakable". These flash drives retain their memory even after being submerged in water,[34] even through a machine wash. Leaving such a flash drive out to dry completely before allowing current to run through it has been known to result in a working drive with no future problems. Channel Five's *Gadget Show* cooked one of these flash drives with propane, froze it with dry ice, submerged it in various acidic liquids, ran over it with a jeep and fired it against a wall with a mortar. A company specializing in recovering lost data from computer drives managed to recover all the data on the drive.[35] All data on the other removable storage devices tested, using optical or magnetic technologies, were destroyed.

Disadvantages

Like all flash memory devices, flash drives can sustain only a limited number of write and erase cycles before the drive fails.[36][37] This should be a consideration when using a flash drive to run application software or an operating system. To address this, as well as space limitations, some developers have produced special versions of operating systems (such as Linux in Live USB)[38] or commonplace applications (such as Mozilla Firefox) designed to run from flash drives. These are typically optimized for size and configured to place temporary or intermediate files in the computer's main RAM rather than store them temporarily on the flash drive.

Most USB flash drives do not include a write-protect mechanism, although some have a switch on the housing of the drive itself to keep the host computer from writing or modifying data on the drive. Write-protection makes a device suitable for repairing virus-contaminated host computers without risk of infecting the USB flash drive itself.

A drawback to the small size is that they are easily misplaced, left behind, or otherwise lost. This is a particular problem if the data they contain are sensitive (see data security). As a consequence, some manufacturers have added encryption hardware to their drives—although software encryption systems which can be used in conjunction with any mass storage medium achieve the same thing,[*citation needed*]. Most drives can be attached to keychains, necklaces and lanyards. The USB plug is usually fitted with a removable and easily lost protective cap, or is retractable.

USB flash drives are more expensive per unit of storage than large hard drives, but are less expensive in capacities of a few tens of gigabytes as of 2011[39][40]. Maximum available capacity is increasing with time, but is less than larger hard drives. This balance is changing, but the rate of change is slowing.

Comparison with other portable storage

Tape

The applications of current data tape cartridges hardly overlap those of flash drives: on tape, cost per gigabyte is very low for large volumes, but the individual drives and media are expensive. Media has a very high capacity and very fast transfer speeds, but store data sequentially and is very slow for random seek of data. While disk-based backup is now the primary medium of choice for most companies, tape backup is still popular for taking data off-site for worst-case scenarios and for very large volumes (more than a few hundreds of TB). See LTO tapes.

Floppy disk

Floppy disk drives are rarely fitted to modern computers and are obsolete for normal purposes, although internal and external drives can be fitted if required. Floppy disks may be the method of choice for transferring data to and from very old computers without USB or booting from floppy disks, and so they are sometimes used to change the firmware on, for example, BIOS chips. Devices with removable storage like older Yamaha music keyboards are also dependent on floppy disks, which require computers to process them. Newer devices are built with USB flash drive support.

Optical media

The various writable and rewritable forms of CD and DVD are portable storage media supported by the vast majority of computers as of 2008. CD-R, DVD-R, and DVD+R can be written to only once, RW varieties up to about 1,000 erase/write cycles, while modern NAND-based flash drives often last for 500,000 or more erase/write cycles.[41] DVD-RAM discs are the most suitable optical discs for data storage involving much rewriting.

Optical storage devices are among the cheapest methods of mass data storage after the hard drive. They are slower than their flash-based counterparts. Standard 12 cm optical discs are larger than flash drives and more subject to damage. Smaller optical media do exist, such as business card CD-Rs which have the same dimensions as a credit card, and the slightly less convenient but higher capacity 8 cm recordable CD/DVDs. The small discs are more expensive than the standard size, and do not work in all drives.

Universal Disk Format (UDF) version 1.50 and above has facilities to support rewritable discs like sparing tables and virtual allocation tables, spreading usage over the entire surface of a disc and maximising life, but many older operating systems do not support this format. Packet-writing utilities such as DirectCD and InCD are available but produce discs that are not universally readable (although based on the UDF standard). The Mount Rainier standard addresses this shortcoming in CD-RW media by running the older file systems on top of it and performing defect management for those standards, but it requires support from both the CD/DVD burner and the operating system. Many drives made today do not support Mount Rainier, and many older operating systems such as Windows XP and below, and Linux kernels older than 2.6.2, do not support it (later versions do). Essentially CDs/DVDs are a good way to record a great deal of information cheaply and have the advantage of being readable by most standalone players, but they are poor at making ongoing small changes to a large collection of information. Flash drives' ability to do this is their major advantage over optical media.

