NUI MAYNOOTH
Ollscoil na hÉireann Má Nuad

CTVR the telecommunications research centre

sfi science foundation ireland
fondúireacht eolaíochta éireann

Utilizing Sparse-Aware Volterra for Power Amplifier Behavioral Modeling

Keith Finnerty, John Dooley and Ronan Farrell
Department of Electronic Engineering, National University of Ireland Maynooth, Maynooth, Co. Kildare, Ireland

INTRODUCTION

Behavioral modeling of power amplifier is an important step in radio frequency system level simulation. Providing a computationally efficient structure can dramatically reduce simulation time. For a non-linear time series such as the Volterra Series, as the number of inputs or the order of non-linearity increases the number of coefficients rapidly increase. This expansion described as the "curse of dimensionality" can greatly reduce the computational efficiency of the model.

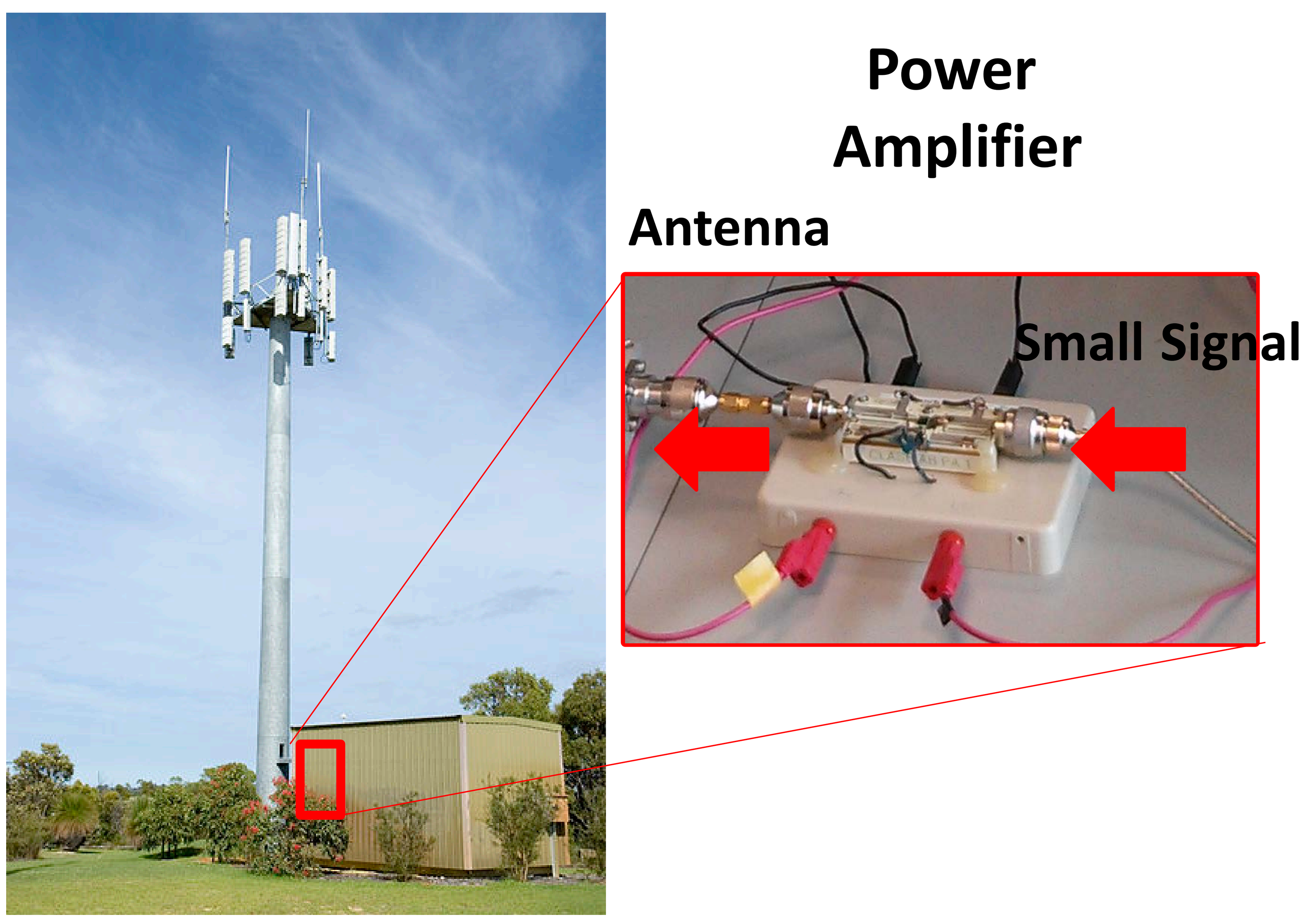

Fig 1. Location of a power amplifier in a base station

THE LASSO ALGORITHM

Parameter reduction is an important tool for data analysis, the two main reasons being prediction accuracy and interpretation. In system modeling with a large number of weights it can be difficult to identify the most influential ones, parameter reduction techniques removes the least important weights to leave core subset which can accurately represent the system behavior.

