LOCAL AREA NETWORKS DATA TRANSMISSION ISSUES

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Abstract **– The present paper concentrates on the analysis of the data transmission quality in local area networks. The information contained by the signal samples may be wasted, and thus, the sampling theory is being used, in order to determine the circumstances of data loss. The identification of the fault causes in transmission systems may be done with the aid of the eye-diagram. In order to avoid cabling faults across local area networks, a cable tester has been built. For the testing and analysis of the data transmissions' quality through several transmission media within a local area network, a dedicated software application has been developed. The application relies on the generation and transmission of periodic signals, data acquisition and interpretation of the results.**

Keywords: *transmission, cable, tester, eye-diagram.*

1. INTRODUCTION

The purpose of this paper is the testing of the baseband transmission quality across network cables in local area networks. A network cable tester has been used for the conducting of the experiments. The developed software application aims at providing an intuitive method of analyzing the quality of the transmission within a certain local area network.
Periodic signals are being generated, transmitted and then analysed, based on the eye-diagram. [Johnson, Graham 1993]

2. PRELIMINARY CONSIDERATIONS

The network cable tester consists of two parts: a transmitter and a receiver. The software application is made up of two sections: a signal generator and an eye-diagram tracing tool. The signal generation and acquisition has been accomplished by using signal acquisition cards.

2.1. The cable tester

In order to test the continuity of a CAT5 straight-through and crossover cables, but also for the polarity and sequence of the wire pairs, the cable tester presented in fig. 1 has been designed. The tester consists of a transmitter and a receiver, for the testing of RJ45 terminator cables.

Figure 1: The Cable Tester.

2.1.1. Description of the transmitter

The transmitter presented in fig. 2 is based on a timing chip (555), which has the main function of providing a count for a decade counter (NTE4017B).

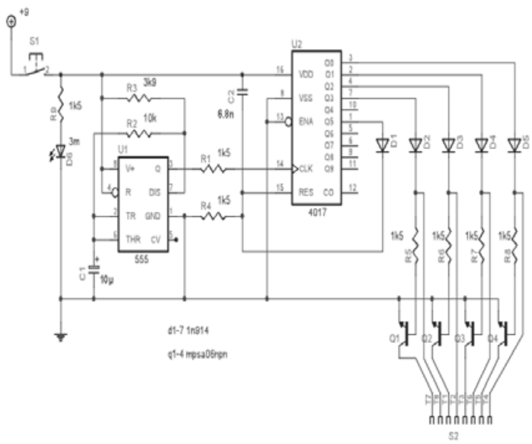

Figure 2: Diagram of the Transmitter.

2.1.2. Description of the receiver

The remote section of the tester is the receiver in fig. 3 and uses dual colour LED's with two terminals. The purpose of the dual colour LED's is to test the polarity of each pair of wires in the cable under test. If a pair has an open circuit or a short circuit, the LED for that pair will not light. The LED's will light up green in order (1-2-3-4) for straight-through cables and for crossover cables, the LED's will light up with pairs 2 and 3 swapped, (1-3-2-4).

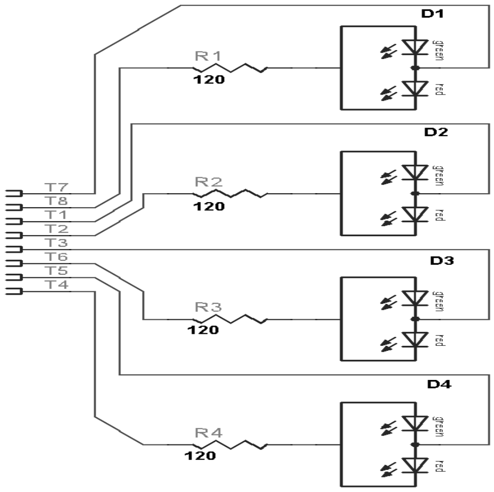

Figure 3: Diagram of the Receiver

2.2. Description of the sound card

A Creative Sound Blaster Live! sound card has been used for the experiments, because it provides a comfortable 100 dB signal-to-noise ratio. The Creative sound card is made up of a Wolfson analog-to-digital convertor and a Cirrus Logic digital-to-analog convertor.
The Cirrus Logic CS4382 convertor is a complete 8-channel digital-to-analog system including digital interpolation, volume control and analog filtering.
The Wolfson WM8775 convertor is a high performance, 24-bit stereo audio analog-to-digital convertor with a 4 channel input mixer. Sampling rates from 32kHz to 96kHz are supported.

