Made for media: IEEE 1394 should rule the roost

James Snider - January 21, 2004

There's a debate in progress in engineering-leadership circles at the top consumer-electronics and computer companies. The topic: Whether to adopt IEEE 1394 for a new generation of CE and PC products or buff up the aging Ethernet standard and assume it will be "good enough" for the robust streaming video that consumers now expect their systems to deliver.

Armed with performance statistics, specification data, and a dose of religious fervor, development teams are discussing whether to try to retrofit an old technology to achieve new capabilities for the home network or move forward with a powerful and proven standard. The debate is intense, at least at some companies, but it risks holding up the growth of home-entertainment networking—and depriving consumers who are ready for it.

Frankly, I don't understand what the fuss is about. IEEE 1394, known commercially as FireWire and i.LINK, was designed from its inception to handle multiple high-definition video streams in real time and to support peer-to-peer networking. Ethernet, which originally emerged before the advent of the personal computer, was not.

Many companies have fully embraced 1394, and it now has an established position on product roadmaps for everything from disk drives to advanced HDTVs. At other organizations, however, teams cannot resist talking about improving Ethernet. The thinking seems to be that Ethernet boasts a proven installed base and low-price components, making it an attractive choice for the home network.

But enhancing Ethernet is not that simple. A major overhaul, including costly and complex new protocol layers, is necessary to even come close to what 1394 can achieve. And even that provides no guarantee that Ethernet will work well.

Engineers who have tried to pump Ethernet up find that they need to add significant amounts of buffering to store video "up front," so that the stream remains continuous during times when the
network gets busy. This buffering creates a minimum 7-second delay each time the viewer changes the TV channel. This will lead not to happy users but to end-user frustration—not a good response in consumer markets that depend on rapid user acceptance.

Conversely, 1394 boasts an extensive and compelling list of features and benefits that make it preferable in these exciting new applications.

At the top of the list, QoS (quality of service). For real-time audio and video transmission, Ethernet lacks the requisite QoS. This is particularly a problem when it comes to high-definition video, which is coming at us rapidly and for which 1394 is perfect. Ethernet's "best-effort" MAC (media access control) system is reliable and proven for data, but it falls far short of the quality 1394's real-time delivery ensures.

Computer networks commonly experience occasional pauses in data transfer. But in an audio/video network, pauses are completely unacceptable. In fact, unscheduled pauses are like the tiling that occurs when satellite-TV reception starts breaking up, disrupting quality.

1394 has built-in support for real-time data, which means that audio and video will arrive at the specified destination on time under virtually all circumstances. A busy network will not cause dropouts in a 1394 network. This guarantees the bandwidth for audio and video applications. Ethernet, under the best of circumstances, can deliver only 60 percent of its available bandwidth, and collisions can reduce throughput to only 15 to 40 percent in a busy network. FireWire operates at anywhere between 50 to 90 percent throughput, guaranteed, depending on the activity on the network.

Another factor: simple interaction between products. FireWire operates using peer-to-peer transmission, so all devices with a 1394 interface can interact with each other. A 1394 network—in contrast to Ethernet—requires no computers or other bulky equipment to handle network-processing tasks.

Ethernet does have a place in the home network. Most home networks today involve sharing an Internet connection, a common printer, and files on other computers. This is like an office network, so Ethernet is fine (although FireWire can also complete all these tasks simply and reliably).

But consider the long-term picture. Anyone looking over the horizon cannot avoid understanding that the move from analog to digital TV carries with it a major shift for home networking, which will come to focus on video sharing—not computer file sharing. It's a quantum leap forward, but it is coming, and it will move the emphasis from a home computer network to a home entertainment network. Any home network that's unable to handle high-definition video in real time will not be a serious contender for widespread adoption.

Some suggest that Gigabit Ethernet will deliver the bandwidth required, easily handling the 45 Mbits/sec required for HD video and solving the problem. The catch here is the difference between "theoretical bandwidth" (the absolute amount) "usable bandwidth" (absolute minus system overhead), and "guaranteed bandwidth." Multiple devices in a network cause collisions in an Ethernet system, and the collisions reduce the usable bandwidth at regular intervals—all the way down to as little as 15 percent.

Another argument, nontechnical but worth a note, is the position of Congress and the current Federal Communications Commission. Both have seen past the short term and into the future to lend support to using the optimal technology required to advance the user experience. In mid-2003 the FCC mandated that all televisions 13 inches and larger provide high-definition reception by 2007, a
mandate that carries with it the requirement for a digital tuning capability, and which has propelled 1394 into a new generation of advanced set-top boxes, personal video recorders, and other products.

Then, in September, the FCC approved an agreement between cable operators and TV manufacturers to establish a "plug-and-play" capability so consumers can plug their cable system directly into their TVs. The effect: a mandate for 1394 in high-definition video devices. Ethernet enjoys no such mandate.

The FCC examined the available technologies and responded with action favorable toward 1394. If government officials can demonstrate such forward thinking, why are some industry leaders still arguing over these standards?

Many of the arguments will become partially moot by mid-2004, with the arrival of a combination 1394-Ethernet device, dubbed 1394c. The new "c" silicon will effectively let a system toggle back and forth between one standard and the other, depending on the task at hand.

Once put into silicon, this physical layer (PHY) will live inside a hub that connects all endpoints in a network—regardless of what protocol those endpoints want to employ. 1394 devices will think they are on a 1394 network, and Ethernet devices will believe they are on a standard Ethernet network.

The new single-silicon PHY will bridge the gap between 1394 and Ethernet, allowing each to be used for applications for which it's best suited. But even before "c" becomes available, FireWire's version "b" has many advantages. Among them, unhindered, repeater-free connectivity at 400 Mbits/sec of devices that can be as far as 100 meters apart. The "b" version is now available in PC products, is coming along in CE systems, and is a leading choice for in-wall systems. It's also set for usage in vehicle entertainment systems.

It would seem that the choice for the home-entertainment network would be clear. However, in the real world, sometimes the best choice is not obvious to everyone.

Managers earn rewards for predicting results and then achieving what they predicted. Therefore, most companies embrace the predictable. When they look at home networking, they consider Ethernet because it is a "networking" technology, whereas 1394 is an AV technology.

What they are missing is that the home network is an AV network. This is going to come back and bite them. The managers of Digital Equipment Corp were busy projecting sales of mainframe computers when two youngsters introduced the Apple 1 and revolutionized the industry, setting DEC on the path to oblivion. "Predictable" is OK for survival until the rules of the game change. The rules are changing, and 1394 is the only networking technology positioned to thrive in the new environment.

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