

IEEE 1394-The Home Entertainment Network

Today we see every company in the consumer electronics and PC industries, as well as the service providers, developing products and strategies for the connected home. All aspects of this connected home -- communications, entertainment and home systems management -- will be interconnected in the future using networking and Internet technology." -- Mike Wolf, senior analyst for In-Stat/MDR

Demand will require a huge expansion in bandwidth for all communications wires entering a home. More people want to network their homes these days, even if it's just to lay the groundwork for the future. -- EC&M Magazine

Home networking traditionally has been an office network in the house, built around the personal computer using the Ethernet™ standard, with the primary benefits of file-sharing, peripheral connectivity, and Internet access. But today, with consumer electronics products moving to all-digital technology, audio and video can be shared across exciting new home entertainment networks. For the newly-emerging home entertainment network there is an ideal standard, a single, easy-to-use link developed specifically to connect every consumer electronics and computer device – with no need for a computer at the center of the network. IEEE 1394 is the *only* technology designed to be a video networking technology.

Unlike Ethernet, which is excellent for data transfer requirements of high speed computing, IEEE 1394 guarantees the vital quality-of-service (QoS) required to transport high definition video simply and easily across a multi-device network. Now, with the advent of 1394b in early 2003, 1394 as the home entertainment network technology was launched to an enthusiastic community of home theater and network installers.

The Basics of 1394

IEEE 1394 is a high speed audio-video transport interface founded by Apple in 1986. In 1995, it became a formal standard, featuring speeds of 100 Megabits per second, 200Mbps, and 400Mbps. Later, the IEEE produced the IEEE 1394a version, which improved the original 1394-1995 version without changing any of the basic capabilities of the original.

1394 is commonly referred to by the brand names "FireWire," preferred by Apple and the PC industry, and "i.LINK," originated by Sony and common in the consumer electronics sector. Both are well-known brand names for the 1394 technology. Geographically, "i.LINK" is the most popular name for 1394 in Japan with "FireWire" common in the rest of the world. It's also common to see the name "IEEE 1394" or "1394."

FireWire provides a flexible topology that simply and easily connects devices in the home entertainment network. Every device, or node, works much like a repeater, moving the signal along to the next node in the cluster. A FireWire-based network can link up to as many as 63 separate pieces of equipment. One future FireWire enhancement will permit a maximum of 1,024 devices to connect over "bridges." This means that a framework set up by FireWire makes it possible to connect more than

64,000 devices or nodes at the same time. FireWire also uses peer-to-peer data transfer, so there is no need to pass A/V data through the computer as it moves from one location to another. As products become part of the FireWire network, they receive an ID number, saving the time and effort usually taken to establish a recognizable location.

FireWire is also versatile: it supports asynchronous functions normally used between PCs and peripherals and isochronous capabilities necessary for shipping real time video. And all versions are compatible with each other, a particularly important factor as the new 1394b emerges in the entertainment network.

The latest version of 1394 is 1394b which came into the market in early 2003. 1394b has doubled the data transfer rate of the 1394a to 800 megabits per second. Even more significantly, it delivers the ability to move audio and video 100 meters, enabling virtually limitless connections among CE and PC products. Additionally, 1394b has extended the choice of cabling options for connecting 1394 devices in the home network. Along with 1394b copper cable, audio and video can now travel through plastic optical fiber, glass optical fiber and Cat5 cable.

Advantages of 1394

Speed and bandwidth: The first feature that makes FireWire stand out is its data rate. The high-speed bus protocol type of FireWire can reach speeds of up to 400Mbps. USB 2.0 promotes itself as a 480 Megabit technology; but USB's inherent overhead means 1394 is still some 50 percent faster than USB 2.0 in terms of usable bandwidth. Ethernet, under the best of circumstances, can only make 60 percent of its available bandwidth available and it is not uncommon to see throughput reduced to 15 to 40 percent in a busy network. FireWire operates in at 50 to 90 percent throughput, depending on the activity on the network.

The new 1394b version of the standard enhances FireWire's position, with speeds of 800Mbps and the 100-meter distances. The first "FireWire 800" products – disk storage and PCs – reached the market early in 2003. On the horizon is a data rate of 1.6 Gigabits per second, and -- longer term -- speeds of 3.2Gbps.

Expandable: FireWire's second advantage is its ability to expand. When compared with USB, the FireWire network is capable of taking in a much larger number of devices. Although in theory USB can simultaneously connect 127 separate pieces of equipment, the reality is different: if more than a dozen USB devices are linked up at the same time, latency and other problems soon surface. On several occasions during worldwide 'plugfests,' the 1394 Trade Association has connected 63 devices with FireWire and streamed video between devices -- with no problems. This expandability represents one of the major advantages of a peer-to-peer technology like FireWire, when compared with master-slave technologies such as USB, Ethernet, and the Digital Video Interface (DVI). In addition, 1394/FireWire is free of the challenge of weak power supplies that can hamper similar systems, since FireWire can act as its own power source if outside power sources are interrupted.

