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Analysis of Different Ways of Crosstalk Measurement in GSM Network

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ABSTRACT

Crosstalk is one of the problems that affect the performance operation of global system mobile (GSM) network. Among the effect of crosstalk are call mute, call drop, wire propagation delay, dynamic power dissipation etc. Crosstalk is an undesirable signal arising due to the coupling capacitances between adjacent interconnecting wires and measured in decibel. In this paper some literature were reviewed and different ways of measuring crosstalk such as Near end croosstalk (NEXT), far end crosstalk (FEXT), Power sum crosstalk (PSNEXT) and alien crosstalk (AXT) were analyzed.

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1. INTRODUCTION

Crosstalk is an undesirable signal from a neighbouring transmission circuit. Crosstalk mainly arises due to the coupling capacitances between adjacent interconnecting wires and is measured in decibel (dB). The crosstalk arising between two wires is found to be proportional to the coupling capacitance between them; the capacitance in turn is determined by the relative positions of the wires. The length of the overlapping segments of any two parallel interconnecting wires, determine the coupling capacitance between them. The coupling capacitance is also inversely proportional to the distance separating two parallel wires. The coupling capacitance between a pair of orthogonal wires is negligible compared to that between a pair of parallel wires and is thus reasonably assumed to be non-existent [1]. Most research agreed that Crosstalk has negative impact on quality of performances on GSM network. Cellular operators have identified speech quality as being a significant competitive factor today in GSM network, which has spurred developments aimed at removing disturbances from the voice channel in cellular systems. A major cause of disturbance in telephony systems is crosstalk which occurs when a caller or a receiver hears another voice entirely different from unknown person due to the interference of one signal channel on another channel. There are different types of crosstalk, namely near end crosstalk (NEXT), far end crosstalk (FEXT), power sum crosstalk (PSNEXT) and alien crosstalk (AXT) respectively. Most research work have employed different technologies in reduction of crosstalk among which are Signal Transformation Avoidance Technique, Crosstalk Minimization in Optical Networks, Crosstalk Reduction in Fabrication Technologies, FIR Filter, Fast block Lms algorithm (FBLMS), Least mean square algorithm (LMS) etc

2. RELATED WORK

[1] Reviewed the effects and impact that crosstalk has on the performance and reliability of VLSI circuits and systems. The author presented a concise but informative review on the various methods that researchers worldwide are implementing for a priori crosstalk avoidance or a posteriori crosstalk minimization in VLSI systems from the point of view of fabrication over the past few decades. Among the reviewed works of the authors there was a reduction of 28.4% of crosstalk when crosstalk minimization in routing method was employed, 45.62% when Coding Scheme for Reduction of Signal Transition method was adopted and 34.2% when Encoding Schemes for Reduction in Signal Transition in Crosstalk Minimization was employed.

[2] Discusses the various algorithms and techniques such as FBLMS, LMS used to reduce cross talk with their trade-offs. The authors proposed a novel technique based on performance parameters of different multipliers which is used to reduce hardware requirement based on logical utilization and FFT method for the analysis of the said algorithms. The authors claimed that there is a reduction of 73.64% in hardware with respect to FFT method while with normal cascade network multiplier the reduction is 83.87%.

[3] Proposed scheme for the monitoring and reduction of crosstalk arising from the limited stop-band rejection of optical band pass filters in dense wavelength division multiplexed (WDM) systems. The optical carrier at each wavelength is modulated with a subcarrier tone unique to that wavelength.

The level of crosstalk from a given channel was determined by measuring the power of the corresponding tone. Crosstalk from other channels can be cancelled in a linear fashion by weighting and summing the photocurrents of the desired channel and several adjacent interfering channels. Alternatively, in nonlinear crosstalk cancellation, decisions are made on the interfering signals, and these decisions are weighted and summed with the photocurrent of the desired channel. For example, assuming an optical filter having a Gaussian passband, the channel density can be increased from 20 to 30%, depending on the number of adjacent channels' detected. The signal-to interference ratio can be increased by 10-20 dB and the system can achieve a BER < 10^{-9} under conditions where, without interference cancellation, the signal-to-interference ratio would be less than 10 dB.

