# Summary

The currently used high-speed interconnect structures consist of distributed components such as cables, circuit board strips and package or chip interconnects. Those structures are combined with connectors, vias, etc., resulting in a complex channel for which it is challenging to obtain accurate and compact models so that electromagnetic interference (EMI) along it can be predicted via simulations. EMI simulation are desirable because they are cheaper and faster in comparison to experimental alternatives, and therefore, they are an invaluable tool in the early phases of the design of an electronic system.

This thesis discussed techniques suitable for the modeling and simulation of generic long electric interconnects. When taking into account all the electromagnetic effects such as propagation delay, losses, reflections, crosstalk, etc. which are present in those structures, standard models are hard to obtain and/or might have a large complexity which slows down the simulations that must be carried out with them. Such models can be achieved in two different ways:

(i) Via physical-based models: the level of detail required for an accurate model is not well know. High detailed models are slow to be solved via 3D full-wave simulations, and simplifications might lead less accurate models, specially when dealing with high-frequency applications. Furthermore, sometimes the detailed design of a component of a high speed link is intellectual property of some companies, and therefore not readily available for engineers which use those parts in their design;

(ii) Via data-driven modeling approach: in this approach, the use of models without the explicit representation of the delays present in the interconnect structure might lead to models which are excessively complex, requiring a very large number of terms in order to capture the phase variations of systems with delay. On the other hand, if the delay characteristics of the interconnect are explicitly represented, the accurate estimation of the delay values that should be used within the model is very difficult.

The first part of this work follows a physical-based approach to produce a model which predicts the behaviour of a complex cable link. It models individually each component of such link, and simulates the complete system in order to achieve the response of the cable link. The modeled system is then validated via experimental data obtained from scattering parameters measurements of the channel, establishing the level of detail needed in those models.

Furthermore, the second part of this work presents a novel approach for the estimation of surrogate model of a generic long interconnect. The proposed approach is based on a powerful and flexible machine learning technique called the least-square support vector machine (LSSVM). The LSSVM regression is used to construct a metamodel of the transfer function describing a generic linear time-invariant system in a delayed-rational form, but without specifying beforehand the time-delays which should be used by the system, side-stepping this critical part of the estimation of delayed-rational models.

By manipulating the estimated metamodel, useful information about it can be extracted. Specifically, the estimated metamodel leads to the accurate estimation of multiple time-delays from the frequency response of the original system. The essential steps and critical criteria for the delay identification procedure are carefully discussed throughout this thesis. By optimizing the LSSVM model via standard techniques used for the tuning of machine learning models, the delays can be searched in a small interval rather than in a extended possible space as is necessary in available techniques for the identification of multiple delays, therefore making this task simpler.

Numerical examples are presented to illustrate the feasibility and performance of the proposed technique and to compare its performances with what is provided by state-of-the-art techniques. The results clearly highlight the capability of the proposed approach to identify the dominant delays in distributed systems, thus allowing to construct compact delayed rational models.