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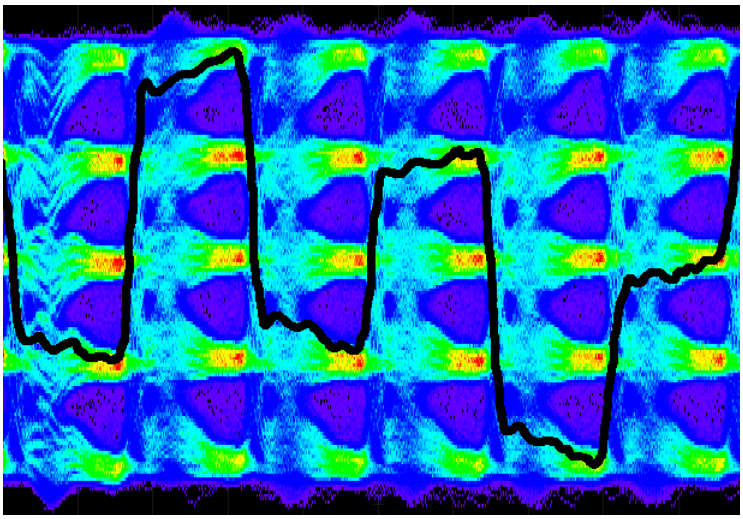

Category 6 Compensates for Weak Gigabit Ethernet Hardware

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Nexans Cabling Solutions
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Summary / Abstract

A common assumption is that all Ethernet cards are the same. Even though these cards are built to industry standards, there is some variability in their transmission characteristics. The use of cards with less than optimum characteristics could result in slower network speed. With network reliability being the number one concern of IT managers, reducing time spent troubleshooting allows IT personnel more time to spend on projects that directly affect the performance of the corporation.

The results of testing performed at the Nexans New Holland Competence Centre shows that Category 6 cabling systems improve the signal-to-noise ratio of the transmission system vs. Category 5e cabling systems. This allows the receivers to more consistently and accurately receive Gigabit Ethernet frames. The improved performance of Category 6 cabling improves the overall reliability of the network, addressing the number one concern of network managers. The additional performance margin of Category 6 allows the use of network components that might otherwise cause significant network downtime and expense.

Introduction

When it comes to active electronics, IT managers assume that the performance of the transceivers on all the switches, hubs and NIC cards in their network is equivalent. There are hundreds, often thousands of transceivers that make up a network and although the cards that contain these transceivers are manufactured to industry standards, unit-to-unit variation can occur. It is possible to have cards with non-optimum transmit or receive characteristics. In fact, this is one of the most common causes of Ethernet transmission errors.

With all the competitive pressures that exist in the business world today, managers are trying to squeeze as much performance from their network as possible. A poorly performing transceiver is often an invisible cause of inefficiencies that can increase the operating costs of a network.

Do you have weak performing cards in your network ?

As part of an ongoing program to investigate the relationship between active and passive components of local area networks, Nexans evaluated eight laboratory-grade Gigabit Ethernet cards. During the course of this evaluation, differences in the quality of cards of the same make and model were observed. One of the eight cards exhibited receiver performance that was not optimum.

The non-optimum card passed all self-tests during the initial evaluation. It also worked properly when transmitting and receiving Gigabit signals from another transmitter when connected by a short patch cord. When the short patch cord was replaced by 100-meter Category 5e channel, however, a significant number of CRC errors and lost frames were generated.

The cards were designed for Gigabit system evaluation. They are built to stringent requirements and go through rigorous quality control before being shipped to a customer. The performance of unit begs an interesting question – If Gigabit Ethernet receivers with weak characteristics occur in lab-grade components isn't it likely that commercially available switches, hubs and NIC cards would experience the same problem or worse?

What is a CRC error ?

To transmit data from station-to station, Gigabit Ethernet places the information in a specific order in a bit frame. Ethernet frames (packets) contain information that identifies the sending and receiving station; contain the data being transmitted, and other information. As part of the verification process to determine if a frame has been accurately received, the sending station generates a CRC (Cyclic Redundancy Check) checksum. The checksum is a unique mathematical representation of the contents of the frame. The receiving station confirms the checksum and makes a judgment if the packet was received intact. If the checksum is not correct, the packet is discarded and must be retransmitted. The presence of CRC errors may indicate a network problem that must be addressed.

The presence of CRC errors is an important indication of network performance. The analysis of CRC errors is one of the primary tools used to gauge the quality of transmission in a network. In some applications such a voice transmission, a small number of errors may be tolerable. In other applications, it is important that all bits are accurately received. For example, when downloading or copying a program, the file may not operate if the destination or source address of one frame is incorrect.

What's different about Gigabit Ethernet receivers ?

The IEEE Gigabit Ethernet committee used some unique techniques to transmit Gigabit Ethernet traffic over twisted pair cabling. Examples of these techniques are: Echo cancelling to minimize reflected noise due to the transmission system, and crosstalk cancellation to minimise interference from one pair to another.

