PROBLEMS:
Gigabit over Category 5 Cable

Jan. 21, 2003

In the past, Multi-Channel Fast Ethernet cards were popular in small, moderate, and enterprise size networks, primarily because the bandwidth between the server and switch could be optimized. Therefore, bottlenecks were eliminated (or significantly reduced).

However, with the advent of Gigabit, it offers (*theoretically*) single port throughput of 1,000 Mbps, or 10 times faster than Fast Ethernet technology (in half duplex). Why then would customers use Multi-Channel Fast Ethernet cards to improve bandwidth? Especially, given the cost of Gigabit Ethernet cards have dropped significantly in recently years.

Well, many companies after asking themselves this same question have moved toward Gigabit technology without (quite understandably in many cases) doing the appropriate research and testing.

Gigabit Over Copper Limitations

According to Intel…

> *99% of the cabling already installed in buildings today is copper Category 5. Not surprisingly, organizations have been reluctant to tear out their existing Category 5 cabling, and lose this investment in order to deploy high-speed networking. Prior to approval of 1000BASE-T, deployment of Gigabit Ethernet tended to be limited to areas where fiber cabling was required or desired. With the adoption of 1000BASE-T, however, widespread deployment of Gigabit is possible over the existing copper infrastructure.*
>
> *The 1000BASE-T physical layer standard provides 1 Gbps Ethernet signal transmission over four pairs of Category 5 UTP cable. It transmits at 125 Mbaud, the same symbol rate as Fast Ethernet. But by using more sophisticated five-level (PAM-5) coding along with four wire pairs, it is able to transmit much more data. To simplify, each wire pair sends and transmits simultaneously, for 250 Mbps per pair (125 Mbaud x 2 bits). Multiplying 250 Mbps by four pairs yields the nominal rate of 1000 Mbps.* [1]

The above statement is, of course, theoretical. And, in the ***real world***, there are significant problems in using Category 5 cabling with Gigabit. Simply, the people who manufacture Ethernet cables understand the physics behind it... the people who buy it do not. Category 5 cables were originally specified in the ANSI/TIA/EIA-568-A document. This document was originally intended to assure that 2 pair networks (one transmitting pair, one receiving pair) would perform to their intended levels (Fast Ethernet). However, with the creation of new encoding schemes (Gigabit Ethernet 1000Base-T), which utilize all four pairs for data transmission, the Category 5 cable is simply not up to the task. [2]

There is significant throughput loss with Category 5 cabling used in a Gigabit environment, and it has to do with several factors. These include **fill content**, **twists**, **frequency range** of 100MHz (need 350MHz), and simply… the overall design of the cable itself.

Specifically, there are several problems including *impedance and structural return loss*, *various types of crosstalk*, *capacitance unbalance*, and *dimensional consistency*… all of which dramatically reduce Gigabit performance over category 5 cabling.

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[1] Intel. http://www.intel.com/network/connectivity/resources/doc_library/white_papers/solutions/copper_guide/gig_over_copper.htm

[2] Belden Cables. Installation Effects Upon Alien Crosstalk and Equal Level Far End Crosstalk. URL www.belden.com

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Reports from the field reflect a typical Gigabit NIC throughput of 200Mbps over Category 5 cable, which is equivalent to Fast Ethernet running in Full Duplex mode. Subsequently, unless one is willing to make a significant investment in their network infrastructure, Network Administrators would be better served buying one of AEI's high performance PCI 10/100 Fast Ethernet single port (P130TX), dual port (P230TX) or quad port (P430TX) cards for their category 5 networks. In an environment where bandwidth and throughput are an issue, AEI recommends one of our multi-channel Fast Ethernet cards (multiple AEI Ethernet cards can be installed in the same system as well). Internal tests of all our 10/100 Fast Ethernet cards reflect 99.9% of wire speed (Reference next subsection).

Conversely, those interested in a "Real World" high-speed network can change their infrastructure from category 5 cabling, to fiber optic or category 6 cabling. Unfortunately, fiber optic cable costs approximately $10/foot, and although category 6 cable is slightly more expensive then category 5 cable, it can still represent a sizeable investment. Prices do not include installation, and de-installation of existing cable, and are subject to change over time. Furthermore, the cost of a good quality Gigabit switch begins at $10,000 and can go over $100,000 in an enterprise network.

You Get What You Pay For…

End-users are always looking for value, and not simply the cheapest product. This is especially true in a server environment where performance is critical.

In a recent LAN test, we measured the performance of our P130TX (PCI 10/100 Fast Ethernet NIC) with three other Ethernet cards. Products A and B were priced between $20 - $35, are very popular, and available nationally at computer retail chains. Product C is manufactured by a company headquartered in Northern California. Their card is targeted for server platforms, and the list price is $125. The final card is AEI's P130TX, which currently lists at $79.

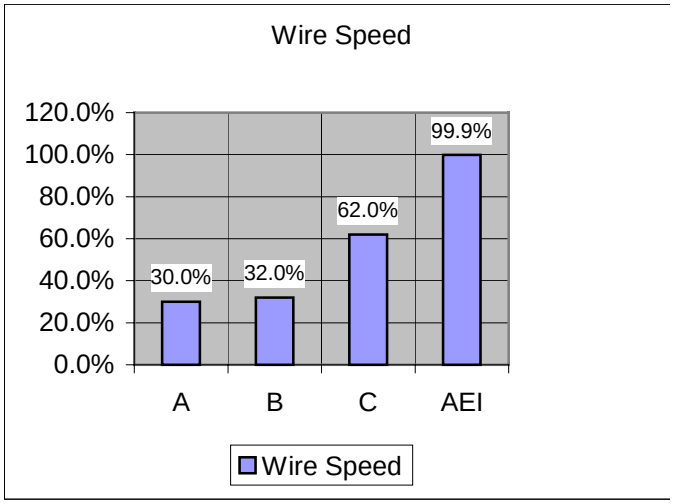

Figure 1

AEI has a long establish reputation for producing high performance network interface cards for the server environment. Quite simply, no other Fast Ethernet card outperforms AEI.

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