

EXECUTIVE SUMMARY

PROJECT NAME: F5-09: RC Device Architecture Exploration

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PROJECT DESCRIPTION: The goal of this project is to develop a fundamental research foundation to explore Reconfigurable Computing (RC) devices and their relationships to applications. The primary motivation for this work is to gain insight on device suitability for a variety of application requirements. New research will define application metrics that relate to device characterization to establish a mapping between the device and application domains. Developing the mapping between the device and application domains will enable application performance prediction on existing and notional devices without requiring the implementation of test code on the target platform. Additionally, previous device characterizations at CHREC focusing upon computational performance, power consumption, and memory limitations will be extended to new architectures including the Achronix Speedster, PACT XPP, and DSP devices. Application and kernel benchmarks will also be developed and evaluated on several devices to provide a concrete device comparison and validation of performance projections.

EXPERIMENTAL PLAN: This project has three major tasks: device characterizations, application benchmarking, and application metrics. The device characterization task will leverage techniques from previous F5 research to perform an in-depth architectural analysis of emerging RC technologies by applying the computational density (CD), computational density per Watt (CDW), and internal memory bandwidth (IMB) metrics defined in our prior publications to new devices. The CD and CDW metrics will be further refined and an external memory bandwidth metric will be created with the goal of characterizing a devices ability to access memory that is off the chip.

Several applications will be investigated as case studies both to shed insight on the application characterization and the device mapping. Hyperspectral Imaging and Sum of Absolute Differences algorithms will be studied in the context of the TILE64 computing platform, with at least one additional application benchmark to be completed by year-end. These case studies will be used to observe the characterizations ability to represent and predict a devices strengths and weaknesses. Kernel benchmarks will be ported to new devices to provide more insight into novel RC architectures as well as currently available commercial alternatives.

Several metrics to describe algorithm parallelism and memory requirements will also be studied. Application parallelism and memory demand can then be mapped to device parallelism capability and memory bandwidth to project application performance on various existing and notional devices. Insights gained in the device characterization task will be used for a notional redesign of existing architectures.

HOW THIS PROJECT IS DIFFERENT

This project differs from previous work by expanding beyond device characteristics to explore application characteristics and the relationships between application metrics and device metrics especially with reference to power. This project will focus on analyzing the ideal mix of device characteristics needed to maximize application performance. Insights gained during device analysis allow for the proposal of notional architecture improvements and the application to device mapping work provides a framework to examine the impact of these improvements. This project emphasizes the growing importance of power in device studies. The device metrics account for power consumed to help reveal devices that are power efficient.

POTENTIAL MEMBER COMPANY BENEFITS: Member companies will be able to benefit from each of the tasks in different ways. From Task 1, members will be able to see comparisons of new RC technologies in a fair and level arena based upon the device metrics developed. Additionally, from Task 2 member companies will have access to benchmark results actually implemented on hardware and code examples for benchmark applications on select platforms. From Task 3, member companies can see how applications can be characterized in order to allow for comparison to device features and characteristics. These three points will work together to aid member companies in making strategic research and development decisions allowing for more time and research efficiency.

EXPECTED DELIVERABLES

- Midterm and final reports documenting research methods, progress, results, and analysis of each task
- Application/device projection model; characterizations of new devices; large-scale benchmark applications
- Several scholarly conference and/or journal publications

PROJECT BUDGET

- Funding for this project is 3.5 memberships.