A Lasso algorithm is a method of weight selection and shrinkage in linear models. Due to the fact that power amplification systems are largely deterministic system and the input and output data is highly correlated, the Lasso method can be very effective in reducing the number of weights in the time series.

Table 1. Results from power amplifier modeling, P is the order of non-linearity, *M* is the number of memory terms, and the reduction of terms is presented as a percentage

		Full Volterra		Reduced Volterra		
P	M	NMSE	Weights	NMSE	Weights	Reduction
5	4	-45.0	125	-44.8	27	78%
5	5	-44.8	251	-44.9	57	77%
7	4	-44.6	329	-45.2	86	74%
7	5	-43.7	791	-45.1	113	86%

MEASURED RESULTS AND MODEL EXTRACTION

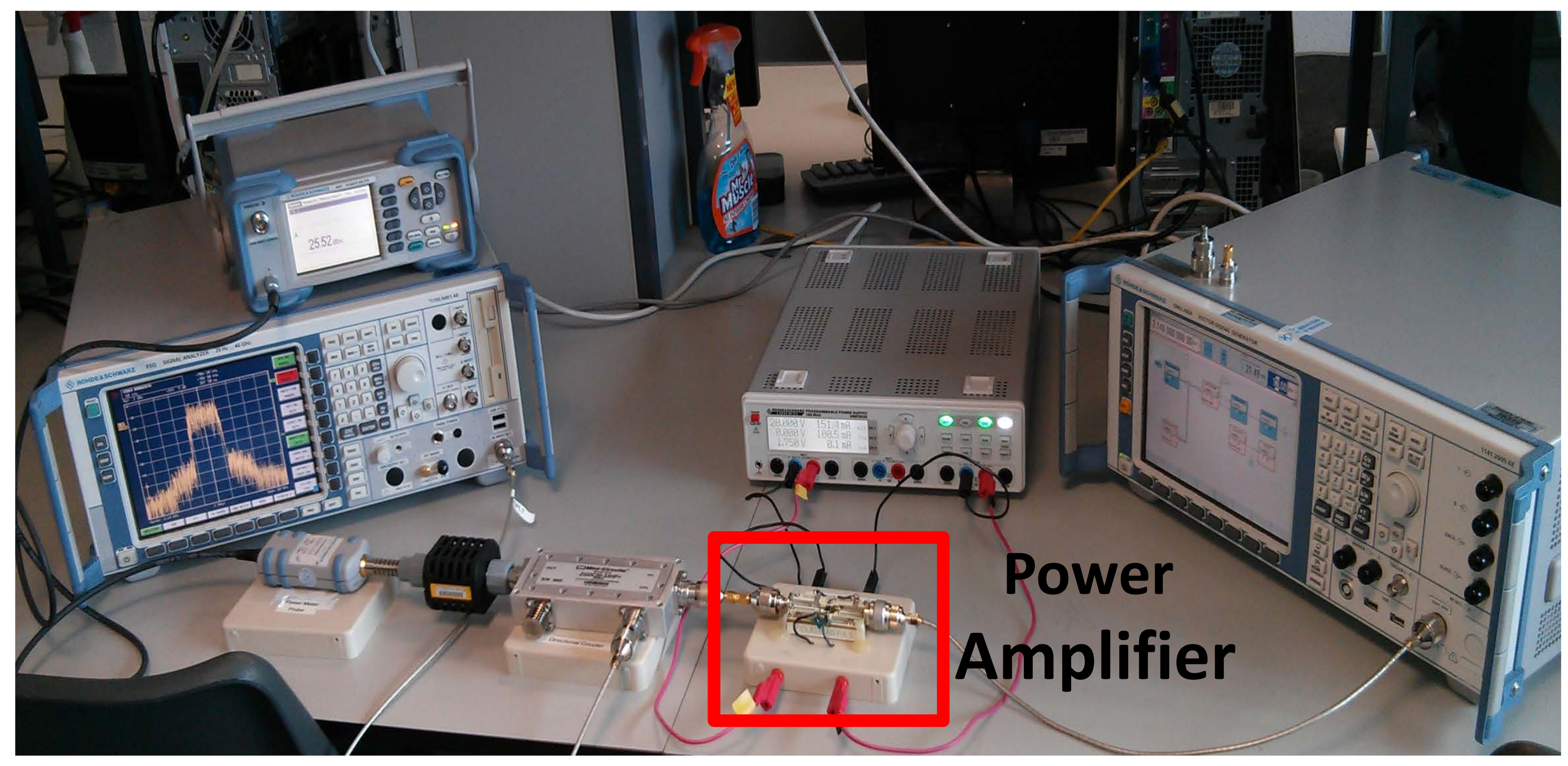

Fig 2. Power amplifier test bench

The signal is generated by a Rhode and Schwarz SMU200A signal generator and captured by a Rhode and Schwarz FSQ vector signal analyzer. The signal was analyzed and the model extracted in Matlab. The results are compared in Fig 3. and Table 1.

