Customizable Domain-Specific Computing

**Project Goal:** This project looks beyond parallelization and focuses on domain-specific customization as the next disruptive technology to bring orders-of-magnitude power-performance efficiency improvement to important application domains.

**Chip-Level Customization**

**Accelerator-Rich Architectures (ARA)**

Now the full-system ARA simulator PARADE [ICCAD 15] is in open-source.

**Example 1:** Accelerating medical image processing [FCCM 14]

**Example 2**: Caffeine Cluster Acc Manager

**Server-Level Customization**

- **CT image reconstruction**
  - 2010: 18 hours
  - 2013: 20 minutes
  - 2015: 6 minutes

- **Denoising**
  - Single-thread CPU: 5 minutes
  - Single-thread GPU: 15 seconds

- **Registration**
  - Single-thread CPU: 10 minutes
  - Multi-thread CPU: 2 minutes

- **Segmentation**
  - Single-thread CPU: 20 minutes
  - Multi-thread CPU: 4 minutes

- **Analysis**
  - Single-thread CPU: 45 minutes
  - Multi-thread CPU: 18 minutes

**Experimental Platform - Convey**

**Data-Center Level Customization**

**Example: CDSC FPGA-Accelerated Cluster**

- **A 24-node cluster with FPGA-accelerators**
- **Scale-up FPGA-acceleration inside each node**
- **Scale-out: on an in-memory cluster**

**Milestone**

- Whole-genome genome pipeline in 4.6 hrs; whole exome pipeline in 28 mins

**Runtime Resource Management for Customizable Heterogeneous Datacenters**

**MapReduce**

**Spark**

**MPI**

**Mesos/Yarn**

**Cluster Acc Manager**

**Distributed File System (HDFS)**

**Node Acc Manager**

**Key Products/Outcomes**

- Over 350 publications, including multiple best-paper awards and a book on “customizable computing”
- A set of open-source software, including the CDSC mapper, PolyOpt, and CMOST compilation tools, and Blaze runtime system for customizable heterogeneous computing;
- Start-up Falcon Computing Solutions, Inc. which focuses on enabling customizable computing in datacenters.

**Outreach/Education**

- Engaged 28 high-school students for summer research with a highly diverse population, including 50% female, 28% African American, and 25% Latinos
- Refined and introduced multiple courses related to parallel and heterogeneous computing, such as “Customizable computing for big-data applications” (CSC239 at UCLA).

**CDSC website:** [http://cdsc.ucla.edu/](http://cdsc.ucla.edu/)