2.3. Description of the software application.

“Network Analyser” is a software application dedicated to the testing and analysis of the data transmission quality through several transmission media within local area networks. “Network Analyser” consists of two sections: the first section is a signal generator and the latter is dedicated to the tracing of the eye-diagram.
“Network Analyzer” relies on the generation and transmission of periodic signals, data acquisition and interpretation of the results. The generation and acquisition of the signals has been accomplished by using the Creative Sound Blaster Live! sound card.
The architecture of the application is presented in figure no. 4.

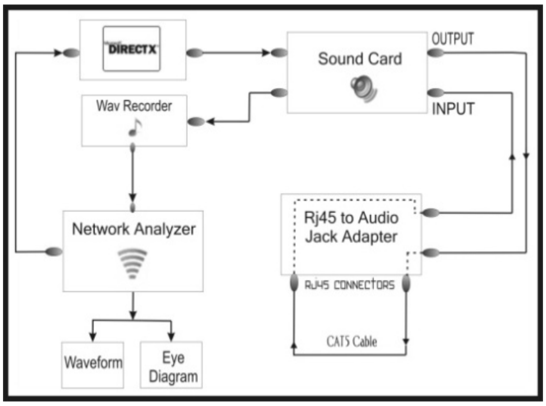

Figure 4: Diagram of the Software Application.

3. MODEL OF OPERATION

The software application provides an intuitive user interface which allows the user to select the parameters of the generated signal in the “Signal Parameters” section, but also the sound card configuration, in the “Sound Settings” section.
Due to the fact that the signal generation is conducted by using a sound card, the recommended frequency range is limited to 20000 Hz, as this is the common frequency range of the sound cards.
The “Signal Parameters” section will eventually indicate the desired number, type and frequency of the signals to be generated, as shown in Fig. no. 5. One can generate a number of up to 10 signals for a single test.

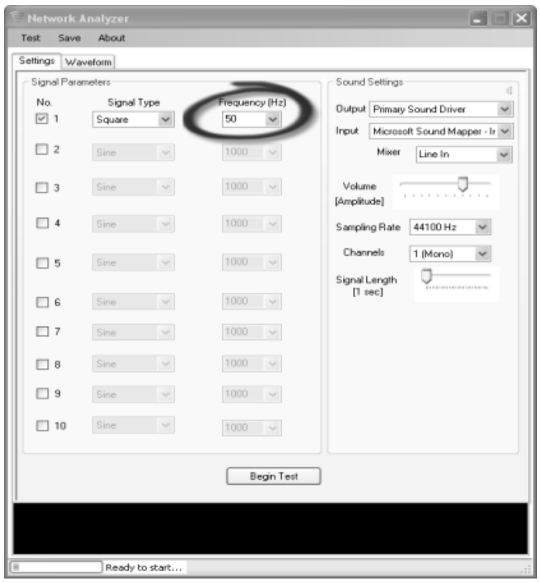

Figure 5: Signal Parameters Section.

In the ,"Sound Settings" section, pictured in figure no. 6, the sound card input, output as well as the corresponding mixer, and the amplitude and also the sampling rate of the generated signals will be selected.

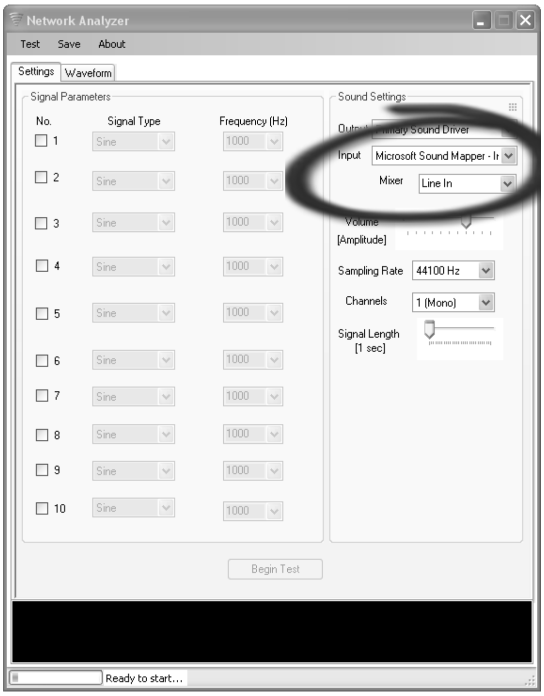

Figure 6: Sound Settings Section.