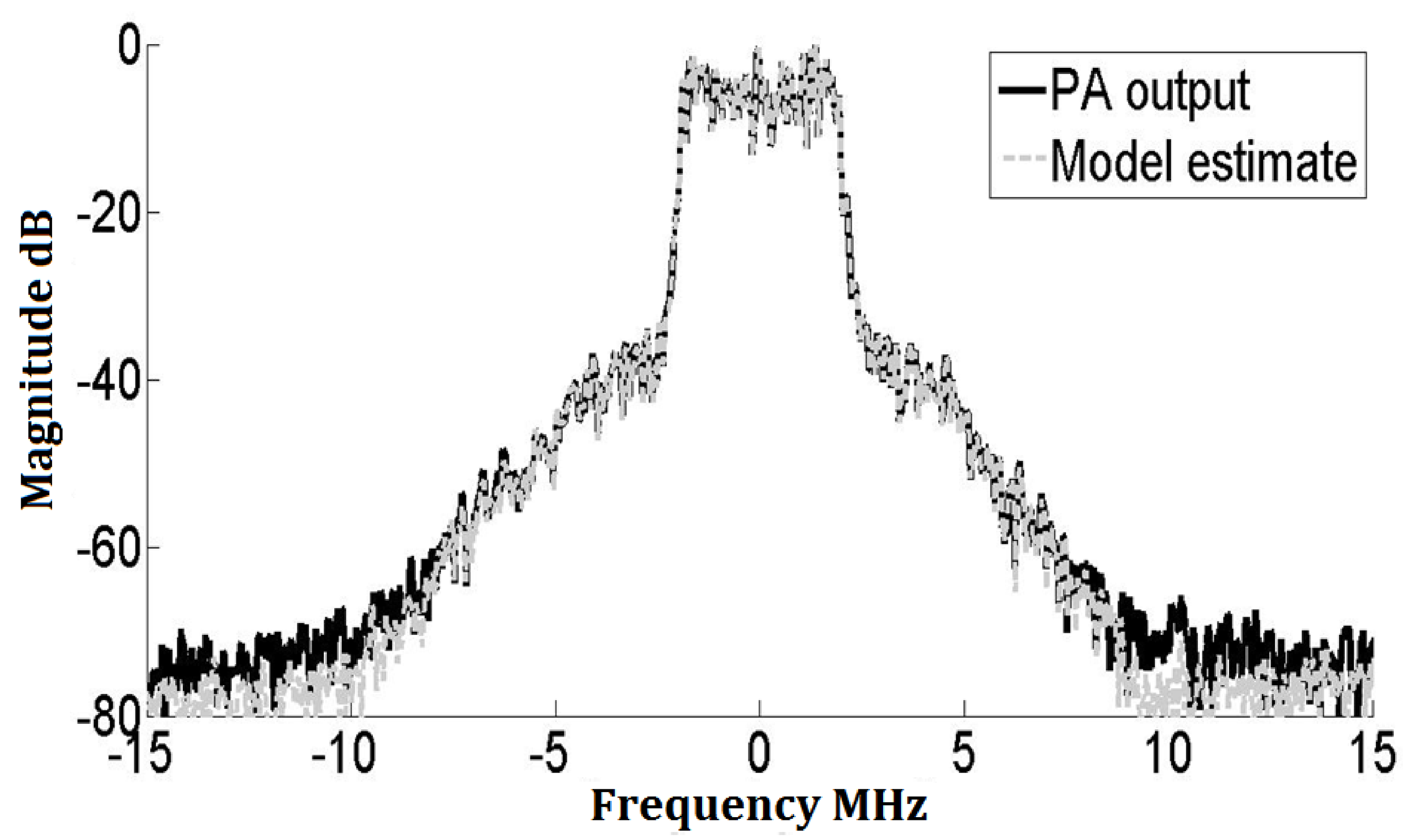

Fig 3. Comparison of performance in the frequency domain

CONCLUSIONS

Table 1 shows that a reduction in the number of weights greater than 70% could be achieved. This represents a significant reduction in computation load.

ACKNOWLEGMENTS

This project is funded by the HEA under PRTLI5 and is being co-funded by the Irish Government and the EU under Ireland's Structural Funds Programmes 2007-2013: Investing in your future. This material is based upon works supported by the Science Foundation Ireland under Grant No. 10/CE/I1853 as part of the Centre for Telecommunications Research (CTVR). The authors gratefully acknowledge this support.

Ireland's EU Structural Funds Programmes 2007 - 2013
Co-funded by the Irish Government and the European Union

EUROPEAN REGIONAL DEVELOPMENT FUND

An Roinn Fiontar, Trádála agus Nuálaíochta
Department of Enterprise, Trade and Innovation

HEA HIGHER EDUCATION AUTHORITY
AN tÚDARÁS um ARD-OIDEACHAS