[4] The configurations of the large scale AWGs filters in the multiplexer/demultiplexer based on different channels spacing designs under usages of the power full software named WDM_ Phasar simulation was introduced. The cascade connection improved its capability in solving the accumulated crosstalk problem in array wave guide (AWG) which becomes the major limiting factor in the sensitivity of the array in long distance optical communication link. Acceptable results are obtained of AWGs filters with cascaded connection after using different channels spacing designs of 64 channels (0.708nm, 0.925nm, and 1.233nm). Computation of the mosts significant results of all input information were computed and then running the simulation resulted in the graphical displays of the output power from which the corresponding channels crosstalk are obtained.

[5] A nonlinear crosstalk minimization algorithm that simultaneously considers self-phase modulation (SPM), cross-phase modulation (XPM), and four-wave mixing (FWM) has been presented and experimentally assessed by the authors. For a passive optical network (PON), in the worst-case scenario, a 1dB power gain is reported by the authors for a bit error rate (BER) of 10^{-9}.

The authors have experimentally demonstrated the effectiveness of their proposed algorithm that is based on Volterra series and genetic algorithm (GA). The authors have reported improvements up to 1.8dB in the Q factor, in the case of a WDM ring transporting 16×10Gbps on-off keying non-return-to-zero codes through standard single-mode fibre, compared to the non-optimized scenario.

Crosstalk noise is minimized using various techniques such as repeater (bidirectional buffer) insertion along with shielding, skewing and shielding & skewing simultaneously. With the help of these techniques crosstalk noise is controlled to a great extent in long interconnects.

Prelayout simulations for crosstalk are carried out for different techniques at 90nm technology nodes using cadence. The influences of these techniques are analyzed and it is found that crosstalk is reduced up to 57% [6].

The authors present two efficient bus-coding methods. The proposed methods simultaneously reduce more dynamic power dissipation and wire propagation delay than existing bus encoding methods. They claimed that their methods also reduce more total power consumption than other encoding methods. The proposed methods transform the bus signal to reduce and eliminate the worst crosstalk types, i.e. Type-4, Type-3, and Type-2. They reduce power and wire propagation delay by decreasing the switching and coupling activities. [7]

[7] Theoretical analysis and numerical simulation is carried out to evaluate the performance of an Optical Add drop multiplexer (OADM) for Wavelength Division Multiplexing (WDM) transmission system in the presence of linear crosstalk due to Fiber Bragg Gratings (FBGs) and optical circulator (OC) which can

be used in Optical Crossconnects. We analyzed here the add drop multiplexing system for multiple wavelength channels, different condition of channel presence and channel separation. We simulate the crosstalk power, signal-to crosstalk ratio (SCR) and bit error rate (BER) of the system with different number of channels presence. Here we compared crosstalk power and SCR for multiple wavelength channels like 4, 8, 16, 32 channels considering different channel separation and drop of channels from the system. It is found that the SCR increases with the channel separation and SCR decreases with increase of the channel Bandwidth (B). BER increases with the number of wavelength channels due to increased in amount of crosstalks.

3. METHODOLOGY

3.1. Crosstalk Measurement

Our analysis of cross talk required a database of accurate and detailed measurements of cross talk between pairs in 25-pair cables. A measurement system was constructed to measure NEXT and FEXT losses of all pair combinations in 25-pair cables. Individual pairs were routed to the stimulus and response ports of a network analyzer via a computer-controlled switch. This allowed the automatic selection of 300 different pair combinations for NEXT measurements and 600 pair combinations for FEXT measurements. Any pair not being measured was terminated in 100 ohms via a balun and a 50-ohm termination internal to the switch. The network analyzer measured the cross talk loss (phase and magnitude) to 40 MHz, and this was downloaded to a computer database. Using this system, the NEXT and FEXT losses were measured for many thousands of pair combinations in a selection of 25-pair cables of varying manufacturer and age.

