Overview of Circuit-Simulation Activities at TKK CTL

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***Abstract*—This paper summarizes the recent circuit-simulation activities at Helsinki University of Technology (TKK), Circuit Theory Laboratory (CTL).**

Keywords—circuit simulation, model-order reduction, behavioral modeling, artificial neural networks, APLAC

I. Introduction

This paper is mostly based on the results of the national projects Advanced Radio Frequency SImulation and Modeling (ARFSIM 2002–2003), MOdeling and Simulation for Advanced Integrated Circuits and Systems (MOSAICS 2004–2005), and Accurate Models Aim for Zero Errors (AMAZE 2006–2008). All these three projects have been funded by the National Technology Agency of Finland, Nokia Corporation, and AWR-APLAC Corporation. In these projects, APLAC circuit simulation and design tool [1] has been used as a common platform for the circuit analysis and modeling methods developed.

II. Analysis methods

During the ARFSIM, MOSAICS, and AMAZE projects, the following analysis methods of APLAC have been developed or considerably improved: DC [2], [3], [4], [5], [6], [7]; AC; transient; multitone harmonic balance [8], [9]; multivariate steady-state time-domain [10]; large-signal–small-signal; phase noise [9]; and oscillator analysis. Also, the EM-simulation method Finite Difference Time Domain (FDTD) has been accelerated [11] and modified to allow FDTD–lumped-element co-simulation [12].

III. Model-order reduction

The whole Model-Order Reduction (MOR) chain can be divided into three steps: 1) *Interconnect modeling*: model, using EM simulation or other methods, the interconnect (e.g., layout parasitics) by a large RLC network. 2) *MOR*: reduce the RLC network to obtain a reduced-order frequency-domain interconnect model (e.g., a set of poles and residues). 3) *Macromodel realization*: link the model obtained to transient simulation of the whole nonlinear circuit by generating an appropriate equivalent-circuit representation. Most of our MOR research has been in the field of macromodel realization [13].

IV. Behavioral modeling

In the field of (quasi-)static Behavioral Modeling (BM) using Artificial Neural Networks (ANNs), we have carried out research [14], [15], [16] and implemented `ANNModelGenerator` in APLAC. Recently, we have started to study ANN-based dynamic BM.

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