The sampling rate must comply with the Nyquist sampling theory [Nyquist 1928, Beaulieu 2002, Shannon 1949]. One must then decide upon the number of channels to be used for the signal generation and upon the span of the generation.

The signal length parameter represents the selected signals' generation time span. This parameter cannot exceed 30 seconds, but the recommended value must be less than 10 seconds, due to the computer's RAM limitations. For example, for the generation of a signal, having a sampling rate equal to 44100 Hz, two channels and a span of 10 seconds, the necessary number of samples is:

"number of channels" x "sampling rate" x "signal length" =2 x 44100 x 10 = 882000 samples.

The software application allows the generation of up to 10 signals during the same test. All these signals must be stored for further use, so the number of necessary samples will be 882000 x 10 = 8820000 samples. As each sample has a 2 bytes representation, the storing of the generated signals will require 17 MB. Considering the fact that the acquired signals must also be stored, the required memory amount for the storing of the samples will be of up to 40 MB.

After the signal generation, the "Signal Waveform" section will display the waveform of the generated and respectively, of the acquired signal. For a 50 Hz square type signal, having an amplitude of 22400, the waveforms of the sent and received signals are depicted in figure no. 7:

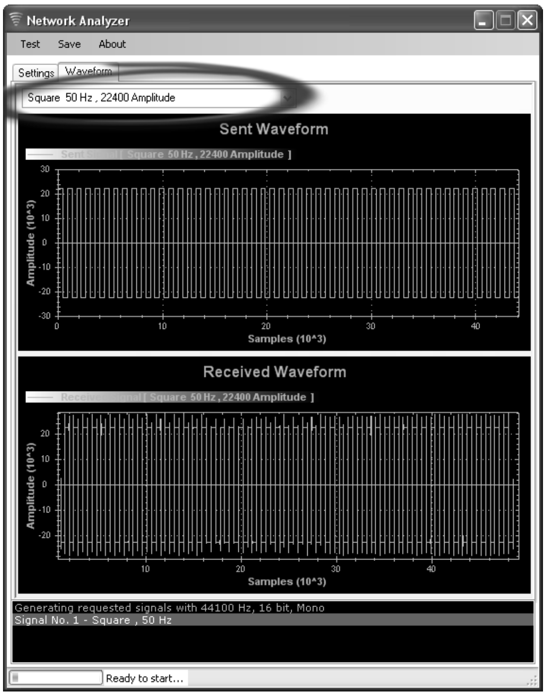

Figure 7: Sent and Received Signals' Waveforms.

A very short span impulse is generated, which corresponds to a '0' to '1' switch of the signal and an equal span impulse for the '1' to '0' switch. The two signals are transmitted over the channel, received and then visualized.

"Network Analyzer" allows the user to select the span of the impulse, defined by the number of samples.

The eye-diagram is an efficient tool in determining the speed of digital transmissions. [Johnson, Graham 1993] The eye diagram allows the identification of possible fault causes and enables the opportunity of forecasting the future performance of the transmission system.

A 1 second span signal has been generated, with a sampling rate of 48000 HZ, with the purpose of tracing the eye-diagram.

One can choose an impulse span of no more than 1000 samples from these 48000 samples, each sample having a span of 0.02083 milliseconds.

The impulse amplitude must be in the range of 0 to 32000, because of the fact that the impulses are generated via DirectX, as shown in figure no. 8.

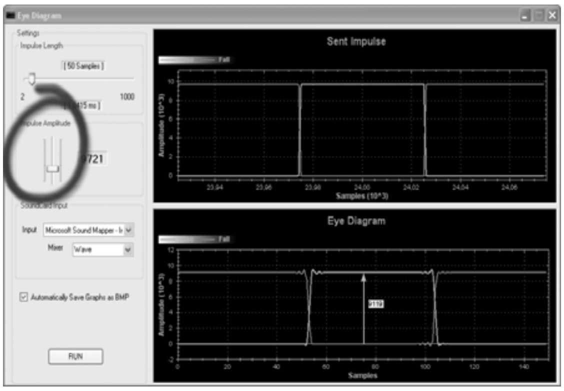

Figure 8: Selection of the Generated Impulse Amplitude.