NEXT: Near end cross talk (NEXT) happens when a signal from a transmitter at one end of a cable interferes with a receiver at the same end of the cable.

$$NEXT= -20LOG(Vn/Vi) \quad (1)$$

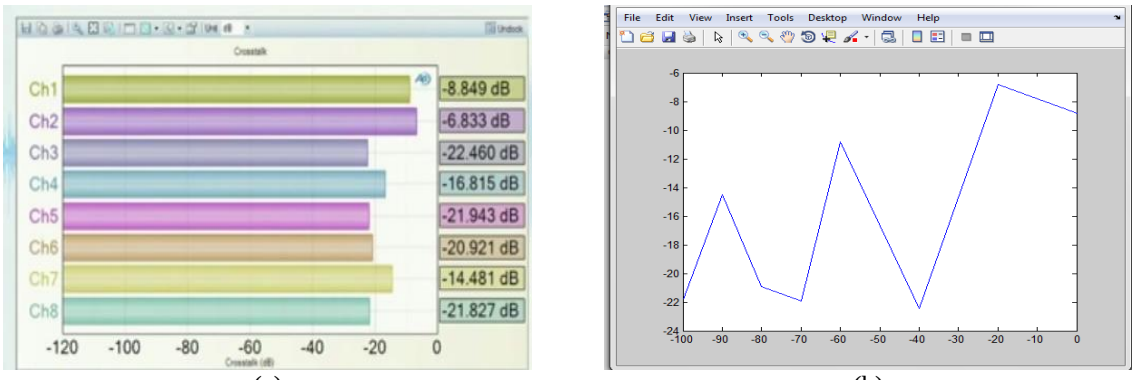
FEXT: this is a type of crosstalk in the unwanted reception by signal by one wire pair from another wire pair at receiving end of the link (dB). The higher the value of decibel, the lower the disruptive effect of crosstalk.

$$FEXT= -20log (Vf/Vi) \quad (2)$$

PSNEXT: Is the algebraic sum of three wire pairs as they affect the fourth pair cable e.g category 6 cable. Cabling bandwidth in excess of 100Mhz makes consideration of PSNEXT. PSNEXT is away of measuring NEXT in the ends of cable due to their close proximity.

AXT: is a unwanted disturbing signal coupling from one balanced twisted-pair component, channel or permanent link to another. Alien is used because unlike pair to pair crosstalk, alien crosstalk is a disturbing noise sources that originates from outside the affected link's cable and

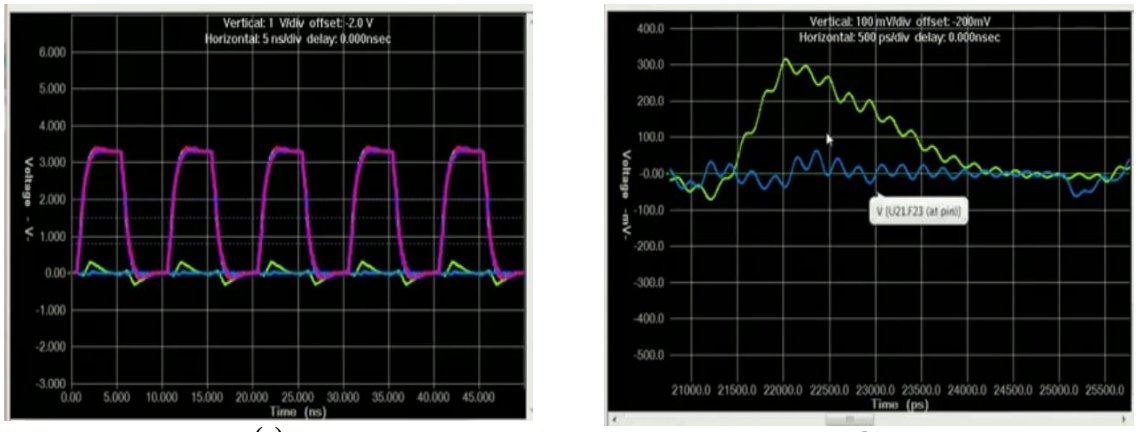
4. RESULT OBTAINED



(a) (b)

Figure 1. (a) Measurement of crosstalk in decibel of (b) waveform of crosstalk measurement Different channe

From the figure 1b above the crosstalk decreases from channel 1 to channel 2, then increases in channel 3, then decrease in channel 4, increase in channel 5, decrease in channel 6 & 7 and then increase in channel 8.



(a) (b)

Figure 2. (a) Crosstalk measured using simulation (b) higher value of crosstalk

The figure 2 above show the result of simulation of crosstalk on a cable coupling region with the highest value of 3000V in figure 2b.