Gigabit Ethernet also uses a specialised five level encoding scheme called PAM-5. PAM-5 provides better bandwidth utilisation by increasing the amount of information sent with each symbol. This increases the number of signal voltage levels that must be differentiated by the receiver.

Figure 1 shows a typical "eye pattern" diagram for 1000Base-T. An eye pattern is a tool used to view the quality of a digital signal. To build an eye pattern diagram, successive Gigabit Ethernet signals such as the one shown are stored on an oscilloscope. Successive signals are superimposed over each other to create the pattern shown. The eye pattern gets its name from the opening (blue) that occurs where no signal has been superimposed. An open eye pattern, such as the one shown in figure 1, is an indication of minimal signal distortion in a system.

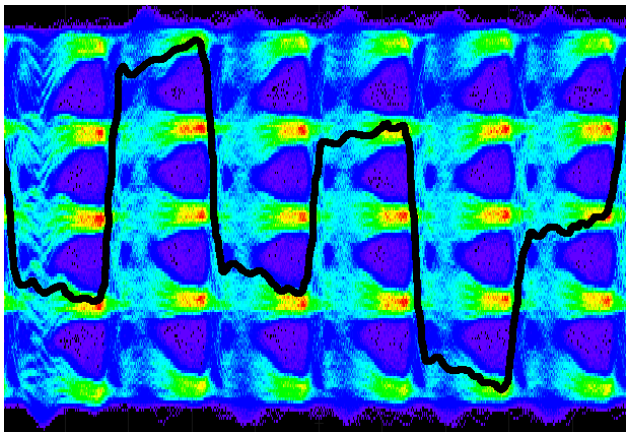


Figure 1 : Typical Gigabit Ethernet Eye Pattern

Compared to older technologies such as 100Base-T or 10Base-T the vertical opening of the eye for a Gigabit Ethernet signal is much closer together. The difference in voltage level that must be interpreted by the receiver is very small. This small voltage difference makes Gigabit Ethernet more sensitive to the signal-to-noise characteristics of the complete transmission system. The vertical size of this opening can be thought of as the noise margin of the system.

Noise is one of the parameters that can distort a Gigabit Ethernet signal and "close" the eye. Examples of noise are: crosstalk from other cables, fast transients caused by turning off and on of electrical systems in nearby electrical cables. Figure 2 shows a Gigabit Ethernet Eye pattern that is distorted. Notice the difference in the shape of the signal compared to the one shown in Figure 2.

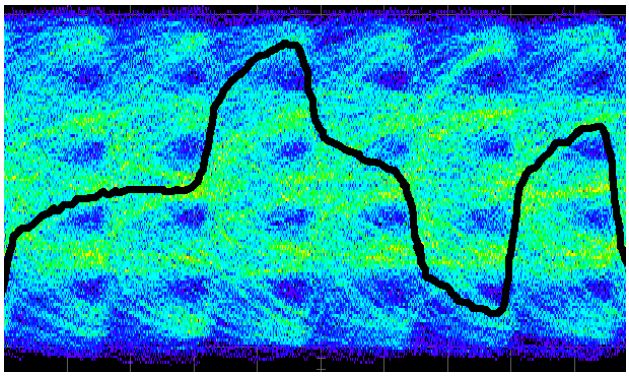
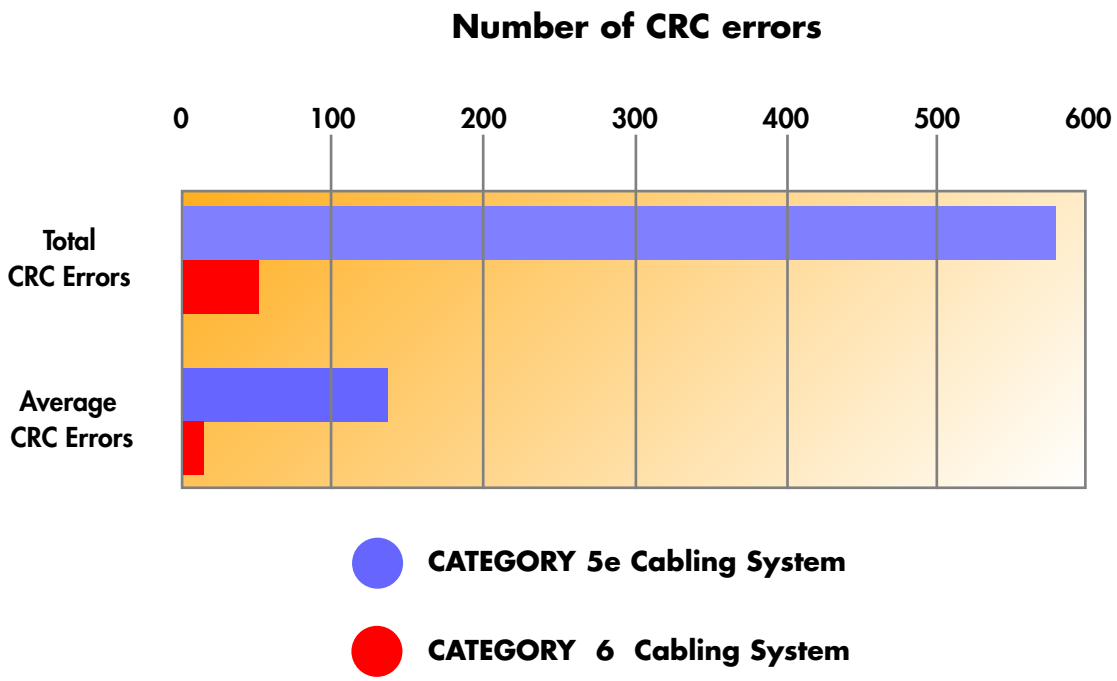


Figure 2 : Closed Gigabit Ethernet Eye Pattern

What are the results of the tests at NHCC ?

