

EXECUTIVE SUMMARY

PROJECT NAME: F1-10, Comprehensive Framework for Application Development Productivity

INVESTIGATOR(S): Dr. Alan George, Dr. Herman Lam, & Dr. Greg Stitt, UF site of CHREC

PROJECT DESCRIPTION:

This project focuses upon refining and integrating existing formulation and design tools from vendors and previous CHREC research to provide a comprehensive, high-productivity tool-flow for RC application development. The tool-flow will be supported on CHREC's Novo-G supercomputer and demonstrated via several application case studies.

The first part of this project will identify and investigate methods necessary for integrating existing development tools to form a comprehensive, end-to-end tool-flow. Existing productivity tools developed as part of previous CHREC research projects, such as RCML, RAT, CMD, SCF, SHMEM+, ReCAP, etc., assist developers during various stages of application development, but lack integration as part of a larger development framework. The new components will be designed to efficiently integrate existing CHREC productivity tools in order to provide a smoother, tool-assisted transition between different phases of application development. Research in this project will also investigate and enhance these tools where necessary, incorporating support for selected vendor tools, to provide an end-to-end development tool chain. The tool chain will include several design-entry points to allow the use of Novo-G as an HPC and HPEC platform.

The second part of this project focuses on showcasing the capabilities of the comprehensive tool chain through selected multi-FPGA application case studies. The applications will be selected from diverse application domains of HPC and HPEC such as bioinformatics (e.g. sequence alignment and analysis), aerospace (e.g. signal and image processing), cryptology, etc. These case studies will be used to evaluate strengths and weaknesses of the comprehensive tool chain when used from varying design-entry points. Feedback will be employed to further refine our comprehensive framework.

EXPERIMENTAL PLAN

In the first part of this project, we will identify and investigate techniques needed to link and integrate the existing development tools in this project's comprehensive end-to-end tool chain. For the missing links identified, a solution to facilitate the transition between existing tools will be proposed and evaluated. In particular, we plan to research and develop methods to provide an automated transition from the formulation phase to design phase of development by bridging the RCML/CMD formulation tools from CHREC to novel design tools from CHREC such as SCF, SHMEM+ as well as selected RC-vendor tools. The comprehensive tool chain and its components will be targeted for and evaluated upon our Novo-G reconfigurable computing boards and supercomputing system. We will also refine and enhance the capabilities of existing individual tools wherever necessary to aid the process of integration and improve overall productivity.

In the second part of the project, we will survey and select application case studies, in consultation with CHREC members, to illustrate the capabilities of Novo-G and exemplify our comprehensive tool chain. Current Novo-G research demonstrates significant speedups with protein and DNA sequence alignment applications (e.g., Smith-Waterman and Needleman-Wunsch) and other bioinformatics applications are of potential interest to CHREC sponsors. Additional application domains such as image and signal processing and cryptology for the aerospace and defense community are also desirable. These case studies will be used to compare and contrast the strengths and productivity improvements by employing different design-entry points available in the tool. The goal is to present a structured methodology for application design which can be applied for developing solutions to other applications.

HOW THIS PROJECT IS DIFFERENT:

Existing productivity tools developed as part of previous CHREC projects address challenges in individual phases of application design, but lack any focus on integration within a larger tool-flow for a cohesive development process. Rather than addressing issues in productivity at individual phases of application development, this project attempts to create a prototype of an integrated framework which leverages the research performed by previous CHREC projects and provides end-to-end support for application developers. Additionally, several multi-FPGA application solutions will be demonstrated on the new Novo-G supercomputer to illustrate the structured methodology for application design.

POTENTIAL MEMBER COMPANY BENEFITS:

- Direct influence over the application case studies and vendor-tools supported in our comprehensive framework
- Key insights, tradeoff analyses and lessons learned from application case studies
- Structured methodology for application-design for developing other applications

EXPECTED DELIVERABLES:

- Prototype of end-to-end tool-flow framework, results and lessons learned from application case studies
- Source code for multiple application case studies
- Several scholarly conference or journal publications

PROJECT BUDGET: 4.5 memberships