Gigabit Ethernet: Analog or Digital?

Irving Gold - October 02, 2000

Campbell, Calif. The Gigabit Ethernet market is "white-hot." Pumping data over copper at 1,000Mbit/sec. (1000Base-T) is no small achievement. In fact one of the industry luminaries recently proclaimed that it is the most complex communications system today. And that is a very correct statement.

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But why Gigabit Ethernet? Let's focus first on a moment of background information. Gigabit Ethernet is part of the IEEE 802.3 standard for the Ethernet communications protocol over copper wire. This standard was put in place in order to provide a common method for the exchange of data within LANs. Over the past 15-plus years, Ethernet has slowly been extended to provide increasingly faster data rates and, as a result, Ethernet is the most pervasive communications technology in use today.

From a historical perspective, the original Ethernet speed was 10Mbit/sec. As market demand for speed increased, users shifted to Fast Ethernet at 100Mbit/sec. data rate. Now with the insatiable demand for even more speed, being driven by the Internet and communications revolution, users are shifting to Gigabit at 1,000Mbit/sec. speeds.

So where's the rub? The challenge is to get data throughput at such high speeds of 1,000Mbit/sec. while still maintaining the same wireline infrastructure, namely the ubiquitous unshielded twisted pair (UTP) Category-5 (CAT-5) copper wire. After all, rewiring a building is a very expensive proposition to be avoided if at all possible.

The most complex part in a Gigabit Ethernet communications system is the physical layer device, the PHY. The PHY is the chip that hooks up to the actual physical wire. It places the data (the 1s and 0s) coming from the higher layers of the network switch onto the physical wire, and in reverse order takes the 1s and 0s off the wire converting them into meaningful data for processing further along the network chain.

Back to the issue at hand, CAT-5 wire consists of four pairs of UTP. A typical unshielded twisted pair copper wire has a bandwidth of around 1MHz, possibly 2MHz on a good day. So how do we get 1,000Mbit/sec. over copper? The only way to pump such high data rates through the wire is to use digital communications methods. These methods make use of complex DSP: the higher the data throughput, the more complex the signal processing.

As we squeeze more data through the wire, specifically at Gigabit data rates, the PHY must overcome many factors that can impair signal quality and introduce significant errors such as:
substandard cabling, noise, signal amplitude degradation due to long cable lengths, cross-talk and interference from adjacent lines, echoes, signal reflections and numerous others. Clearly complex signal processing algorithms are involved. Thus Massana concludes that the solution is a DSP play, pure and simple. Well, at least one would think so.

Back to a history for a moment. The original 10Mbit/sec. Ethernet PHY was a pure analog design, no major signal processing challenges there. As the market shifted to Fast Ethernet (100Mbit/sec.) these same analog providers redesigned their analog PHY solutions for the higher data rates. Again no major signal processing design challenges, analog design techniques are used extensively. No so for Gigabit. The IEEE 802.3 spec clearly mandates complex modulations and algorithms. So how come these analog Ethernet PHY providers claim they're developing analog-based Gigabit PHYs?

Well, that's the beauty of the free market, but the proof is in the pudding. At present, none of these analog PHY providers have actually brought a product to the market. In fact the only two Gigabit Ethernet PHYs on the market today are based on DSP techniques, both of them designed by companies which are experts in DSP. Massana feels vindicated in using DSP for its own PHY designs. The market is still waiting for those analog PHY designs. Stay tuned.

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