User Friendly: 1394 is very easy to use. When adding or removing devices from a FireWire system, users do not need to turn off the system or the power source. All of FireWire's peripherals possess the universal plug and play function. In addition, peer-to-peer data transmission rids the system of the need for added software and other complicated set-ups. Even the casual user has no trouble running a smooth operation.

Low Cost: Due to the fact that FireWire has peer-to-peer transmission, all devices that have a FireWire interface can interact with each other. Using FireWire, computers and other bulky equipment previously required for data processing are not needed for the relay of information. Thanks to FireWire's independent nature, the system's operating cost is competitive with USB and SCSI. Furthermore, when transferring audio and visual data, FireWire systems skip the time-consuming "digital-to-analog-to-digital" step because full digital interaction between all devices in the FireWire framework eliminates the step.

Asynchronous & Isochronous: IEEE 1394 supports both asynchronous and isochronous transmission. This means that a FireWire interface can not only be used on most computer peripherals and information appliances, but can also be applied to devices that require quick reaction time, one example being Internet video.

Wide Range of Applications: The range of applications for FireWire is very diverse – more than any other PC or CE standard. It is in many markets including information appliances, consumer electronics, automotive networks, industrial and instrumentation, professional broadcasting and record, and even aerospace and defense applications. This versatility gives IEEE 1394 the competitive edge, as the industry reaches for a single standard that will bring all appliances under the management of a single system. While other networking technologies were developed for less complex environments, such as PC peripheral-sharing or lighting and climate control, FireWire was developed for the *most* challenging application of all -- the sharing of multiple high definition video streams between multiple devices -- including PCs and peripherals. All the other uses for a home network are easily implemented on 1394.

IEEE 1394 to make it big in 2004

FireWire has been heralded as the fastest, most versatile home network now out on the market. 1394 not only connects the personal computer to a proliferation of peripherals, but it can also form a system operating home appliances, creating a household where everything from cooking to lawn maintenance can be monitored by your computer. Although manufacturers anticipated the widespread use of this standard nearly three years ago, 1394 was slow to take off due to the slow adoption of HDTVs. And the leading industry regulators also have recognized the benefits of 1394, which include the ability to make copies of audio and video for personal use, a significant and well-established digital 'right.' Recent pro-1394 mandates coming from the Federal Communications Commission, including the requirement that all televisions 13 inches and larger provide high definition capabilities by 2007, has propelled 1394 into a new generation of HDTVs, STBs, PVRs, and other products.

Home entertainment networks weren't ready for development when 1394 emerged, but the time has come. The situation can be compared with the launch of the set-top box, which took off when the cable modem emerged.

Now that the FCC is requiring the addition of 1394 in A/V products, companies such as Mitsubishi -- a market leader in large screen TVs -- are making the most of the leadership position with 1394 and creating significant excitement for FireWire among retailers. Support is strong, too, from leading editorialists: Home Theater, Widescreen Review, CE Pro and other publications have cited FireWire as the ideal home networking standard.

As the home entertainment network emerges and grows, so will the 1394 standard. According to leading industry analysts and the 1394 Trade Association, the worldwide home networking equipment and residential gateway market is expected to grow from some \$600 million in 2000 to almost \$5.7 billion by the end of 2004.

S800BaseT

One of the most exciting developments impacting networking and the 1394 standard is a new technology known as "S800BaseT," which effectively combines Ethernet and 1394 capabilities on a single chip that can direct the appropriate standard to go to work for tasks it performs best. For instance, PCs speak Ethernet, which gives that networking technology a natural edge in home-networking applications. But IEEE 1394, better known as FireWire, has inherent QoS (quality of service) features that make it a better choice for consumer-electronics applications involving high-bandwidth video and audio. Now the shepherds of both technologies are working to combine them in a way that would be invisible to consumers.

The 1394 Trade Association is working with the Institute of Electrical and Electronics Engineers to develop a combined Ethernet/1394b PHY (physical layer). Once put into silicon, this PHY lives inside a hub that connects all endpoints in a network regardless of what protocol those endpoints want to employ. That is, 1394 devices will think they are on a 1394 network, and Ethernet devices will believe they are on a standard Ethernet network. Within the network, a bridge allows Ethernet traffic to cross over to the 1394 "side" and vice versa.

The appeal of the concept is how it can change the electronics landscape for consumers. Instead of worrying about different network technologies, users instead will be able to see a single RJ-45 wall jack able to work with whatever device they choose to plug into it. Inside the walls, an infrastructure of category-5 cable will carry *both* Ethernet and 1394 traffic.

The key to the effort is an autonegotiation protocol that allows each port to select from various link-layer protocols, including 10- and 100-Mbit/sec Ethernet, 100-Mbit/sec 1394b, Gigabit Ethernet, and 400- or 800-Mbit/sec 1394. The 1394 Trade Association expects to see silicon vendors introduce the PHY early next year.