Senior Design Project Proposal

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1. Project Title: FPGAsolve: FPGA based hardware accelerator for power systems solvers

2. Project Description:

Power systems analysis tools are based on algorithms that are computationally intensive, typically executed in software, on readily available computers. In order to speed-up such computations – and facilitate in this way near-real time power system analysis and optimization – one can use FPGA based hardware accelerators.

The goal of this project is to design and implement a hardware emulation system to accelerate the solution of power systems. This is a project in hardware/software co-design of numerical methods for the power flow solution of distribution systems. The project will involve the partitioning into software and hardware components of a standard Newton-Raphson method for solving systems of linear equations. These components will be developed in software using C/C++ or Matlab and in hardware using VHDL/Verilog and FPGAs. The hardware-accelerated solver can be used to design near-real time monitoring and analysis tools

3. Project Design Objectives:

The following are the main steps.

1. Partitioning of the power flow solution into components to be executed in hardware (FPGA board) and software (typical computer). This will be done based on an in-depth analysis of the numerical Newton-Raphson method for the power flow solution of a distribution system. The goal is to identify the components that represent runtime bottlenecks of a typical all-software implementation.

2. Components decided to be implemented in hardware will be designed and implemented using a hardware description language such as VHDL or Verilog. They will be synthesized and tested using an FPGA development board and associated CAD tools such as Xilinx ISE software package. Components decided to be implemented in software will developed using a programming language such as C/C++.

3. Once both the hardware and software components start working together, we will test the whole power analysis tool on real data.

4. Maintain a project website.

4. Project Prerequisites:

Some experience with programming in VHDL/Verilog and C/C++. Basics of numerical methods for solving systems of linear equations. Familiarity with digital design and FPGAs.

Most importantly, students should be self-motivated to learn new interdisciplinary approaches that bridge knowledge and skills from algorithms, numerical methods, hardware description languages and digital design, programmable logic devices (FPGAs), and programming in C/C++ and/or Matlab.