Size comparison of a flash drive and a 3.5-inch floppy disk

Flash memory cards

Flash memory cards, e.g. Secure Digital cards, are available in various formats and capacities, and are used by many consumer devices. However, while virtually all PCs have USB ports, allowing the use of USB flash drives, memory card readers are not commonly supplied as standard equipment (particularly with desktop computers). Although inexpensive card readers are available that read many common formats, this results in two pieces of portable equipment (card plus reader) rather than one.

Some manufacturers, aiming at a "best of both worlds" solution, have produced card readers that approach the size and form of USB flash drives (e.g. Kingston MobileLite,[42] SanDisk MobileMate.[43]) These readers are limited to a specific subset of memory card formats (such as SD, microSD, or Memory Stick), and often completely enclose the card, offering durability and portability approaching, if not quite equal to, that of a flash drive. Although the combined cost of a mini-reader and a memory card is usually slightly higher than a USB flash drive of comparable capacity, the reader + card solution offers additional flexibility of use, and virtually "unlimited" capacity.

An additional advantage of memory cards is that many consumer devices (e.g. digital cameras, portable music players) cannot make use of USB flash drives (even if the device has a USB port) whereas the memory cards used by the devices can be read by PCs with a card reader.

External hard disk

Main article: External hard disk drive

Particularly with the advent of USB, external hard disks have become widely available and inexpensive. External hard disk drives currently cost less per gigabyte than flash drives and are available in larger capacities. Some hard drives support alternative and faster interfaces than USB 2.0 (e.g. IEEE 1394 and eSATA). For writes and consecutive sector reads (for example, from an unfragmented file) most hard drives can provide a much higher sustained data rate than current NAND flash memory.

Unlike solid-state memory, hard drives are susceptible to damage by shock, e.g., a short fall, vibration, have limitations on use at high altitude, and although they are

shielded by their casings, they are vulnerable when exposed to strong magnetic fields. In terms of overall mass, hard drives are usually larger and heavier than flash drives; however, hard disks sometimes weigh less per unit of storage. Hard disks also suffer from file fragmentation which can reduce access speed.

Obsolete devices

Audio tape cassettes and high-capacity floppy disks (e.g. Imation SuperDisk), and other forms of drives with removable magnetic media such as the Iomega Zip and Jaz drives are now largely obsolete and rarely used. There are products in today's market which will emulate these legacy drives for both tape & disk (SCSI1/SCSI2, SASI, Magneto optic, Ricoh ZIP, Jaz, IBM3590/ Fujitsu 3490E and Bernoulli for example) in state of the art Compact Flash storage devices – CF2SCSI.

Encryption and Security

Main article: USB flash drive security

As highly portable media, USB flash drives are easily lost or stolen. All USB flash drives can have their contents encrypted using third party disk encryption software, which can often be run directly from the USB drive without installation (for example, FreeOTFE) although some, such as TrueCrypt, require the user to have administrative rights on every computer it's run on.

Archiving software can achieve a similar result by creating encrypted ZIP or RAR files.

Some USB flash drive manufacturers have produced USB flash drives which use hardware based encryption as part of the design, removing the need for third-party encryption software; though a number of these have been shown to have security problems, and are typically more expensive than software based systems which are available for free.

A minority of flash drives support biometric fingerprinting to confirm the user's identity. As of mid-2005, this was an expensive alternative to standard password protection offered on many new USB flash storage devices. Most fingerprint scanning drives rely upon the host operating system to validate the fingerprint via a software driver, often restricting the drive to Microsoft Windows computers. However, there are USB drives with fingerprint scanners which use controllers that allow access to protected data without any authentication.[44]

Some manufacturers deploy physical authentication tokens in the form of a flash drive. These are used to control access to a sensitive system by containing encryption keys or, more commonly, communicating with security software on the target machine. The system is designed so the target machine will not operate except when the flash drive device is plugged into it. Some of these "PC lock" devices also function as normal flash drives when plugged into other machines.

