Proceedings of the 4th WSEAS Int. Conf. on Information Security, Communications and Computers, Tenerife, Spain, December 16-18, 2005 (pp535-538)

Crosstalk and Isolation measurements in copper wires

G. AGAPIOU[1], T. DOUKOGLOU[1], P. GEORGIADIS[1], G. GEORGAKOPOULOS[1], E. PLAKIDIS[1], P. RORRIS[1], K.IOANNOU[2], A.IOANNOU[1], A.GARMPIS[3]

[1] Mobile and Radio Communications Research Laboratories
OTE S.A., Athens,
GREECE
[2] Wireless Telecommunication Laboratory,
Department of Electrical and Computer Engineering, University of Patras,
Rion 26500, Patras
GREECE

[3] Department of Applied Informatics in Management & Economy
Technical Education Institute of Messologi
GREECE

Abstract: - Crosstalk is an important factor that needs to be considered and study its effects in copper wires, especially when voice communication takes place. Its presence has proven to be a impaired factor in the performance of communication services. This paper measures the isolation losses and the crosstalk losses as a function of the frequency and the length of the copper wires.

Key-Words: - Fiber Architectures, VDSL

1. Introduction

Hybrid fiber/copper architectures, like fiber to the home (FTTH) combined with a very-high bit rate digital subscriber line (VDSL) for the last segment, have attracted considerable interest in recent years as promising to deliver high bandwidth over existing telephone lines to businesses and residential premises [1]. With Ethernet like performance that extends the copper segments to typically few hundred meters, VDSL can be acted as Long Reach Ethernet that supports transmission at higher frequencies of up to 30 MHz. With the deployment of FTTB (Fiber To The Building) and FTTC (Fiber To The Curb), VDSL provides a cost effective, readily available, and rapidly deployable solution that offers needed bandwidth. VDSL and the emerging VDSL2 draft are the pertinent high-speed transmission modalities for these lengths. The last mile connectivity to the end user that is provided via VDSL and copper pair wires, gains in speed but loses in distance or range. Factors such as Insertion loss (IL), near-end crosstalk (NEXT) and far-end crosstalk (FEXT) interferences play an important role in the provision of high speed services to the premises of the user. The interference between nearby cables can have a negative impact on the performance of the affected cable(s).

2. FEXT-NEXT, Insertion Loss measurements procedure

The most important test in qualifying the performance of a copper cable is the insertion losses and the FEXT and NEXT crosstalk losses. NEXT occurs when signal from one pair of wire radiates and is picked up by an adjacent pair of wire, while FEXT is similar to NEXT, except the signal is sent from the local end and crosstalk is measured at the far end.

Proceedings of the 4th WSEAS Int. Conf. on Information Security, Communications and Computers, Tenerife, Spain, December 16-18, 2005 (pp535-538)

For the purposes of the Cross-Talk (FEXT, NEXT) and Insertion Loss measurements, an HP-4195A Network-Spectrum Analyzer was used along with the HP-35676A/B reflection/ transmission test kit, applied to twisted pairs of copper cables with different lengths. Measurements were taken for 50m, 100m, 200m, 300m, 400m and 500m and for pairs belonging to the same or different adjacent group.

Impedance matching from 50Ω to 75Ω was used between the Network Analyzer and the HP35676A/B to match the 50Ω input impedance of the analyzer to the 75Ω impedance of the reflection/transmission kit. Also, Balance transformers (baluns) were used to match the 75Ω system impedance to the 120Ω impedance of the twisted pairs and change the asymmetric mode of the network analyzer to the symmetric mode of the twisted pair. These baluns covers the frequency range up to 30MHz which was the maximum frequency that we took a measurement. The input and output wires of the cables were then attached to a Kronen Mini Distribution Frame. Figure 1 illustrates the test bed topology.

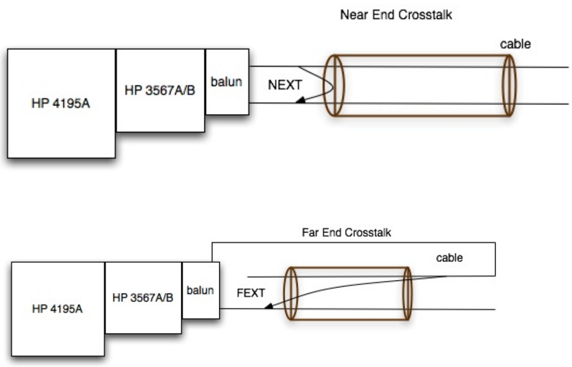

Figure 1: NEXT and FEXT measurements topology

The 1dBm output of the analyzer is split into two paths by the external splitter, one of which is used as a reference signal (R), and the other is used as the test signal (T). The resulting ratio is then stored in a PC, using the GPIB port. Frequency sweeping is performed all the way from 10 Hz to 30 MHz. Data points are acquired in 4.25 kHz increments. The number of data points for each full measurement should then be 30 MHz / 4.25 kHz = 7058. Since the analyzer can only record 401 frequency points at a time (in each sweep), a full frequency range sweep was completed by doing 18 individual sweeps (each covering approximately 1.7 MHz range = 401 × 4.25 kHz). Therefore 1.7 MHz × 18 = 30.6 MHz. The starting frequency for each sweep is the ending frequency of the previous one. This way a total of 7201 complex data points were collected in each full measurement (18 × 401 complex data points).

