Design and evaluation of channel models for DSL applications

Wim FOUBERT

Nowadays, telecommunication operators are looking for efficient methods in communication to meet the ever increasing bandwidth demand of the user. In this PhD we focus on high bandwidth data communication over the telephone lines network. A very promising approach to increase the capacity of Digital Subscriber Line (DSL) technology is to exploit the eigenmodes of the cable.

Current DSL systems make only use of differential mode signals between the two wires of a twisted pair. However, the access network from the last departure point to the home consists in many situations of a quad. An extra signal mode, the so called ‘phantom mode’, makes use of the four wires together to construct a third signal path over four wires. It is shown that the two differential modes and the phantom mode are all eigenmodes of the cable.

To exploit also the phantom mode, a new model for a twisted quad has been developed starting from Maxwell’s equations and based on the multiconductor transmission lines theory. The per-unit-length parameters are determined individually, starting from cable geometry and material properties only. Their properties are investigated and their quantitative values are verified by simulations and measurements. The model of the twisted quad has been verified by a measurement on a Belgacom quad line. A good match between the simulated and the measured reflection coefficient results.

Next we have been focusing on the eigenmodes of the cable system. Theoretically speaking there is no crosstalk between these eigenmodes. The zero crosstalk is confirmed by simulations. Measurements on real cables show that the crosstalk is indeed small.

At the end, the theoretically achievable data rate is calculated for a quad, that exploits the two differential modes and the phantom mode. Because the phantom mode is more attenuated, its bit rate is smaller than that of the individual single pairs. Nevertheless, it is shown that exploiting the phantom mode leads to a significant increase in data rate.