2. Custom Instructions for bit-operations in (heterogeneous) multicore systems -- Dr. Lesley Shannon

Background: Traditionally, processor architectures largely manipulate data using byte/word-length operations. However, as the desire to increase processing throughput while reducing power consumption grows, programmable custom computing platforms are increasingly desirable. Processors provide generically provide support for a set of operations that can be used to achieve any objective – but not efficiently. The ability to add custom instructions to a processors architectural pipeline and instruction set enables application-specific operations to perform more efficiently. Moreover, with the inclusion of proper compilation support, the compiler is able to detect the operations that appropriately map to these custom units from a programmer’s software, without the software designer specifically using them.

Objective: The goal of the project is to have a student design some custom instructions for bitwise operations. They will need to design a new execution unit for the hardware as as modify gcc to use these new instructions. This would provide our group and project expertise and a template for any future extensions we might wish to design for our multicore platform. The student would also gain experience and understanding as to how multicore and heterogeneous multicore processor architectures are designed and used to accelerate application execution.

Skills needed:
- Programming competency in either VHDL, Verilog, or SystemVerilog HDL;
- Keen understanding of hardware design and fundamental processor architecture.
- Competency with FPGAs and their CAD tools (either Xilinx or Altera- however Xilinx is preferable);
- High-level language programming skills (preferably C or C++);
- Competent to navigate large code bases.
- Strong Critical thinking skills required and the ability to work independently
- Completed ensc350 by time of start of coop (required)
- Designed a MicroBlaze/NIOS/ARM based SoC on an FPGA would be very helpful, but is not required.
- Experience with the Linux kernel and/or device driver design might also be an asset, but not required.

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