On the estimation of the loop topology with SELT

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1 Introduction

Telecom operators base their DSL-tariffs mainly on the offered bit rate. The maximal achievable bit rate is different for each customer, because it depends on two parameters. On the one hand, the transfer function of the 'subscriber loop', which depends on the network topology (the cabling between the central office and the subscriber) and on the other hand the Power Spectral Density of the noise. Equipment able to measure these two parameters already exists. However, the presence of a technician at the customer's home is still needed. This is the main disadvantage of the so-called "Dual-Ended Line Testing". In contrast, Single-Ended Line Testing (SELT) aims at identifying the subscriber loop by measuring the S_{11} parameter at the central office and using a noise model. This eliminates the dispatching of a technician, but is of course much more complex and intrinsically less accurate than with DELT. A useful tool in this is Time Domain Reflectometry [1].

2 Time Domain Reflectometry

Time Domain Reflectometry is based on knowledge about the reaction of an electrical signal on the possible presence of an impedance discontinuity in the transmission line. An excitation signal is injected in the subscriber line at the central office. The signal propagates along the line and if a discontinuity is present, a part of the signal will be reflected and will return to the central office. The amount of reflection is given by formula (1) where Z_1 is the impedance before the discontinuity and Z_2 is the impedance after the discontinuity. By collecting, processing and analysing these reflections, the subscriber loop can be discovered.

$$\rho = \frac{Z_2 - Z_1}{Z_2 + Z_1} \qquad (1)$$

3 Identifying the subscriber loop

The most common topologies of the subscriber loop [2] are

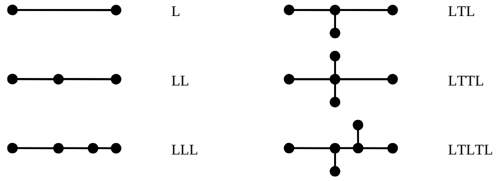

Figure 1 : Common topologies of the subscriber loop

depicted in Figure 1. A thorough literature study confirms that no operational SELT-system exists which can predict the subscriber loop accurately in all cases. The basic idea of our approach is described in Figure 2. To start, a simple topology is proposed and the according model is simulated. Then the parameters of the model are estimated in order to give the best match with the measurement. The main parameters are the line length(s) and the cable type(s). If no satisfying match can be found, a more complex topology will be tried out, and the process is repeated.

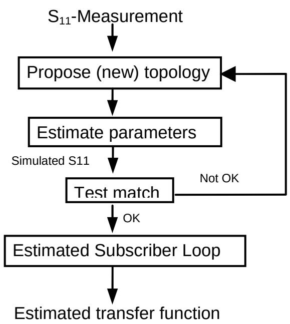

Figure 2 : Flow chart of the TF estimation process

4 Conclusions and Future Work

It is important for the operators to know the maximal capacity of their network. SELT can be a useful tool in this. SELT can also be used as a quality control tool for a line, especially when several operators share a same network. Improving the estimation of the subscriber loop with SELT remains thus a very useful research topic.

References

[1] T. Bostoen, P. Boets, M. Zekri, L. Van Biesen, T. Pollet and D. Rabijns, "Estimation of the Transfer Function of a Subscriber Loop by Means of One-Port Scattering Parameter Measurement at the Central Office", IEEE Journal on Selected Areas in Communication-Twisted Pair Transmission, Vol. 20, No. 5, pp936-948, June 2002

[2] T. Vermeiren, T. Bostoen, F. Louage, P. Boets, and X. O. Chebab, "Subscriber Loop Topology Classification by means of Time Domain Reflectometry", IEEE International Conference on Communications, Anchorage USA, 11-15 May, 2003