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Computer Data Backup & Transfer: The Need for USB 3.0

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History of USB

Originally released in 1995[1], the initial USB 1.0 specification was a serial bus standard designed to provide a universal method of connecting computers to peripheral devices.

Unlike its serial and parallel predecessors, which used different connector types for different devices and often required users to install drivers and tweak device settings, the USB standard offered much simpler "plug and play" connectivity as well as the ability to "hot swap" devices without having to reboot the computer. USB 1.0 also eliminated the complicated installation procedures that were inherent to previous connection standards.

The first revision to the USB standard (USB 1.1) took place in 1998[2], at which time it gained broad consumer acceptance, partly due to the fact that popular operating systems such as Window® 95(SE) and Windows 98 offered USB support. At the time, USB offered theoretical[ii] data transfer rates ranging from 1.5 Mbps to 12 Mbps[3], surpassing the existing bandwidth offered by standard serial (115 Kbps) and parallel (115 KBps) connections.

Universal Connectors
One of the distinct advantages of the USB interface was the standardized, easy-to-connect nature of the connectors.

The original USB standards (USB 1.0/1.1) as well as USB 2.0 used the same connector types: USB 'A', USB 'B', USB 'Micro' and USB 'Mini'. The links to graphics of various forms of USB connectors:

Figure 1: USB A-B cable
Figure 2: USB A-Mini-B cable
Figure 3: USB A-Micro-B cable

USB 2.0
While common devices such as scanners, printers and PDAs (Personal Digital Assistants, also referred to as Palmtop computers in contemporary terms), could now be connected with greater ease, the range of devices that could be connected through USB expanded into different applications, such as external storage devices. Whereas the speed of USB 1.0/1.1 was sufficient for printers and scanners where performance speeds were dictated as much by mechanical operation as they were by throughput, the speed limitation of original USB standards made newer, more robust applications inefficient.

The need for improved data transfer speeds prompted the eventual release of the USB 2.0 (often referred to as "Hi-Speed USB") standard in April of 2000[4], which delivered 480 Mbps (theoretical burst rate) bandwidth – roughly 40x that of the original USB standard.

Based on the theoretical data transfer rate offered by the two standards, imagine transferring a 100MB[5] file from an external hard drive enclosure to a computer:

- Over a USB 1.0/1.1 connection: 100MB x 8 = 800Mb/12Mbps = 67 seconds
- Over a USB 2.0 connection: 100MB x 8 = 800Mb/480Mbps = 1.7 seconds

[1]*Seebach, P. (26 Apr 2005 , April 26). Standards and specs: the ins and outs of usb. Retrieved from http://www.ibm.com/developerworks/power/library/pa-spec7.html*
[2]*Seebach, P. (26 Apr 2005 , April 26). Standards and specs: the ins and outs of usb. Retrieved from http://www.ibm.com/developerworks/power/library/pa-spec7.html*
[3]*USB Definition. Pc magazine encyclopedia. Retrieved (2010, March 17) from http://www.pcmag.com/encyclopedia_term/0,2542,t=USB&i=53531,00.asp*
[4]*"Documents." USB.org. USB Implementers Forum, Inc., 27 April 2000. Web. 17 Mar 2010. http://www.usb.org/developers/docs/.*
[5]*1 Megabyte (MB) = 8 Megabits (Mb). Thus, in this example, 100 MB = 800 Mb. The term Mbps refers to Megabits per second.*

[i]*The USB Implementers Forum, Inc. is a non-profit corporation founded by the group of companies that developed the Universal Serial Bus specification, created to provide a support organization and forum for the advancement and adoption of Universal Serial Bus technology. StarTech.com is a member of the USB-IF.*
[ii]*Theoretical data transfer rates are for reference only, as an indication of the maximum data transfer rates under ideal operating conditions. During typical use, the actual transfer rate will be much less than in theory.*

The Need for USB 3.0

Much like the demand that fueled the transition from USB 1.0/1.1 to USB 2.0, the introduction of advanced new applications that rely on USB technology has created the need for further enhancements to the USB standard. Older USB specs are often simply too slow for these new, data-hungry applications.

Using the previous example of external storage applications, given the drastic increase in hard drive capacity over the last decade, transferring the contents of an external hard drive requires more bandwidth than has ever been necessary; whereas a 1TB[6] hard drive is now commonplace, such capacity was unheard of in 2000, around the time when the USB 2.0 standard was first released. As such, the size of the data transferred back and forth between an external storage device and a computer has increased.

Similarly, the types of media/data that are being transferred/utilized have evolved in proportion to the new technologies that have been developed. As data/media becomes “richer”, the speed at which it can be transferred becomes a pivotal aspect of the convenience and quality it offers. High quality multimedia files, for example, can range from a few gigabytes in size to tens of gigabytes, depending on the compression used, or lack thereof. Transferring or streaming such a file using USB 2.0, while possible, can become cumbersome enough to make it impractical to transfer or stream in the first place.

Clearly, to accommodate the increase in data size that goes hand in hand with new forms of media, a new standard is required in order to more easily handle current file sizes. USB 3.0 does just that.

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[6]*1 TB = 1 Terabyte = 1,024 Gigabytes*

USB 3.0 Speed and Compatibility

In late 2008, version 3.0 of the USB specification was released to the USB-IF, which enabled developers to begin implementation in future products.

For a product to be classified as USB 3.0 compliant, it must meet several requirements. From a performance standpoint, two of the objectives that must be met for a product to be certified as USB 3.0 compliant are:

- Support for data rates of up to 5Gbps
- Backward compatibility with USB 2.0

Speed
With a data transfer rate of 5Gbps - roughly 10x as fast as was specified in USB revision 2.0 and 400x times as fast as the original USB specifications (1.0/1.1), USB 3.0 delivers a solution that more suitably harnesses the capability of modern storage devices and the large file sizes of high quality media.