The resulting eye-diagram is presented in figure no. 9.

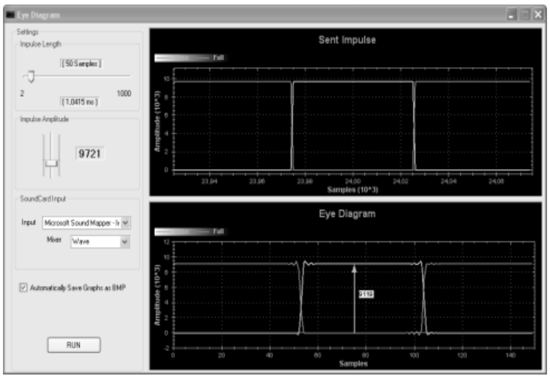

Figure 9: Eye-diagram.

The upper section of the diagram in figure no. 9 depicts the two generated impulses, and the lower one reflects the eye-diagram, obtained by the acquisition of the two impulses.
The eye-diagram is a transmission quality indicator, as the opening of the eye can be measured and is equal to the amplitude of the generated signals. An ideal transmission is defined by a maximum opening of the eye, as this represents the signal-to-noise ratio of the sampled signal. [Johnson, Graham 1993]
An ideal transmission channel can be defined by (1):

$$y(t) = Au(t-\tau) \quad (1)$$

$$Y(\omega) = Ae^{-j\omega t}U(\omega) \quad (2)$$

The real transmission channels are being influenced by interference and noise [Mackay 2003, Cover, Thomas 2006] and may be described by (3):

$$H(\omega) = Y(\omega)U(\omega) \quad (3)$$

These influences determine the difference between the transfer functions for the ideal and real channels. The real transmission channels are of a dispersive nature.

$$H(\omega) = A(\omega)e^{j\varphi(\omega)} \quad (4)$$

One of the most important frequency variable parameters which cause dispersion is the attenuation (5):

$$a = 20\lg(\frac{A(\omega)}{A}) \quad (5)$$

4. EXPERIMENTAL RESULTS

The impulse span and the attenuation are closely correlated: the shorter the span of the impulse, the higher the attenuation, and the longer the span, the lower the attenuation (6):

$$L_x = 20\lg(\frac{U_x}{U_{ref}}) \quad (6)$$

where: L_x - level of the signal;
By maintaining a constant impulse amplitude, the level chart can be traced:
The level should be equal to 0, given an ideal transmission medium (7):

$$U_x = U_{ref} \Rightarrow L_x = \lg(1) = 0$$

(7)
The signal crosses the transmission medium, reaching the destination, where it is being received with a certain attenuation, which indicates a negative value of the level, as shown in figure no. 10:

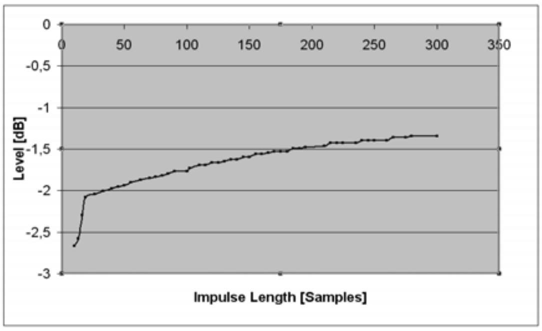

Figure 10: Signal Level.

The chart in figure no. 10 demonstrates the fact that when the impulse span is equal to 0,2083 milliseconds, the attenuation is very high. The attenuation of the signal will decrease, should this time span increase.
Because of the use of a sound card, which sets a frequency range of up to 20000 Hz, the conducted experiment is unfortunately limited by the fact that higher frequency signals could not be generated.

4. CONCLUSIONS

Should an aquisition card be used instead of a sound card, the experiments demonstrate the possibility of creating a series of virtual tools, which can be reconfigured to match the requirements of real systems. The virtual testing methods contrast the high cost hardware equipments.

References

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