USB 3.0 vs USB 2.0

Autor:
Data de publicació: 10-12-2016

Over the last 14 years, the Universal Serial Bus (USB) has become the standard interface to connect devices to a computer. Whether it's an external hard drive, a camera, the mouse, a printer, or a scanner, the physical connection to transfer data between devices generally is a USB cable. The interface is indeed universal.

USB technology has been under development since 1993. The first official definition, USB 1.0, was introduced in 1996. It provides a Low-Speed transfer rate of 1.5 Mbits/s for sub-channel keyboards and mice, and a Full-Speed channel at 12 Mbits/s. USB 2.0, which came in 2001, made a leap to Hi-Speed transfer rates of up to 480 Mbits/s. In 2010, USB 3.0 finally hit the market. Table 1 shows a summary of important specification differences between USB 2.0 and USB 3.0.

Table 1. Summary of key USB 2.0 and USB 3.0 technical specifications.

USB 3.0 (SuperSpeed USB)

USB 3.0 is the third major version of the Universal Serial Bus (USB) standard for computer connectivity. Among other improvements, USB 3.0 adds a new transfer mode called "SuperSpeed" (SS), capable of transferring data at up to 5 Gbits/s (625 MB/s), which is more than ten times as fast as the 480 Mbit/s (60 MB/s) high speed of USB 2.0. Besides different connectors used on USB 3.0 cables, they are also distinguishable from their 2.0 counterparts by either the blue color of the ports or the SS initials on the plugs.

A successor standard named USB 3.1 was released in July 2013, providing transfer rates up to 10 Gbits/s (1.25 GB/s, called "SuperSpeed+"), which effectively put it on par with the first version of Thunderbolt.

USB 2.0 (High-Speed USB 2.0)

In 2002, a newer specification USB 2.0, also called Hi-Speed USB 2.0, was introduced. It increased the data transfer rate for PC to USB device to 480 Mbps, which is 40 times faster than the USB 1.1 specification. With the increased bandwidth, high throughput peripherals such as digital cameras, CD burners, and video equipment could now be connected with USB. It also allowed for multiple high-speed devices to run simultaneously. Another important feature of USB 2.0 is that it supports Windows XP through Windows update.

Physical differences

The physical difference between USB 2.0 and USB 3.0 is the number of wire connections. This new topology greatly improves bus utilization, resulting in improved system throughput. USB 2.0 uses four wires, which supports half-duplex communication. In this architecture, a single bi-directional data pipe is used where data only flows in one direction at any given time. In comparison, USB 3.0 adds five wires for a total of nine wires, and utilizes a unicast dual-simplex data interface that allows for two uni-directional data pipes, with each pipe handling communication for a single direction.

Types of USB connector left to right (ruler in centimeters): Micro-B plug, UC-E6 proprietary (non-USB) plug, Mini-B plug, Standard-A receptacle (upside down), Standard-A plug, Standard-B plug

Bandwidth differences

USB 3.0 has improved upon the bulk data transfer mechanism of USB. The effective bandwidth available via the bulk transfer method is around 400 MByte/s; approximately 10 times that of USB 2.0. This important transfer mechanism has enabled machine vision camera vendors to build high-throughput USB 3.0 cameras. This has created significant cost-saving opportunities for integrators as well as improving the overall system speed and efficiency. Users can now use fewer cameras while still covering the same imaging area with large resolution USB 3.0 cameras. The higher bandwidth also allows for faster frame rate, increasing the performance of the system.

Power delivery

USB 3.0 also provides more efficient power management and increased power delivery over USB 2.0. The amount of current draw for USB 3.0 devices operating in SuperSpeed mode is now 900 mA, resulting in an increase in total power delivery from 2.5 W to 4.5 W (at 5 V).

Communication architecture differences

USB 2.0 employs a communication architecture where the data transaction must be initiated by the host. The host will frequently poll the device and ask for data, and the device may only transmit data once it has been requested by the host. The high polling frequency not only increases power consumption, it increases transmission latency because the data can only be transmitted when the device is polled by the host. USB 3.0 improves upon this communication model and reduces transmission latency by minimizing polling and also allowing devices to transmit data as soon as it is ready.

Power consumption and capacity

USB 3.0 has been designed to reduce power consumption while increasing its capacity to support and deliver more power. The introduction of USB Battery Charging 1.2 specification allows up to 7.5W of power to be supplied to USB 3.0 devices. USB 3.0 also offers an improved mechanism for entering and exiting low-power states, depending on whether a device is active or not, and eliminates power-consuming polling.

Cable length: USB 3.0 vs USB 2.0

The standard maximum cable length is 5 meters for USB 2.0 devices. The USB 3.0 standard does not specify a standard length; the maximum distance currently supported in USB 3.0 is 3 meters.

Timestamp enhancements

Unlike USB 2.0 cameras, which can range in accuracy from 0 to 125 us, the timestamp originating from USB 3.0 cameras is more precise, and mimics the accuracy of the 1394 cycle timer of FireWire cameras.

PHY register & network topology visibility

It is possible to view the network topology of USB 3.0 cameras on the bus. However, PHY node information is not available. USB 2.0 cameras do not provide an interface for viewing either topology or PHY node information.

USB 3.0 Vision

Several machine vision standards exist today for popular interfaces such as IIDC for FireWire and GigE Vision for Ethernet. The standards provide a common way to access and control machine vision cameras, increasing the ease of use and allowing interoperability between different hardware and software vendor.

While no camera control standard exists for USB 2.0 cameras, a new standard called USB3 Vision was has been ratified in 2013 for USB 3.0 cameras. USB3 Vision builds upon the popular GeniCam standard and defines USB 3.0 related requirements, device identification and control interfaces, data streaming mechanisms, mechanical requirements, and testing frameworks.

Conclusion

USB 3.0 -- or Super-speed USB -- overcomes key limitations of other specifications all these limitations with six (over IEEE 1394b) to nine (over USB 2.0) times higher bandwidth, better error management, higher power supply, longer

cable lengths and lower latency and jitter times. These advantages, coupled with the fact that USB 3.0 has become a standard in the consumer market with a lot of hardware supporting native USB 3.0, has made this interface a de facto choice for cameras in a relatively short period of just a year, post the official ratification of USB 3.0 Vision standard in January 2013.

Abhishek Gupta is a business analyst for Cypress Semiconductor. He has a B.E. in Electronics & Communications from Maharishi Dayanand University, Haryana, India. He has worked with Agilent Technologies as a Logistics Coordinator (RoHS Specialist) and can be reached at agni@cypress.com.