Although the speed supported by USB 3.0 would be overkill for external hard drives to date, given the current mechanical performance capabilities of the drives, USB 3.0 is the ideal solution for various RAID applications (RAID 0) or SSDs (Solid State Drives) wherein drive data transfer rates exceed those supported by USB 2.0 or eSATA.

Backward Compatibility
Based simply on the number of USB devices that have shipped to date worldwide - estimated at 10 billion[7] and counting - the backward compatibility of USB 3.0 with USB 2.0 is vital.

Although for a device to utilize the full capability of USB 3.0, a USB 3.0 compliant host bus and USB 3.0 cable are required, a USB 3.0 device (such as a USB 3.0 external hard drive enclosure, or USB 3.0 hard drive docking station) would still be able to function at typical USB 2.0 speeds when connected to a USB 2.0 host[8]. This is extremely important as it means much less expense for users who would have had to replace their existing USB devices with newer models for the sake of compatibility with the new standard.

Power Management
Another core benefit of USB 3.0 is its power efficiency, which is more conducive to energy conscious computer architecture. Some of the main power management enhancements are:

- Replaces continual Device Polling with asynchronous notifications, utilizing fewer system resources
- The introduction of link power management states, which enable power savings when the connection between the host and the device is idle
- The transition to low power states can be initiated by either the host or the device, which helps minimize the amount of overall power drawn from the host
- “Suspend” capabilities that enable devices to remove power from all of their circuitry or only portions of the circuitry that are not in use

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[7] *Perenson, M. "USB 3.0 Promises Faster Speeds, Backward Compatibility." PCWorld. PCWorld Communications, Inc., 06 January 2009. Web. 17 Mar 2010. <www.pcworld.com>*
[8] *Universal Serial Bus 3.0 Specification." Revision 1.0. Section 11-3. USB Implementers Forum, Inc., 2008. Print*

USB 3.0 Plugs and Receptacles

Much like its predecessors; USB 3.0 will offer a variety of plug and receptacle types. As defined by the most recent revision to the standard, USB 3.0 will employ the following plug and receptacle types:

Receptacle (Port)	Plug (connector) Accepted	Notes
USB 2.0 type 'A'	USB 2.0 type 'A' USB 3.0 type 'A'	A USB 3.0 'A' plug can be inserted into a USB 2.0 'A' receptacle
USB 3.0 type 'A'	USB 3.0 type 'A' USB 2.0 type 'A'	Defined as the 'host connector'; same shape as the USB 2.0 'A' connector, with a different internal pin structure
USB 3.0 type 'B'	USB 3.0 type 'B' USB 2.0 type 'B'	Used for large, stationary peripherals such as external hard drives, printers; A USB 3.0 'B' plug cannot be connected to a USB 2.0 'B' receptacle
USB 3.0 Powered type 'B'	USB 3.0 Powered type 'B' USB 3.0 type 'B' USB 2.0 type 'B'	Allows a USB 3.0 device to provide power to a USB adaptor, without having to use an external power supply
USB 3.0 type 'Micro B'	USB 3.0 type 'Micro B' USB 2.0 type 'Micro B'	Used for small handheld devices; a USB 2.0 'Micro B' plug will work in a USB 3.0 'Micro B' receptacle
USB 3.0 type 'Micro AB'	USB 3.0 type 'Micro B' USB 3.0 type 'Micro A' USB 2.0 type 'Micro B' USB 2.0 type 'Micro A'	The USB 3.0 'AB' receptacle is the same shape as that of USB 3.0 'Micro B', with a different internal pin structure; used on USB 'OTG' (On The Go) products

USB 3.0 standard also defines several different types of cable assembly, to provide the connection between USB 3.0 host and peripheral devices. Some examples include:

- USB 3.0 'A' plug to USB 3.0 'B' plug
- USB 3.0 'A' plug to USB 3.0 'A' plug
- USB 3.0 'A' plug to USB 3.0 'Micro-B' plug
- USB 3.0 'Micro-A' plug to USB 3.0 'Micro-B' plug
- USB 3.0 'Micro-A' plug to USB 3.0 'B' plug

USB 3.0 Device Availability

Based on the speed and performance the standard supports, it is predicted that the majority of products available at the onset of USB 3.0 will be geared around external storage solutions.

Although USB 3.0 devices such as printers and scanners are not yet commonly available, StarTech.com offers a growing selection of products that support USB 3.0 connections, allowing users to prepare for the new generation of USB 3.0 consumer devices and take advantage of the benefits of existing USB 3.0 devices (such as external storage) including:

- A USB 3.0 SATA Hard Drive Docking Station for 2.5"/3.5" HDD
- A USB 3.0 SATA Hard Drive Docking Station (packaged with a PCIe-based USB 3.0 Controller)
- A USB 3.0 SATA Hard Drive Docking Station (packaged with ExpressCard-based USB 3.0 Controller)
- A USB 3.0 Hard Drive Enclosure for 3.5" SATA Hard Drives
- A USB 3.0 SATA Hard Drive Enclosure (packaged with PCIe-based USB 3.0 Controller)
- A USB 3.0 SATA Hard Drive Enclosure (packaged with ExpressCard-based USB 3.0 Controller)
- A USB 3.0 Hard Drive Enclosure for 2.5” SATA Hard Drives
- A USB 3.0 to SATA External Adapter
- A 2 Port PCIe-based USB 3.0 Adapter Card
- A 2 Port ExpressCard-based USB 3.0 Adapter Card
- A PCIe-based USB 3.0 Adapter Card (1 Internal port, 1 External port)