The FEXT and NEXT measurements for a 400m copper wires as the frequency increases from 0 to 30 MHz for which the measurements are done in a copper pair of the same cable or in a pair where the wires belong to different cable, are shown in Figures 2-5.

The insertion losses are shown in Figures 6-11 for copper wires that range from 50m to 500m as the frequency increases from 0 to 30 MHz.

3. NEXT, FEXT Measurements

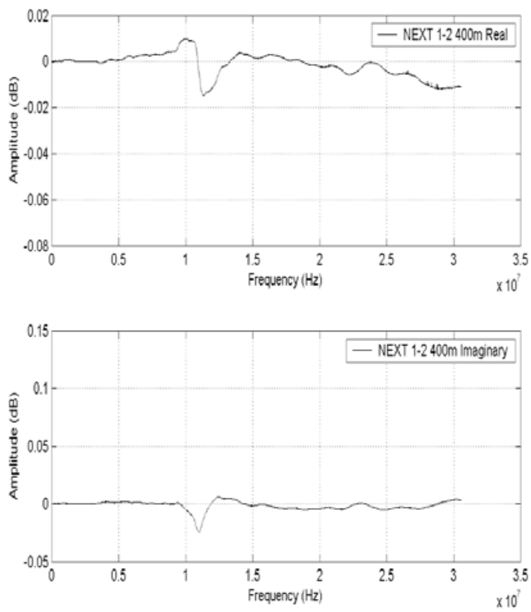

Figure 2: NEXT measurements, 400m, same team

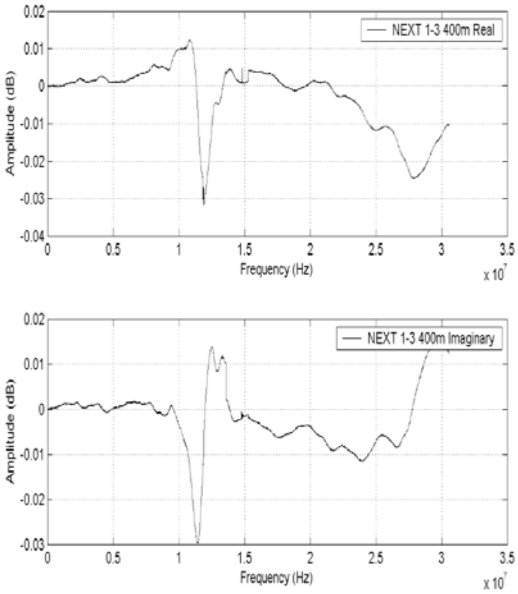

Figure 3: NEXT measurements, 400m, adjacent team

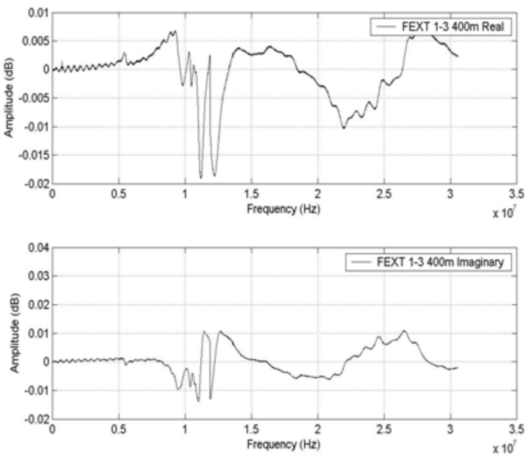

Figure 4: FEXT measurements, 400m, same team

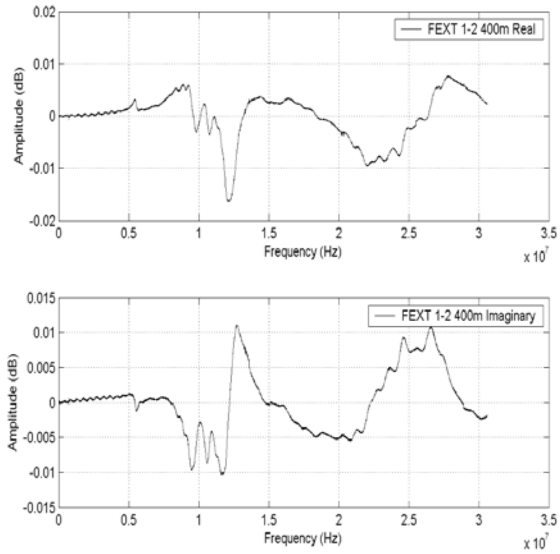

Figure 5: FEXT measurements, 400m, adjacent team

4. Insertion Loss Curves