The non-optimum card was used to perform a series of tests to examine its transmission characteristics over a Category 5e and a Category 6 cabling channel. The test channels consist of 90 meters of horizontal cabling, a 4-meter equipment and work area cord and a 3 meter cross connect cord. The Category 5e channel utilises Nexans LANmark-5 cable with LANmark-5 connecting hardware. The Category 6 channel utilises LANmark-6 cable with LANmark-6 connecting hardware.

Chart 1 compares the number of CRC errors detected by the test equipment. The chart contrasts differences in the number of CRC errors generated over Category 5e cabling and Category 6 cabling. The total and average number of CRC errors is tabulated for the non-optimum card.



For the non-optimum card a total of 543 CRC errors were counted over Category 5e cabling. The number of CRC errors was reduced to 39 when the testing was repeated over Category 6 cabling. On an average per test basis, 136 CRC errors were measured over Category 5e cabling while this was reduced to 10 per test with Category 6 per test. The test results shows more than a 13x reduction in the number of CRC errors using Category 6 cabling.

What conclusions can be made ?

- The signal-to-noise ratio of the transmission system is based on the performance of all the equipment that is part of the system. This includes the transmitters and receivers that are part of the switch or NIC card, and the cabling system that is the passive part of the system.

- The Gigabit Ethernet card used in this test had very weak receiver characteristics. The weak receiver reduced the signal-to-noise of the overall transmission system. This made it more susceptible to errors caused by differences in the signal-to-noise of different cabling systems. The improvement in the signal-to-noise of the passive part of the transmission system reduced the number of CRC errors. The use of Category 6 cabling helped to compensate for the presence of the weak Gigabit Ethernet card in the system.

- The reduced insertion loss (attenuation) of Category 6 cabling allows a stronger signal to reach the receivers. This makes it much easier for the Gigabit Ethernet receiver to identify the voltage level of the signal and correctly interpret the data. The insertion loss for Category 6 cabling is improved by an average of approximately 10% over Category 5e cabling.

- A common assumption is that all Ethernet cards are the same but as seen in this testing, there is variability in the characteristics of these units–even among expensive laboratory-quality cards. Other studies have shown that there is variability in the performance of cards manufactured by the same manufacturer and model number. Although Gigabit Ethernet cards are manufactured to exacting quality standards, these components may demonstrate a great deal of inconsistency in performance. Some cards may exhibit very strong performance while others may only meet industry standards or worse. The performance of the cards may also drift with age, exposure to heat and other environmental factors.

- Would a card with this kind of performance bring down your network? That is doubtful. But it could cause network slowdown and take valuable time to troubleshoot. This is a real world problem that IT managers have run into at some point in their career.

- Given these variations in card performance, the test data shows that the use of Category 6 cabling systems improves performance and system reliability. The test results show more than a 13x reduction in the number of CRC errors using Category 6 cabling.

- Network reliability is the number one concern of IT managers. Time spent troubleshooting is more effectively spent on projects that directly affect the performance of the corporation. Category 6 cabling systems improve the signal-to-noise ratio of the entire transmission system allowing the receivers to more consistently and accurately receive Gigabit Ethernet frames. The improved performance of Category 6 cabling improves the overall reliability of the network, meeting the number one concern of network managers. The additional performance margin of Category 6 allows the use of network components that might otherwise cause significant network downtime and expense.

Nexans Competence Centre

Nexans' New Holland Competence Centre (NHCC), located in New Holland, Pennsylvania focuses on advanced product design, applications and materials development for premise cabling solutions. The Advanced Systems Laboratory uses state-of-the-art proprietary tools to analyse and develop advanced cabling solutions. The Advanced Materials Development Laboratory utilises sophisticated analytical capabilities that facilitate the development of advanced materials and processes. An international team of experts in the fields of cable, connectors, materials, networking, standards, telecommunications and testing supports the NHCC. The centre is a part of a global Nexans R&D network, with headquarters at the Nexans Research Centre (NRC) Lyons, France.

Global expert in cables and cabling systems

Nexans Cabling Solutions
Alsembergsesteenweg, 2 b3 - B 1501 BUIZINGEN - Belgium
Tel: +32 (0)2 363 38 00 • Fax: +32 (0)2 365 09 99

E-Mail: info.ncs@nexans.com
www.nexans.com/ncs