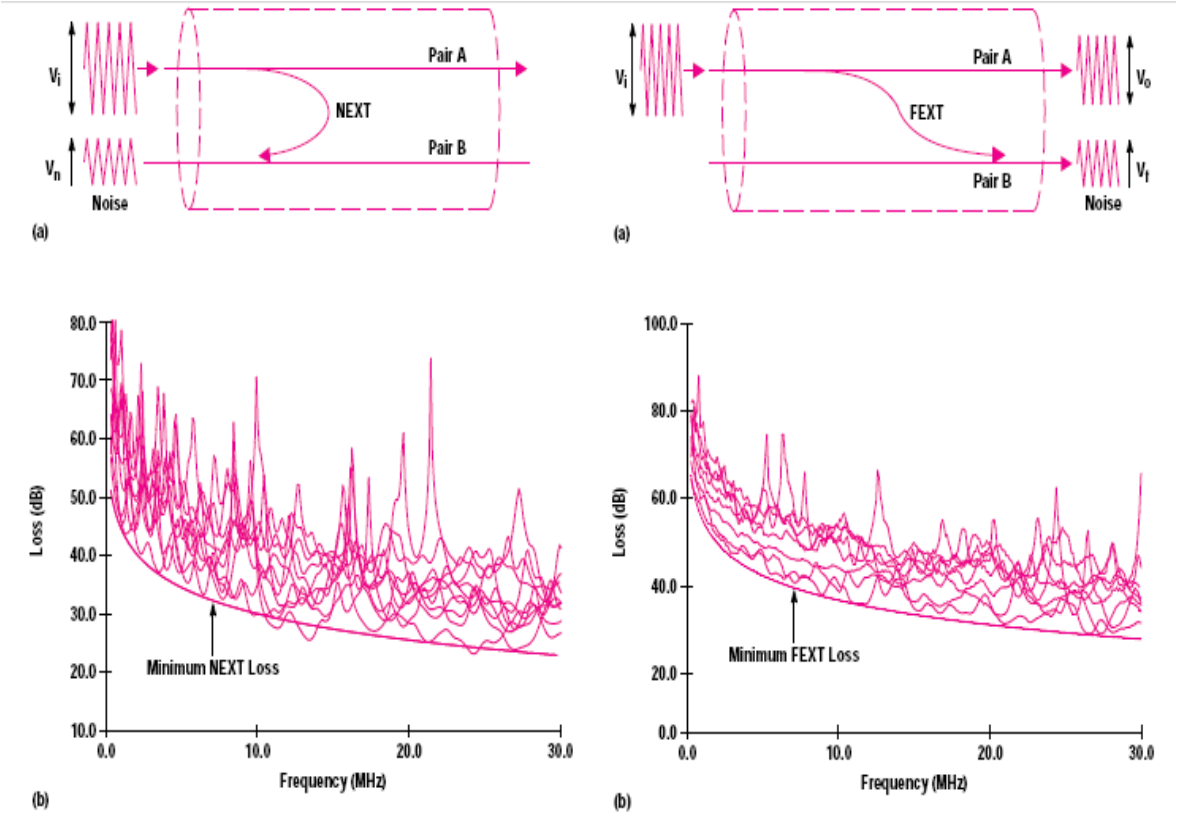


Figure 3. (a) Near-end cross talk (NEXT)
(b) Minimum theoretical NEXT loss and actual measurements

Figure 4. (a) Far-end cross talk (FEXT)
(b) Minimum theoretical FEXT loss and actual measurements

Figure 3b above shown the measurement of crosstalk in decibel. As the decibel value increases the frequency decreases. There is an arrow indicating the minimum NEXT loss.
Figure 4b above shows the measurement of crosstalk in decibel. The frequency increases with decrease in decibel value. The arrow indicates the minimum values of FEXT.

5. CONCLUSION

Crosstalk is one of the problems that reduce the operation performances of GSM network. There is need to measure the crosstalk in GSM network so that ways to reduce it will be properly looked into. Different ways in which crosstalk can be measured were analyzed. The behaviour of crosstalk in eight different channels were analyzed and simulation of a cable coupling region were simulated.

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