Maven: A Manycore Vector-Thread Processor

Yunsup Lee, Christopher Batten, Krste Asanović
Parallel Computing Laboratory
University of California, Berkeley

1 Motivation

Future manycore processors will be energy-constrained, and thus the primary metric for evaluating these architectures will be energy-efficiency. In this work, we investigate new architectural and microarchitectural mechanisms which enable a wider array of applications to be mapped to energy-efficient vector units.

2 VT Architecture Paradigm

Vector-threading (VT) is a new abstraction for programmers in which a control processor (CP) manages a vector of virtual processors (VPs). The control processor can use vector-fetch commands to broadcast instructions to all VPs, or each VP can use VP control instructions to direct its own control flow. Vector memory commands move blocks of data in and out of VP registers, while VP loads and stores enable less structured data-access patterns.

3 The Maven VT Processor

The Maven VT processor is a manycore vector-thread architecture which uses a "sea-of-lanes" approach with tens to hundreds of single-lane vector-thread units tiled across the chip. Each lane is highly tuned to exploit data-level parallelism temporally, and lanes can be "ganged" together to exploit some degree of data-level parallelism spatially.

4 Energy-Efficiency for Various Kinds of Kernels

The left graph shows the flexibility of vector-thread, vector, and multithreaded architectures. It also maps kernels on the energy-performance graph as well. As we don't have an energy model for Maven yet, we present the actual measured energy-efficiency on the Scale VT Processor. The Scale VT Processor is an instantiation of the vector-threading architectural paradigm designed for low-power and high-performance embedded systems. The logical virtual processor vector is striped across an array of physical vector lanes, so that each lane is responsible for managing the state and execution of multiple virtual processors.

5 Executing Kernels on Maven

We picked three kernels (FFT, Dither, and IP Lookup) and show how they execute on Maven. The FFT kernel is straightforward to vectorize. The IP lookup kernel seems easier to map it to a multithreaded architecture. The image dithering kernel is somewhat in the middle. Maven provides an easy programming model for these three kernels, and can run them energy-efficiently.

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