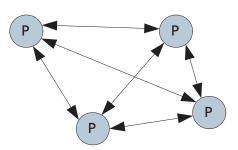# FireWire® vs. USB 2.0

Introduction

Recently, several high-performance digital camera systems have been introduced that utilize the USB 2.0 interface. As one might expect, a rather lively marketplace debate over the relative merits of USB 2.0 versus FireWire has ensued. Through use of extensive third-party publications, this paper attempts to shed some light on the key performance differences.

Architecture

In order to fully appreciate the performance differences between USB 2.0 and FireWire (IEEE-1394), it is important to first understand the architectural differences between these two interconnects.

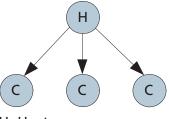
P: Peer

Figure 1. Typical Peer-to-Peer Network Topology

FireWire

Developed by Apple Computer in the 1990s, FireWire was eventually proposed as a replacement for SCSI (Small Computer System Interface) by the IEEE (Institute for Electrical and Electronics Engineers). The Apple invention is defined in the IEEE-1394 standard (see Wikipedia references) and positioned for real-time video transfers.

As shown in **Figure 1**, IEEE-1394 employs a *peer-to-peer* connection. Peer-to-peer networks use the power of connected participants as opposed to relying on a small, concentrated number of servers. The advantage of this strategy is that IEEE-1394 provides sustained data rates without requiring a computer host for interconnection between peripherals.

USB 2.0

USB (Universal Serial Bus) was developed by a consortium of companies in the 1990s. It was incorporated as a standard in the same year that IEEE-1394 was standardized. As **Figure 2** illustrates, USB features a *master-slave* configuration that requires a host (master) and a client (slave). USB is controlled through the host and is typically referred to as the *host controller*. Most often, the host is a personal computer. This configuration requires overhead on the host side in order to maintain the transfer of data between host and client, hence reducing overall sustained data rates. If communication between two clients is needed, then the data rates are reduced even further.

H: Host
C: Client

Figure 2. Typical Master-Slave Network Topology

Performance

Based on published throughput rates, it has been suggested that USB 2.0 (480Mbits/s) delivers higher performance than IEEE-1394a (400Mbits/s). When taken at face value, the rates certainly seem to support this assertion. Practical application, however, indicates otherwise.

In fact, the increased CPU and host control overheads attributable to the master-slave topology of USB 2.0 actually reduce its sustained throughput to rates lower than those of IEEE-1394a. **Figure 3** displays the results of a benchmark test conducted by USB-Ware with an external IDE hard drive (visit http://www.usb-ware.com/firewire-vs-usb.htm).

There are many such examples of the performance differences between USB 2.0 and IEEE-1394a available on the internet. For instance, somewhat similar results can be seen at http://www.barefeats.com/usb2.html. Although the Bare Feats website reports a difference in metrics between Mac computers and Windows®, the fastest sustained data rate of USB 2.0 is still slower than the sustained rate of IEEE-1394a.

On the site, Bare Feats shows that the IEEE-1394a data rates of the PowerBook for READ and WRITE are 38MB/s and 35MB/s, respectively. Comparing the maximum data rate of USB 2.0 achieved on Windows with that of IEEE-1394a on the Mac computer (since the Windows rates were not published for IEEE-1394a), IEEE-1394a still outperforms USB 2.0 by 15% for READ and by 29% for WRITE.

FireWire vs. USB 2.0 Hard Drive Performance Comparison
Read and write tests to the same IDE hard drive connected using FireWire and then Hi-Speed USB 2.0 show:

Read Test:
- 5000 files (300 MB total) FireWire was 33% faster than USB 2.0
- 160 files (650MB total) FireWire was 70% faster than USB 2.0

Write Test:
- 5000 files (300 MB total) FireWire was 16% faster than USB 2.0
- 160 files (650MB total) FireWire was 48% faster than USB 2.0

Figure 3. Benchmark Test of USB 2.0 vs. FireWire (IEEE-1394a)

Item	USB 2.0	FireWire
Printed Data Rate	480Mbits/s	400Mbits/s
Sustained Data Rate (READ)	33MB/s	38MB/s
Sustained Data Rate (WRITE)	27MB/s	35MB/s
Architecture	Master-Slave	Peer-to-Peer
Designed for	Convenience	Speed
Biggest Advantage	Standard on 90% of personal computers	Sustained data rates perfect for video or media devices
Biggest Disadvantage	Requires external power for high-performance CCD cameras	Not usually standard on personal computers

Table 1. Comparison Chart: USB 2.0 vs. FireWire (IEEE-1394a)

Comparison Chart

Table 1 presents a quick look at the differences between USB 2.0 and IEEE-1394a. One difference between the two interconnect technologies, namely, the ability to power peripherals, is of particular importance. IEEE-1394a offers 16W of power across the bus, whereas USB 2.0 only provides ~2.4W. Therefore, USB 2.0 requires even the most basic digital cameras to be externally powered.

Summary

Independent benchmark tests between USB 2.0 and IEEE-1394a show that IEEE-1394a is the performance winner, even though the published rates tell a different story. IEEE-1394a lends itself to real-time video transfer due to higher sustained data rates. It is also very useful because of its peer-to-peer topology and ability to independently power CCD cameras from a host controller.

USB 2.0, meanwhile, has evolved into a convenient interconnect for external hard drives, flash drives, and consumer-grade digital cameras, owing to the availability of these ports on just about every computer now sold. As previously mentioned, overall sustained data rates are reduced by the master-slave topology of USB 2.0 (due to overhead and increased CPU load). The inability to provide substantial power is another downside, creating the need for an additional connection to the high-performance camera.

Both USB 2.0 and IEEE-1394a have advantages and disadvantages. If performance is critical, then IEEE-1394a is the clear choice. If performance is not as important, then USB 2.0 represents a ready option.

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