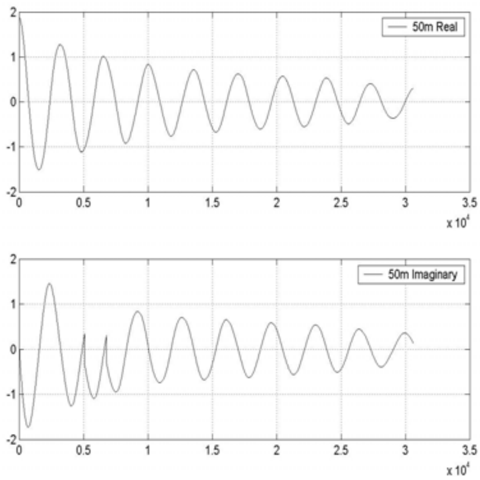

Figure 6: 50 meters

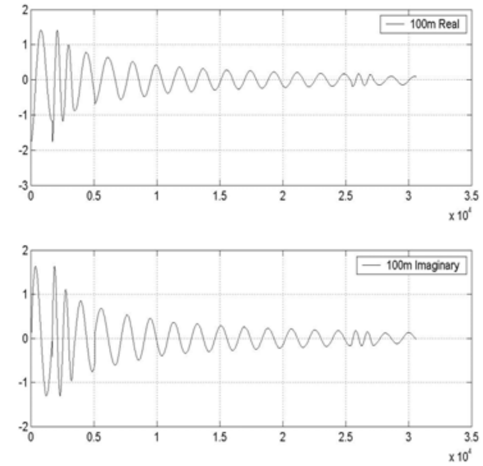

Figure 7: 100 meters

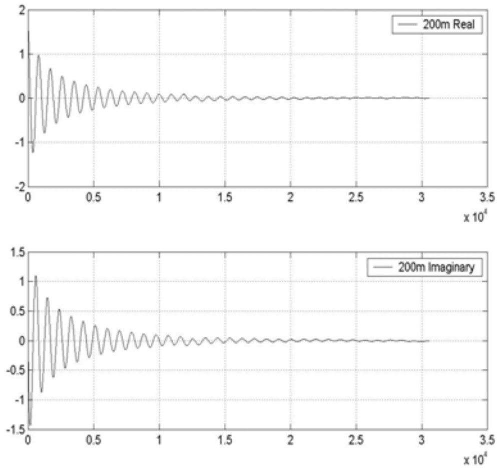

Figure 8: 200 meters

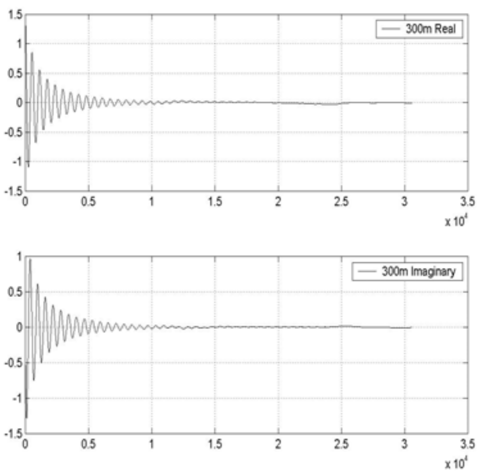

Figure 9: 300 meters

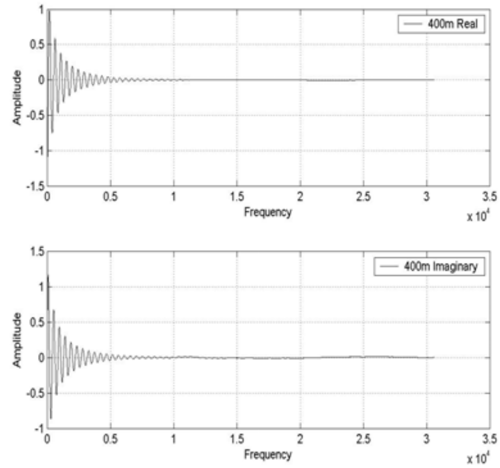

Figure 10: 400 meters

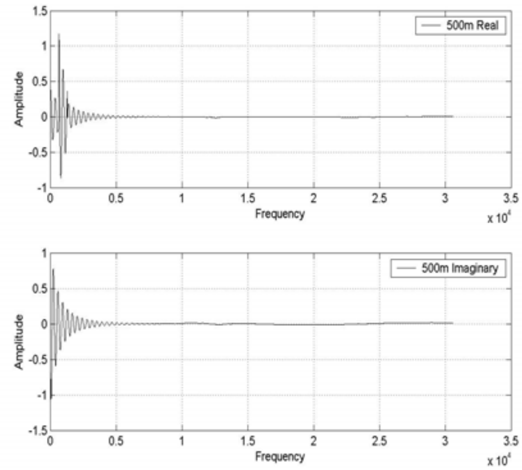

Figure 11: 500 meters

5.Conclusions

In this paper it is shown that the FEXT, NEXT crosstalk interference losses and the insertion losses are important quantities that need to be measured in order to qualify the performance of copper wires that are aimed to provide high speed services to the premises of the end users. The above losses increase as the frequency and the length of the copper wires increase.

References

[1]. *Last mile technology,* (2004), http://www.telsyte.com.au