Security threats

Flash drives may present a significant security challenge for some organizations. Their small size and ease of use allows unsupervised visitors or employees to store and smuggle out confidential data with little chance of detection. Both corporate and public computers are vulnerable to attackers connecting a flash drive to a free USB port and using malicious software such as keyboard loggers or packet sniffers.

For computers set up to be bootable from a USB drive it is possible to use a flash drive containing a bootable portable operating system to access the files of a computer even if the computer is password protected. The password can then be changed; or it may be possible to crack the password with a password cracking program, and gain full control over the computer. Encrypting files provides considerable protection against this type of attack.

USB flash drives may also be used deliberately or unwittingly to transfer malware and autorun worms onto a network.

Some organizations forbid the use of flash drives, and some computers are configured to disable the mounting of USB mass storage devices by users other than administrators; others use third-party software to control USB usage. The use of software allows the administrator to not only provide a USB lock but also control the use of CD-RW, SD cards and other memory devices. This enables companies with policies forbidding the use of USB flash drives in the workplace to enforce these policies. In a lower-tech security solution, some organizations disconnect USB ports inside the computer or fill the USB sockets with epoxy.

Naming

By August 2008, "USB flash drive" had emerged as a common term for these devices, and most major manufacturers [45] use similar wording on their packaging, although potentially confusing alternatives (such as Memory Stick or *USB memory key or 'Pen drive'*) still occur.

The myriad different brand names and terminology used, in the past and currently, make USB flash drives more difficult for manufacturers to market and for consumers to research. Some commonly-used names actually represent trademarks of particular companies, such as Cruzer, DataTraveler, TravelDrive, ThumbDrive, and Disgo.

Current and future developments

Semiconductor corporations have worked to reduce the cost of the components in a flash drive by integrating various flash drive functions in a single chip, thereby reducing the part-count and overall package-cost.

Flash drive capacities on the market increase continually. As of 2010, few manufacturers continue to produce models of 1 GB and smaller; and many have started to phase out 2 GB capacity flash memory. High speed has become a standard for modern flash drives and capacities of up to 256 GB have come on the market, as of 2009.

Lexar is attempting to introduce a USB FlashCard,[46][47] which would be a compact USB flash drive intended to replace various kinds of flash memory cards. Pretec introduced a similar card, which also plugs into every USB port, but is just one quarter the thickness of the Lexar model.[48] Until 2008, SanDisk manufactured a product called SD Plus, which was a SecureDigital card with a USB connector.[49]

SanDisk has also introduced a new technology to allow controlled storage and usage of copyrighted materials on flash drives, primarily for use by students. This technology is termed FlashCP.

Flash drives for non-USB interfaces

See also: Solid-state drive

The majority of flash drives use USB, but some flash drives use other interfaces, such as IEEE1394 (FireWire),[50][51] one of their theoretical advantages when compared to USB drives being the minimal latency and CPU utilisation that the IEEE1394 protocol provides, but in practice because of the prevalence of the USB interfaces all IEEE1394-based flash drives that have appeared used old slow flash memory chips[52] and no manufacturer sells IEEE1394 flash drives with modern fast flash memory as of 2009, and the currently available models go up only to 4 GB,[53] 8 GB [51] or 16 GB, depending on the manufacturer. FireWire flash drives that needs to be connected to FireWire 400 port cannot be connected to a FireWire 800 port without an adaptor and vice-versa.

In late 2008, flash drives that utilize the eSATA interface became available. One advantage that an eSATA flash drive claims over a USB flash drive is increased data throughput, thereby resulting in faster data read and write speeds.[54] However, using eSATA for flash drives also has some disadvantages. The eSATA connector was designed primarily for use with external hard disk drives that often include their own separate power supply. Therefore, unlike USB, an eSATA connector does not provide any usable electrical power other than what is required for signaling and data transfer purposes. This means that an eSATA flash drive still requires an available USB port or some other external source of power to operate it. Additionally, as of September 2009, eSATA is still a fairly uncommon interface on most home computers, therefore very few systems can currently make use of the increased performance offered via the eSATA interface on such-equipped flash drives. Finally, with the exception of eSATA-equipped laptop computers, most home computers that include one or more eSATA connectors usually locate the ports on the back of the computer case, thus making accessibility difficult in certain situations and complicating insertion and removal of the flash drive.

See also

- Computer data storage
- Portable application
- USB Flash Drive Alliance
- Universal Serial Bus
- Flash memory
- Dead Drop (USB)
- Readyboost

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